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Commentary

'RADIO Research 1959' has recently been published* and is the annual report of the Board and the Director of the Radio Research Station of the Department of Scientific and Industrial Research. The year under review was, in many respects, a noteworthy one for the Radio Research Station. With the termination of the International Geophysical year at 31 December 1958 the detailed study and analysis of the observational material obtained was started in earnest; particular attention being given to the material brought back from the Royal Society's base at Halley Bay, Antarctica. Observational work on transmissions from artificial earth satellites was vigourously pursued and arrangements were made for the staff of the Research Station to participate in a greatly extended programme of space research. In addition the study of radio wave propagation by way of both the troposphere and ionosphere was continued with the aid of new equipment developed for the purpose: notably, an airborne radio refractometer and a fixed radar equipment for the troposphere, and a wideband sweep equipment for studying ionospheric propagation over long distances. A great deal of 'routine' research was also carried out during the year including work on the technique and precision of radio measurements at ultra high frequencies and on this subject useful co-operative measurements have been made on an international basis.

The Report is also noteworthy in another respect: it is the last that will be presented by Dr. R. L. Smith-Rose who retired in October of this year and has been succeeded as Director by Mr. J. A. Ratcliffe. It is with pleasure that we pay tribute to Dr. Smith-Rose and the magnificent work which the Radio Research Station has carried out under his direction and we wish every success to Mr. Ratcliffe, the incoming Director.

Although the analysis and correlation of the I.G.Y. data and the other work carried out by the Research Station is of great interest and assistance to our understanding of wave propagation and the future planning of communications systems, the most intriguing part of the Report is that which deals with space research; both the work which has already been carried out and the increasing emphasis which is to be placed on this section of the Station's research in the future.

In the year under review the main items in the space programme of the Research Station have been the determination of the position of satellites by radio and optical observations; the prediction of future positions and the calculation of precise orbital information: and the measurement of the characteristics, such as the Doppler and Faraday effects, of the received signals. The World Data Centre for Rockets and Satellites which was established at Slough in October 1958 is also in operation and is fulfilling its intended purpose of collecting data on space research and exchanging it with the two other centres in Washington and Moscow: the flow of data is, however, still relatively small and consists mainly of satellite positional observations.

About the future importance of the space research programme the Radio Research Board, under the chairmanship of Mr. O. W. Humphreys, is quite emphatic. They are convinced of the importance of space research and point out that rockets and satellites offer new ways of pursuing and extending the fields of research in which the Station has largely specialized in the past: not only can observation of the characteristics of radio waves provide valuable information about wave propagation and the earth's atmosphere, notably the ionosphere but, even more important, instruments carried by rockets and satellites enable direct measurements to be made of the physical properties concerned. As an example, ionization density can be measured 'on site', while the electromagnetic and particle radiation which produces the ionization can be examined directly. The Research Board go on to state that the Station should collaborate to the fullest possible extent in the space programme, both by assisting in the reception and analysis of the data transmitted from satellites and also by designing experiments for flying in the British-instrumented satellites which are to be launched from American rockets in accordance with the arrangements which have already been announced. In furtherance of these objectives the proportion of the Research Station's effort which is devoted to space research will be increased to fifty per cent in the immediate future.

There may be considerable doubt and argument as to whether the greatest return, for the effort expended, can be obtained by launching a man into space or by confining oneself to the launching of instruments. There can, however, be no doubt at all about the effectiveness of the rocket and satellite, in one form or another, as an instrument of research. It provides the most potent means yet devised for gathering information concerning the earth's atmosphere and the conditions in outer space—information which can play a vital role in the design of present-day communications systems for the maximum efficiency, and which may well lead to new and exciting systems of communication in the future.

* *Radio Research 1959. Published for the Department of Scientific and Industrial Research by Her Majesty's Stationery Office.*

An Electronic Combination Lock

By K. A. Steele*

A description is given of a binary electronic combination lock which uses a pair of Dekatron glow transfer tubes as stepping switches. Some aspects of probability theory concerning binary combinations are discussed. A test performed on the combination with a random binary source gave results in agreement with the theory.

(Voir page 732 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 737)

AN electronic selector operated by a binary sequence may be used to advantage as the combination for a lock. One advantage arises from the simplicity of the encoder, which may be a two-position switch. This is useful in cases where the lock must be operated frequently and quickly. For example, it may be necessary for a large group of people to have relatively easy access to an area which must otherwise be closed to the public for safety reasons. Another advantage results from the ease of adapting to remote control. It is well suited, for example, to the control of several locks from one location.

The electronic selector consists basically of two stepping switches. The selector is operated by first advancing one stepping switch a certain number of positions, then advancing the second switch in similar fashion (though not necessarily by the same number as the first), and finally advancing the first switch a further number of positions. When both switches have been advanced by the correct amount, the proper relation exists to cause the output circuit to operate. After a short time delay the switches are reset automatically to their normal starting positions. It is essential that each stepping switch be advanced a particular number of positions and that changes from advancing one switch to advancing the other occur at particular steps in the sequence and in the correct order. Circuits are provided which usually cause the stepping switches to reset to their normal starting positions if the correct sequence is not used. In certain circumstances a departure from the correct sequence does not cause a reset. This characteristic of the selector will be discussed later.

In the following discussion it will be assumed that the encoder which causes the stepping switches to operate is a two-position switch with spring return to centre off. Movement of the switch lever up generates an 'up' trial and advances one stepping switch forward by one position while moving it down generates a 'down' trial which advances the second stepping switch by one position. A combination consists of a sequence of trials of 'up' and 'down' polarities arranged in three groups and a successful combination is one which causes the output circuit of the electronic selector to operate. It is necessary to begin a combination with the selector reset to its normal starting condition. If it is not reset (as may occur if part of a correct sequence has been left on the selector), a sequence must be used which will ensure this condition before beginning the combination sequence itself.

The ease with which a successful combination may be discovered either by accident or by design, is of interest. The probability of obtaining a successful combination in a random sequence of trials will be considered. This can be done fairly simply by considering the probability in three stages:

(1) The probability, p_1, of a successful sequence assuming that the selector is in its reset condition prior to the commencement of the sequence.

(2) The probability, p_2, that the selector is reset after any trial assuming that all incorrect trials and the last trial of a successful sequence cause a reset.

(3) The probability, p_3, that an incorrect trial does cause a reset. This must be included because the selector does not reset when an incorrect trial occurs at a polarity change in the correct combination. The selector was designed to operate in this manner because it results in a simpler circuit.

The probability that the correct sequence occurs and causes the output circuit of the selector to operate is the compound probability:

$$p_1 \; p_2 \; p_3$$

The probability, p_1, depends only on the length of the sequence and is equal to $1/2^r$ where r is the length of the combination sequence. It is simply the probability of the correct combination occurring in r random trials and it will be successful provided the selector is initially in its reset condition. This is a well-known result of probability theory for repeated independent trials which can have only two equi-probable outcomes.

The probability, p_2, that the selector is reset at any particular trial is given by

$p_2 =$ probability of an incorrect trial + probability of a successful sequence.

The probability of an incorrect trial is $\frac{1}{2}$ in a random sequence and the probability of a successful sequence is $p_1 p_2$. Therefore,

$$p_2 = \tfrac{1}{2} + p_2 \; (1/2^r)$$

$$\text{or } p_2 = \frac{2^r}{2^{r+1} - 2}$$

The probability, p_3, that an incorrect trial causes a reset is less than one because an incorrect trial at a change of polarity in the sequence does not cause the selector to reset. The selector, as described, operates on a three group combination which means there are two changes of polarity in a correct sequence. Trials at which the first and second polarity changes occur will be denoted by n_1 and n_2 respectively. No reset will occur at these trials if they are incorrect or at subsequent trials of the same polarity. A following trial of opposite polarity is necessary to cause a reset. Thus, sequences of trials are possible which do not cause a reset and have zero probability of being successful. This has the effect of making it more difficult to determine the correct combination by chance without increasing the number of trials in a combination. Typical trial sequences, including some with incorrect trials with no reset, are shown in Table 1 for a combination 3 up, 4 down, 3 up.

It is possibly easiest to determine the probability, p_3, by first calculating the probability of an incorrect trial

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not causing a reset. Trial n_1, if incorrect, does not cause a reset. The probability of this happening is $1/2^{n_1}$. The n_1+1, n_1+2, etc., trials will also be incorrect with no reset if they follow and have the same polarity as an incorrect n_1 trial. These trials have probabilities of $1/2^{n_1+1}$, $1/2^{n_1+2}$, etc. A second set of incorrect trials with no reset is possible commencing with the n_2 trial and have probabilities of $1/2^{n_2}$, $1/2^{n_2+1}$, $1/2^{n_2+1}$, etc. Thus, the total probability of an incorrect trial with no reset is:

$$1/2^{n_1} + (1/2^{n_1+1}) + (1/2^{n_1+2}) + \ldots\ldots + 1/2^{n_2} + (1/2^{n_2+1}) + (1/2^{n_2+2}) + \ldots\ldots = 1/2^{n_1-1} + (1/2^{n_2-1})$$

Since the total probability of an incorrect trial with or without reset is 1, then the probability of an incorrect trial with reset is:

$$p_3 = 1 - (1/2^{n_1-1} + 1/2^{n_2-1})$$

Now the compound probability may be found since p_1, p_2, and p_3 are known:

$$p_1p_2p_3 = (1/2^r)\,(2^r/(2^{r+1}-2))\,(1 - (1/2^{n_1-1}) - (1/2^{n_2-1}))$$

$$= \frac{2^{n_1-1}\,2^{n_2-1} - 2^{n_1-1} - 2^{n_2-1}}{(2^{r+1}-2)\,(2^{n_1-1}\,2^{n_2-1})}$$

The example combination used in Table 1 is a 3 up, 4 down, 3 up sequence. The length of the sequence, r, is 10,

TABLE 1

TRIALS* 1 2 3 4 5 6 7 8 9 10 11 12	INCORRECT TRIALS WITH NO RESET	EXPLANATION
U U U D D D D U U U	0	Correct combination.
U U D	0	Wrong with reset at Trial 3.
U U U U D	1	Wrong and no reset at Trial 4. Reset at Trial 5.
U U U U U U U D	4	Wrong and no reset at Trial 4. No reset at Trials 5, 6, 7. Reset at Trial 8.
U U U D D U	0	Wrong with reset at Trial 6.
U U U D D D D D U	1	Wrong and no reset at Trial 8. Reset at Trial 9.
U U U D D D D D D D D U	4	Wrong and no reset at Trial 8 and at Trials 9 to 11. No success at Trial 10. Reset at Trial 12.

* *The first trial is made from a reset state.*

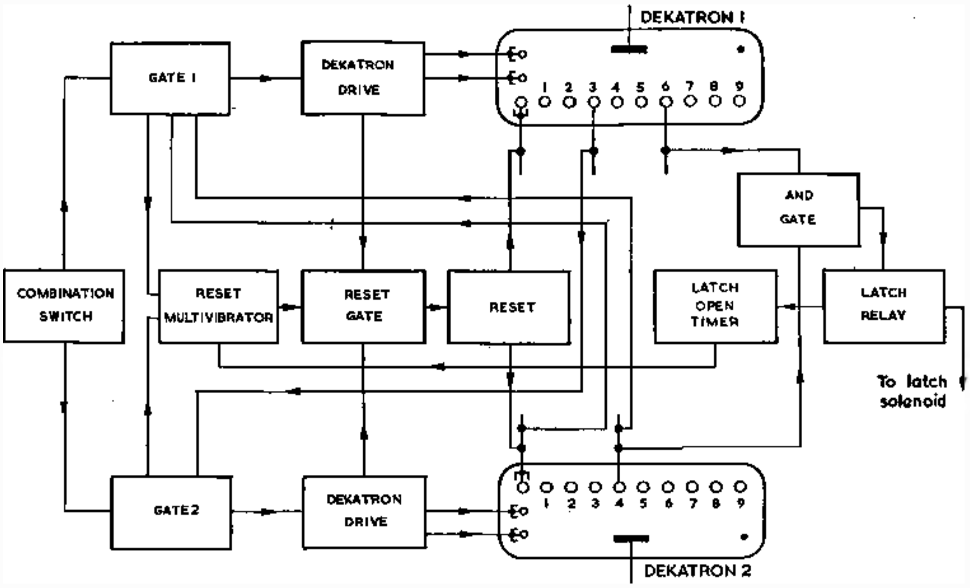


Fig. 1. Electronic selector for combination lock

n_1 is 4, and n_2 is 8. Substituting these values in the above equation gives a probability of 1 in 2 359. That is, the correct combination will cause the output circuit of the selector to operate once in 2 359 trials of a random sequence on the average.

The effect of the position of the polarity changes in a combination may be illustrated by calculating the probability of a 1, 1, 8 combination. The probabilities p_1 and p_2 remain the same as for the 3, 4, 3 combination since they depend only on the length of the combination. The probability, p_3, however, is greatly reduced because the polarity changes are closer to the beginning of the combination. The probability of success in this case is 1 in 8184.

The equation for the compound probability, $p_1p_2p_3$, may be extended to include combinations with more than two polarity changes quite easily. For each additional polarity change another term on the form $1/2^{n-1}$ must be added in the expression for p_3.

The theory outlined above has been tested experimentally by operating the electronic combination lock on a two-channel random binary pulse source. Part of the output circuit was removed so that a continuous count of successes could be made. Table 2 gives the results of the tests on a 3, 4, 3 combination:

TABLE 2

INPUT RATE	TOTAL INPUT PULSES	NUMBER OF SUCCESSES	MEAN RECURRENCE OF SUCCESSES
100 p/s	3 092 665	1 340	2 308
1 kp/s	5 989 369	2 570	2 330

The calculated result is a mean recurrence rate of 1 success in 2 359 trials. The experimental figures are within the standard deviation of a random count. For 1 340 success counts the standard deviation of the recurrence rate is 63 and for 2 570 success counts it is 46. It, therefore, seems likely that the basis for calculating the probability of a successful combination is correct.

Finding a correct combination by chance may be made more difficult if all resets, except the one after a successful sequence, are forced to some position other than the normal reference. This has the effect of adding an extra group of trials to the combination, but this group need

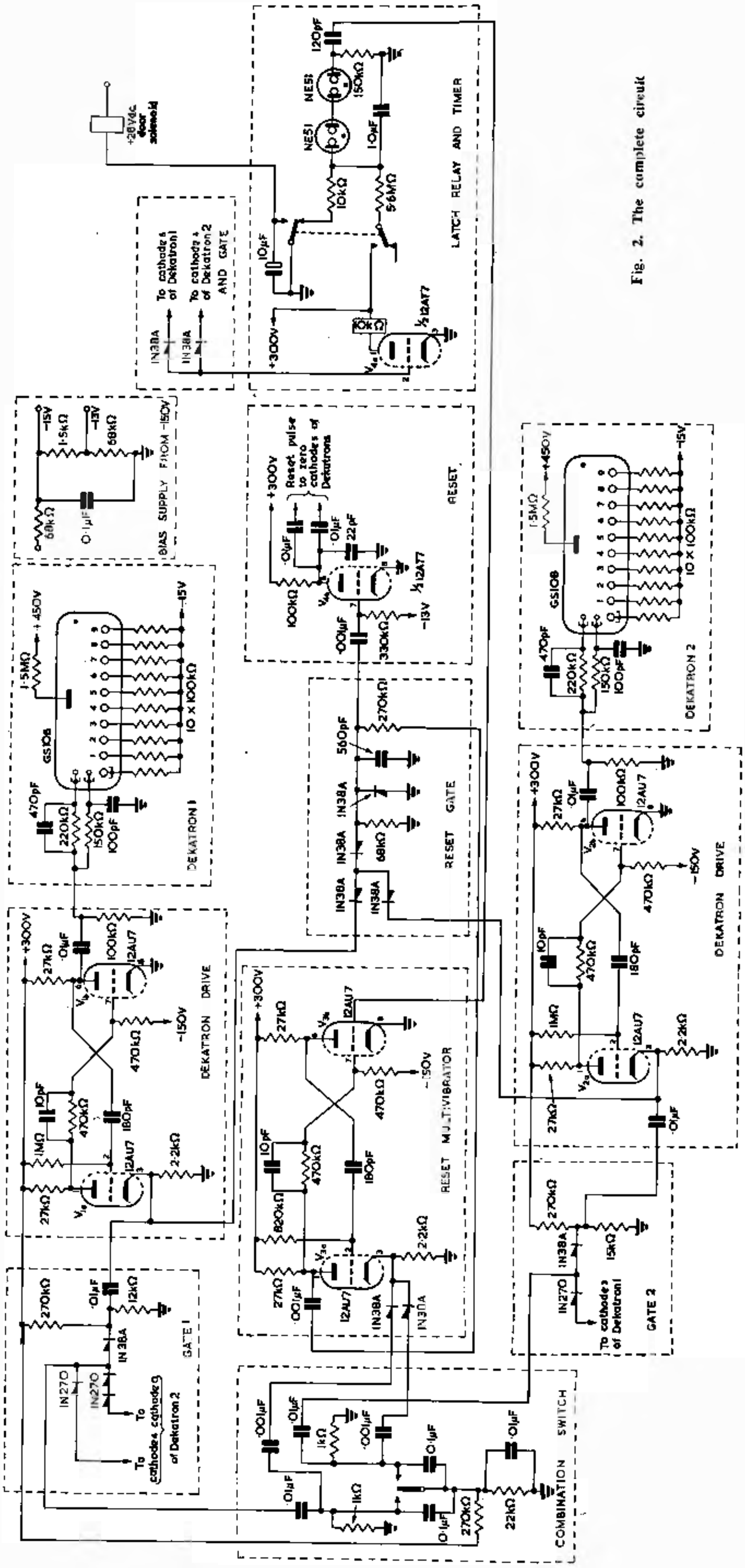


Fig. 2. The complete circuit

only be used when a mistake has been made. In any case, it is generally necessary to know a sequence which will ensure bringing the selector to the correct reference position before starting a combination.

Circuit Description

The electronic selector uses two Dekatron counter tubes, as stepping switches. Closing the combination switch in one direction causes the discharge of one Dekatron to advance one cathode, while closing the switch in the opposite direction steps the other Dekatron one count forward. After the proper sequence of counts in each Dekatron an AND gate operates and causes a relay to be energized for control of an external circuit. The selector is used with a power solenoid to operate the latch on a door. Several gates are used in the circuit to ensure that only one simple sequence of combination operations will 'open' the lock.

Operation of the unit will be described with reference to the block diagram shown in Fig. 1 The complete circuit, except for power supply, is shown on Fig. 2. The Dekatrons are shown connected for the combination sequence: three up, four down, three up on both of these diagrams.

The pulse generated at the combination switch must pass through a diode gate to trigger the multivibrator drive to a Dekatron and so advance the count. The gates ((1) and (2) on Fig. 1) are cross-connected to Dekatron cathodes for enabling bias. For example, gate No. 1 is open to allow a count on Dekatron 1 if the glow in Dekatron 2 is on either cathode 0 or 4. Similarly a pulse will not pass gate 2 to count on Dekatron 2 unless the glow in Dekatron 1 is on the third cathode. If this was the complete circuit there would still be a large number of ways in which the encoder switch could be operated to obtain the correct combination (as illustrated, cathode 6 of Dekatron 1 and cathode 4 of Dekatron 2 conducting the glow discharge). To avoid this, a reset circuit is used which resets the glow in both Dekatrons to the zero cathodes each time a mistake has been made.

The reset multivibrator is triggered on every switch closure either up or down. Its output pulse passes through the reset gate to an amplifier which drives the zero cathodes of both Dekatrons highly negative and forces the glow to these electrodes. The reset gate is connected to the outputs of both Dekatron drive multivibrators. If a pulse from the combination switch passes gate 1 or gate 2 to trigger a Dekatron drive multivibrator, the reset gate will be 'closed' to the pulse from the reset multivibrator. This corresponds to a correct combination pulse and no reset takes place. If an input pulse cannot pass gate 1 or 2 to trigger a Dekatron drive, the reset pulse passes through its gate and drives the reset amplifier to bring the glow in both Dekatrons to the zero cathodes.

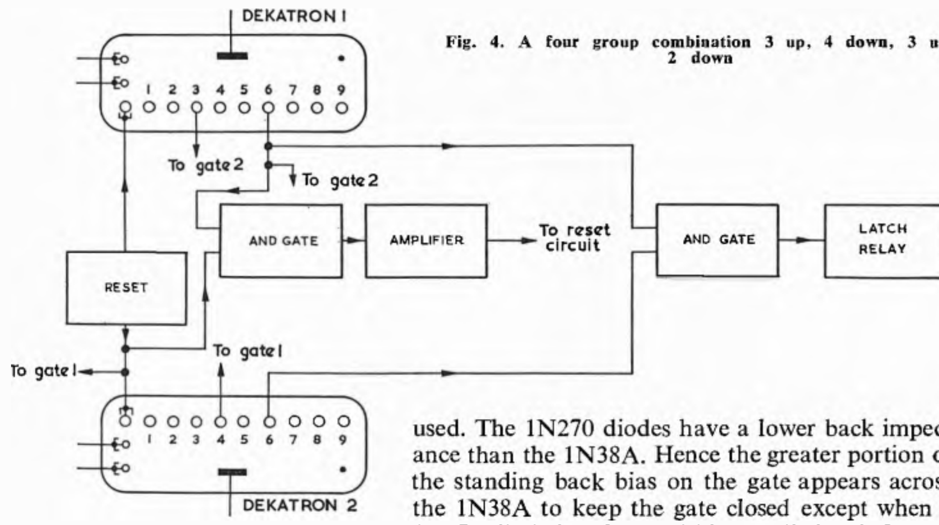


Fig. 4. A four group combination 3 up, 4 down, 3 up, 2 down

As discussed earlier, cases do arise in which an incorrect input pulse will not cause a reset. For the connexions illustrated in Figs. 1 and 2, any number of 'up' trials may be made without causing a reset provided the glow in Dekatron 2 is on cathode 0 or 4. This is also true for 'down' trials provided the glow in Dekatron 1 is on cathode 3. These cases of no reset with an incorrect trial serve to make the combination more difficult but do not allow a different combination to open the lock except by a much more difficult sequence. For example, the combination illustrated is 3 up, 4 down, 3 up; but 13 up, 4 down, 3 up or 3 up, 14 down, 3 up are also correct combinations.

When the glow in each Dekatron rests on the correct pair of cathodes an AND gate is operated and the output latch relay closes. This relay may be used to control any desired electromechanical device, and in the particular case of the door lock, the relay completes the circuit to a power solenoid connected to the door latch.

The latch open timer generates a delayed pulse to trigger the reset multibrator and reset the glow in the Dekatrons to the zero cathodes after a delay of about five seconds. The voltage applied to a pair of NE-51 indicator lamps in series rises slowly through a long time-constant *RC* network until the NE-51's fire and thus generate the trigger for the reset multivibrator. A five second delay provides sufficient time to open the door after the latch solenoid has been energized.

The component circuits of the unit should require no additional description except perhaps the gates 1 and 2. It will be noted from Fig. 2 that two different diodes are used. The 1N270 diodes have a lower back impedance than the 1N38A. Hence the greater portion of the standing back bias on the gate appears across the 1N38A to keep the gate closed except when a 1N270 diode has forward bias applied to it from a Dekatron cathode. Two 1N270 diodes in series from gate 1 to the zero cathode of Dekatron 2 are necessary because the minimum reverse rating of a single diode is lower than the negative resetting voltage applied to the zero cathodes of the Dekatrons.

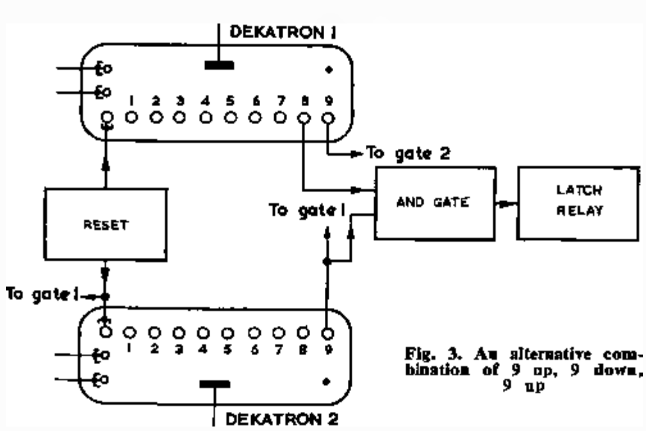


Fig. 3. An alternative combination of 9 up, 9 down, 9 up

Combination changes may be made quite easily by changing the connexions to the Dekatron cathodes. The connexions for a longer combination are shown in Fig. 3. This is a 9 up, 9 down, 9 up combination which requires a success run of 27. For this case the mean recurrence rate is once in over 268 000 000. If the combination switch was operated randomly once per second, the correct combination would occur once in 8½ years on the average. This is of the same order as a four digit mechanical dial combination with 100 numerals per dial. If it is desired to make the selector highly tamper-proof without making the combination sequence very long, timing or error counting devices which can cause lock-out may be included in the unit.

While the selector shown on Fig. 2 operates with a three group combination, simple additions to the circuit may adapt it to a four or more group combination. Fig. 4 indicates the Dekatron connexions for a four group combination: 3 up, 4 down, 3 up, 2 down. The output AND gate is operated by the No. 6 cathodes of both Dekatrons. In addition an AND gate must be provided to cause a reset to zero if cathode No. 6 of Dekatron 1 and cathode 0 of Dekatron 2 are conducting simultaneously. This is necessary to avoid the possibility of a 6 up, 6 down code being used successfully.

Simplification of the circuit could likely be made by using cold-cathode trigger tubes in place of the multivibrators. This would reduce power supply requirements and the operating speed would still be much faster than necessary. Manual switching is not likely to exceed a rate of 5 per second while a circuit using trigger tubes should be capable of responding to at least several hundred input pulses per second.

The selector will operate satisfactorily on supply voltages within ±10 per cent for the +300V and −150V supplies. The 450V supply for the Dekatrons should be held to within ±15V.

Acknowledgment

The author wishes to thank Messrs. J. H. Craven, W. L. Haney and A. Staniforth for their advice and encouragement and also Mr. M. Beghetto who did the construction and testing.

A Histogramming Counter for Magnetic Tape Data

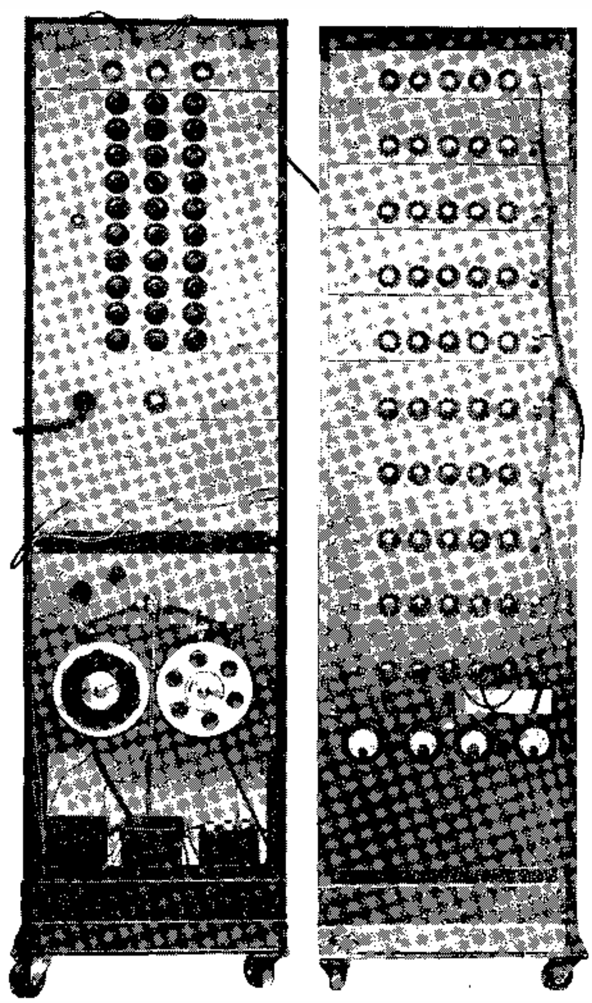
By Peter Dawe*, M.A., M.Sc.

The use of magnetic tape instead of paper tape for recording results in the type of experiment involving a frequency distribution can offer advantages in regard to the measurement and sorting of the data recorded. A system is described that employs electronic circuits for automatically measuring and sorting the recorded data in an experiment which requires the results in a statistical form. The circuits employ transistors, valves, and Dekatron selector tubes, and it is shown how the pulses may be recorded on, and reproduced from, a multi-channel magnetic tape, in a manner comparable in simplicity with the ink marking of a paper tape.

(Voir page 732 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 737)

MARKS in the form of pulses stored on magnetic tape can nowadays offer a convenient alternative method for recording the results of certain experiments when compared, for example, with the use of ink marks made on a belt of moving paper. In particular, for some psychological experiments connected with investigating reaction times, the need to make and sort ruler measurements of the separation between two or more ink marks on paper, representing, say, a stimulus and response, can be replaced, with magnetic tape recording, by an automatic measuring and sorting device in the form of a Dekatron counter, made to count pulses from a magnetic tape 'ruler' track, gated in and out of the counter by the stimulus and response pulses, recorded on another track, or tracks.

A time interval can then be measured by counting a batch of pulses, and this can be histogrammed, according to its magnitude, by deriving further pulses from applying the first batch across a set (say, ten) of coincidence circuits set to the numbers desired as the abscissae for the histogram. The pulse output from these is an active measure of the size of the time interval, and it can be used to drive a selector tube to gate, and so enable a count to be registered on any one of a set of (the same number, ten) ordinate counters. Successive time intervals of different magnitude will therefore register counts on different ordinate counters depending on the numbers set up on the ten or more coincidence circuits, and, of course, on the magnitude of the time interval recorded on the tape. The final histogram may have any number or spacing of ordinates, the magnetic tape being replayed for each set of ordinates required. Also, for a ½in magnetic tape, there will be seven channels available (one channel being used for the 'ruler' track) for the recording of a sequence of events, the time relations between any pair of which can be histogrammed separately for each replay of the tape. The counter is of general application, in that any magnitude which may be converted into, or represented by, the spacing of a pair of pulses on a tape, e.g. a velocity or a pulse amplitude, may be sorted into a histogram on replaying the tape. It is intended that all the tracks should be recorded simultaneously with the 'ruler', so that variations in tape speed, either during recording or playback, will not affect the accuracy of the count. The mechanical engineering of the tape deck need not, therefore, be of a high precision, and it is envisaged that a simple portable deck would suffice to record the results of particular experiments.



The histogramming counter, ordinate counters and power supplies

An instrument having a similar, although somewhat more specific and exacting purpose is the pulse-height analyser[1] or discriminator used in nuclear physics research. This employs a different principle of operation, with a delay line, memory circuits and c.r.t. display, and it is designed to sort out incoming pulse amplitudes, by a technique of random sampling, at an average rate of 1 250p/s.

The Dekatron Counter

In the Dekatron instrument here described, the main counter for the pulses from the 'ruler' track is a three

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tube high speed counter (for three significant figure measurements), using GS10D Dekatron selector tubes. The pulses from the track are gated into it through a 6F33 short suppressor grid base pentode, the bias for this grid being derived from the collector circuit of a grounded base bistable pair[2] of OC70 transistors, and these are triggered directly from one state to the other by the amplified 'stimulus' and 'response' pulses reproduced from the tape. Provision is also made for this bistable circuit to be triggered manually in order that the gate may always be closed before replay commences, or opened if it is desired to check the counting of the ruler track. The counter is capable of counting 20 000p/s from the 'ruler' and therefore the tape can be replayed at a high speed. For example, with a 'ruler' of about 200p/in of tape, the maximum playback speed would be 100in/sec, and the minimum recording speed would be 5in/sec in order to accommodate a 1 000p/s signal on the track at a pulse spacing of 200 to the inch. A typical reaction time experiment may take an hour to perform and record, but the result can then be histogrammed in less than five minutes.

For the purpose of histogramming the results, the cathodes of each Dekatron selector tube are each wired to the ten wafer contacts on one of a set of three (× ten, in parallel) rotary switches, the wiper contacts of each group of three being joined to one of ten coincidence gates. These circuits are similar to those used in a batching counter[3], although in this case the output from the coincidence gates feeds into a common line. It consists of a number of pulses, between one and ten, depending on the magnitude of the count reached on the high-speed counter. This group of pulses is made to operate a (12-way) Dekatron selector tube (actually having eleven possible outputs since one cathode, '0', is used as the resetting position), the voltages from the cathodes of which are directly used to gate open, in turn, the ten ordinate counters, and so enable a count to be registered on them. These counters also utilize Dekatron selector tubes and are capable of storing up to a 4-digit number for which an electrical output can be obtained, if required, for the purpose of further computation. Simpler mechanical units could, however, be used for the ordinate counters, if required, the inputs being again gated through a pentode or other suitable device. All the selector tubes, except, of course, those in the ordinate counters, are reset to zero after a count is registered. Fig. 1 shows the schematic layout.

Recording

The recording of pulses on to the tape is carried out quite simply, by triggering a transistor flip-flop circuit, using a pair of OC72 transistors. One of these passes a saturating current of 40mA through the recording head (Epsylon Industries type RP8/45/3) for 100μsec. For the purpose of generating the 'ruler' track, at a frequency of 1 000p/s, the flip-flop is driven by a simple transistor oscillator (Venner unit type TS1), and for recording the single 'stimulus' and 'response' pulses on to the tape other OC72 flip-flops are triggered by the discharge of a capacitor initiated by closing a pair of contacts, either by hand, or by a relay. This method is found to be entirely reliable, i.e. giving only one pulse for each manual operation of a key. If a capacitor is not used and the circuit is triggered by applying a step of voltage directly to the flip-flop, the variation in contact resistance at the key is liable to give rise to several pulses for each operation of it. With capacitor initiation it must of course be ensured that the charging time-constant is well within the key repetition frequency. A subsequent resistor and capacitor provide some degree of pulse shaping, and the final shape of the trigger pulse applied to the base of the transistor is 1V amplitude and 10μsec in width. The component values are not critical since the circuit can be made to trigger at 0·25V. The circuits used are shown in Fig. 2.

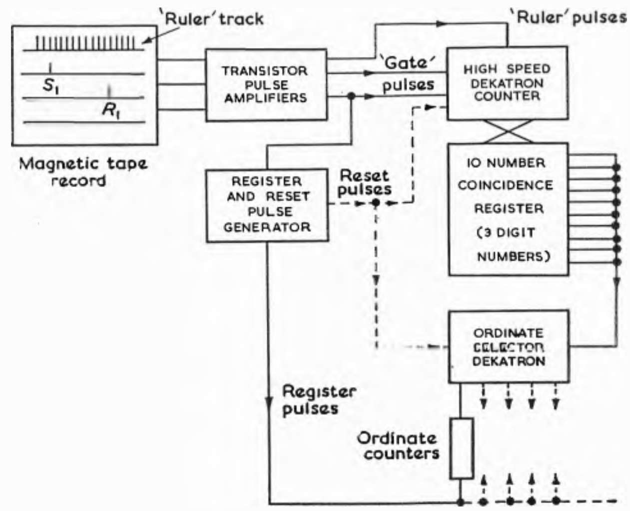

Fig. 1. The schematic layout

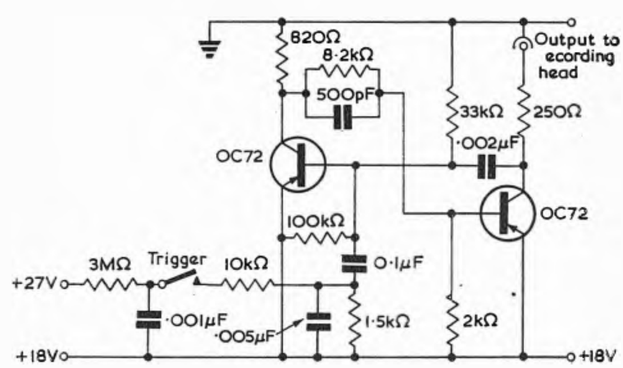

Fig. 2. Recording flip-flop

The Pulse Amplifiers

The pulses reproduced from the tape are amplified by transistor pulse amplifiers before being fed into the Dekatron counting and gating circuits. These amplifiers are of conventional form (Fig. 3) utilizing three stages of linear amplification, a Schmitt trigger, providing a reference to eliminate noise pulses and a circuit whereby the output pulses are shaped to a fixed width and amplitude, and a final amplifier stage. The output pulses are 15V in amplitude and 100μsec in width. The amplifiers are matched at the input and output by suitable transformers. It is worth noting that such amplifiers are extremely easily assembled, each being entirely accommodated on a single 12-way tag board, and in the laboratory, their voltage supply can be conveniently obtained from three small 6V accumulators, the average current consumption being of the order of 40mA.

In order to eliminate any possible confusion due to the loss of a stimulus or response pulse, either through a tape defect, or experimental error, the output polarity of the amplifiers handling these pulses is made opposite, a negative going pulse opening the gate to the high speed counter and a positive going pulse closing it. The loss of a pulse then only leads to the loss of one result. This reversal in polarity of the output pulse is obtained simply by reversing the connexions from the output transformer. In the case of the amplifier for the 'ruler' track pulses this transformer is eliminated and a high impedance output obtained, and fed directly into the grid circuit of the high speed counter.

Resetting the Ruler Track Counter and Histogram Circuits

The main circuit is straightforward, the three GS10D selector Dekatrons being coupled with double-triodes, and supplied with pulses through the gating pentode. It is reset to '000' directly, by applying a 160V pulse to all the other electrodes of the Dekatrons. For this purpose, these electrodes, and the cathodes of the coupling tubes, are returned to earth through the cathode load resistor (2kΩ) of a low impedance (N78) pentode. This is supplied with a positive pulse at the grid in order to reset the Dekatrons. The ordinate selector Dekatron is reset to '0' at the same time by a negative pulse (100V) applied to the '0' electrode. Before these reset pulses become effective, however, it is necessary to provide a positive register pulse to all the histogram ordinate counters, a count being registered on the counter having an open gate, this being determined by the count on the ordinate selector Dekatron. The three pulses necessary (two positive and one negative) are obtained from an ECC81 flip-flop circuit triggered by the amplified pulse derived from the transistor bistable circuit as it closes the gate to the ruler track counter. This flip-flop circuit also provides about 0·5msec delay to ensure that the ordinate selector Dekatron has stepped on and opened the appropriate gate before the register pulse is applied to the ordinate counters. The circuits are shown in Fig. 4 and include amplifying valves and diodes to remove unwanted pulses of the opposite polarity. The operation of the registering and resetting circuits in the manner described entails that about a millisecond elapses after the recording of one result before the counter is ready to measure and sort the next result. This time could be shortened if required, but for the type of experiments envisaged this delay is of no importance.

The Coincidence Circuits

The ordinate selector Dekatron, which gates open the ordinate counters, is driven by the pulse output from the ten coincidence gates (for ten ordinate counters). Each gate gives a pulse when its particular three-digit number is reached and, therefore, ten groups of three rotary switches are provided, one for each gate. Each of the 'units' digit switches have their wafer contacts wired in parallel and on to the 'units' Dekatron selector cathodes, 0 to 9; similarly for the 'tens' and 'hundreds' switches. The three wiper contacts from each three-digit group of switches are joined through OA81 diodes on to the grid of a triode which is normally biased off by fixing the cathode potential at about 40V positive to earth. For this purpose an h.t. bleeder resistor is joined to the cathode, and although the grid is also returned to h.t. via a high resistance, the grid potential is held down towards earth through one or more of the diodes and

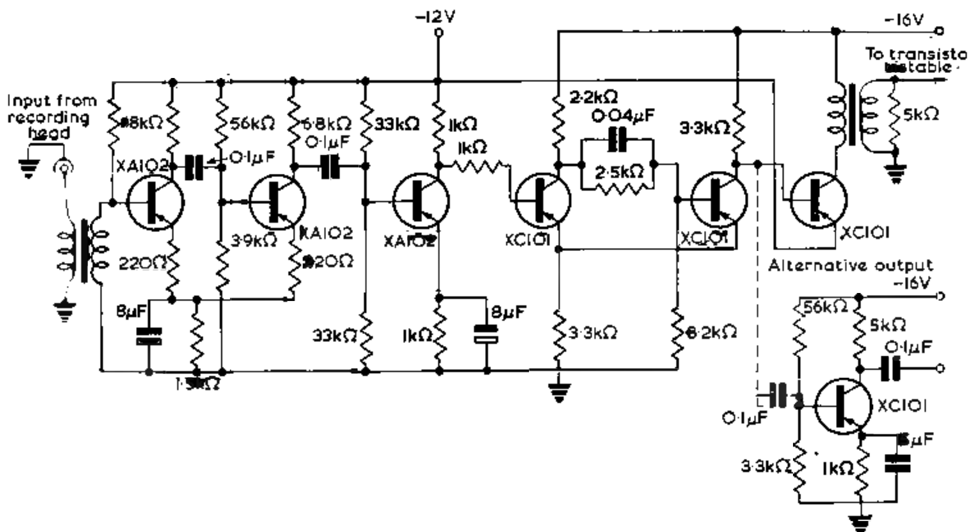

Fig. 3. Pulse amplifiers

Dekatron cathode resistors, until the Dekatrons reach a chosen three-digit number. The cathode resistor of the N78 resetting valve also forms part of the cathode resistor for these triodes, in order that the large positive reset pulse used to reset the Dekatrons, does not pass through the coincidence gates. The grid of a coincidence triode will normally be at about 20V above earth, until a particular three-digit number set on the switches is reached. The valve then conducts, and passes a pulse on to the ordinate selector Dekatron to gate open the appropriate ordinate counter. The general arrangement of the circuit is shown in Fig. 5.

Practical Construction

The equipment is accommodated in two G.P.O. type racks including the power supplies, tape deck, and ten Dekatron ordinate counters. With the use of mechanical units for the ordinate counters, and a portable tape deck for recording, including the required transistor pulsing circuits and 1kc/s generator, the equipment needed for replaying the tape could be housed in a single rack.

Results

In order to provide for a simple check on the proper functioning of the equipment, a test tape was prepared, having five different pairs of known pulse spacings on it, respectively, 77, 87, 97, 107 and 117msec in duration, and each pulse pair was repeated 150 times. For replay,

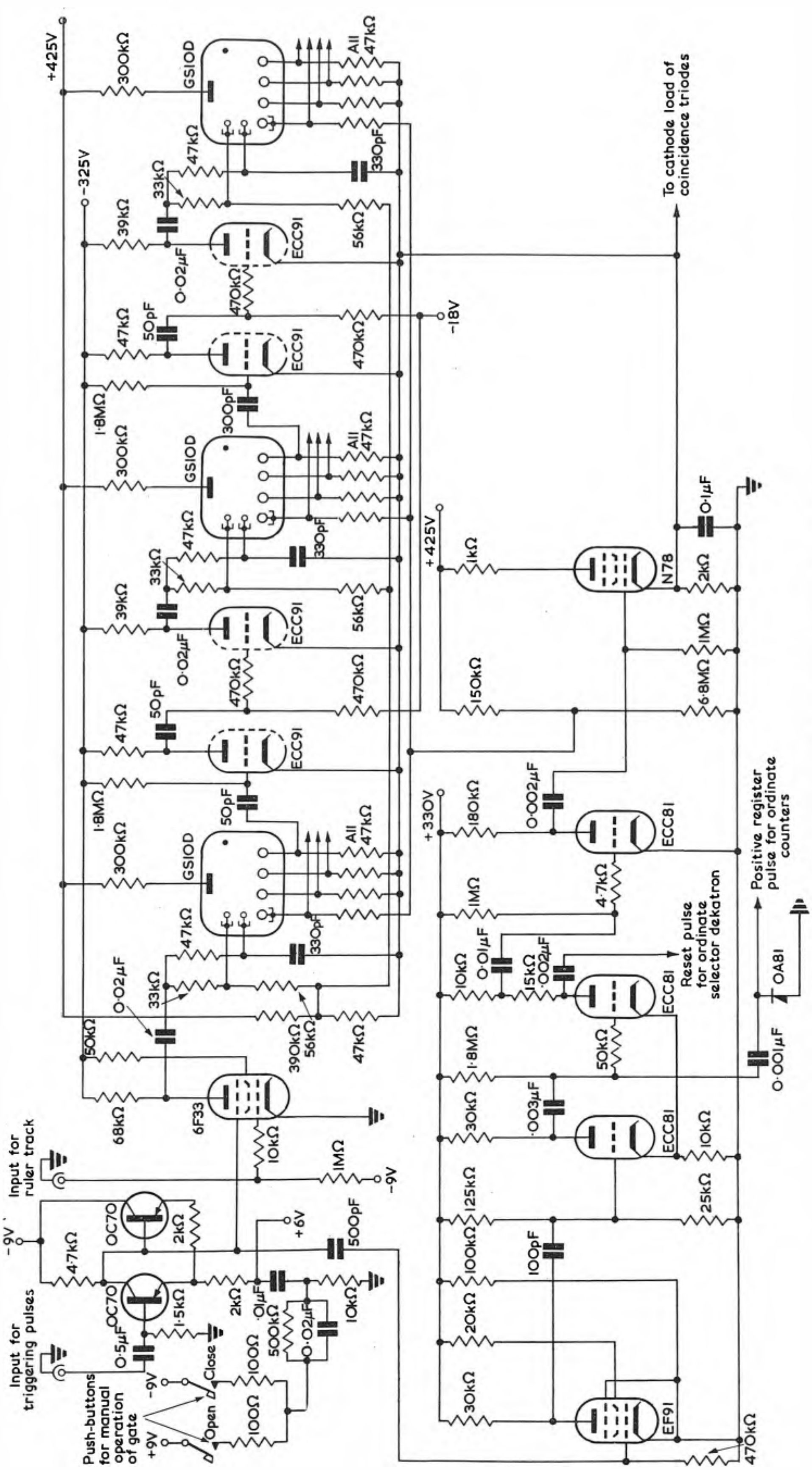

Fig. 4. The histogramming counter, gating and resetting circuits

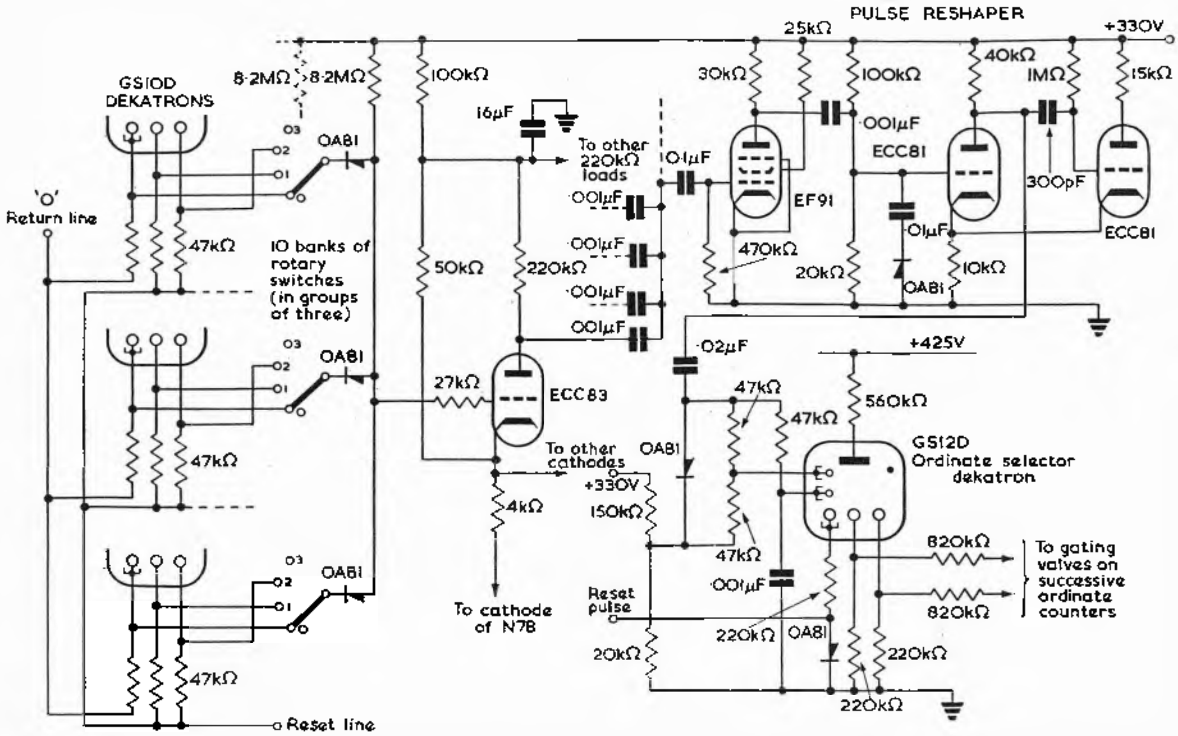

Fig. 5. The ordinate selector switches and coincidence pulse amplifiers

Fig. 6. Histograms of simple reaction times to neon light stimulus

the ten ordinate counters were set at 5msec apart, from 75msec, and a count of 150 was registered on each alternate ordinate counter.

Two histograms of simple reaction times to a neon light stimulus are shown in Fig. 6. The first histogram (solid line) is the result of a continuous series of reaction time tests, under normal conditions, the light stimulus being given in a fairly random manner by a human operator. The second histogram (dotted line) shows the result obtained when the same subject, tested in a similar manner, was with a heavy cold, and had been taking aspirin. About 1 000 reaction times were recorded in each experiment. The two histograms are, of course, only included to illustrate the article, and are not intended to be of any particular psychological significance. The recording was made at a tape speed of 5in/sec, each experiment taking about 20min, while playback was at 30in/sec, this speed change being conveniently obtained by changing both the capstan motor speed and drive wheel diameter.

Acknowledgments

The author wishes to thank Dr. J. A. Deutsch for his particular encouragement with this project, and for his original suggestion of the 'ruler' track method of recording particular experimental results. He also would like to thank Mr. P. Cocklin and Mr. R. Shrimpton for their ready assistance with the wiring and mechanical construction work, and to make grateful acknowledgment to Professor R. C. Oldfield for the facilities afforded to the author.

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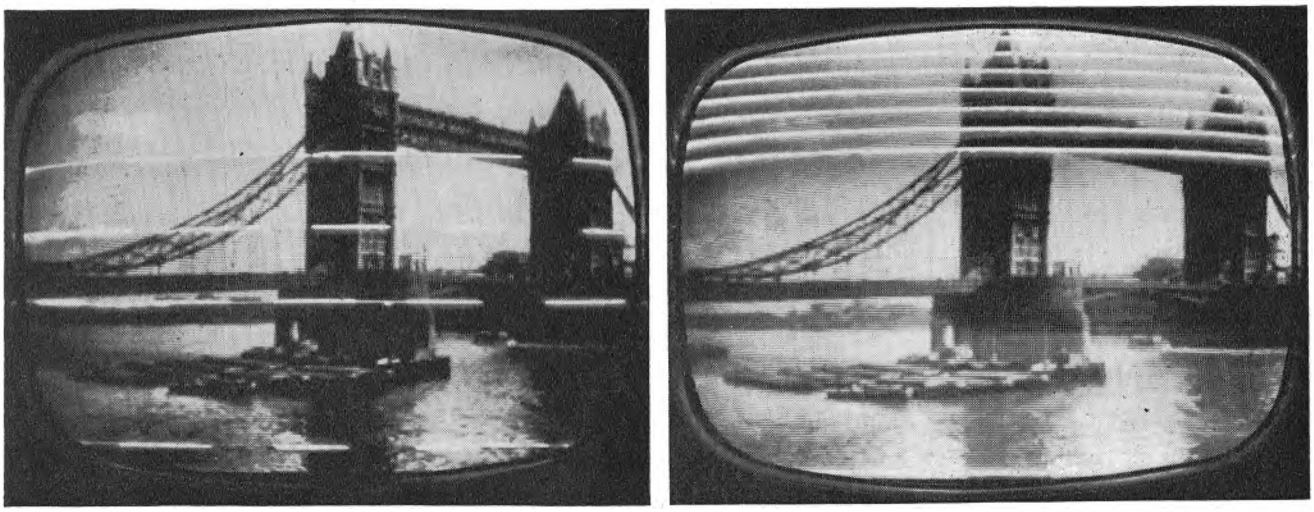


A CONTROLLED INTERFERENCE GENERATOR

By W. E. Matthews* and P. L. Mothersole*, A.M.Brit.I.R.E., A.M.I.E.E.

To study the performance of a television receiver in unfavourable locations extensive field tests are normally required. The generator described in this article produces realistic interference signals from an electric motor and a motor car ignition simulator, thus enabling extensive tests to be undertaken in the laboratory.

(Voir page 733 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 738)

UNSUPPRESSED motor car ignition systems and brush type electric motors, etc., produce impulsive noise that may disturb the operation of a television receiver. The circuits in a receiver that are most affected by such interference signals are the synchronizing and a.g.c. circuits. When the operation of such circuits is studied in the laboratory a source of realistic noise pulses is required, the amplitude and frequency of which can be controlled. This requirement is particularly important when export receivers are to be designed, operating on a different standard (e.g. 625 lines) from that of the local transmitter (e.g. 405 lines), since prolonged field tests are not possible. In this article an interference generator is described that produces controlled interference from an electric motor or a motor car ignition simulator.

Interference Generator Requirements

Ignition Interference Generator

A normal four cylinder motor car engine produces two interference pulses per engine revolution and the engine operates between about 1 000 and 5 000rev/min. Thus the p.r.f. of the interference pulses is between about 30 and 170c/s. Interference pulses could be generated by a simple multivibrator pulse-modulating an r.f. oscillator. However, to obtain the very wide frequency spectrum characteristic of impulsive interference a spark gap must be used. The spark gap can be mounted in a screened box and the interference picked up on a coupling loop at low impedance.

A practical method of generating interference pulses is therefore to use a normal sparking plug driven by a transformer. The direct current in the transformer primary is switched by a valve driven by a multivibrator circuit operating at the required frequency or p.r.f. A line output valve is suitable for switching such a circuit since it can pass a high peak current and withstand high peak anode potentials.

The interference output of a motor car is liable to very sudden changes in frequency, due, for example, to gear changing. It is desirable to simulate this effect since the sudden change in frequency is liable to produce unexpected effects in a receiver. The multivibrator driving the output pentode can be frequency modulated by a sawtooth waveform to produce this effect.

Mains Locked Interference

Many types of interference signals are locked to the supply mains, for example, electric motor brush noise. Electric motor interference is conveniently generated by a small motor, such as a shaver motor, operated in a screened box. The interference can again be picked up on a coupling loop at low impedance.

For testing receiver circuits it is very convenient to have a burst of sharp noise pulses, the bursts occurring at a p.r.f. of 50c/s and locked to either the supply mains or the television field synchronizing signal. An adjustable delay must be provided to enable the position of the burst to be located anywhere over the field period including the field synchronizing pulses. Furthermore, the width of the burst and the p.r.f. of the pulses occurring in the burst must be adjustable. Such a test waveform can be simply generated in conjunction with the type of ignition noise generator discussed above.

Generator Output

Since the output from the type of generators described above is at radio frequency the output can be added directly to the r.f. output of a normal television pattern

* *Mullard Research Laboratories*

For explanation of above photographs see text on page 688.

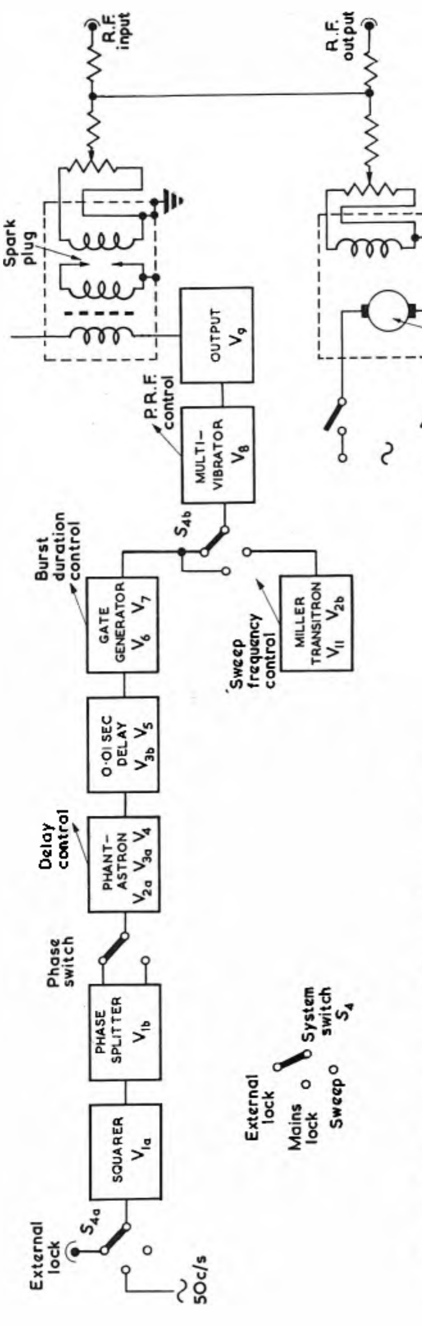


Fig. 1. General arrangement of the interference generator

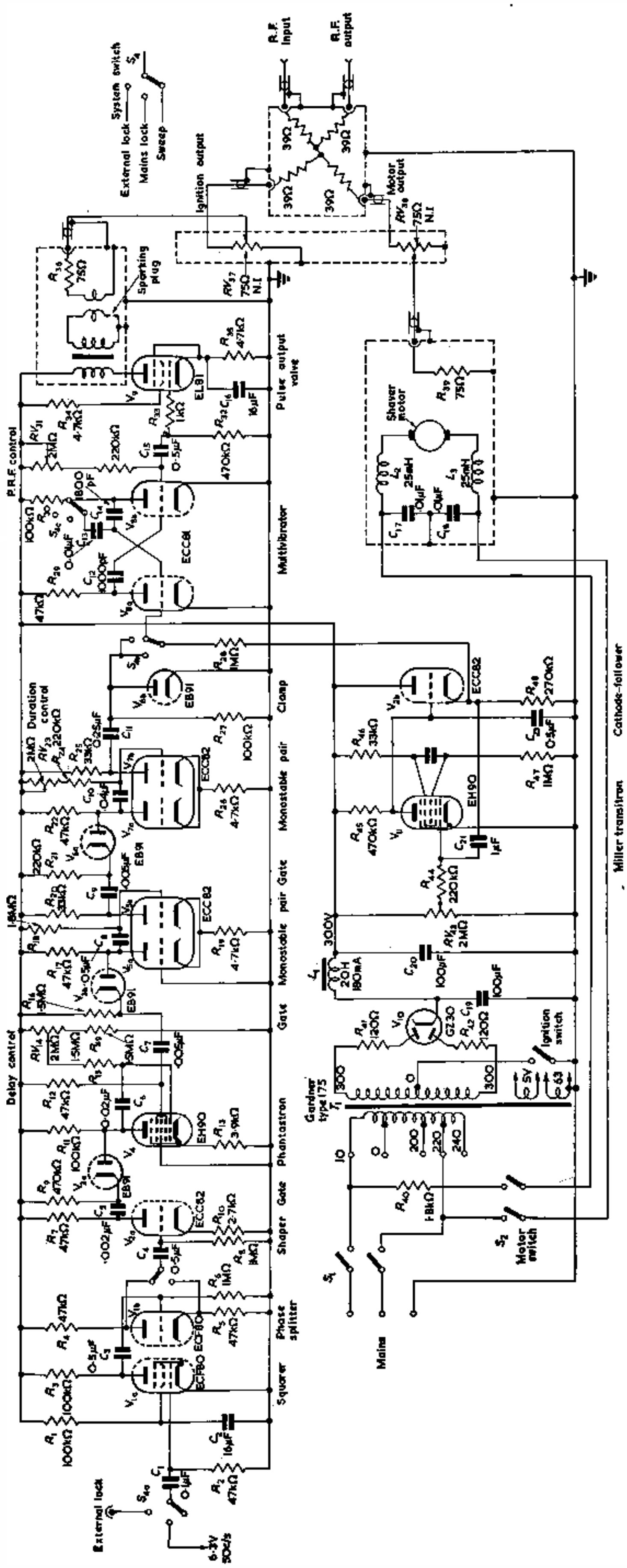


Fig. 2. The complete circuit of the generator

generator via an attenuator. Thus the signal-to-noise ratio at the receiver input can be varied by controlled amounts.

The Complete Generator

General Description

The block diagram of a generator based on the ideas discussed above is shown in Fig. 1.

The sparking plug is connected across the secondary of a transformer, the primary being driven by the output valve V_9. The interference p.r.f. is determined by the free-running multivibrator (V_8) which can be frequency modulated or gated depending on the position of the system switch. When the switch is in the 'sweep' position the sawtooth output of the Miller Transitron (V_{11}, V_{2b}) modulates the multivibrator.

The gate pulse, required to produce a burst of interference pulses, is locked either to an external 50c/s signal or to the supply mains, depending on the setting of the system switch. The 50c/s input is squared by the pentode valve (V_{1a}) and applied to the phase-splitter (V_{1b}). The phase switch enables the gate pulse to be locked to either phase of the 50c/s input.

The output from the phase-splitter is used to trigger a Phantastron variable delay circuit. When an external frame synchronizing pulse is used to trigger the generator it is very desirable for the interference burst to occur at the same time as the synchronizing pulse (see Fig. 3). For this reason a further fixed delay of about 10msec is provided. This enables the noise burst to smoothly traverse the frame synchronizing period of the receiver under test. The output of the fixed delay circuit triggers the variable width gate pulse generator (V_6, V_7).

The interference output from the sparking plug and the shaver motor are applied via separate attenuators and matching pads to the r.f. output socket.

Circuit Description

The complete circuit diagram for the generator is shown in Fig. 2, and the significant waveforms in Fig. 3. The operation is as follows:

The 50c/s input is squared by the pentode amplifier V_{1a} and applied to the phase-splitter V_{1b}. The output waveform is applied via the phase switch to a further shaper V_{2a} and differentiated by the network C_5R_9. The negative going edge drives the gate diode V_{3a} into conduction and triggers the Phantastron delay circuit V_4. The duration of the anode run-down is determined by the grid time-constant and the positive aiming potential. The variable aiming potential (RV_{14}) is used to control the delay time of the circuit. The output from the screen grid is differentiated (C_7R_{16}) and the negative edge drives the gate diode V_{3b} into conduction triggering the fixed delay monostable pair V_5. This circuit is arranged to provide a fixed delay of about 10msec. The output from the anode of V_{5b} is differentiated (C_9R_{21}) and the negative edge drives the gate diode V_{6a} into conduction triggering a further monostable pair V_7 to produce the gate pulse. The duration of the pulse produced by this circuit is adjustable (RV_{23}) and determines the width of the burst of interference pulses. The gate pulse is negatively d.c. restored by the clamp diode V_{6b}.

When the system switch S_4 is switched to the 50c/s positions the control grid of the multivibrator V_8 is connected directly to the anode of the clamp diode V_{6b}. The negative charge on the coupling capacitor C_{11} due to the diode current holds the multivibrator cut-off until the positive going gate pulse drives the multivibrator into

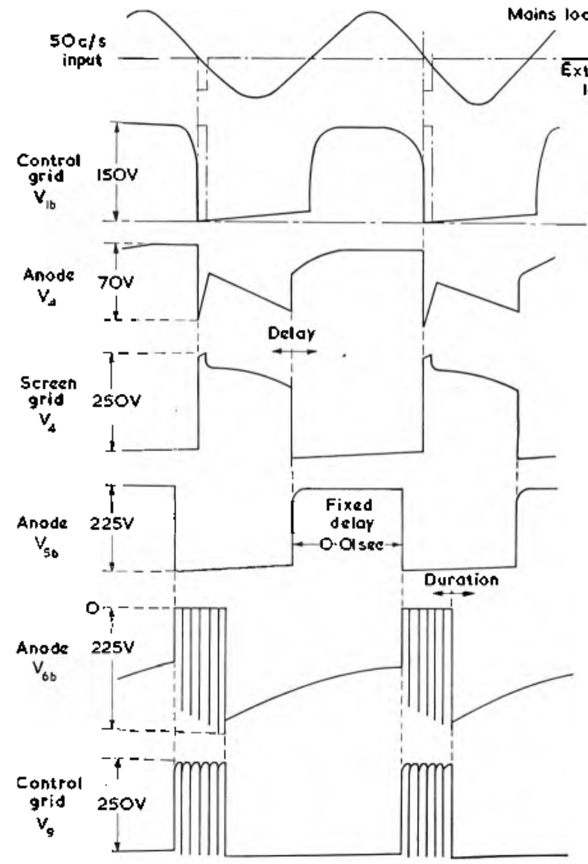


Fig. 3. Waveforms at various parts in the circuit

conduction (i.e. V_{7b} cut-off). The multivibrator therefore produces a train of pulses for the duration of the gate pulse, the p.r.f. of these pulses being determined by the free-running frequency of the multivibrator (RV_{31}).

When the system switch S_4 is switched to the sweep position the aiming potential for the multivibrator (V_{8a}) is the output of a Miller Transitron circuit. The feedback path from anode to control grid consists of a cathode-follower V_{2b} and the Miller capacitor C_{21}. The cathode-follower provides a low impedance output to the multivibrator to prevent variations in the grid current of V_{8a} due to adjustment of the p.r.f. control from affecting the sweep frequency. The flyback time of the Transitron is reduced by the addition of capacitor C_{23}.

The outputs from the sparking plug and motor are applied to separate attenuators and individual mains switches are also provided (S_3, h.t. switch for the ignition circuits and S_2 mains switch for the motor) to enable the different types of interference to be generated separately.

Construction

No special precautions are necessary in the construction of the generator, except in the mounting of the motor and sparking plug, since the circuits are not critical and operate at low frequencies. The sparking plug and the associated driving transformer were mounted in a screened box. The sparking plug used was a standard type, having its air gap reduced since it operates at about 7kV. The coaxial output was terminated in a 75Ω resistor (R_{36}) in series with small pick-up coil consisting of about six open turns of insulated wire.

A rotary type of shaver motor was used, the normal suppressor capacitors being removed from the commutator. It was mounted in a separate screened sound-

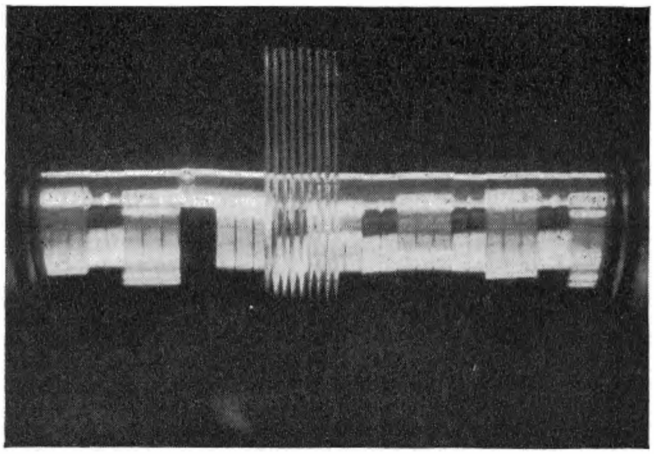


Fig. 4. A burst of interference pulses locked to the field synchronizing pulse of the generator

proof box, with two additional filters in the mains supply leads. The coaxial output was terminated with a 75Ω resistor (R_{39}) mounted close to the motor, no additional pick-up loop being necessary.

Separate 75Ω non-inductive potentiometers (RV_{37} and RV_{38}) were used to attenuate the output, these controls being mounted in a separate screened box. The output from these controls was added to the television signal in a separate screened four-way pad. The attenuation provided by these controls on Band III is not completely satisfactory, and for accurate measurements a switched attenuator should be used.

Results and Conclusions

The unit has proved invaluable for studying the effects of noise on the performance of synchronizing circuits in the laboratory. The photographs on page 685 show noise pulses on a 405 line (positive modulation) receiver. In the first the system switch is in the sweep position and in the other the 50c/s position producing a burst of interference pulses. In Fig. 4 the video waveform is shown in a 625 line (negative modulation) receiver with the unit producing a burst of interference pulses locked to the field synchronizing pulse of the generator.

Acknowledgments

The authors would like to thank the Director of the Mullard Research Laboratories and the Directors of Mullard Limited for permission to publish this article.

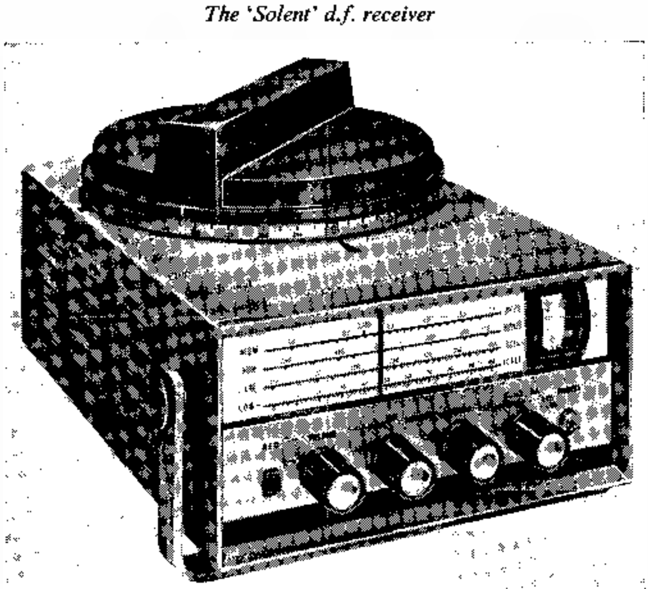
Direction Finder for Small Craft

Pye Ltd have recently introduced a fully portable direction-finding receiver which is intended for use on yachts and other small craft. It offers, in one case, all the facilities of a large ship's installation.

With the Pye 'Solent', accurate d.f. bearings can be taken from radio beacons on the long wave beacon band. Sensitivity and selectivity compare favourably with that of fixed installations, and extensive trials have shown that bearings can be taken to an accuracy of ±1°. A signal strength meter gives visual indication of signals when direction and sense finding, thus giving greater accuracy than the usual audible method. The meter is also used for checking battery strength.

The d.f. aerial is of new design using a ferrite rod which is mounted, together with a compass rose, on top of the receiver case. The signal strength meter, full vision dial and other controls are mounted on the front panel, all controls being kept to a minimum in order to combine simplicity with the utmost accuracy. Two sockets are provided—one for headphones, and the other, on the aerial housing, to take an external aerial for sense finding. This also greatly increases the range of the receiver on the shipping band. A beat frequency oscillator is incorporated so that the 'Consol' method may be used for long-range navigation.

The 'Solent' d.f. receiver



The self-contained receiver employs nine transistors and works off eight standard 1½V torch batteries. These features together with printed circuits, make it light, portable and highly robust.

In addition to the long wave beacon band, the Solent will also cover the medium-short wave trawler band. An 8in elliptical loudspeaker specially designed to work in conjunction with transistor circuits is incorporated.

Transistors for Lift Control

The new electronic equipment developed by J. & E. Hall Ltd of Dartford is believed to be the first application of the use of transistors throughout for the control of lift operation. A prototype unit has been in operation continuously for the past year, during which time it has proved entirely reliable and has required no attention whatever or maintenance.

Until now, the installation of control equipment has presented difficulties arising from the bulk, weight and reliability of the units. Furthermore, with a mechanical selector, there is little choice regarding the position occupied by it. In the new J. & Hall electronic equipment both these difficulties are overcome. The control unit is small, light and easy to install, and its position in relation to the remainder of the installation is not dictated by any mechanical requirements. It can therefore be sited in the best position for ease of installation and accessibility. Approximate dimensions of a transistor control unit for eight floors are: Width 12½in, depth 6in, height 18in.

The static switching unit contains no moving parts whatsoever, its operation being entirely electronic. By eliminating relays, with their numerous contacts, maintenance requirements are reduced virtually to nothing. The functions of control and selection are combined in a single unit, which is entirely enclosed and dustproof.

A control system is built up from assemblies, each of which provides control for one floor. There are three basic types covering terminal floors, intermediate floors and output respectively, and each incorporates its own selector unit. Assemblies can be quickly removed in the event of a defect occurring, and a spare substituted and connected up immediately, only three small basic transistor units being required for this purpose in installations of any size. In accordance with modern practice in electronic engineering, the connexions from each assembly are provided with solderless taper pin terminations, which allow for instant connexion or disconnexion from the terminal blocks on the frame. As the unit operates on low voltage and very small currents are involved, the wiring is of light gauge and is easy to handle, while 'live' wiring presents no danger.

A 1Mc/s Magnetic Core Buffer Store for use with a Card Punch or Line Printer

By J. B. James*

A high speed buffer store is described which is capable of accepting data from a computer at the rate of one character per microsecond and thereafter of providing a series of decoder parallel outputs suitable for a printer or card punch. Square loop magnetic cores, used in a one core per bit system, form the memory elements and such cores are also used in the driving circuits, as a means of reducing the number of active elements. Decoding and parity check circuits are described which make novel use of memory-sized cores.

(Voir page 733 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 738)

THE input and output equipment associated with a data processing computer normally operates at a much slower speed than the computer. The coupling of such equipment to the computer can often best be done by means of a buffer store. Such stores allow one computer to deal readily with a large number of input and output equipments. They are particularly valuable when the data is dealt with in a serial mode by the computer and in a parallel mode by the input or output machine.

In the system to be described, the data is fed from the computer on eight lines in parallel. These eight lines allow up to 50 characters to be represented, together with a parity digit used for checking purposes. The rate of feeding from the computer can be as high as one character per microsecond.

The card punch being considered, punches 80-column cards and the characters are represented in each column by either one or two holes punched in 12 possible row positions, marked Y, X, 0, 1 . . . 9. The operation of the punch is such that the card is punched row by row, the first operation being to punch all the required holes across the card in the 9-row and then to follow this by punching the 8-row and so on. The rate of punching is 100 cards per minute.

The line printer operates in a similar manner. A drum contains along its length 120 rings of type face. Each ring has 50 characters spaced evenly round the circumference and so arranged that a given character appears in the same position along the length of the drum. The drum revolves continuously behind the stationary paper and hammers are arranged to hit the paper against the drum when the required characters are in the correct position. At a given instant a particular character is printed in all the required positions across the line of print. This is followed 1·5msec later by the printing of the next character in its required positions. The 120 characters that make up a line of print are thus printed in one revolution of the drum.

These equipments are coupled to the computer by means of a buffer store capable of holding the data relevant to a single punched card or a line of print, i.e. a store of 8 rows and of 80 or 120 columns. The store has to be capable of accepting data serially from the computer at frequencies of up to 1 character per microsecond and thereafter of providing a number of decoded outputs, on 80 or 120 lines, at the times required by the card punch or line printer.

Outline of Store

Cost has been an important consideration in designing a buffer store to meet these requirements. This has led to a design in which the mode of operation has been kept simple, and in which as much as possible of the same equipment is used during both the input and output operations. In particular, the requirement to fill the store at a maximum rate of 1 column per microsecond, has led to the design of a single-core-per-bit store which can be read and re-written in as many microseconds as there are columns, plus one.

A schematic diagram of the complete store is shown in Fig. 1. The data is stored in a matrix 8 by 80 or 120 of 0·05in diameter square loop ferrite cores of S4 material. The odd numbered columns are arranged separately from the even numbered columns, so that reading and writing can take place simultaneously in the two portions of the store.

There are two wires connected in series through each column of cores and these are connected to a magnetic scan circuit. This circuit provides full read and partial write current pulses for each column of the store in turn. The column current pulses provided are −400mA for read and +250mA for write.

Each row of cores carries two wires, one connected to the input of an amplifier and write circuit, and the other connected to the output of the same circuit. The output wire of the write circuit also extends to additional sets of memory type cores arranged as a decoder and as a parity checker.

The amplifier and write circuit is such that, if a core storing a '1' is read during the reading time, that information is stored in the amplifier and write circuit and, during the next writing time, the write circuit provides a positive current of 270mA on its output line. If, on the other hand, a '0' is read, then the circuit stores this and provides a negative current of 270mA during the next writing time. The input portion of the amplifier is inoperative during the writing time. When new information is being written into the store the normal input to the amplifiers is blocked and replaced by the lines carrying the new information.

The width of the current pulses used is nominally 0·8μsec, but the circuits are such that they may be as narrow as 0·65μsec. Reading of the memory cores, with a column current of 400mA on 2 turns, takes place in approximately 0·3μsec—well within the width of the current pulses. The total writing ampere-turns are 770mAt for a '1' and 230mAt for a '0'. The 770mAt is sufficient to adequately switch the memory cores within the shortest writing time of 0·65μsec, and the 270mAt disturb-current on the row-line, is below the knee-current for these cores.

The decoder matrix of cores is operated in a similar manner. Writing-in is accomplished by the coincidence of the same row-currents as flow through the store proper,

* *International Computers and Tabulators Ltd.*

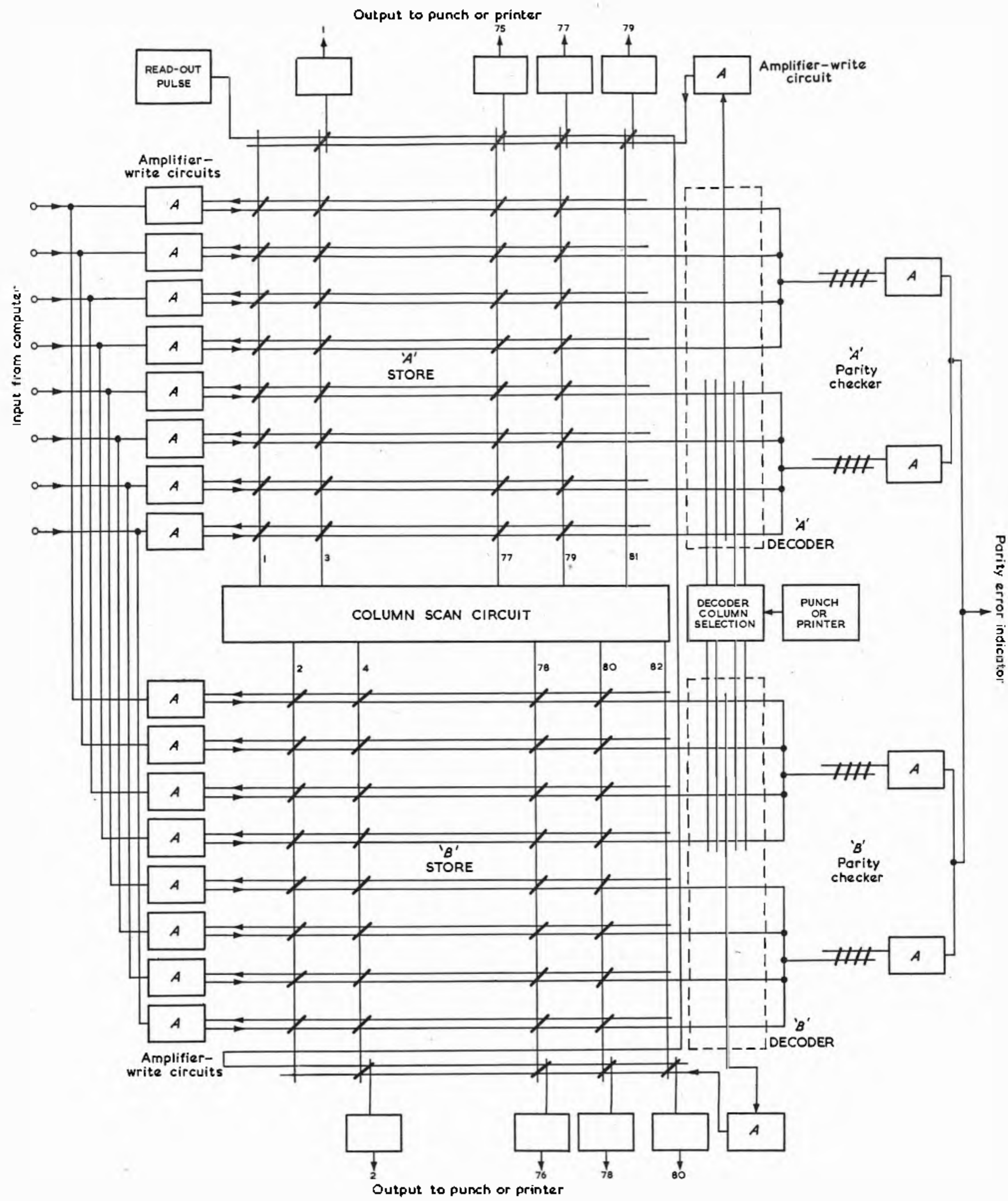


Fig. 1. The complete buffer store

and an appropriate column current which selects the correct column in the decoder matrix. Each column corresponds to an AND circuit into which data can be written and which, when read out, provides '1' or '0' outputs according to whether or not the input data corresponded to the requirements of the particular AND circuit. Reading of the decoder matrix as a whole is done by two or three amplifiers which feed one write circuit. This circuit operates in the same manner as the store amplifier and write circuits, in that it provides a positive or negative row-current during the writing time acording to the reading of the decoder matrix during the previous read period.

The output line of the decoder amplifier and write circuit threads an additional row of memory cores in the store which are fed by the same column scan circuit. Each of these cores has a four-turn output winding, and it is from these cores that the 80 or 120 parallel output is provided.

The operation of the store will now be considered from the point of view of circulating and decoding a pattern of information already in the store. This takes place at 1Mc/s with 0·8μsec wide current pulses.

During the first microsecond period the scan circuit provides an output which is connected so as to read column 1 in the A portion of the store. The information in column 1 is thus transferred to the A amplifier and write circuits. During the second microsecond, the scan circuit output provides a partial write current for column 1 and a read current for column 2 in the other portion of the store. At the same time, the A amplifier and write circuits provide row-currents in accordance with the information read from column 1 during the previous period. The information taken from column 1 is thus re-written in the same column. Also at the same time, an appropriate column write current is supplied to a selected column in the decoder matrix and the information from column 1 of the store is thus written into that column of the decoder.

In the third microsecond, column 3 of the store is read, column 2 is re-written into the store and the B decoder, and the appropriate column of the A decoder is read, thus storing in the A decoder amplifier and write circuit the result of decoding the information in column 1.

In the fourth microsecond, column 4 is read, column 3 is re-written into the store and the A decoder, the decoded column 2 information is read out of the B decoder, and the result of decoding column 1 is written into the output in column 3.

Similarly, in the fifth microsecond period, column 5 of the store is read, column 4 is re-written into the store and the B decoder, the decoded column 3 information is read out from the A decoder, and the result of decoding column 2 information is written into the output core in column 4.

At the end of 83 or 123 microseconds, according to the size of the store, the contents of the whole store will have been examined and the decoded result will be contained in the output line of cores. At the instant required by the punch or printer, these output cores are simultaneously read to provide input signals for 80 or 120 read-out circuits, which cause the appropriate holes to be punched, or characters to be printed. When the time comes to punch the next row of holes, or print the next character, the whole operation is repeated using a different column of the decoders.

On completion of the punching or printing the store is refilled with new information from the computer. To do this, a gating circuit causes the amplifier and write circuits to take their input from the computer instead of from memory cores. The information is received from the computer in words of from one to twelve characters, at the rate of one character

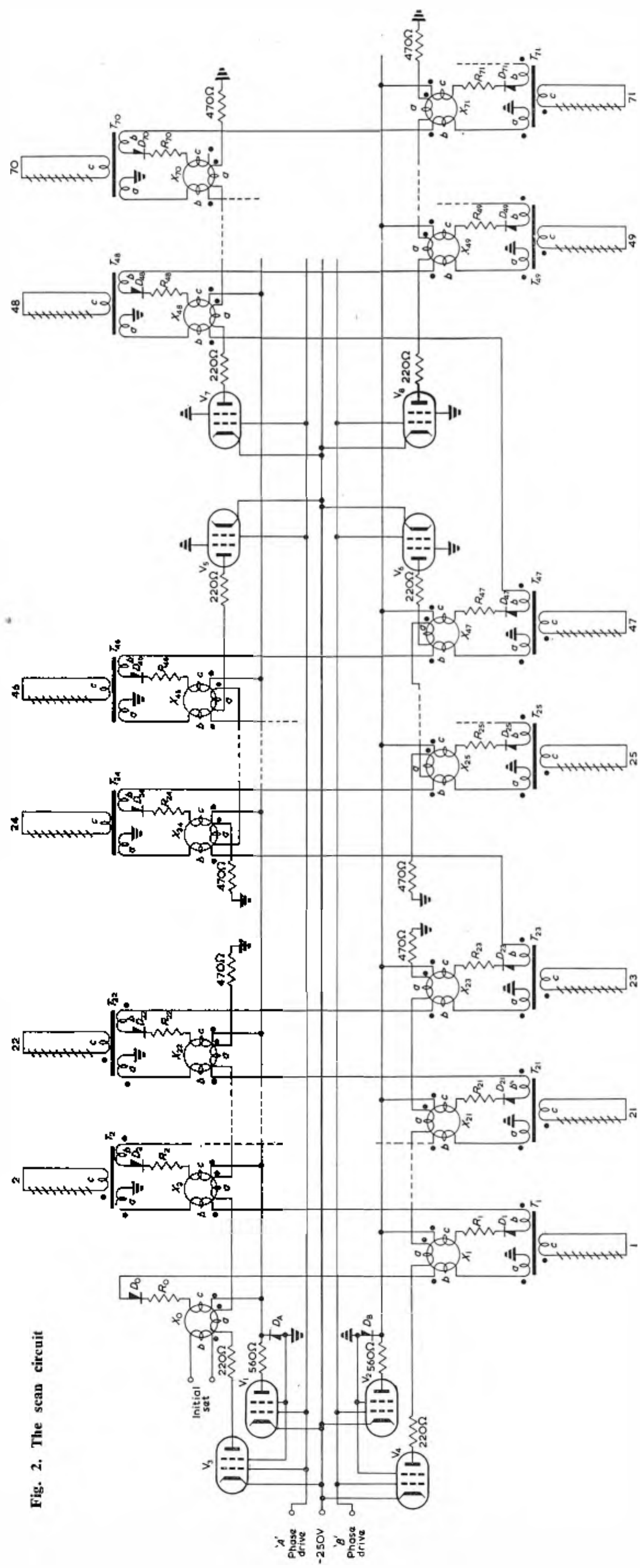


Fig. 2. The scan circuit

per microsecond, but with gaps between words of any length. A control signal from the computer causes the column scan circuit to step along the correct number of steps each time information is transmitted.

Scan Circuit

This circuit is required to provide read currents of −400mA and write currents of +250mA into each column of the store in turn. In order to ensure proper setting of the memory cores during the writing time these current pulses must be accurately controlled in amplitude, and the duration of them must not be less than 0·65μsec. On the other hand, the width of the pulses must never be greater than 0·85μsec in order that the store may operate at its highest frequency. Such pulse requirements could not be met using transistors available at the time and a valve-driven square loop core circuit has been used.

The overall arrangement of the scan circuit is shown in Fig. 2. Circuits of this type have been previously described[1,2,3] mainly for use as shift registers or counters. The special features of the circuit shown arise from its use with a store and from the high operating speed.

The circuit is operated from a source of two phase voltage pulses, 0·85μsec wide, which are applied alternately to the grids of the *A*- and *B*-phase driver valves. These voltage pulses are of sufficient amplitude to bottom the pentode drivers, and the drive currents are defined by the series resistors in the anode circuit.

X_0 to X_{80} (considering an 80-column store only) are wound square loop cores. Initially X_0 is in the '1' state (this being the state such that a drive pulse will switch the core) and all the others are in the '0' condition. The first drive pulse is applied on the *A*-phase and a current pulse of 300mA passes through the *a* windings of all the wound cores on this phase. Core X_0 is switched from the '1' state to the '0' state and the other *A*-phase cores are unaffected. In the process of switching, core X_0 behaves as a current transformer and a current is passed through winding *b* of X_1 and winding *a* of T_1. The effect of this current is that X_1 is set to the '1' state and a current pulse corresponding to a read pulse passes through column 1 of the memory cores.

The next drive-pulse is applied on phase-*B* with the result that X_1 is switched to the '0' state, X_2 to the '1' state, a partial write-pulse is applied to column 1 and a read-pulse is applied to column 2. Each drive-pulse thus reads the next column of memory cores and writes in the previous column with the aid of row currents applied at the same time. This operation can take place at any frequency up to the maximum of 1Mc/s by varying the time-interval between drive-pulses.

The windings on the cores X_0 to X_{80} are such that the drive and output ampere-turns are large compared with the ampere-turns required to actually switch the core and, in this way, an accurately controlled current waveform is preserved. It is also necessary to arrange for the windings *a* and *c* to be close together on the core. A small output tends to be produced when the wound cores already in the '0' state are driven further into saturation, but this is suppressed by the diodes D_A and D_B, as will be explained.

The switching time for the wound cores used in this way, is fixed by the voltage developed across the output windings *c*, which is a function of the impedance of the output circuit. The number of memory cores being switched may vary from 0 to 9, according to the pattern stored, and hence the impedance offered by them will vary accordingly. Resistors R_0 to R_{80} are included to swamp this variation. If the wound core being driven from the '1' state to the '0' state is not fully switched within the duration of the drive pulse, due to the impedance of the output circuit being too low, then a large '0' output will result from that core when next driven. The presence of D_A and D_B again helps to suppress such outputs.

Diodes D_0 to D_{80} prevent current flowing in the output circuits, when the wound cores are being set and diodes D_A and D_B are included primarily to prevent current flowing in the previous circuit when a core is being driven from '1' to '0', e.g. when X_1 is being driven from '1' to '0', D_A prevents current flowing through the *c* winding of X_0. Valves V_1 and V_2 permit D_A and D_B to conduct when required by passing a current of some 400mA through them. The value of this diode current restricts the total value of current that can flow in all the 40 output circuits. At the beginning of the drive-pulse, therefore, when one wound core is attempting to produce a full output and 39 others are attempting to produce '0' outputs, this current restriction of D_A or D_B suppresses the '0' outputs.

The inductance of the *a* windings on the wound cores (when driven further into saturation), together with the capacitance between the windings and ground, forms a transmission line, with the result that the current pulses from the driver valves are delayed as they pass through the line of cores. The effect of this delay is to reduce the time during which the furthest column current and the row current are coincident through the memory cores. A delay of 0·15μsec, corresponding to a minimum writing pulse width of 0·65μsec, is the most that can be tolerated and this limits the number of wound cores that can be driven by a pair of drive-valves to a scale of 24 (12 cores on each phase). By using two resistors to define the anode current of the drive-valves and placing them at either end of the line of wound cores, an approximate match to the line is secured and reflections are avoided.

The presence of the delay in the current pulse through the *a* windings prevents the same current being used to make the diodes D_A and D_B conduct[1] and the separate valves V_1 and V_2 are necessary. With a large scan circuit, the addition of two more valves is not, however, significant and there is advantage in being able to set the diode currents slightly higher than the current through the *a* windings.

When the '1' in the scan circuit passes from one scale of 24 to the next, it was found desirable to avoid a jump in the timing of the output pulse to the store and, therefore, the following scale of 24 is arranged with the driver valves at the other end of the line of cores.

All the driver valves, on one phase, are operated together and the common diodes, D_A and D_B, ensure that the scales of 24 which are without a '1', do not pick up a '1' by the process of enlarging a '0' disturbance, stage by stage. The total mean current required by the drive valves is small, as the store spends most of its time waiting for the card to move to the next row, or the print drum to reach the next character.

Amplifier and Write Circuit

Fig. 3 shows the amplifier and write circuits for four rows of the store. The rest of the store is arranged in similar groups of four rows. The memory cores in each row are divided into two halves and the amplifier input wire is cross connected, so as to balance the disturbance which the row write current would otherwise produce in this line, due to the mutual inductance between the two wires. Without the balancing arrangement, it would be difficult to prevent the disturbance, produced at the end of the write pulse, extending into the reading time, the time interval between them being sometimes as short as 0·15μsec.

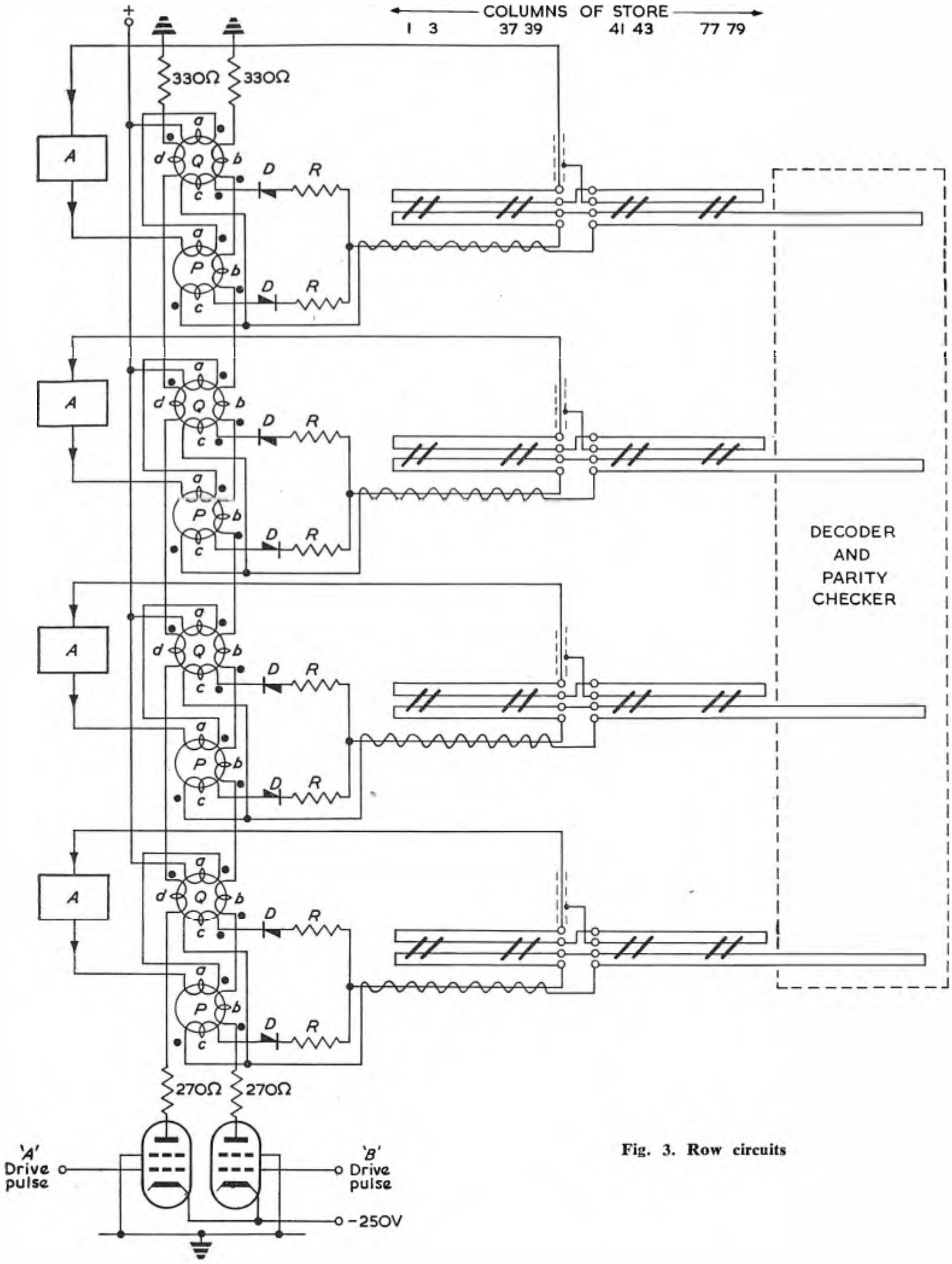


Fig. 3. Row circuits

amplifier output current. The setting pulse for the Q core is narrower than the normal drive pulse and occurs within the time of the amplifier current. If, during the reading time, a memory core storing a '1' is read then the P core becomes set and the setting of the Q core is inhibited. If a '0' is read, then the reverse occurs. In this way the next row-current is +270mA after reading a '1' and −270mA after reading a '0'.

Decoder Circuit

In order to illustrate the principle of operation, a part of the decoder matrix is shown in Fig. 4. Four rows, corresponding to lines, 1, 2, 4 and 8, and the decoder columns for numbers, **6, 7** and 8 are included.

The row write lines extend through the store into the decoder matrix. Writing into the decoder cores is accomplished by the coincidence of these currents and an appropriate column current. Separate wires are provided through each column for reading and writing. The selection of the particular column to be used for the decoding operation is carried out by a circuit of wound cores, similar to the scan and row write circuit. It is controlled by the card punch or line printer.

The row write wires thread the decoder cores in either of the two directions. As the row current is positive for a '1' and negative for a '0', this means that either the normal output of the store, or its complement, can be written into the decoder cores. A single amplifier input wire threads the matrix and this is connected to an amplifier write circuit similar to the ones used with the store.

The columns of the decoder basically correspond to OR circuits, in that, if during the writing time one or more cores in the column selected is set, then during the next reading time the amplifier write circuit will receive a pulse such as to set the P core and inhibit the Q core. In this decoder the columns are used as AND circuits. This is done by reversing the input row wires, to provide the complement of the normal input, and reversing the polarity of the output current from the P and Q cores. An output current

A full-wave rectifier is incorporated in the amplifier circuit to deal with the different polarities of input from the two halves of the store. The amplifier includes a gating circuit, so that it is inoperative during the writing period.

To provide a memory in the amplifier and write circuit, and also as a means of economizing on drive-valves, wound square loop cores are used to couple the circuits with the row write lines. These cores are similar to the wound cores in the scan circuit, in that they behave as current transformers when set, and pass on only a small '0' current pulse when not set. The ampere-turns required to set them is small compared with the ampere-turns they handle.

These cores are arranged in pairs, so that the P cores produce a positive output and the Q cores a negative output. The P core is connected so as to be set by the output current of the amplifier, while the Q core is set by a drive valve current and inhibited by the presence of an

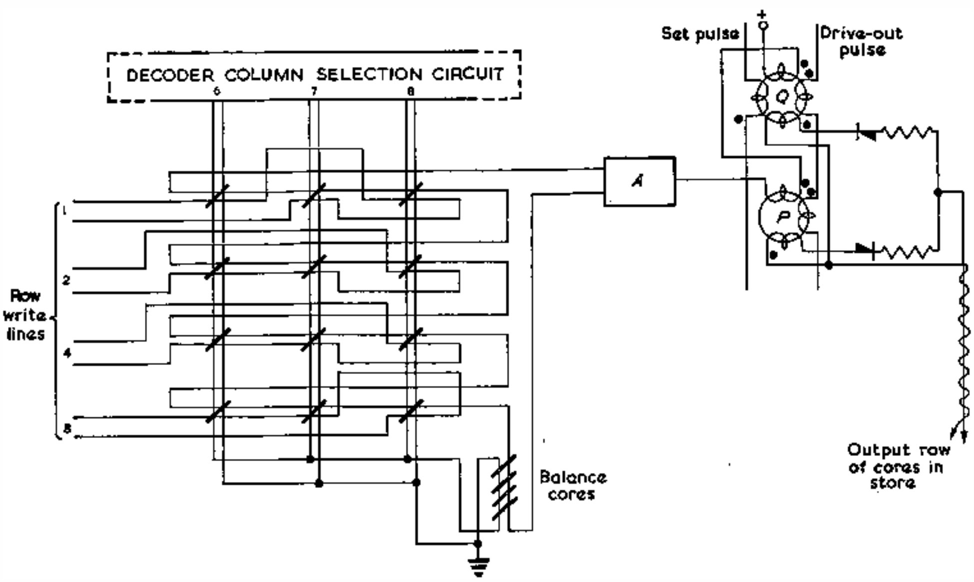


Fig. 4. Portion of decoder matrix

of the correct polarity to set the appropriate core in the output line of the store is thus only provided if the input to the decoder is such as not to set any of the cores in the selected decoder column. In order to make it easier for the decoder amplifier write circuit to discriminate between the addition of four '0' outputs from a decoder column and a single '1' with three '0's, a set of four balance cores is included. These cores are never set and they are wired so as to provide an opposing voltage to the four '0' outputs during the reading time.

The full decoder matrix for a punch buffer corresponds to seven rows and twelve columns. The method of coding on the card is such as to raise some added complications, but the principle is as illustrated.

For a printer, two separate decoder matrixes are required, one dealing with three rows of the store and the other dealing with the remaining four rows. The outputs from the two decoders are then combined in a conventional diode type AND circuit.

Parity Checker

When a character is transferred from the computer to the buffer store, it includes a parity digit carried on the 8th line. The parity digit is held in the buffer store with the others and its value is such as to make the total number of '1's for each character, an odd number. By checking that this number is odd both during the filling of the store and each time the store is circulated to provide a decoded output, a means is introduced for providing an automatic indication of a fault condition.

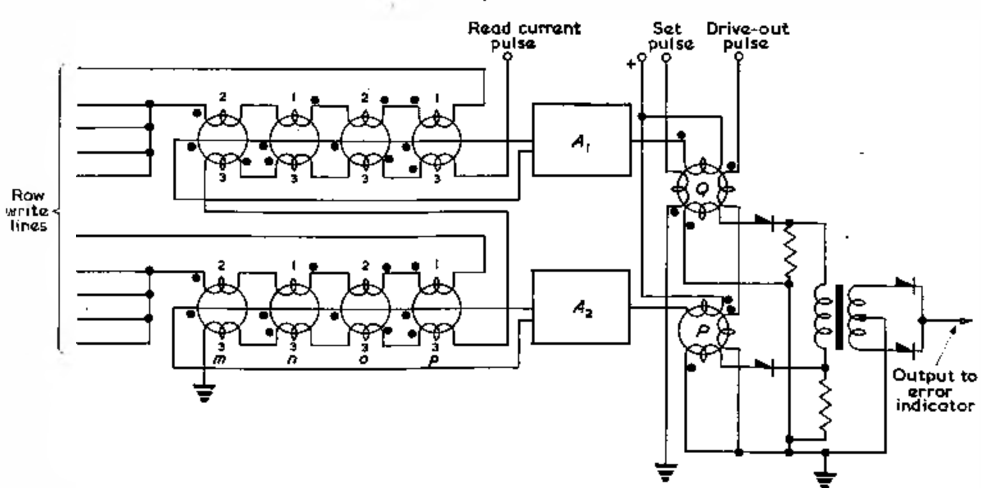
The circuit used to make this check is shown in Fig. 5. The row write lines are grouped in two sets of four lines and the total current for each set of four lines serves as a writing current for four memory sized cores. Row currents are +270mA for a '1' and −270mA for a '0'. The possible total currents for four lines are therefore + 1080, + 540, 0, − 540 and −1080mA. These correspond to an even, odd, even, odd, even number of '1's.

The wiring and the cores are such that core m is set by + 1080 and + 540mA and not by the other input conditions; core n by + 1080mA only; core o by − 1080 and − 540mA; core p by − 1080mA only. During the reading time for that half of the store, the four cores are read. Cores m and o provide a positive output to the amplifier and cores n and p provide a negative output. The circuit is such that a negative output, if present, will always more than balance a positive output and the amplifier circuit is only sensitive to positive pulses. It follows, therefore, that the amplifier will only produce an output in a reading period following a writing period in which cores m or o were set by themselves, i.e. when the number of '1's on the four lines was odd.

The task of cores m and o is a relatively easy one, in that they have only to discriminate between, at the most, the unbalance between two currents of nominally 540mA and full current of 540mA. Cores n and p, however, have the more difficult task of discriminating between 540mA and 1080mA in a time as short as 0·65μsec. The value of 540mA is below the value of current required to disturb these cores, but 1080mA is not sufficient to fully switch the cores in this time. However, by threading the amplifier input wire twice through the larger n and p cores, their output following such writing conditions, is more than sufficient to balance the output from the smaller m or o core.

The amplifiers used are similar to the store amplifier write circuits and the outputs pass through wound core circuits—a P core for a normal output and a Q core for a

Fig. 5. Parity check circuit



complement output. The check on each of the four lines is combined to form a parity check on the eight lines, by adding in opposition, the output from a P core of one amplifier with the Q core of the other. If four of the lines are odd and four of them are even, then there will be similar outputs from both P and Q cores and the resultant will be zero. If, however, they are both odd or both even, there will be an unbalance and a signal will be sent to the error indicator.

Conclusions

The arrangement of the store is such that the drive pulse requirements are very straightforward –only a two-phase pulse supply, with two widths of pulses, being required. During the filling of the store, the number of drive pulses has to be related to the number of characters being transmitted from the computer, but otherwise, the scan circuit is allowed to run round and the drive pulses are terminated by an output from the last stage of the scan circuit. This is comparatively easy to arrange.

It would have been possible to use only a single decoder and parity checker, but the cost of the additional complication in the drive pulse circuits to combine the two halves of the store in a single output would outweigh the cost of the extra decoder and parity checker.

The use of unwound memory sized cores (in the sense that only one or two turns are required) in the decoding and parity checking system has many attractions. Such a system compares favourably in cost with an assembly of the usual computer type logical 'bricks' and it can be very reliable.

Acknowledgment

Acknowledgment is made to International Computers and Tabulators Limited for permission to publish this article and to the staff at the Stevenage Laboratory who assisted in the design, building and testing of this equipment.

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A New Data Handling System

Hagan Controls Ltd—a recently formed member of the Plessey Group of Companies—have introduced the Kybernetes Data Handling System to meet the demand for a versatile, high-accuracy digital data recorder of high input capacity.

The system operates with:

A mean analogue-to-digital conversion time of 11msec.

An input capacity of up to 1 000 points.

A scan rate of 4 points per second.

An overall accuracy of 0·1 per cent or 1 digit.

Any type of output device.

Information from the point of measurement is taken in the form of an electrical analogue signal and is converted into numerical form for display or record.

The information thus collected can be displayed on a digital indicator, recorded on tape, or typed on a log sheet. By means of selector switches on the control panel the system will perform the following operations at the rate of one point per second:

(1) Give a display of the time, point number and point value on demand.
(2) Type out 'on demand' a complete log.
(3) Type out at timed intervals a complete log.
(4) Type out 'on demand' a group of preselected points.
(5) Type out 'on demand', and repeatedly, a complete log.
(6) Type out 'on demand', and repeatedly, a group of selected points.
(7) Remain in a rest position.

In all the seven conditions mentioned above a continuous scan for alarm conditions is made at the rate of four points per second, or three points when another operation is taking place at the same time.

Alarm points are printed out in red on one typewriter giving the time, point number and point value, and these values are printed out again in black when the alarm has been cleared. At the same time a signal lamp is illuminated and an alarm bell rings as long as the alarm conditions exist, the bell being cancelled manually as desired. High and low alarm values are selected on pin boards.

Log points, prefixed by the time of logging, are printed out in tabulated columns for the point value only, 90 points being accommodated on one typewriter. A symbol is also printed to indicate a power failure before, or during, the log, thus giving warning of possible inaccuracies during the print out.

Standard inputs to the logger of 10 or 100mV a.c. or d.c. give a reading of 100 on the display, the three most significant figures being printed out. By means of pin board programming, this reading can be multiplied up to 9999, the input can be characterized to give square root extraction, thermocouple linearization, and multiplication or division.

The accuracy of typewritten data is $\pm 0{\cdot}1$ per cent of full-scale (i.e. 1 000) or plus or minus one digit—whichever is greater.

The input from the measurement points must be of electrical form and of a minimum full scale span of 10mV; this can be either a.c. or d.c. The maximum full scale span is 100mV. Voltages below the minimum span would require special amplification while those above would be reduced by a precision potentiometer. These input signals are selected one at a time by input relays, there being one relay for each input point arranged in banks of ten. In addition to connecting the two incoming signal connexions to the Data Logger through gold plated contacts, other contacts on these relays select the span setting, the function and the alarm level.

The input relays are selected by means of mercury relays in frames known as the X, Y, and Z actuators. The X actuator selects the relays in a bank of 10, the Y actuator the particular bank up to 100 points and the Z actuator up to a maximum selection of 1 000 points.

Each actuator comprises a Sequencer for logging, a Sequencer for alarming, two Diode Buffers, a Gate, and a Register.

The actuator is driven from pulses derived from a Master Timing Generator and the selection of input relays from the Alarm Sequencer is continuous. Selection of inputs by the Log Sequencer is initiated by one of the six possible display modes, the Log Sequencer stopping when it reaches predetermined points for trend or log, these points being permanently predetermined by the wiring. The Alarm Sequencer pauses during the time a Log Sequencer makes a selection, and in the case of a point being in an alarm condition, the Alarm Sequencer will take precedence.

All input signals to the logger, after passing through the input relays, are taken directly to a high stability high gain d.c. amplifier.

The d.c. amplifier output is of the same polarity as the input signal, an input of 100mV giving a full scale output of 25V. The output of the amplifier is compared with a linear or characterized sweep voltage output generated by a Miller integrator circuit; the integrator is clamped by relays at the end of each sweep. The polarity of output from the Miller integrator is opposite to that of the d.c. amplifier.

The comparison between the output of the d.c. amplifier and the Miller integrator is used to gate pulses from a crystal oscillator to the counters, the output from the crystal oscillator being gated into the counters at the instant of applying the charging voltage to the input of the Miller integrator by the charging chassis. The count continues until equal and opposite voltage coincidence occurs, whereupon the gate is closed by the Stop Comparator and the count ceases.

The crystal oscillator generates pulses at the rate of 500kc/s which are fed to a four decade counter; this is thereby set to a digital decimal number proportional to the amplifier input in millivolts.

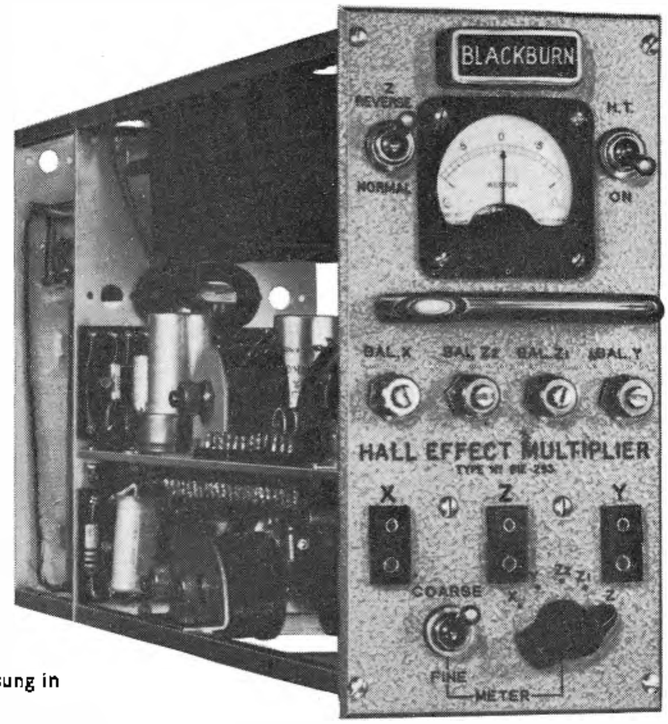
When required for display the digital number stored in the counter is transferred to a Register. Relays in the Register chassis provide means for operating digital displays, or solenoids of print out or tape punch devices, and also hold information while the scan continues at a faster rate than the rate of print out.

A HALL EFFECT ANALOGUE MULTIPLIER

By H. Fuchs*, B.Sc., Ph.D. and D. G. Flockhart*

This article describes a Hall effect analogue multiplier which has been designed to operate with analogue computers. It deals with the detailed design of such a unit and concludes with the performance which has been achieved.

(Voir page 733 pour le résumé en français; Zusammenfassung in deutscher Sprache auf Seite 738)



THE Hall effect analogue multiplier described is suitable for operating with electronic analogue computers. The equipment accepts input signals of ± 100V on its X and Y terminals and produces an output of ± 10V on its Z terminal which is proportional to the product of the two input voltages.

The equipment combines the frequency response of an electronic multiplier with a higher degree of accuracy than has been achieved with multipliers operating over a similar bandwidth.

The development of the unit has been made possible by the availability of indium-arsenide multiplying elements. The multiplying element used in the Blackburn multiplier is manufactured by A.E.I. Ltd.

System Description

The Hall effect in semiconductors may be defined broadly as follows:

When a current I_x flows in a slab of semiconductor along the x axis and a magnetic field H_y is applied along the y axis a voltage V_z will be developed along the z axis which obeys the equations:

$$V_z = BI_xH_y$$

In order to make use of this effect in analogue computers, precision amplifiers are needed, firstly to produce the polarizing current I_x and the magnetizing current I_H from sources with a relatively high output impedance. Secondly, precision amplifiers are required to generate an output voltage of substantial magnitude from the millivolt output voltage obtained from the semiconductor crystal.

In addition, the output amplifier must have a high inphase rejection ratio, that it to say its inputs must be floating, since no common earth is permitted between the input current generator and the output voltage amplifier, in the crystal.

Finally the multiplying element has to be mounted in a constant temperature enclosure to minimize drift due to temperature variations.

A block diagram of a complete multiplier is shown in Fig. 1.

Input amplifier X is a high gain feedback amplifier which

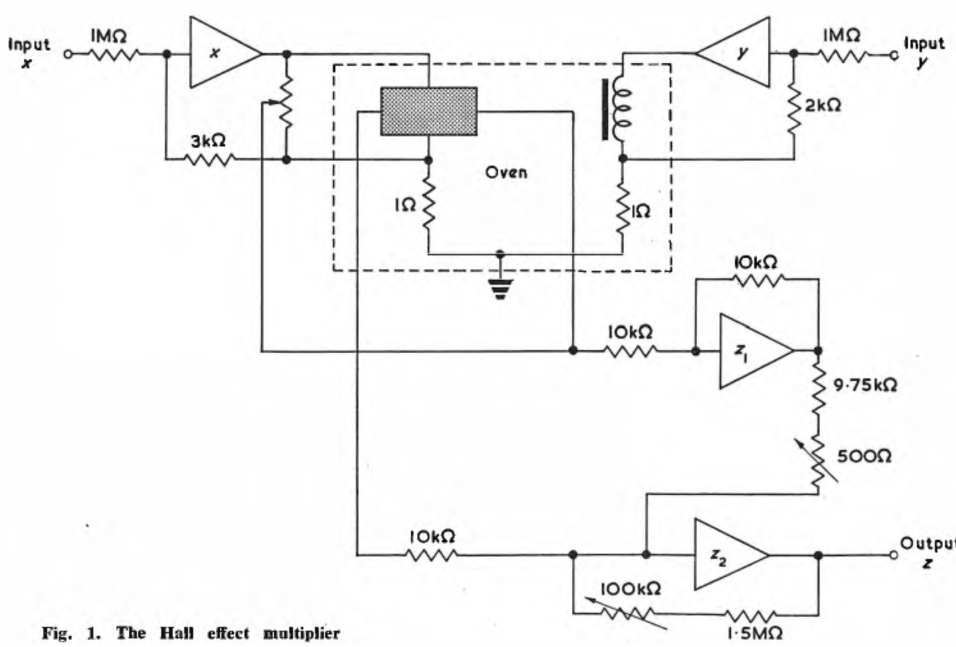


Fig. 1. The Hall effect multiplier

* *Blackburn Electronics Ltd.*

accepts ± 100V on its input and produces an output of ± 300mA through the crystal. Current feedback from a series resistor in the crystal circuit is used to stabilize the current gain.

Input amplifier Y is similar in all respects to amplifier X but feeds the coil of an electromagnet. Current feedback is again applied from a series resistor in the coil circuit and the output is ± 200mA.

of the whole system for multiplication with an accuracy of 0·3 per cent, is 100c/s.

Circuit Description

Amplifier X

The circuit diagram of amplifier X is shown in Fig. 2. The maximum current through the crystal is limited to 300mA in order to reduce heat dissipation and thus preserve the linearity of the system.

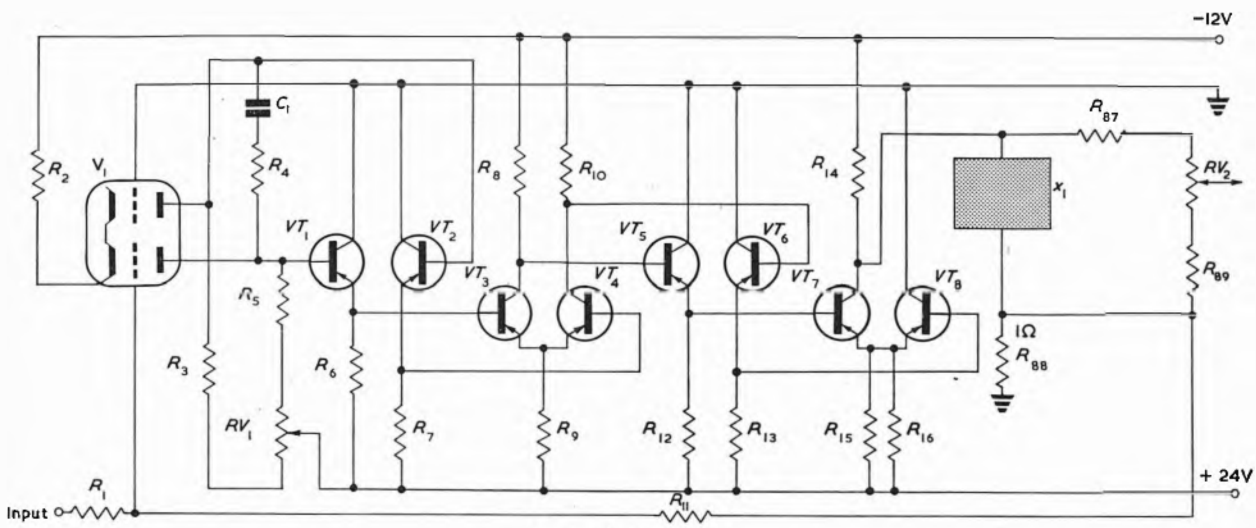


Fig. 2. The X amplifier

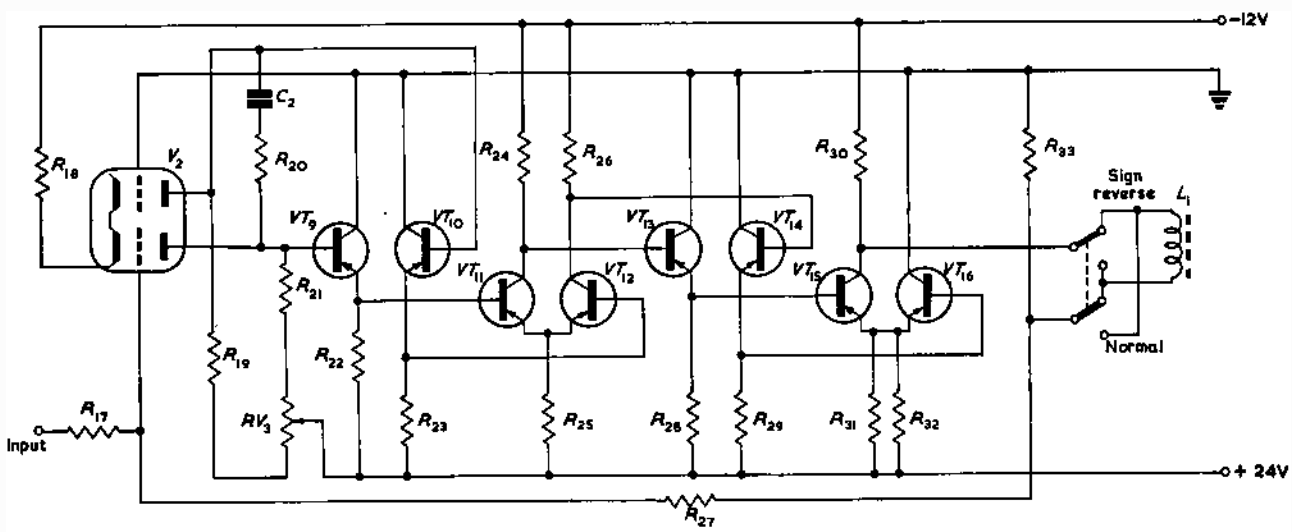


Fig. 3. The Y amplifier

Neither of these amplifiers is drift corrected since the voltage gain is only 1/500 and the drift at the input is, therefore, not significant.

The output from the crystal is approximately 100mV full scale and this voltage is applied to the input of amplifiers Z_1 and Z_2.

Amplifier Z_1 has an effective gain with feedback of -1.

Summing the output of amplifier Z_1 and the second output from the crystal, at the input of amplifier Z_2, results in a very high in-phase rejection ratio. Only the differential output from the crystal is amplified in Z_2. The gain of this amplifier with feedback is approximately 150. Amplifier Z_2 produces ± 10V at a current of 100μA. The bandwidth

This current is obtained from amplifier X with an input voltage of 100V.

A balanced amplifier has been designed to facilitate direct coupling and provide compensation against power supply voltage variations. To minimize drift due to variations of ambient temperature a hard valve is used in the first stage of the amplifier.

The input voltage is connected to the grid of V_{1a} via the 1MΩ input resistor R_1. The high output impedence of the differential amplifier V_1 is converted to a low impedance by VT_1 and VT_2 operating as emitter-followers. The differential signal is then further amplified by a long-tailed pair of transistors VT_3 and VT_4. The outputs are taken, via emitter-followers, VT_5 and VT_6 to the power transistors

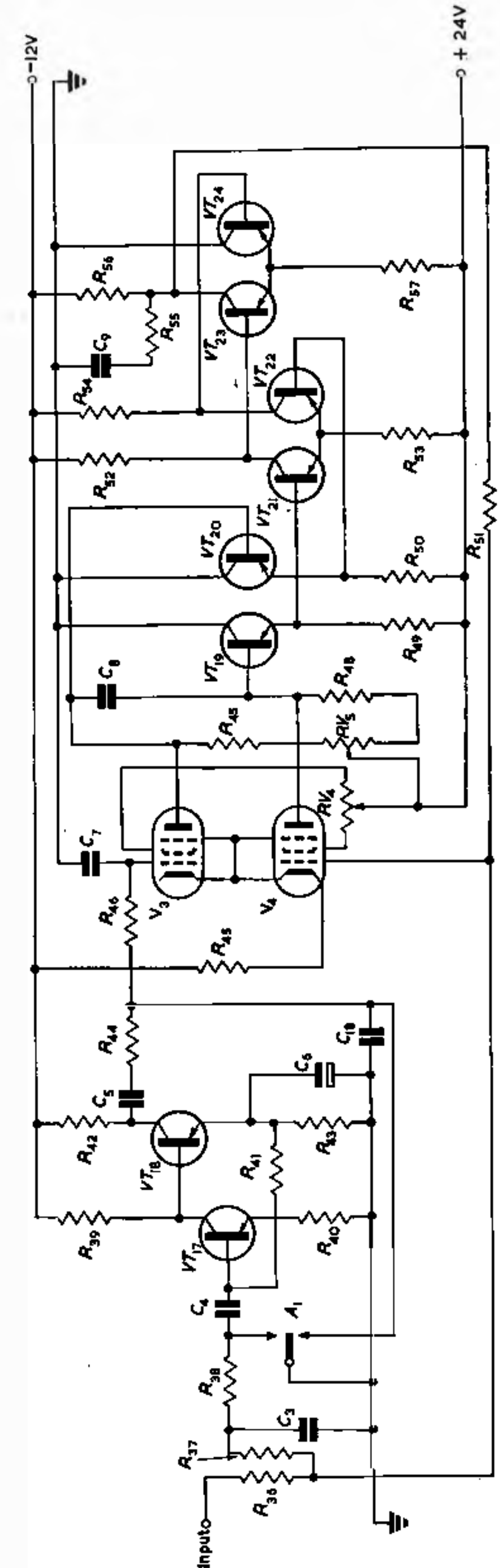


Fig. 4. The Z_1 amplifier

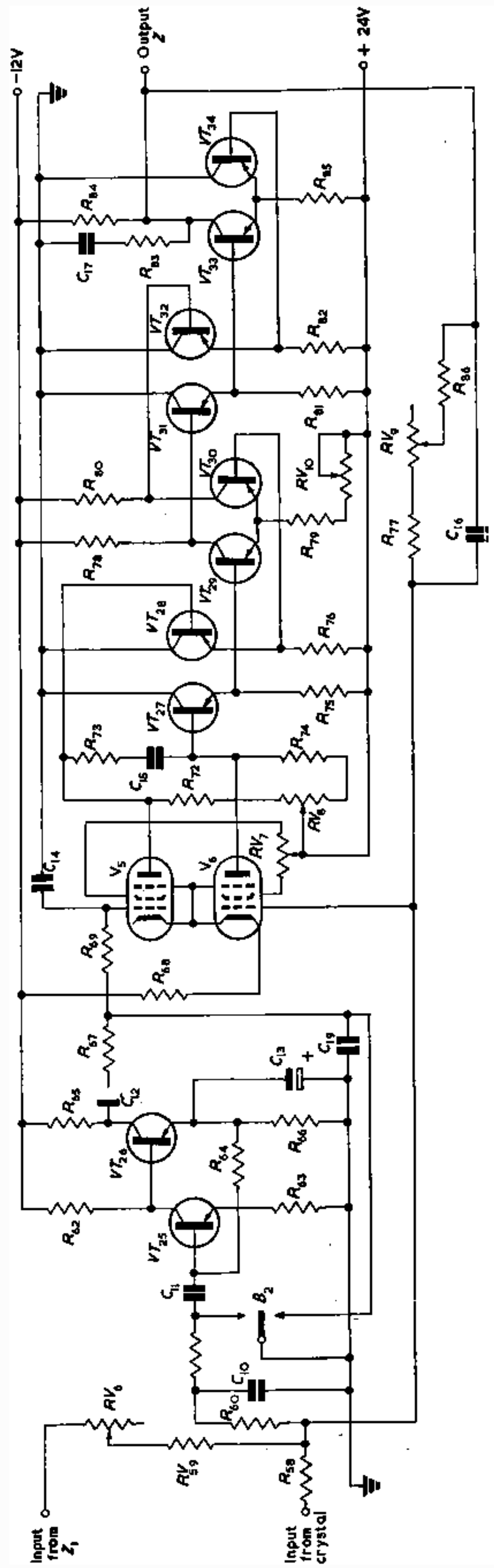


Fig. 5. The Z_2 amplifier

VT_7 and VT_8 which perform the dual function of amplification and push-pull to single ended conversion.

The compensating network R_4 and C_1 is incorporated to stabilize the amplifier against feedback oscillations.

The amplifier load consists of the crystal in series with a 1Ω resistor. Because of the variations of crystal resistance with temperature, constant current gain (as opposed to a constant voltage gain) is necessary and this is achieved by taking the feedback via R_{11} from the junction of the crystal and the 1Ω series resistor.

The amplifier is balanced by varying RV_1, the input resistor R_1 being earthed by a switch and the output level monitored by the 50-0-50 microammeter.

Amplifier Y

The circuit of amplifier Y is shown in Fig. 3 and is similar to that of amplifier X. The output current is limited to 200mA and constant current gain is again necessary because the impedance of the coil of the electromagnet varies both with frequency and temperature.

By the use of current feedback a magnetizing current proportional to input voltage is guaranteed, irrespective of frequency.

The balance control for the amplifier is RV_2.

The main source of non-linearity in the multiplier is the hysteresis in the electromagnet. This effect is minimized by using a Feroxcube core with relatively large air-gap, and also by limiting the magnetizing current to as low a figure as is consistent with obtaining a reasonable output voltage from the crystal.

An alternative approach would be to inject a high frequency 'dither' signal on the coil to ensure that hysteresis is always cancelled; this signal would be superimposed on the output and would also have to be of a substantial magnitude if it was at a fairly high frequency.

This technique has not been adopted in this multiplier.

Amplifier Z_1

This is a high gain directly coupled drift corrected amplifier with its gain limited by negative feedback to −1. The circuit diagram is shown in Fig. 4.

The drift is automatically reduced by means of a mechanical chopper and an a.c. amplifier. The drift voltages appearing at the summing point A are converted to 50c/s square waves by a mains actuated Ericsson high speed relay. The resultant square waves are amplified approximately 800 times and then synchronously rectified by the chopper. After filtering, the d.c. voltage is applied to one of the grids of the cathode coupled input valves.

The main amplifier is directly coupled throughout.

Two valves are used on the input and are arranged to have electrometer type characteristics, the grid current being kept to below 10^{-11}A. The valves are connected as a long-tailed pair, one grid being the input grid of the amplifier and the other grid being fed from the drift correction channel.

The two anodes are connected by emitter-followers VT_{19} and VT_{20} to a long-tailed pair of transistors VT_{21} and VT_{22}. The output from these transistors is taken to the output stage VT_{23} and VT_{24} which serves the dual purpose of amplification and push-pull to single ended conversion. The stabilizing networks C_8, R_{55} and C_9 are used to stabilize the amplifier against feedback oscillations. The input and feedback resistors R_{36} and R_{51} are both 10kΩ.

The amplifier is balanced by varying RV_4, the input resistors being earthed by a switch, the output being connected through amplifier Z_2, to the microammeter.

Amplifier Z_2

This is again a high gain directly coupled drift corrected amplifier, similar to amplifier Z_1.

The main differences are:

(a) The gain with feedback is approximately 150

(b) Two extra transistors VT_{31} and VT_{32} are used as buffers between the penultimate and the ultimate stage to increase the internal gain.

Two stabilizing networks are required, C_{15} and R_{73} and C_{17} and R_{53}.

There are two input resistors, R_{58} from one side of the crystal and R_{50}, in conjunction with RV_5, from the output of amplifier Z_1.

Multiplier Unit

The muliplier unit has been described fully in the literature[1,2].

A low impedance coil is necessary for this application to utilize the low voltage/high current characteristics of transistor circuits.

The potentiometer RV_3 compensates for any inaccuracies due to the crystal output terminals, not being exactly opposite each other. Although the temperature coefficient of the multiplying unit with compensating resistors is 0·02 per cent/°C, this figure may be as much as an order of magnitude worse under certain circumstances. In order to minimize the errors due to temperature variations, the multiplying unit is mounted in a constant temperature oven, the temperature being controlled to within 0·1°C.

Performance

Tests were carried out on a batch of five multipliers, these multipliers being used with a stabilized transistor power supply constructed to be compatible with the multipliers.

The specification to which the units performed is shown in Table 1.

TABLE 1

Input	±100V d.c. or 70·7V r.m.s. 0 to 700c/s
Drift and Noise	Less than 10mV at the output
Departure from best straight line	±0·3 per cent of full scale
Input impedance at X and Y	1MΩ
Output Swing	±10V into 100kΩ

The bandwidth of the multiplier is defined as that range of frequencies within which the phase difference between the input and output sine waves is less than 12 minutes of arc. The multiplier may be used at higher frequencies with a reduced accuracy.

The power supply required for the unit is +24V d.c. 3A and −24V 1·5A, 6·3V a.c. 50 mA, 6·3V a.c. 3A.

The weight of the unit is 9·5 lb and its size is 8in × 4in × 14in.

Acknowledgments

The authors wish to acknowledge the assistance of members of the design staff of Blackburn Electronics Limited and the permission of the Directors to publish this article.

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The Differential Analyser and its Realization in Digital Form

(Part 2)

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

(Voir page 666 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 674)

THE DIGITAL INTEGRATOR

The integration of the Y input increments to form the integrand may be considered first. Suppose that a typical integrand has the behaviour indicated in Fig. 4, the stepped curve describes the behaviour of the digital representation which may also be numerically described as in Table 1. The second line of the table gives the values of Y measured in quanta and the third line gives the corresponding Y increments. In this particular illustration the increments are all either 1 or 0 quanta, but in general, increments may be any small integral number of quanta, positive, negative or zero. Given the initial value, Y is uniquely defined by its series of increments.

The above process may be performed by a reversible counter whose contents increase by one unit on the arrival of a +1 increment and decrease by one unit on the arrival of a −1 increment. The reversible counter clearly behaves, in digital form, in a manner similar to the lead screw and bracket of the wheel and disk integrator, and may therefore be taken as its digital equivalent.

The next operation to be considered is the rolling of the wheel on the disk. Referring to the fundamental equation:

$$\delta Z = Y \cdot \delta X$$

it is apparent that the operation which takes place is the multiplication of the independent variable increment δX by Y to produce the output increment δZ. The output increments are then summed or in the limit integrated to give an answer which is the total rotation of the output shaft.

In the digital case the independent variable increment is, in general, an integral number of quanta, and a multiplier is necessary. The design of the digital integrator may be considerably simplified if it is assumed that the X input-rate is restricted so that its increment in each iteration period is either +1,0, or −1 quanta. In this case the multiplication may be replaced by addition or subtraction.

In order to explain the process of digital integration the case in which all the independent variable increments are equal to +1 is taken first. This is the simplest case and it occurs in practice when integrating with respect to time. Suppose the continuous curve of Fig. 5 represents the velocity of a particle as a function of time and it is required to obtain the position at any given time. Superimposing the grid as in the previous example the digital form of this velocity-time graph is obtained as the stepped curve, the resulting numerical values of the velocity and velocity increments as functions of the iteration period being given in the first three lines of Table 2.

During each iteration period one step of the integration is performed, and reference to Fig. 5 shows that the increment of the integral is equal to the area of the rectangle whose height represents the current value of Y during the period. Taking the quantum of time as being equal to the iteration period the area of the rectangle is, to some scale, numerically equal to the value of Y.

The digital process of integration thus consists of successively adding the Y numbers and gives the sum of the rectangles as the approximate measure of the area. Obviously, the finer the quantization, and the shorter the iteration period the more accurate is the approximation. The result of the addition is given in line four of Table 2 and represents to some scale the area under the curve as a function of the iteration period.

The case in which the independent variable increments are not all equal to +1 quantum is more complicated. Suppose that the curve shown in Fig. 5 represents Y as a function of X instead of T, and suppose that X is given as a function of T in Fig. 6 and Table 3. The values of X are shown in line 3 and the corresponding values of Y, obtained from Table 2, are shown in line 5. From the basic equation:

$$\delta Z = Y \cdot \delta X$$

it follows that the increment of the integral in any iteration period is obtained by multiplying the value of Y by the X increment which is given in line 2. Since the magnitude of the X increment is never greater than one quantum the value of the integral after a given number of iteration periods is thus obtained by either adding or subtracting Y

TABLE 1

Iteration period	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Value of integrand Y	2	3	4	5	6	7	8	9	10	11	11	11	12	12	12	13	13	13	13	13
Increment δY		1	1	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0

TABLE 2

Iteration Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Y Increment	1	1	0	1	0	0	0	0	−1	0	0	1	0	1	0	0	−1	0	−1	
Y	5	6	7	7	8	8	8	8	8	7	7	7	8	8	9	9	9	8	8	7
Integral of Y	5	11	18	25	33	41	49	57	65	72	79	86	94	102	111	120	129	137	145	152

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TABLE 3

Iteration Period	1	2	3	4	5	6	7	8	9	10
X Increment δX	1	1	0	1	1	–1	0	0	0	1
Value of X	2	3	4	4	5	6	5	5	5	5
Y Increment δX	1	0	0	1	0	0	0	0	0	0
Value of Y	6	7	7	7	8	8	8	8	8	8
Increment of Integral $Y\,\delta Y$	6	7	0	7	8	–8	0	0	0	8
Value of Integral	6	13	13	20	28	20	20	20	20	28

or doing nothing according as $\delta X = 1, -1$, or 0 respectively. Line six of Table 3 gives the increment of the integral corresponding to each iteration period and they are accumulated to give the values of the integral in line 7.

The arithmetical operations which have been described may be performed by means of the device shown in Fig. 7. The current value of the integrand and integral are held in two stores or registers which may be referred to as the Y and I registers respectively. The Y register is designed to operate as a reversible counter and is capable of accumulating increments to keep the integrand up to date. Between the Y and the I registers there is a transfer mechanism which is controlled by the independent variable increments δX and operates once per iteration period in the following way:

(a) If $\delta X = 0$ during the iteration period the mechanism does nothing.

(b) If $\delta X \neq 0$ during the iteration period the mechanism either adds or subtracts the current value of Y to the value of the integral in the I register according as $\delta X = 1$ or -1 respectively.

The precise physical form taken by the register and transfer mechanism obviously depends on the detailed design of the complete machine, and is not considered here.

Interconnexion and Scaling

The digital integrator is not quite in the form required for use in a differential analyser since its output, which is the number in the I register, is the whole number value of the integral. The device is, in fact, equivalent to the wheel and disk rate integrator with an indicator on the output shaft. If it is intended that the output is to become the input of other integrators, e.g. as in the schematics illustrated in Figs. 3(b) and 3(c) it is necessary that the output should be available in incremental form as an integral number of quanta. The last lines of Tables 2 and 3 give a measure of the integral to some scale but not necessarily in terms of the most suitable quantum. Recalling that the quantum size is a measure of the accuracy of the digital representation it becomes apparent that the output quantum should be determined by the accuracy of the digital integration process and hence by the accuracy of the inputs. A simple numerical example is now given to show how the output quantum size is determined in practice.

Consider the examples of the integration of a velocity-time function to obtain distance travelled. The accuracy of representation of velocity is determined by the velocity increment in relation to the maximum velocity which can occur. Suppose that the maximum velocity which can occur is 1ft/sec and the velocity increment 1/10ft/sec. Also, suppose that the time quantum which is the iteration period is 1/10sec. For a body travelling at 1ft/sec the value of Y must be 10 and during a second the integration process is shown in Table 4.

Since in 1sec at 1ft/sec the body travels 1ft, the last line of Table 4 gives the distance travelled in units of 1/100ft. However, since the time may only be determined

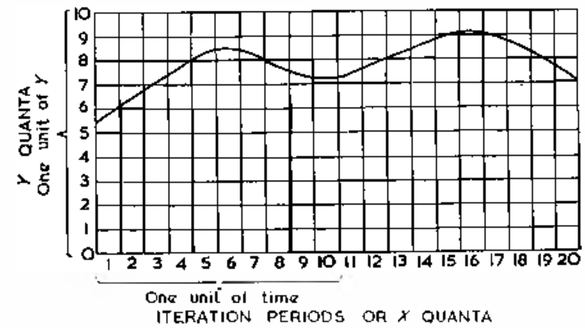


Fig. 5. Digital integration with respect of time

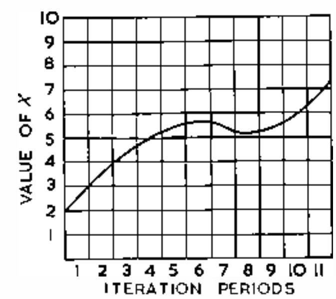


Fig. 6. Variation of independent variable X

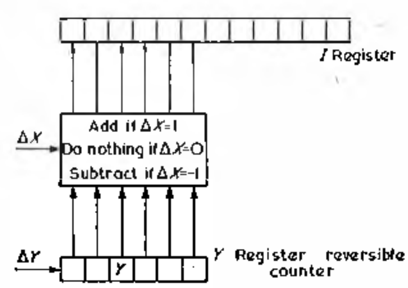


Fig. 7. The digital integrator

to the nearest 1/10sec, the distance can only be known to 1/10ft, and this represents the minimum significant change in the output which may be warranted by the accuracy of the input. The maximum value of Y is taken as this represents the worst possible case. Thus the size of the output quantum is determined by the independent variable quantum and the maximum value of the integrand and is 1/10ft. A parallel may now be drawn to the process of multiplication of two numbers. The long multiplication process results in a double length number, but only the most significant half is taken as the answer since this represents the maximum accuracy which may be justified by the accuracy of the factors.

The number in column 3, Table 5, is the most significant half of the integral of Y (obtained from the bottom row of Table 2). This gives an indication of the way in which it is necessary to modify the device shown in Fig. 7 to give incremental outputs. In Fig. 7 the I

register is shown as having more digits than the Y register so that it accumulates the total value of the integral. In Fig. 8 the I register has been shortened so that it has the same capacity as the Y register. The effect of this is that the I register, or R register as it is now called, is unable to accumulate all the Y's and it overflows periodically. Returning to the numerical example, suppose the Y and R

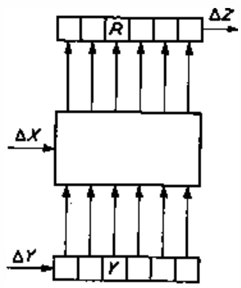


Fig. 8. The digital integrator giving incremental outputs

registers may hold the numbers 0 to 9 and consider the effect of successively adding the Y's given in Table 6.

Assuming that the initial R is zero, the addition of the first value of Y (5) increases R to 5. The addition of the next value of Y (6) would take R to 11 if the R register contained sufficient capacity. Since the maximum value the R number may take is 9, the R register must emit an overflow resulting in a new R number equal to 1. Table 6 shows the behaviour of the R number and the resulting overflows which occur. Comparing Tables 6 and 5 an important fact emerges viz: the pattern of overflows in Table 6 and increments in the integral of Table 5 are identical. Thus in order to obtain the increments of the integral in terms of the appropriate quantum size it is only necessary to detect the overflows which emerge from the R register.

The device shown in Fig. 8 is therefore the appropriate digital equivalent to the wheel and disk integrator without its output indicator. It takes in increments of the integrand, δY, and sums them to give Y the integrand. It multiplies Y by δX and adds this into the R register to give the appropriate increments of the integral as an overflow pattern. This device therefore takes in and emits increments and may therefore be connected to the inputs or outputs of other integrators to form schematics. The digital integrator may also be regarded as a rate multiplier, in which the rates are streams of pulses or increments. As in the case of digital numbers there is always an upper limit to the number which may be represented, so there is a maximum pulse rate which consists of one increment per iteration period, known as 'full machine rate'. Similarly smaller pulse rates may be defined by the ratio of the number of increments to iteration periods. Representing an increment by 1 and no increment by 0 some typical pulse rates are shown in Table 7.

Taking the simple numerical example again, if the Y register is completely full, i.e. $Y = 10$, the R register overflows every time $\delta X = 1$. Thus an X input of full machine rate results in a full machine rate output. If the Y register is only half full, i.e. $Y = 5$, one overflow occurs for two $\delta X = 1$ inputs, thus the ouput pattern consists of alternate overflow and non-overflow, as shown in the second line of Table 7. Similarly for any Y number it is found that the overflow pattern corresponds to a rate which is the input rate multiplied by the ratio of the Y number to the number required to fill the register. The overflow patterns which would result from full machine δX are thus identical to those in Table 7. In practice the δX increment is never greater in magnitude than one quantum. This, interpreted in terms of rates means that the δX rate is never greater than full machine rate. Since the output rate of an integrator is only equal to the δX input rate when Y has its maximum value the greatest value which an output rate

TABLE 4

Iteration period	1	2	3	4	5	6	7	8	9	10
	←				ONE SECOND					→
Integrand (velocity in quanta)	10	10	10	10	10	10	10	10	10	10
Integral (distance travelled)	10	20	30	40	50	60	70	80	90	100

TABLE 5

Iteration period	Integral of Y	Integral in terms of quanta (ft.)	Increments
1	5	0	0
2	11	1	1
3	18	1	0
4	25	2	1
5	33	3	1
6	41	4	1
7	49	4	0
8	57	5	1
9	65	6	1
10	72	7	1

TABLE 6

Iteration period	Y	R	
1	5	5	
2	6	1	overflow
3	7	8	
4	7	5	overflow
5	8	3	overflow
6	8	1	overflow
7	8	9	
8	8	7	overflow
9	8	5	overflow
10	7	2	overflow

TABLE 7

Iteration period	1	2	3	4	5	6	7	8
Full Rate	1	1	1	1	1	1	1	1
$\frac{1}{2}$ Rate	0	1	0	1	0	1	0	1
$\frac{3}{4}$ Rate	0	1	1	1	0	1	1	1
$\frac{1}{4}$ Rate	0	0	1	0	0	1	0	0
Zero Rate	0	0	0	0	0	0	0	0

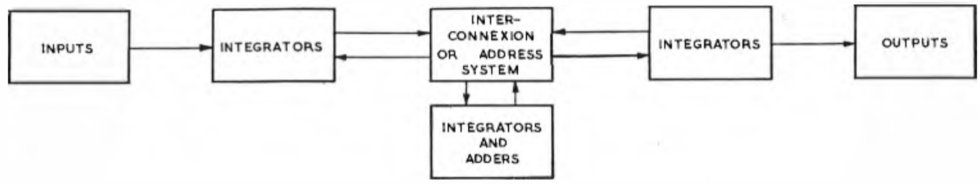


Fig. 11. General organization of a simultaneous d.d.a.

may take is also full machine rate. Thus provided the problem is scaled correctly so that in no case does a Y register overflow, all integrator output rates are less than, or equal to, full machine rate. Thus the output of an integrator may be connected to the δX input of another integrator. It is not possible to connect more than one output to the δX input since the sum may exceed full rate, but this is possible in the case of the δY or integrand input since there is no limitation on the number of quanta in the Y increment.

While for the sake of illustration the capacities of the Y and R registers have been taken as ten quanta, in a practical integrator the capacities would be much larger. For example, 1 000 quanta would be taken for an accuracy of 0·1 per cent; usually in the case of machines using the binary code the capacity is some power of two. In all cases the output quantum is determined by the overflow of the R register and it is found that this always represents a suitable size as warranted by the accuracy of the inputs.

The Digital Differential Analyser

The digital differential analyser (abbreviated to d.d.a.) consists essentially of a collection of digital integrators which may be interconnected in any required manner to solve problems. There are many ways in which a d.d.a. may be organized and these fall into two main types. In machines of the 'simultaneous' type each integrator has its own associated arithmetic unit which allows concurrent operation of all integrators. Machines of the sequential type have a common arithmetic unit and the Y,R number pairs are brought out of a main store in turn to undergo the integration process.

For the simultaneous d.d.a. the iteration period is the time taken to perform one integration step, whereas for the sequential d.d.a. the iteration period is the time taken to process all integrators in turn.

Each type has its own inherent advantages and disadvantages. For example the simultaneous d.d.a. has a constant iteration period regardless of the number of integrators being used. Whereas for the sequential d.d.a. the iteration period increases and the machine becomes slower for more complex problems. On the other hand, the penalty paid in terms of increased size or amount of equipment is much heavier for the simultaneous machine.

D.D.A's may be further subdivided into serial or parallel machines according to the way in which the arithmetic is performed. A detailed discussion of this distinction is given elsewhere[4]. The main point of interest, however, to bring out at this stage is that parallel machines are faster than serial machines but require more equipment.

Interconnexion of integrators is straightforward for simultaneous d.d.a's. All that is necessary is to transmit the overflows which appear simultaneously at the end of each iteration period to the appropriate inputs by some physical means. Fig. 9 illustrates the operation of the simultaneous d.d.a.

Operation of sequential d.d.a's is more complex and is illustrated in Fig. 10. The iteration period is now the time taken to process all the integrators in turn, and the time taken to process one integrator is called an 'integration' period. For convenience, the integration periods are labelled $I_1, I_2, \ldots I_n$.

Interconnexion requires an integrator output or δZ store and the method of operation may be most easily explained by means of a simple example. Suppose that the problem to be solved requires that the output of integrator 1 be connected to an input of integrator 10. The δZ or overflow of integrator 1 appears at the end of period I_1, and is transmitted to the δZ store. In the period I_9 this overflow is read from the store so that it is available during I_{10} for the processing of integrator 10. Since the output of integrator 1 may also be required for other integrator inputs the reading process must leave the value of δZ_1 unchanged until the next I_1 period when a new overflow appears. Thus integrator interconnexion is achieved by means of routing signals to appropriate positions of the overflow store and sampling at appropriate times of the iteration period. The device which performs this operation is known as the address or programming unit of the machine.

In order to make the machine fully operational input and output facilities are necessary. Inputs may be of three types, i.e. initial integrand values, constants or continuously varying quantities which can come from other equipment. Similarly outputs may also be of two types, i.e. fixed quantities which result at the end of a machine run or variables

Fig. 9. Simultaneous d.d.a. operation

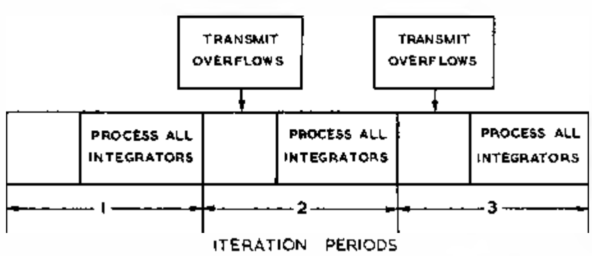
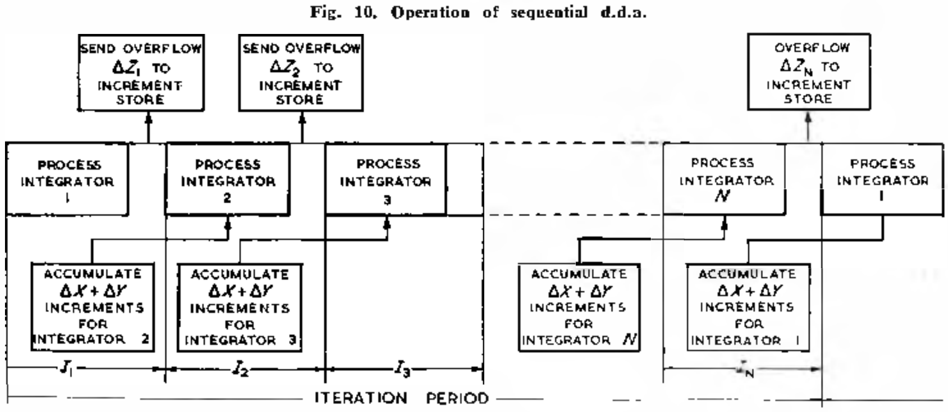


Fig. 10. Operation of sequential d.d.a.



which may be transmitted to a plotting table or other external equipment.

Figs. 11 and 12 show the general organization of the two types of d.d.a. A suitable way of arranging the inputs and outputs for the simultaneous d.d.a. is to connect them physically to the appropriate integrators. Interconnexion may be achieved by direct connexion of inputs to outputs,

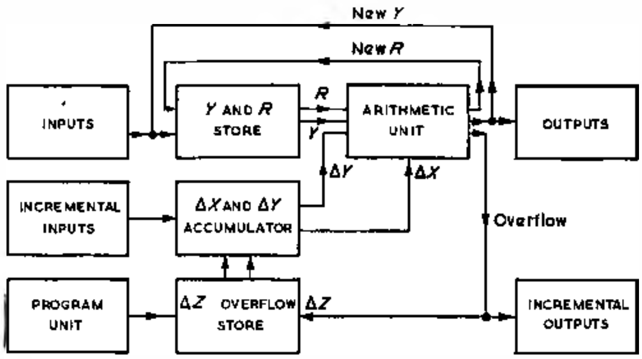


Fig. 12. General organization of a sequential d.d.a.

or all integrators may be connected to a central address system as in Fig. 11 which could consist of a plug board. This simultaneous machine also requires adders which correspond to the differential gears of the mechanical differential analyser.

For the sequential machine inputs and outputs are connected to the main store and operate during the appropriate integrator periods of the cycle. Sometimes incremental inputs and outputs are used and their connexion to the machine is shown in Fig. 12.

Conclusion

Many digital differential analysers have been built in the U.S.A. during the last ten years and several in the U.K. more recently. The advent of the transistor, diode and ferrite core as circuit elements has enabled the latest generation of these d.d.a's to assume the form of particularly neat, compact and reliable computers.

The authors will be describing in detail the logical design and circuit elements of one such machine, CORSAIR, in a series of articles to be published in this journal during the next few months.

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Conductive Rubber as an Analogue Device *

Rubber or other flexible plastic material can be made conductive by the addition of carbon products such as graphite. The electrical resistance is dependent on the carbon density and particle size. The resistance can also be changed by mechanical distortion of the material. This physical change reduces the cross-sectional area and the contact pressure between adjacent carbon particles. This property of resistance change against mechanical stress can

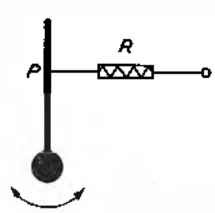
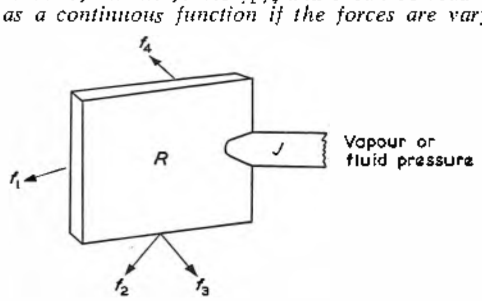


Fig. 1. A.C. generator

P is a simple pendulum to which is attached a strip of conductive rubber R. This resistance R varies as the swing of pendulum P

Fig. 2. Complex mechanical transducer

The resultant of all the forces f_1-f_4 and J can be read instantly or as a continuous function if the forces are varying



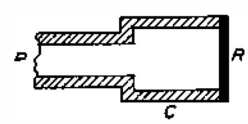
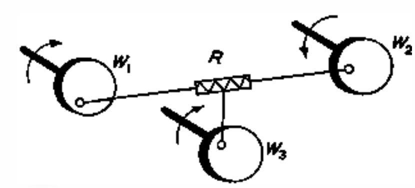


Fig. 3. Analogue element

A rubber membrane is held in a suitable container C. The resistance R varies as pressure P

Fig. 4. Function generator

The rotary movement of the wheels W_1, W_2, W_3 produces a complex resistance change in the rubber strip R



be utilized in a number of applications, a few of which are suggested in Figs. 1 to 4.

Magnetic Recording of Radar Information *

It has been suggested that a requirement exists for recording of airport surveillance radar information on magnetic tape to enable a record to be kept for possible future enquiries. As most radars used for this purpose have a dead time of perhaps 90 per cent, it is suggested that this could be made use of to reduce bandwidth requirements. In particular, each scan of the radar could be stored on a storage tube of the 'Radechon' type and read out during the 'dead' time between scans. Where the 'dead' time is 90 per cent of the total, this would give a 9:1 reduction in bandwidth. The principle may, of course, be extended to use more than one tube, with a corresponding reduction in bandwidth.

* *Communications from E.M.I. Ltd.*

A High Power Transistor-Magnetic D.C. Amplifier

By G. Sarkar*, B.E., D.I.C.

A d.c. amplifier is described in this article which employs a transistor chopper in the input stage, two transistor amplifiers as the intermediate stage and a magnetic amplifier as the final output stage. The unit is designed to have a high input impedance and to amplify d.c. input signals of the order of a few millivolts to give an output of several hundred watts.

(Voir page 733 pour le résumé en français; Zusammenfassung in deutscher Sprache auf Seite 738)

THE main features of the amplifier can be summarized as follows:

(1) High gain

(2) High power output

(3) Fast speed of response

(4) Negligible d.c. drift with time and temperature

(5) Compact and rugged design not susceptible to shock, vibrations and microphonics.

The amplifier has two main sections (Ref. Fig. 6). The first section consists of a transistor chopper followed by a single transistor pre-amplifier stage. The main function of the transistor chopper being to convert the input d.c. signal to give a train of square wave pulses. This enables a.c. coupling to be used in the following stages and thereby reduces the d.c. drift to a minimum. The amplitude modulated square waves are then amplified by a common-emitter transistor stage working in class-*A*. A silicon transistor is chosen for this stage to minimize drifts due to extreme variations of ambient temperature. A voltage gain of approximately 3×10^2 is obtained in this stage.

In the second section a push-pull transistor amplifier stage drives a push-pull magnetic amplifier stage working on the half-wave flux reset principle. A power gain of approximately 45dB is obtained in this section.

The chopping frequency and phasing of the intermediate stages are arranged to be such as to produce amplitude modulated square waves of the same frequency as the supply to the magnetic amplifier. The amplitude modulated square waves are used as resetting pulses for the transductors of the magnetic amplifier. The general arrangement is shown in the schematic diagram, Fig. 16.

Transistor-Chopper Stage

Junction Transistor as a Switch

The principle of the transistor chopper is based on the well-known switching behaviour of a junction transistor in the common emitter connexion[1,3].

The principle of operation involved is as follows: The collector emitter impedance of a transistor depends on the polarity and magnitude of the base current. With reference to Fig. 1, when the emitter-base diode is biased in the forward direction sufficient current flows to saturate the transistor, the output impedance drops to the order of 20Ω. But when it is biased in the reverse direction, only the leakage current of the diode (base-emitter) can flow. The magnitude of this leakage current is of the same order as the collector leakage I_{co} (in common base connexion). Under these conditions, the output collector impedance of the transistor rises to the order of 1MΩ. The extreme variations in output impedance can be effectively used as an open or closed switch.

De-merits of a common-emitter Connexion

The main disadvantage with a common-emitter connexion is its relatively high leakage current compared to the common base connexion. The magnitude of the collector leakage current is given by the following formula[3].

$$I_{co}' = (1 + \alpha') I_{co} \quad \text{.............. (1)}$$

At a junction temperature of 25°C the average value of I_{co}' for a germanium transistor is about 150μA compared to an I_{co} of 4μA under the same conditions. The term α', i.e. current gain, is also more sensitive to temperature than α; as such, it makes I_{co}' more variable with temperature. The value of I_{co}' increases to approximately eight times its value at 45°C from an ambient temperature of 25°C. From Fig. 2 it can be seen that if the base current

Principal Symbols

E_i	=	Input d.c. voltage
E_{out}	=	Output d.c. voltage
E_c	=	A.C. chopping voltage
E_{cm}	=	peak value of E_c
V_c	=	A.C. collector supply voltage
V_{cc}	=	peak value of V_c
V_{be}	=	Transistor base-emitter voltage
V_{ce}	=	Transistor collector-emitter voltage
I_b	=	Transistor base current
I_c	=	Transistor collector current
α	=	Current gain (Common base connexion)
α'	=	Current gain (Common emitter connexion)
I_{co}	=	Collector reverse leakage current (common base)
I_{co}'	=	Collector reverse leakage current (common emitter)
R_i	=	Input series resistor
R_b	=	Base series resistor
R_{ce}	=	Collector-emitter impedance
e_s	=	A.C. supply voltage
e_c	=	A.C. control voltage
R_c	=	Rectifier; R_o = Leakage resistance; R_o' = Critical value of R_o
R_L	=	Load resistance
N_c	=	Number of turns of control winding
N_L	=	Number of turns of load winding
N_R	=	Number of turns of reset winding
I_R	=	Reset current
E_o	=	A.C. load supply voltage
$E_{o(pk)}$	=	peak value of E_o
N	=	$N_L : N_c$
I_L	=	Load current

* *Associated Electrical Industries (Manchester) Ltd.*

is maintained at zero, the collector leakage current will rise to about 1mA with a junction temperature rise of 45°C.

Remedy by using Alternating Chopping Wave

The disadvantages mentioned above can be overcome by using an alternating voltage as the base drive. The operation involved is as follows.

As stated above, for switching purposes, if a datum level

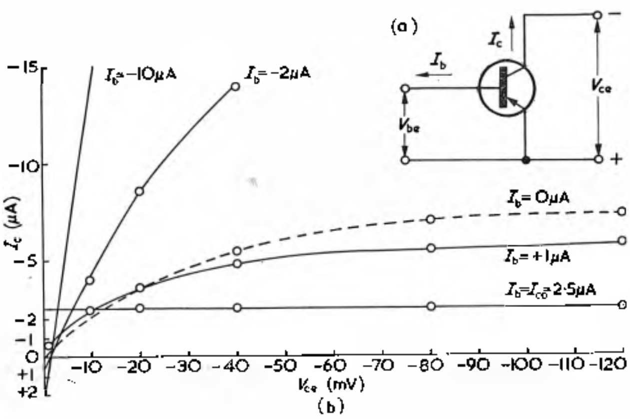


Fig. 1. Common emitter characteristic of a pnp transistor

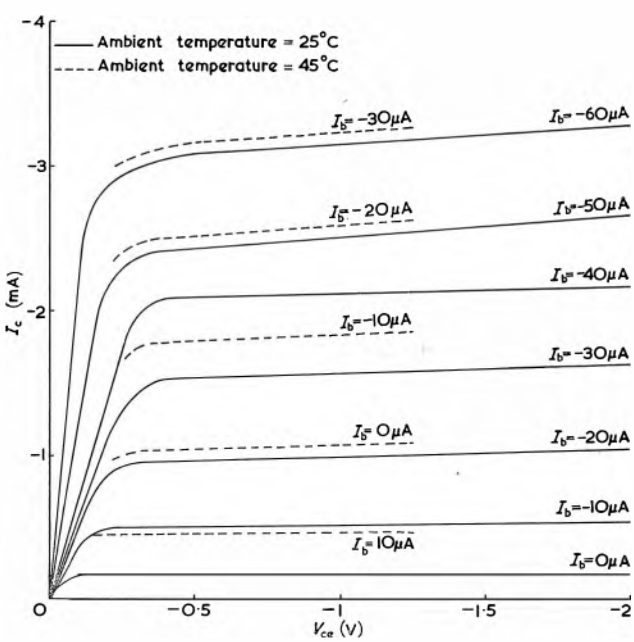


Fig. 2. Drift of characteristics due to variations in ambient temperature

of zero voltage is set for the base ('off' condition) and the transistor (pnp type) is switched to the 'on' condition by means of negative pulses, then the 'off' condition impedance will reduce considerably (i.e. behave as a poor switch) with rise of temperature. This is particularly important where there is a steady input voltage across the collector-emitter terminals.

This problem can be solved by using a positive pulse to bias the base-emitter diode in the reverse direction sufficiently during the 'off' condition and thereby reducing the leakage current to a minimum and output impedance to maximum. This, in effect, will tend to increase the potential between the emitter and base and thereby reduce the flow of carriers to a minimum. It can be seen from Fig. 3 that at 50°C a positive base current of 32μA will only produce a current of approximately the same order in the collector circuit and negligible current in the emitter circuit. The 'off' condition impedance could be further improved if the transistor was connected in the inverted condition, i.e. the collector and emitter connexions reversed. In the inverted connexion, the positive current reduces to about 2μA at 50°C (see Fig. 4).

Where switching of a transistor is required to be done rapidly, at equal intervals of time, this can very effectively and conveniently be done by using an alternating voltage

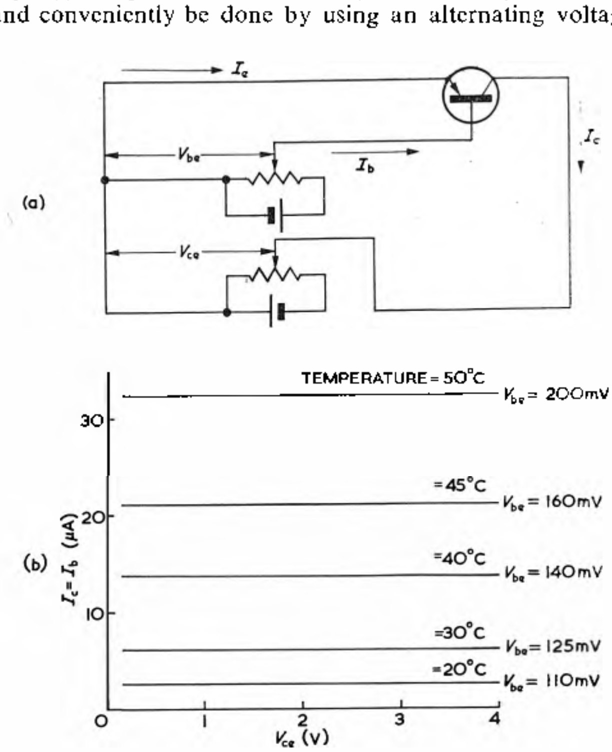


Fig. 3. 'Off' condition characteristic with base-emitter diode biased in the reverse direction

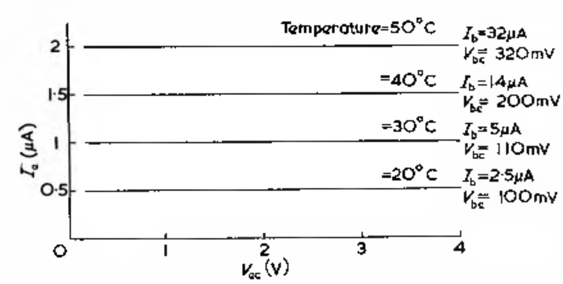


Fig. 4. 'Off' condition characteristic with transistor operated in the 'inverted' manner

capable of driving the base hard into its saturation condition in either direction. The negative half cycle will bias the base in the forward direction and represent the 'on' condition, whereas the positive half cycle will bias it in the reverse direction for the 'off' condition.

Design of Transistor Chopper

The transistor chopper circuit based on the principle of transistor switching is unique in its simplicity, stability and low levels of switching pedestal. The mode of operation is as follows:

Fig. 5 represents a transistor connected in the inverted manner. E_i is the d.c. input voltage and E_c the alternating chopping voltage. During the positive half cycle of E_c, the transistor is in the 'off' condition and thus exhibits a very high impedance. The input resistance R_i is of the order of 1kΩ. Hence, during 'off' condition, as $R_{ce} \gg R_i$, the input voltage appears practically undiminished across the output as E_o.

During the negative half cycle of chopping voltage E_c, base current flows to saturate the transistor, which causes the transistor to bottom and the collector emitter impedance drops to a minimum, i.e. $R_{ce} \ll R_i$. Under these conditions the input voltage is nearly totally dropped across R_i and the voltage appearing across the output is very small.

It may be noted that with zero signal input the collector emitter potential V_{ce} is of the order of 1mV. As such, the device is virtually free from switching pedestal. The slope of the wavefronts of the output voltage caused by the sinusoidal nature of the chopping voltage could be improved by the suitable design of the base resistor R_b. If the saturation current is reached at about half the

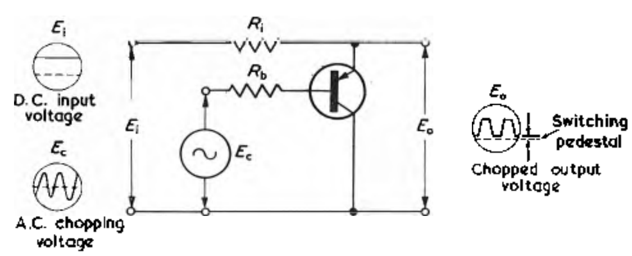


Fig. 5. Transistor-chopper circuit using a.c. voltage as a chopping voltage

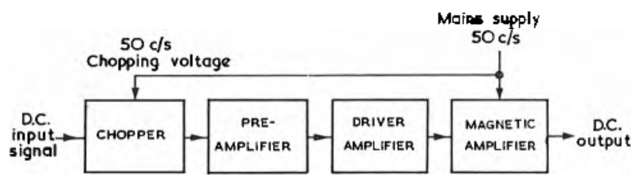


Fig. 6. Block schematic for the transistor-magnetic d.c. amplifier

peak value of the chopping voltage, the slope of the wavefronts is very much reduced.

$$R_b = \frac{E_{cm}/2}{\text{Saturation Current}} \quad \ldots\ldots\ldots \quad (2)$$

Class-A Transistor Amplifier Stage

The train of chopped d.c. voltage, (i.e. square waves) from the transistor chopper is coupled through a capacitor to a single transistor amplifier stage, working in class-*A*. The common emitter method of connexion is chosen for this stage as it gives both voltage and current gain and requires only a single source of supply for its operation. Unfortunately, with germanium transistors, this method of connexion is also the least stable and most susceptible to temperature variations (see Fig. 2). As such, it requires elaborate stabilizing circuits and design considerations to have a satisfactory operation within rather narrow limits of ambient temperature.

With the development of silicon transistors, a maximum junction temperature limit of 200°C compared to 75°C for that of germanium transistors, has been achieved. In the normal ambient temperature conditions, i.e. 20°C to 50°C, the performance of silicon transistors is extremely satisfactory without the use of any stabilizing circuits. Therefore an npn type of silicon transistor has been chosen for this stage. The output is transformer coupled to the third stage, which is a class-*B* push-pull transistor stage.

Power Amplifier Stages

Class-B Push-pull Transistor Stage

The main function of this stage is to raise the power level of the input signal to a value adequate for driving the final magnetic amplifier stage. The mode of operation of this stage is described as follows:

With reference to Fig. 8, the characteristics of the transistors are drawn back-to-back to represent the class-*B* operation. The collectors are supplied with an a.c. voltage V_c, the maximum value of which is V_{cc}. When the transistor is driven hard into its saturation condition, i.e. the base current supplied $\geqslant I_{b(sat)}$ (saturation base current), the voltage drop across the transistor is reduced to a minimum and nearly the full supply voltage appears across the output. The instantaneous current is given by:

$$I_c = (V_c/R_c)$$

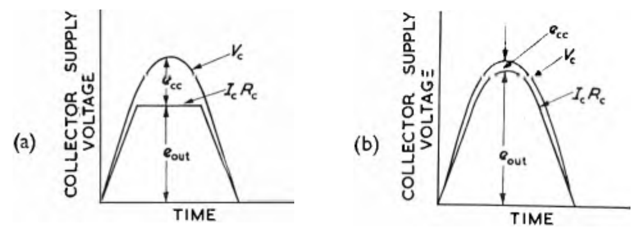


Fig. 7. Output voltage waveform of the transistor with square wave base input

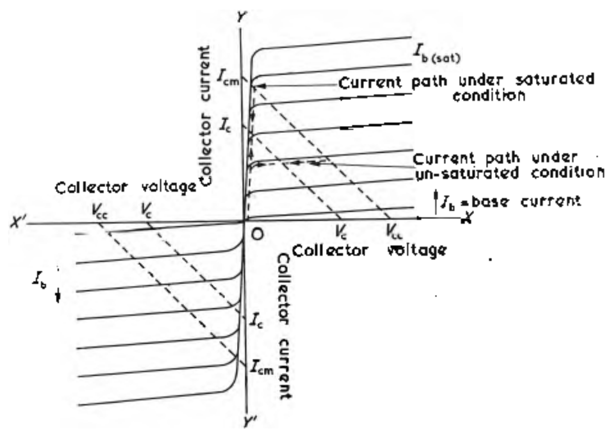


Fig. 8. Class 'B' operation characteristics of the transistor

and the maximum value is given by $I_{cm} = (V_{cc}/R_c)$. This is shown in Fig. 7(b).

When the base current supplied is less than $I_{b(sat)}$, the current path followed is shown in Fig. 8 and the voltage output is shown in Fig. 7(a). This gives a flat topped sine wave output, the height of the flat top being proportional to the magnitude of the base current supplied. A typical oscillogram for an output current pulse under unsaturated condition is shown in Fig. 9.

Magnetic Amplifier Stage

The final power amplifier stage is a magnetic amplifier working on the half-wave flux reset principle.

Half-Wave Flux Reset Working Principle

With reference to Fig. 10(a), the transductor core *T* has two sets of winding, i.e., load winding F_LS_L and control winding F_CS_C. The letters *F* and *S* indicating the 'finish' and 'start' of the winding. The load and control windings are supplied from a.c. voltage sources e_s and e_c respectively. The series resistances in the circuit are R_L in the load circuit and R_C in the control circuit. The supply voltages are phased to operate in alternate half cycles.

For the sake of simplicity, the circuit elements are assumed to have ideal characteristics, i.e. the B-H loop of the transductors are assumed to be perfectly rectangular and the rectifiers to have no leakage.

With reference to Fig. 10(b), assume the initial condition of the transductor core is at t_0 and the polarity of the a.c. voltage is such that current starts to flow in the reset circuit—(the load circuit voltage source being oppositely phased is blocked by the rectifier MR_1).

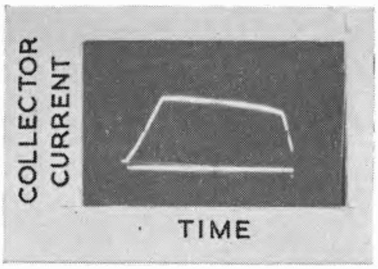


Fig. 9. Oscillogram of a typical output current pulse

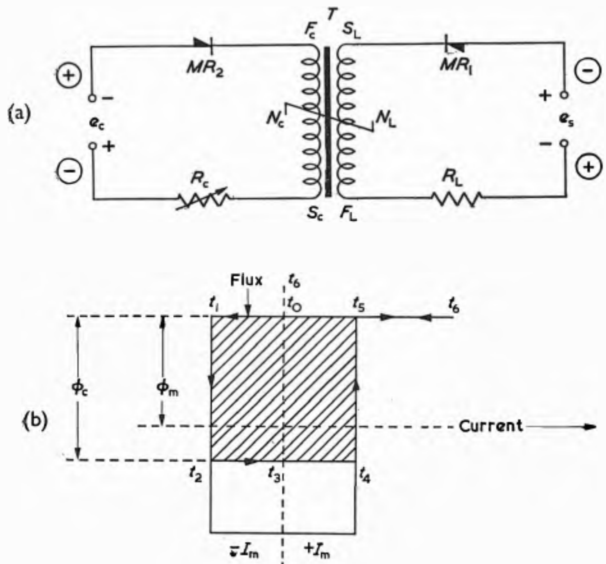


Fig. 10. Half-wave flux reset working principle of magnetic amplifier

As current starts to rise in the reset circuit, the transductor remains saturated during the time t_0 to t_1, until the current rises to a value I_m. With reference to Fig. 11(a), during time t_0 to t_1, the voltage is dropped entirely across the resistance R_C and the voltage at the instant t_1 is given by:

$$e_1 = I_m R_C$$

As soon as the current reaches the value I_m, the flux in the transductor core begins to change, the current remains constant at I_m. This is possible due to the rectangular nature of the core characteristic. The sinusoidal rise in supply voltage being entirely absorbed by the core. This state continues until time t_2 after which the instantaneous voltage cannot maintain the current I_m. During the interval t_2 to t_3, there is no change in core flux and the current is reduced to zero at t_3. The total volt-time integral absorbed by the resistance R_C and the core is given by the shaded area OACD and ABC respectively. As the magnitude of the flux change is given by:

$$\phi = (1/N_c)\int e\,dt = (1/N_c) \times \text{Volt-time integral} \propto \frac{\text{Area ABC}}{N_c} -$$

by varying the value of the resistance R_C the area OACD and at the same time area ABC (i.e. flux change) ϕ_c can be varied.

During the following half cycle, the current in the load circuit begins to rise from t_3. The voltage rise between the time t_3 and t_4 is entirely absorbed by load resistance R_L (see Figs. 10(b) and 11(b)). At the instant t_4 the curent in the load curcuit reaches the value $I_m \times (N_c/N_L)$ and the flux starts changing in the core in the opposite direction. Flux change takes place during the time t_4 to t_5 and the volt-time integral during this period is represented by the shaded area QRST. At t_5 the flux ils restored to its saturation value when the voltage across the coil drops to zero and the full voltage appears across the load. At this instant,

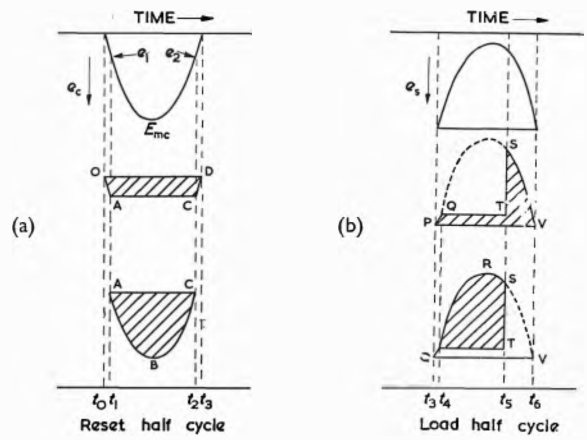


Fig. 11. Voltage waveforms of the magnetic amplifier

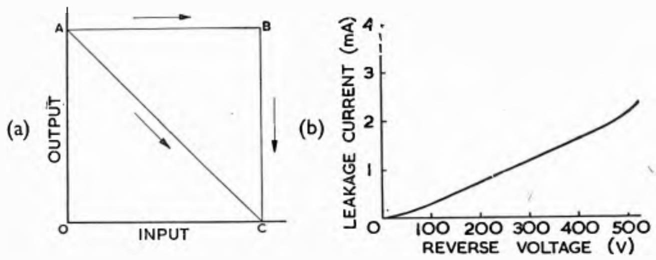


Fig. 12. Theoretical characteristic of a magnetic amplifier with constant current drive and ideal core

the load current I_L jumps to a value given by:

$$I_L = (e_5/R_L)$$

Afterwards, the current follows the applied voltage waveform until it drops to zero at t_6. The mode of operation being similar to that of a thyratron, the angle corresponding to the firing instant t_5 is also called the firing angle for magnetic amplifiers.

Full Wave Operation

The method of connexion as shown in Fig. 10(a) could effectively be used in a full wave operation by connecting two transductors in push-pull. The full wave connexion is shown in Fig. 16.

The voltage source for reset is a centre-tapped transformer and the supply source for the load circuit is derived from single-phase a.c. mains with rectifiers connected in bridge formation. The bridge connexion eliminates the use of a centre-tapped mains transformer thereby reducing the cost and bulk of the equipment.

Operation of the Magnetic Amplifier with Constant Current Drive

From the theory of flux reset amplifiers, it has been established that the output of the magnetic amplifier can be varied linearly by the linear variation of the control circuit resistance. But it has been shown that the output of the class-B stage is in the nature of flat topped current pulses, the maximum value of the pulse, $I_{C(max)}$ (at the flat top) being determined by the input signal. As such, if current pulses of this nature are applied to the reset circuit

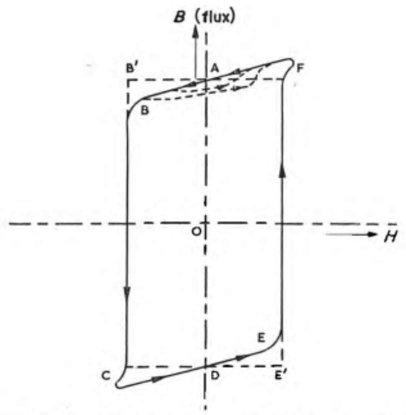


Fig. 13. Typical leakage characteristics for practical cores

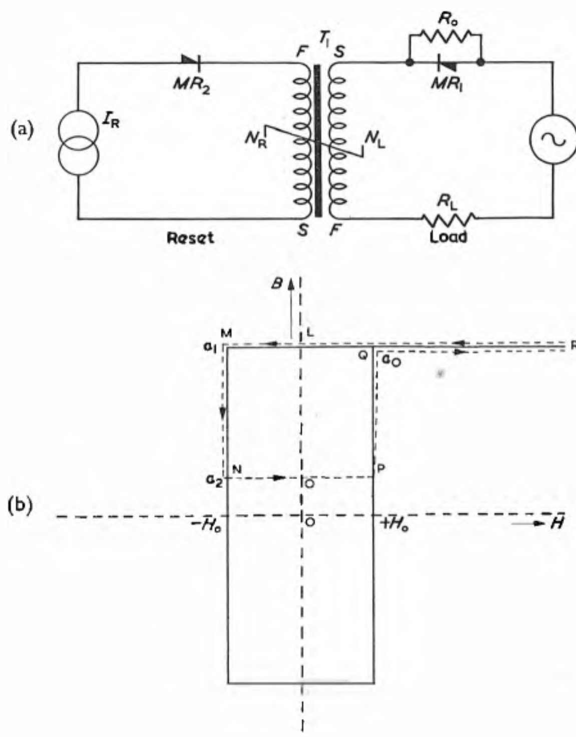


Fig. 14. Magnetic amplifier operation with constant current drive

of the magnetic amplifier, one could expect the following result. There would be no change of flux in the core if $I_{C(max)} < I_m$ and as soon as a pulse with magnitude $I_{C(max)} = I_m$ is applied, complete reset would take place and theoretically the output would be reduced to zero. This is shown by the curve ABC. Fig. 12(a). This would only present two stable conditions of the amplifier, one 'on' and the other 'off' condition, thus making it anything but a linear amplifier.

Fortunately, the circuit behaves in a different manner in practice. This is due to the fact that practical circuit elements have characteristics which differ from the ideal. The rectifiers used in practice have a fair amount of leakage and the B-H loops of the practical core materials are not perfectly rectangular, especially the corners which are fairly rounded (see Figs. 12(b) and 13)).

Circuit Operation with Imperfect Circuit Elements

It is important to note that with constant current drive, the leakage of the load circuit rectifiers plays a major part in the linear operation of the magnetic amplifier unit, instead of the on-off performance of the theoretical amplifier with perfect circuit elements.

The mode of operation is described as follows: With reference to Fig. 14(a), E_o is the a.c. supply source connected in series with a rectifier MR_1, load winding N_L and load resistance R_L. The control or reset winding is connected in series with a rectifier MR_2 and current

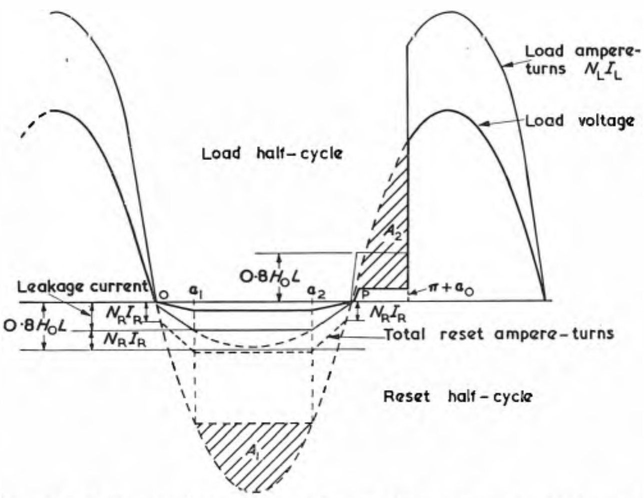


Fig. 15. Voltage and current waveform with imperfect circuit elements

source I_R. The current source supplies a train of amplitude modulated flat topped current pulses at the same frequency as that of the supply E_o. The phasing of the reset current pulses being opposite to the conducting half cycle of load circuit. The leakage of the rectifier MR_1 is diagrammatically shown as a resistance R_o shunted across it. The magnetic material is assumed to have a square loop B-H characteristic with infinite permeability at $\pm H_o$ (see Fig. 14(b)).

With reference to Fig. 15 the ampere-turns necessary to start reset $= 0{\cdot}8H_oL$ where L is the length of mean magnetic path.

$$E_o = E_{o(pk)} \sin\theta; \quad E_{o(pk)} = \text{Maximum value of } E_o$$

On the reset half cycle let $N_R I_R$ be the reset ampere-turns supplied by the current source I_R which is not sufficient to start resetting action. During this half cycle the voltage from E_o is being blocked by the rectifier MR_1, but the leakage resistance of the rectifier being finite, a current flows through the load winding which is given by:

Leakage current through $N_L = (E_o/R_o)$ $(\because R_o \gg R_L)$

This leakage current helps to reset the core along with the reset ampere-turns $N_R I_R$. Thus when the total reset ampere-turns rises to the value $0{\cdot}8H_oL$, the core begins to reset and the a.c. voltage rise is fully absorbed by the core. Hence there being no further voltage rise across the rectifier, the leakage current remains steady until the voltage drops and the resetting action of the core ceases.

Let: α_1 = The angle of the a.c. cycle at which resetting starts.

α_2 = The angle at which resetting stops.

It is apparent from the symmetry of the *B-H* loops that:

$$\alpha_2 = \pi - \alpha_1 \quad \text{.................. (3)}$$

$$\cos\alpha_2 = -\cos\alpha_1 \quad \text{.............. (4)}$$

The voltage rise between α_1 and α_2 is absorbed by the core in the process of resetting. This is given by the area A_1.

$$\therefore \text{Area } A_1 = \int_{\alpha_1}^{\alpha_2} E_{o(pk)} \sin\theta \, d\theta - (E_{o(pk)} \sin\alpha_1)(\alpha_2 - \alpha_1) \quad \text{............ (5)}$$

$$= E_{o(pk)}[2\cos\alpha_1 - (\pi - 2\alpha_1)\sin\alpha_1] \quad \text{.... (6)}$$

During the following load half cycle, it starts from the point O (Fig. 14(b) and travels along OP. There being no change of flux during this period, the voltage rise is fully absorbed by the load resistance R_L and the current is given by E_o/R_L. As soon as the current reaches the point P, i.e. $N_L I_L = 0{\cdot}8H_oL$, the core flux begins to change and the load current L_L remains steady until the core is fully saturated at the point Q. After saturation, the full voltage across the load and the load current jumps up to a corresponding value.

Let: $\pi + \alpha_0$ = The value of the angle at the point Q.

The reset volt-time integral is given by:

$$\text{The area } A_2 = \int_0^{\alpha_0} E_{o(pk)} \sin\theta \, d\theta \text{ [assuming } R_L \times 0{\cdot}8H_oL/N_L \text{ relatively small]}$$

$$= E_{o(pk)}(1 - \cos\alpha_0) \quad \text{................ (7)}$$

The value of α_1 is given by:

$$\frac{E_{o(pk)} \sin\alpha_1}{R_o} N_L + N_R I_R = 0{\cdot}8H_oL$$

$$\alpha_1 = \sin^{-1}(0{\cdot}8H_oL - N_R I_R)\frac{R_o}{E_{o(pk)}N_L} \quad \text{........ (8)}$$

and $\alpha_2 = \pi - \alpha_1$

Since the magnitude of flux change and hence the volt-time integrals are equal on opposite half cycles.

$\therefore$ Area A_1 = Area A_2

$$E_{o(pk)}[2\cos\alpha_1 - (\pi - 2\alpha_1)\sin\alpha_1] = E_{o(pk)}(1 - \cos\alpha_0)$$

$$\cos\alpha_0 = 1 - 2\cos\alpha_1 + (\pi - 2\alpha_1)\sin\alpha_1 \quad \text{........ (9)}$$

The average load voltage during the complete cycle is given by:

$$E_{L(av)} = \tfrac{1}{2}\pi \int_0^{\pi} E_{o(pk)} \sin\theta \, d\theta = (E_{o(pk)}/2\pi)(1 + \cos\alpha_0) \quad \text{............ (10)}$$

Substituting the value of $\cos\alpha_0$

$$E_{L(av)} = (E_{o(pk)}/\pi)[(1 - \cos\alpha_1) + ((\pi/2) - \alpha_1)\sin\alpha_1] \quad \text{............ (11)}$$

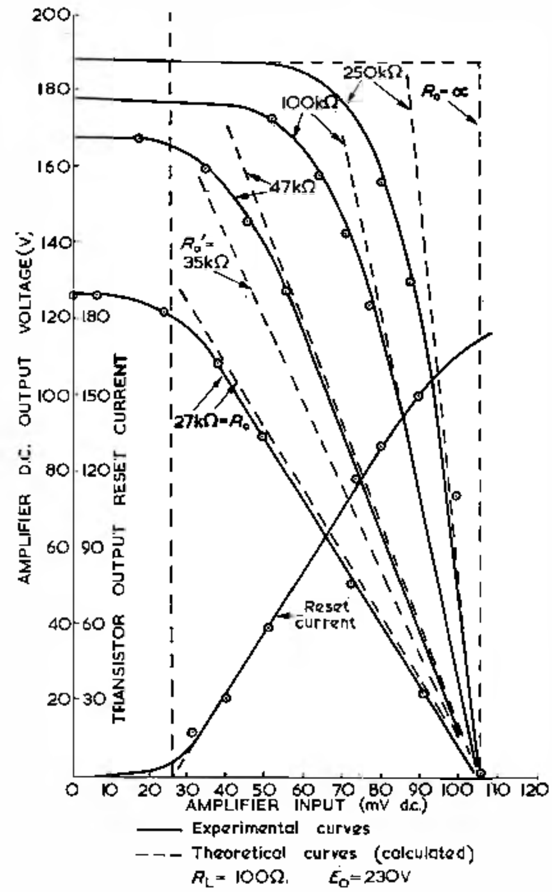


Fig. 17. Co-relation of theoretical and experimental results

As seen from Fig. 15, the amount of reset depends on the value of the angle α_1. The higher the value of α_1, the smaller is the reset area A_1. For no reset $\alpha_1 = 90°$.

$$\sin\alpha_1 = 1 \text{ and } E_{L(av)} = (E_{o(pk)}/\pi) \quad \text{........ (12)}$$

To achieve linear variation of output from the start, the following conditions are necessary. With no reset current input, i.e. $I_R N_R \doteq 0$, the value of α_1 should be equal to 90° and the value should decrease linearly with the increase of input current I_R. As such the limiting value of $\sin\alpha_1 = 1$ at $I_R N_R = 0$.

Let: R_o' = Critical value of leakage resistance R_o necessary for the above conditions.

From equation (8) $\therefore 1 = 0{\cdot}8H_oL \cdot (R_o'/E_{o(pk)}N_L)$

$$R_o' = (E_{o(pk)}N_L/0{\cdot}8H_oL) \quad \text{............ (13)}$$

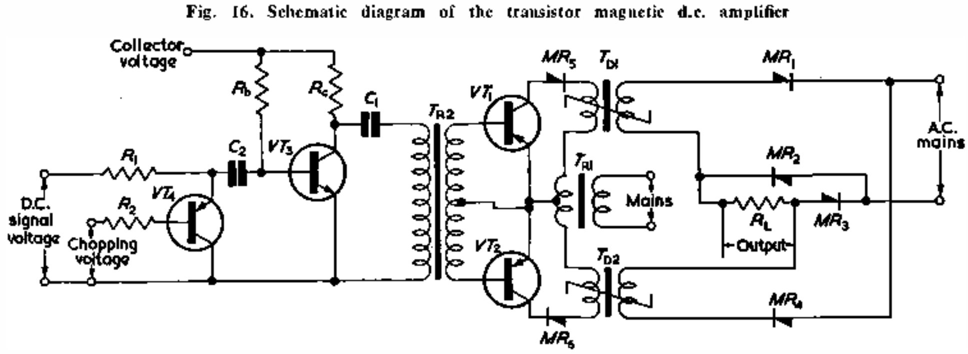
If the leakage resistance $R_o > R_o'$, no resetting action takes place unless the re-set ampere-turns increases to a certain level.

$$E_{o(pk)}N_L + N_R I_R = 0{\cdot}8H_oL .$$

$$N_R I_R = 0{\cdot}8H_oL - \frac{E_{o(pk)}N_L}{R_o} \quad \text{......... (14)}$$

When the leakage resistance $R_o < R_o'$ resetting action takes place even with no reset current input. The value of the angle α_1, with no reset current is given by:

Fig. 16. Schematic diagram of the transistor magnetic d.c. amplifier



$$x_1 = \sin^{-1}\left(\frac{0{\cdot}8H_oL \ . \ R_o}{E_{o(pk)}N_L}\right)$$

From equation (8):

$$= \sin^{-1}(R_o/R_o')$$

Experimental Results

With reference to Fig. 17, the close proximity of the experimental and theoretical curves can be noticed. The deviation due to rounding off at the top part is due to the slope and rounding off of the corners of the *B-H* loop of practical core material, as shown in Fig. 13. This deviation of *B-H* loop has not been considered in the analysis for the sake of simplicity.

Conclusion

In general, it can be concluded that the amplifier has a fairly high power gain, of the order of 70dB, and a voltage gain in the region of 1 000. With the development of transductor core material capable of handling high power, the scope of power output for this amplifier could be in the region of kilowatts. The response time of the amplifier being only limited by the magnetic amplifier stage is equal to one cycle of the supply frequency. The drift with time and temperature was found negligible.

The immediate application of this amplifier seems to lie in the servo-mechanism field, where the requirements for the amplifier are high gain, drift free, fast response and a compact rugged design. As a matter of interest, this amplifier has been used by the author in the Ward-Leonard speed control loop of a d.c. machine. The results obtained were highly encouraging with an accuracy figure in the region of 0·001 per cent.

Acknowledgments

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A Data Logger-Alarm Scanner

This equipment has been designed to meet the needs of industrial process control and research establishments for a highly versatile and flexible data handling equipment.

The equipment is unique in that some of the 'building bricks' made by other suppliers are used in the system. Only units which are well proven have been chosen, the remaining 'bricks' being developed and manufactured by Microcell; the complete apparatus is systems engineered and custom built by Microcell Ltd.

Any transducing element which gives a d.c. output signal can be fed into the equipment while a.c. transducers and pneumatic transducers can be used via suitable convertors.

The signal sampling unit consists of five individual plug-in sealed relays with gold contacts. The switching noise level introduced by these relays is extremely low so that microvolt signal levels can be handled without any degradation.

The contact configuration on these relays can either be six pairs of make contacts or four changeovers. Bridge input configurations can therefore be handled without difficulty and the changeover arrangement allows individual points to be continuously monitored through the back contacts.

For simple systems, adequate spare contacts are available on the one relay for auxiliary purposes (e.g. for calling up channel number, span or scaling factors, alarm groups etc) but for the more complex systems sufficient spare contacts are often not available. To overcome this limitation, each signal sampling unit is provided with a bank of additional relay sockets, one for each signal relay, which can be plugged in if required. The relay driving transistor is capable of driving two relays in parallel should two relays be required.

These signals sampling units can be built up to meet the total channel requirements of a system (e.g. 200 channel logger would have 40 signal sampling units).

Each signal unit contains a five-stage ring counter, so that with each pulse from the programme unit, the counter moves on one and so calls in the appropriate sampling relay. Each unit contains five bridging links so if a channel is not required in a scan it can be bridged out. In addition the input and output lines to the ring counter in each signal sampling unit are brought back to a common, readily accessible patch board so that blocks of channels can be bridged out if required, or allocated any scanning sequence.

The programme unit contains the count down circuits from 50c/s for scanning rates less than 50 per second, and it also controls the sequence of operation of all the various units in the system.

When an equipment is alarm scanning, the speed of stepping is determined by the driving pulse frequency of the programme unit; when an alarm condition is found and print out is required, or when continuous data logging is called for, the speed of stepping is determined by the speed of operation of the output device. A gate between the pulsing unit and the shift register drive line is closed and inhibits any further stepping until the output device (strip printer, typewriter, tape punch, card punch) has completed it's operation.

For most applications, the Mullard high speed analogue to digital convertor type L.281. is used. This is a three digit, 0·1 per cent convertor with a conversion rate of 1 000/second; this speed of operation is too fast for most data logging applications since no output printer can operate at this speed although the digital data can be recorded on magnetic tape at this speed. However, this high conversion rate is useful where high speed alarm scanning is required or where single channel high speed acquisition is needed.

Alarm levels, high or low or both, can be allocated to every channel if needed, but grouped alarm levels are usually adequate. Alarm levels are set up on decade selector switches and the allocation of these levels is selected by pin boards.

The alarm detection system is a digital one. The decimal figures which are set up on the alarm setting decades are compared directly with the decimal figures appearing at the output of the analogue to digital convertor. Any three figures (0·1 per cent convertor) or four figures (0·01 per cent convertor) appearing at the convertor output which are equal to or greater than the level setting will trigger an alarm bistable and so initiate an alarm indication (in the case of a high alarm); for a low alarm any figures appearing at the convertor output which are equal to or lower than the level setting will initiate a low alarm indication.

For alarm scanning applications, visual indication of the channel number is usually required and also a strip printer record giving time, channel number and measured value. One requirement often met, is that the alarm printer only prints the alarm record once, remains quiescent on the particular channel only during subsequent scans, and prints out again when the channel returns to normal.

For the visual indication and the return to normal print facility, an alarm memory is needed. Transistorized bistables perform this function with relays giving contact closure for lamp illumination; spare contacts are available on these relays for auxiliary and plant control purposes.

Neon lamps, nominally in groups of 25, are used for the annunciator panel, since these meet the requirements of reliability and long life.

Output devices of various forms are available depending on the requirements of the system and digital arithmetic units are under development for carrying out simple mathematical calculations on the data derived from the logging equipment.

A Frequency Measuring Receiver

By G. F. Meakes*

The combination of a high stability receiver and a digital frequency counter enables the carrier frequency of transmissions to be measured quickly and accurately. The instrumental accuracy is unaffected by modulation or poor signal-to-noise ratio and measurements are possible with signal carrier levels of less than one microvolt.

(Voir page 733 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 738)

THE equipment described covers the range 12·5kc/s to 30Mc/s without gaps and the desired signal is presented in digital form. The inaccuracy varies from within 1 or 2 cycles at low frequencies to a few parts in 10^7 at high frequencies.

The equipment used consists of standard Racal receiver[1] type RA. 17 with a low frequency adaptor type RA. 37 and digital frequency counter type S.A. 21. Small modifications are made to the receiver and counter for this particular service. In addition, there is an auxiliary comparator panel which contains a cathode-ray indicator, fine tuning arrangements, frequency standard and harmonic generators. An external standard may be used if greater overall accuracy is required. The whole assembly is shown in Fig. 1.

Fig. 1. The complete frequency measuring equipment

Operation

The receiver is used in a normal manner in that the signal is tuned in as desired. The lissajous figure on the cathode-ray tube is then observed and brought to a state of slow rotation by careful adjustment of the receiver kilocycle control. The lissajous figure may then be brought to rest by means of the fine tuning control on the frequency comparator panel. As soon as this is done, the push-button on the frequency counter is depressed resulting in an immediate indication of frequency. The signal frequency is now indicated by the megacycle control on the receiver *plus* the fraction of a megacycle as indicated on the counter. It will be normal to use the frequency counter on the one second sampling period, but for more accurate results a ten second period may be used. Alternatively, for quicker and less accurate results, the 0·1sec period may be used. The receiver second v.f.o. has a very high short term stability and thus even on the 10sec sampling period will hold the figure on the cathode-ray tube steady. However, any variations in the signal to be measured during the sampling period will cause rotation of the lissajous figure and this may be clearly seen on the cathode-ray tube.

The whole process of tuning in and obtaining the frequency of any transmission takes from about five to ten seconds from start.

Circuit Description

A simplified block diagram of the receiver showing the frequency changing circuits employed is shown in Fig. 2. It will be seen that this arrangement is particularly suited to frequency measuring applications since the standard 1·0Mc/s input frequency is the only reference required to enable any discrete one megacycle spectrum of signals in a range 1 to 30Mc/s to be converted to frequencies between 2 and 3Mc/s. The accuracy and stability of this conversion is determined solely by the 1Mc/s reference since any drift of oscillator v.f.o. 1 cancels in the difference term derived from the second mixer. It is thus possible to select the desired spectrum without significant error and to indicate whole numbers of megacycles per second by the calibration of the first v.f.o.

Individual signals in the output spectrum are selected by the 2 to 3Mc/s interpolation receiver which consists basically of the mixer 3, a variable oscillator v.f.o. 2 and of a final intermediate frequency amplifier centred on 10kc/s.

If the interpolation receiver is lined up such that the carrier of the signal to be measured produces an i.f. output of precisely 100kc/s, it is a simple matter to determine, from the frequency of v.f.o. 2, the actual fraction of a megacycle associated with that signal. Owing to the frequency inversion which takes place in the first mixer, a signal at the high frequency end of any selcted spectrum will appear as a signal at the low frequency end of the spectrum from the second mixer. For example, if the selected spectrum is 10 to 11Mc/s (v.f.o. 1 tuned to 50·5Mc/s) then a signal at 10Mc/s will appear as 3Mc/s and a signal of 11Mc/s will appear as 2Mc/s at the input to the interpolation receiver.

In order to produce a final intermediate frequency of 100kc/s, the frequency range of oscillator v.f.o. 2 is from 2·1 to 3·1Mc/s and it will therefore be necessary to compare the frequency of v.f.o. 2 with a standard 3·1Mc/s reference frequency to establish the received signal frequency. This is then indicated by the number of megacycles

* *Racal Engineering Ltd.*

shown on the receiver 'megacycle' control and the beat difference between v.f.o. 2 and the reference 3·1Mc/s, and this is shown on the frequency counter. To avoid practical difficulties in operating the frequency counter down to zero frequency, the reference frequency used is 3·2Mc/s resulting in a 100kc/s frequency displacement on the frequency counter. This, however, is easily modified in that, although it indicates from zero to 1Mc/s, it is in fact operating in the range 100kc/s to 1·1Mc/s. Thus the display frequency is the true fraction of a megacycle of the desired frequency being measured.

When frequencies below 1·0Mc/s are being measured, the signal path is via the RA.37 low frequency adaptor which consists of an r.f. stage and a balanced mixer fed from the harmonic generator producing a 2·0Mc/s reference heterodyne signal. Since the required output spectrum lies between 2 and 3Mc/s and is higher than the heterodyne frequency, no frequency inversion takes place and thus, in order to provide the correct frequency to the frequency counter, a reference signal of 2·0Mc/s is employed. A switch selects the appropriate reference frequency and desired receiving channel. Since v.f.o. 2 is used as a transfer standard, it must be set very precisely, and, to simplify this, a fine frequency control with a range of a few tens of cycles is available; this, toegther with the cathode-ray tuning indicator, makes it possible to obtain a stationary lissajous figure when the intermediate frequency of the receiver is in step with the 100kc/s derived from the standard source.

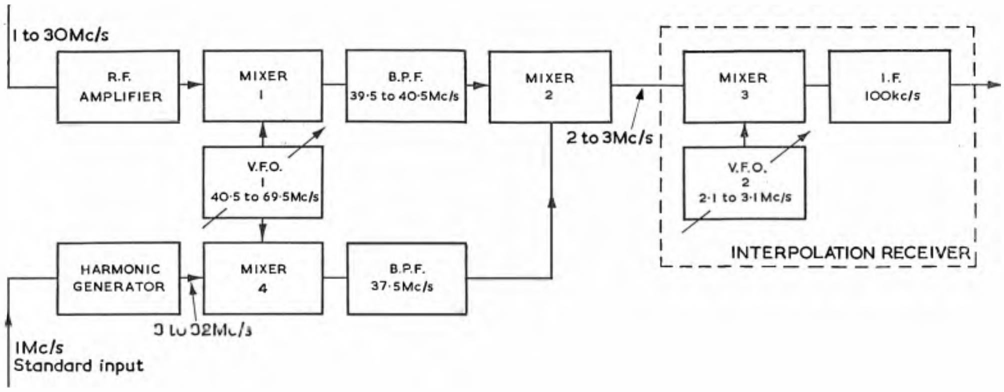


Fig. 2. Simplified diagram of the receiver

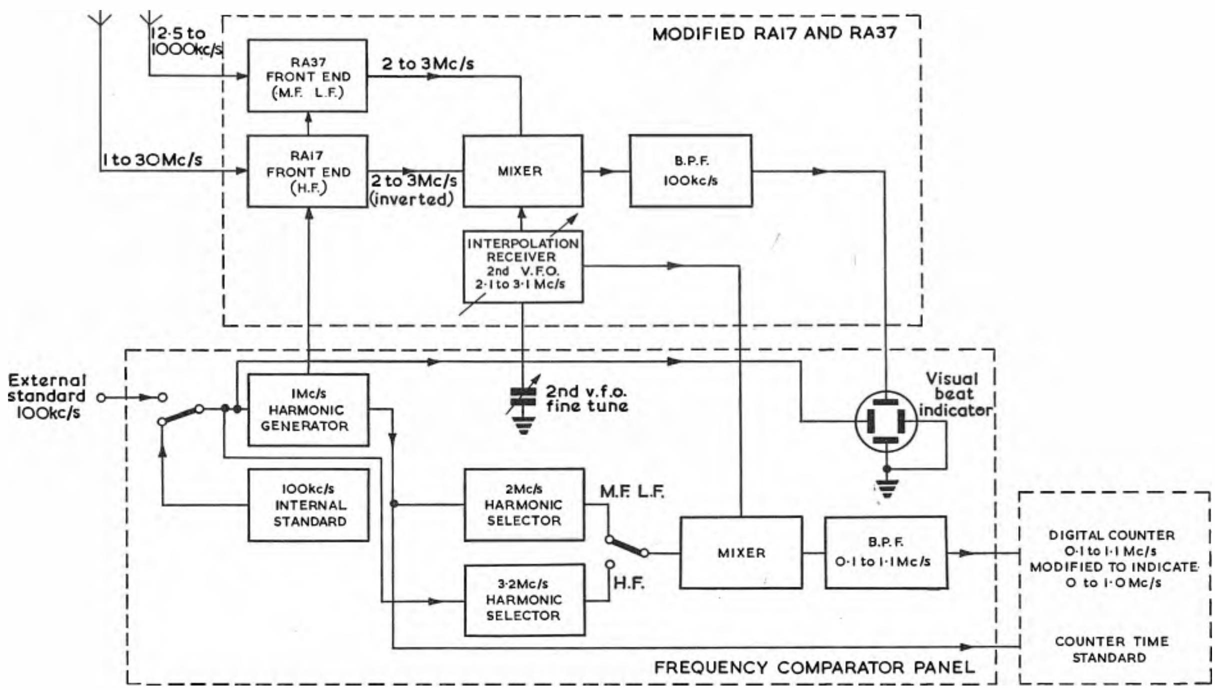


Fig. 3. Simplified diagram of the complete equipment

A simplified block diagram of the complete equipment is shown in Fig. 3.

REFERENCE

1. Unconventional Communications Receiver: *Wireless World*. *63*, 388 (1957). (Brit. Pat. 714 684).

Multipliers and Dividers in A.C. Computers

By C. Holt Smith*, C.B.E., M.Sc., M.I.E.E., and Alladi Prabhakar*, B.E., M.S., M.I.R.E.

A simple multiplier or divider can be made utilizing the exponential shape of the initial part of the characteristic of many electronic devices. Brief descriptions are given of a thermionic valve divider, a transistor multiplier and a transistor divider developed on the above principles.

(Voir page 733 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 738)

In alternating current computers it is often desirable to be able to multiply or divide an a.c. signal by a d.c. signal (which may itself be a rectified a.c. signal) giving an a.c. signal which is the product or ratio of the two input signals.

For such a device, use can be made of the exponential nature of the small signal characteristics of most electronic devices, such as valves, transistors and semiconductor diodes.

The characteristic of such a device can be written as:

$$I/b = \exp V/a \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where V and I are the input voltage and current

b is the current for zero volts, and

a is the voltage for a current of 2·7 b amperes.

A divider can be made from such a device if it is supplied from two constant current generators giving respectively a direct current I_0 and an alternating current $i \cos pt$. The voltage across the device is given by:

$$\begin{aligned} V &= a \log\left(\frac{(I_0 + i \cos pt)}{b}\right) \\ &= a \log (I_0/b) + a \log (1 + (i/I_0) \cos pt) \\ &= a \log (I_0/b) + a\, \{i/I_0 \cos pt + \\ &\qquad 1/2\, (i/I_0 \cos pt)^2 + \ldots\} \end{aligned}$$

The alternating output of such a device will be:

$$a\{i/I_0 \cos pt + 1/2\,(i/I_0 \cos pt)^2 \ldots\} \quad \ldots\ldots \quad (2)$$

The first term gives the desired output, an alternating signal proportional to i/I_0. The following terms represent an error which is dependent on the ratio i/I_0. If this ratio does not exceed 0·2 the error will be less than 1 per cent. Since the ratio i/I_0 is indicated in the output of the system it is easy to determine when the errors result.

A multiplier can be made by measuring the alternating current flowing into the exponential device when a direct current and an alternating voltage are applied. If a direct current I_0 is supplied, the voltage across the device will be:

$$V_0 = a \log I_0/b \quad \ldots\ldots\ldots \quad (3)$$

If, in addition, an alternating voltage $v \cos pt$ is applied the current flowing will be given by:

$$\begin{aligned} I &= b \exp\left(\frac{(V_0 + \cos pt)}{a}\right) \\ &= b \exp V_0/a \exp (V/a \cos pt) \\ &= I_0 \exp (V_0/a \cos pt) \\ &= I_0\{1 + (V/a) \cos pt + 1/2\,(V/a \cos pt)^2 + \ldots\} \end{aligned} \quad \ldots\ldots\ldots\ldots \quad (4)$$

The second term in the bracket gives the required relation:

$$I = (I_0 v/a) \cos pt$$

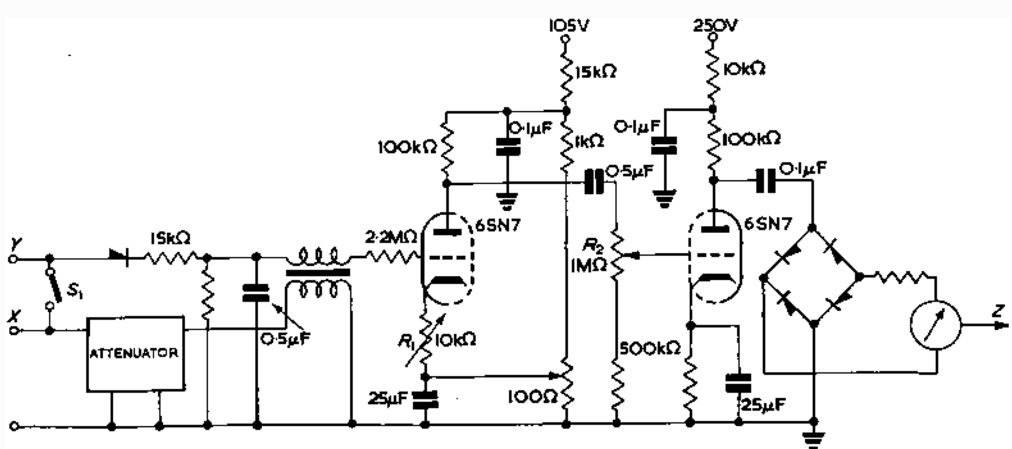
Succeeding terms represent an error, the magnitude of which depends only on the ratio v/a. The square term can be reduced by a push-pull arrangement of two multipliers, the cubic term will introduce an error dependent only on the ratio of v/a. If v does not exceed 0·3a the error will not exceed 1 per cent.

Triode Divider

A triode divider on the above principles has been made to accept two alternating signals x and y and display the ratio z on a d.c. meter. The detailed circuit arrangement is shown in Fig. 1.

The circuit employs a 6SN7 twin triode, the first half of which with a low voltage stabilized anode supply and 2·2MΩ series grid resistor forms the logarithmic amplifier unit. The second half of the 6SN7 which is RC coupled to the first supplies the necessary gain and lowers the output impedance. A full-wave rectifier using crystal diodes enables the a.c. signal to be fed to the d.c. meter. The adjustment R_1 is preset to obtain optimum performance at low values of the divisor and the adjustment R_2 sets the overall gain of the system to give unity output on the meter when the

Fig. 1. The triode divider circuit



* *Formerly Institute of Armament Studies, Poona.*

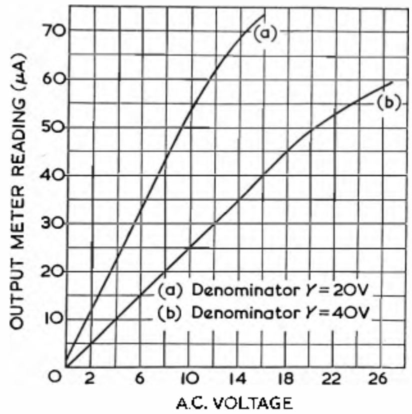


Fig. 2. Output meter reading against voltage

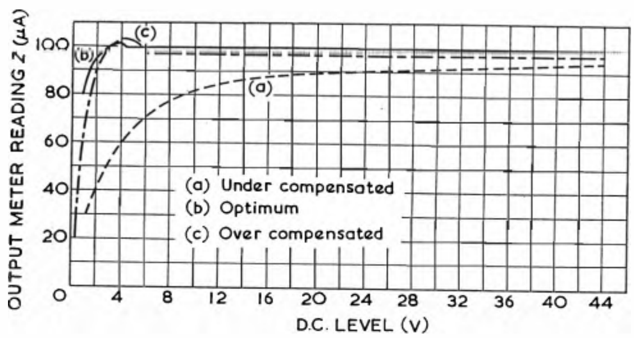


Fig. 3. Output meter reading against d.c. level

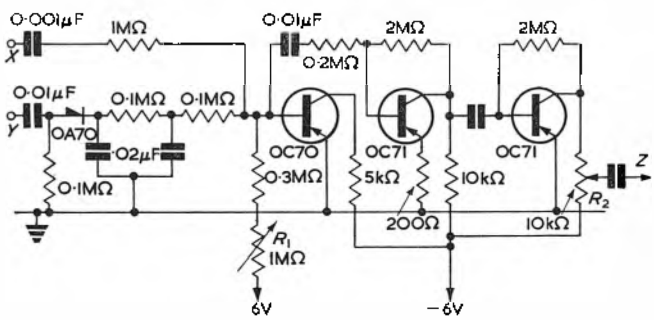


Fig. 4. Transistor divider circuit

switch S_2 is closed giving identical values to divisor and dividend.

The unit works satisfactorily giving errors less than 2 per cent of full-scale for values of the divisor between 2 and 50V and for values of dividend not greater than the values of the divisor. The performance curves of the divider are given in Figs. 2 and 3. Fig. 2 expresses the relation between the a.c. input and output meter reading at two d.c. levels, while Fig. 3 is a plot of the output versus ratio of identical values of denominator and numerator voltages at three different settings of the feedback resistor R_1. The adjustment R_1 is fairly critical, and has to be set at the proper value before using the instrument.

Transistor Divider

The transistor divider makes use of the exponential form of the $V_b - i_b$ characteristics of the transistor OC70 at very low current levels. The circuit diagram of the divider is shown in Fig. 4.

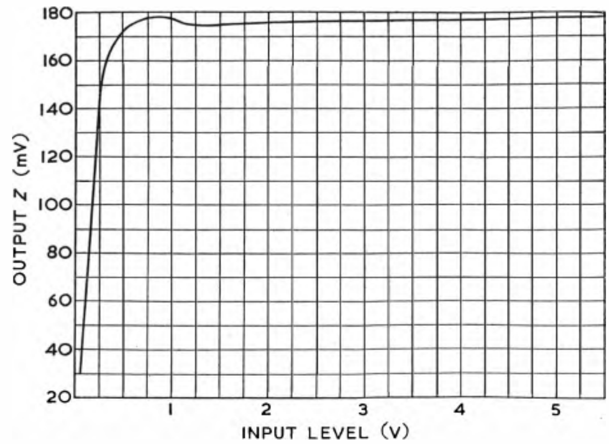


Fig. 5. Output plotted against input level

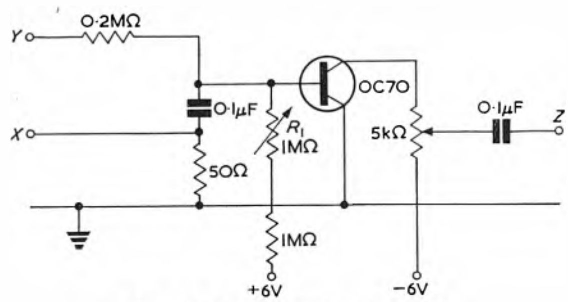


Fig. 6. Transistor multiplier circuit

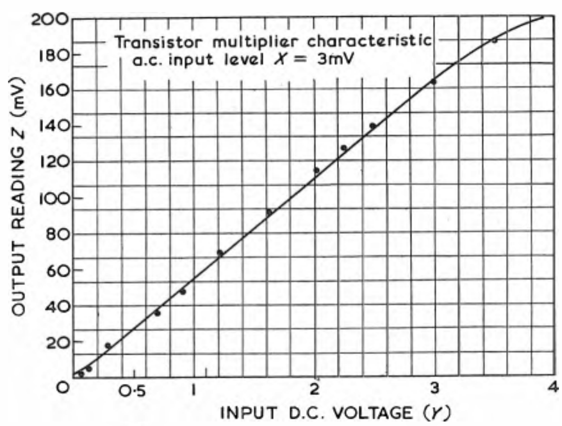


Fig. 7. Experimental results on the multiplier

An a.c. signal x which is the numerator voltage is fed to the base of the first transistor though a series resistor of 1MΩ. The denominator signal y which is also a.c. is rectified before it is fed to the base. The alternating voltage developed across the base-emitter junction is proportional to the ratio x/y. The sensitivity of this divider is approximately 12mV across the base emitter junction for identical values of divisor and dividend and can be increased as desired by introducing one or two stages of further amplification. The control R_1 is adjusted to give optimum performance at low values of the divisor. The unit gives errors less than two per cent for values of divisor between 0·4 and 6V and for values of dividend not greater than the divisor. Fig. 5 expresses the relation between output z and ratio of identical values of denominator y and numerator x.

Transistor Multiplier

The transistor multiplier also makes use of the exponential form of the $V_b - i_b$ characteristics of the transistor

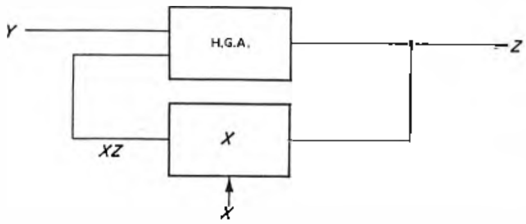


Fig. 8. Feedback divider

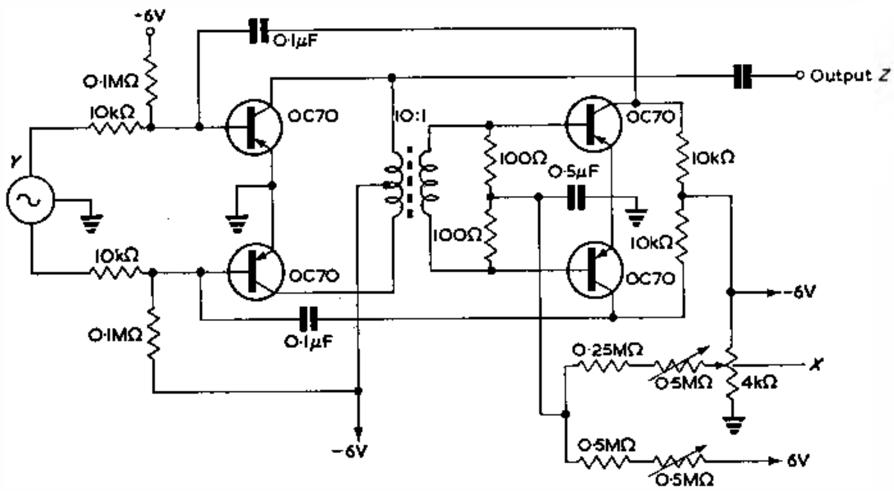


Fig. 9. Circuit of feedback divider

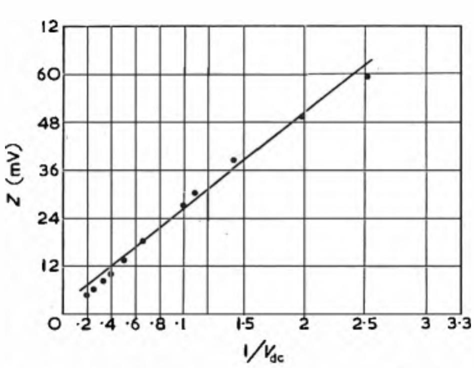


Fig. 10. Output plotted against the reciprocal of y

OC70. The circuit diagram of the multiplier is shown in Fig. 6.

The multiplier is fed by an a.c. signal x and a d.c. signal y and the output voltage z which might be displayed on an a.c. millivoltmeter is proportional to the product xy. The circuit centres round the Philips transistor OC70 whose $V_b - i_b$ characteristic at very small current levels is exponential in character. The equation connecting emitter base voltage and junction current in this region is approximately represented by:

$$I - 5 = e^{24v}$$

where I is expressed in microamperes and v in volts. With a series resistor of 0·2MΩ in the y channel and a 5kΩ load resistor in the collector circuit the output level without further amplification may be given by the relation:

$$z = kxy$$

where $k = 20\text{V}^{-1}$ and x, y and z are in volts.

This relation is in conformity with experimental results on the multiplier which are expressed in Fig. 7.

Feedback Divider

Use can be made of the multiplier described above to built a divider using the feedback arrangement shown in the block diagram of Fig. 8.

The arrangement illustrates the implicit computation of the quotient $z = -x/y$ by continuous (approximate) solution of the machine equation $yz + x = 0$. The detailed circuit diagram of the divider is shown in Fig. 9.

The first stage of the divider consists of a transistor push-pull amplifier having an overall gain of 35 to 40. The z output is tapped from the primary of the output transformer as shown. The secondary of the transformer is connected to the multiplier stage which is also a balanced circuit using two multipliers in a push-pull arrangement. The multiplier output is fed back to the input of the amplifiers through capacitors. The divider has an overall accuracy of 3 to 4 per cent in the range y = 0·3 to 4V and x = 0 to 20mV. Fig. 10 is a plot of the reciprocal of y versus the output z. In view of the transformer coupling employed between the amplifier and the multiplier stages satisfactory frequency response can be obtained only over a limited frequency range. Both in terms of accuracy and frequency response the exponential divider is superior to the feedback divider. It is also easier to design an exponential divider.

Conclusion

The triode and the transistor dividers described above fulfil the need for simple high speed dividers in computers where they can be used for the analogue computation of small quotients. The transistor multiplier which has also been described is an exceedingly simple and elegant device in an Isograph. The Isograph needs several multipliers and its construction can be greatly simplified by incorporating the transistorized multipliers developed.

Acknowledgment

The authors thank Mr. K. B. Mahajan and Mr. D. N. Hingne of the Institute of Armament Studies, Kirkee, for their experimental assistance in the course of the above investigation.

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BOOK REVIEWS

Fundamentals of Electron Devices and Circuits

By H. R. Weed & W. L. Davis. 584 pp. 397 Figs. Medium 8vo. Sir Isaac Pitman & Sons Ltd. 1960. Price 60s.

THE authors have aimed at providing a text-book covering the essential concepts of a.c. circuit theory and electron devices which would be equally useful to the electrical and non-electrical engineer. Fundamentals are dealt with throughout; specific applications have been described only to the extent necessary to provide a means for illustrating principles.

In the first Chapter (8 per cent of the book) fundamental laws and basic concepts of circuit theory are given. The material included here is not nearly sufficient for the first-year electrical engineering course at a British university and could have been omitted to reduce the price. Even though a complete understanding of electronic circuits would be seriously hindered without a complete familiarity with the principles treated in Chapter 1, readers could have been expected to look for them elsewhere, possibly with the exception of transients and Fourier series. Introduction of both c.g.s. and m.k.s. units in a book of this kind is particularly unfortunate.

The remainder of the book is excellent. Chapters 2 to 6 (about 20 per cent of the book) deal with electron emission, motion of electrons in electric fields, diodes, single-phase and polyphase rectifier circuits, power-supply filters and crystal and metal rectifiers. Chapter 7 introduces the triode and Chapter 9 the tetrode, pentode and other multigrid valves. Valve amplifiers are treated in Chapters 8 and 10. Sections are devoted to interelectrode capacitances, resistor-capacitor and transformer couplings, radio-frequency, direct-coupled and push-pull amplifiers, harmonic analysis, power output, phase invertors, feedback and the cathode-follower.

Chapter 11 deals with transistor circuits. Properties of metallic conductors, insulators and semiconductors and the effect of impurities in the intrinsic semiconductor are described. The transistor equivalent circuit is introduced and the circuit equations for the common-base, common-emitter and common-collector arrangements are presented. Chapter 12 is concerned with magnetic amplifiers and the following three Chapters with gas-tube characteristics and circuits and controlled rectifiers. The final 20 per cent of the book is devoted to timing circuits, regulators, operational amplifiers, oscillators, electronic instruments and photocells.

The book is attractively laid out with numerous excellent illustrations and is written in an extremely clear style. In a book covering such a wide field certain topics have of necessity had brief treatment. To supplement the work many useful references could have been included. Two valuable features, particularly to students, are several exercises in the text left for the reader and a collection of carefully chosen problems at the end of each Chapter. It is a pity that answers for these problems are not given. The inclusion of many more worked examples would have been helpful. Several minor misprints and errors were noticed. Readers may experience some difficulty with certain symbols.

The book can be strongly recommended as being of considerable assistance to all students taking electronics in University degree and similar courses, particularly mechanical and other non-electrical engineers. It should also prove to be a valuable University and technical college library book.

F. A. BENSON

An Introduction to Machine Translation

By E. Delavenay. 123 pp. 2 Figs. Demy 8vo. Thames & Hudson Ltd. 1960. Price 25s.

DURING the last decade, books and articles have appeared on the machine translation of language and the book under review attempts to give a comprehensive study of the field up to the present time.

The first chapter is a short introduction to the subject. This is followed by a chapter on automatic digital calculators. It is unfortunate that numbers which appeared correctly in the French original have become altered in translation. On page 20 the number 294912 appears as 294.912, and elsewhere "milli-second" has become "micro-second." This gives the impression that the author does not know his subject and spoils what is otherwise a clear, simple introduction to the capabilities of computers.

The third chapter contains a brief history of machine translation. It is divided into two sections, the first giving the dates and names of workers in the field, the second, a survey of how the concepts behind machine translation were explored, abandoned or developed.

The next three chapters contain a more detailed and technical examination of the aspects of machine translation which are at present being developed. In Chapter Four the author considers multi-lingual translation and the arguments for and against the use of a meta-language. The chapter ends with an account of a Russian programme for multi-lateral translation.

Chapter Five deals with syntax and morphology and is followed in Chapter Six by a consideration of computer storage in relation to machine translation. The author considers lexical problems and the translation of idioms and polysemantic words with special reference to category analysis, the micro-glossary, and the Thesaurus method.

The book concludes with an assessment of future prospects. This appears to the reviewer to be over-optimistic, especially since the figures are supposed to apply to existing computing machines.

The book contains a postscript, an appendix, a glossary and a bibliography. It is eminently readable and can be recommended to specialist and layman alike.

A. D. BOOTH

Radioactive Wastes Their Treatment and Disposal

General Editor J. C. Collins. 219 pp. 46 Figs. Demy 8vo. E. & F. N. Spon. London. 1960. Price 55s.

IN the last decade people have become more conscious of the importance of radioactivity and of the drastic ways in which it could affect their lives, for the increasing uses of radioisotopes in industry and medicine, and the increasing number of nuclear power stations, inevitably mean an increase in radioactive waste. In addition, the testing of nuclear weapons results in release of radioactive material into the atmosphere.

The book is undoubtedly one of the most important contributions of recent years to the field of Wastes Engineering.

The first half of the book is of a fundamental nature, explaining the problems which have to be understood when dealing with radioactive material, and the second half deals specifically with the treatment and disposal of liquid, solid and gaseous radioactive wastes, and includes valuable information on the results of laboratory work and on the experience gained in operating treatment plants in different parts of the world.

Solid State Physics in Electronics and Telecommunications Vol. 1. Part 1

Edited by M. Désirant & J. L. Michiels. 638 pp. 454 Figs. Royal 8vo. Academic Press Ltd., New York. London. Price 128s. 6d.

IN Volume 1, "Semiconductors Part 1," which is here under review, the balance is a little tenuous, there being 63 pages on progress and one entitled "Crystals, Electronics and Man's Conquest of Nature" by Shockley which presumably can be classified as a review of the contribution to Human Welfare. We can therefore safely regard Dr.

Shockley's paper as a second order effect and with only one comment on it proceed to the rest. The one comment is that, in his own words, "much of the support for progress in solid state electronics is motivated by military needs."

The book is a reasonably useful addition to the current literature on the fundamental theory, properties, and preparation of semiconductors. In the main the papers deal with germanium, and silicon, compound semiconductors being dealt with in Volume 2 along with applications and devices. Most of the papers are in English, several are in French, and a few are in German. They are divided into six sections: Preparations of Semiconductors and Applied Problems, Properties of Semiconductors, Solid State Theory, Effects of Intense Electric Fields, Noise, and Surface Phenomena. Among the authors are to be found many internationally well-known names, a factor which is a tribute to the organizers of the Conference. However, it is not a text book. Nor is it an up-to-date communication, since the Conference was two years ago and many of the papers are published elsewhere. It is nevertheless a publication for the specialist, and its value to him will be its collection of reports on related topics making for easy reference and availability, rather than its breadth, depth and newness of material.

The book is extremely well produced on good quality paper. The diagrams and photographs have been reproduced remarkably well considering the divergence of their original quality, although some of abscissa and ordinate figuring need not have aped the submicroscopic nature of the dimensions to which they referred. The cost working out at about two shillings a paper, the book is cheap by any standard.

B. K. RIDLEY

Basic Technical Electricity

By H. Cotton. 246 pp. 74 Figs. Crown 8vo. Cleaver-Hume Press Ltd. 1960. 3rd Edition. Price 12s 6d.

THIS new edition has been revised so as to employ solely the metre-kilogram-second system of units now preferred, for their convenience, by the electrical engineering professional bodies. Questions are provided to test the reader's knowledge at every stage, and all important principles are demonstrated by worked examples.

Theorie et pratique des circuits de l'électronique et des amplificateurs

By J. Quinet. 272 pp. 175 Figs. Medium 8vo. 4th Edition. Volume 1—Théorie et applications du calcul des imaginaires à l'étude des circuits. Dunod, Paris. 1960. Price 22 NF.

THIS book has been used for years as a basic text in many electronic schools. The author, J. Quinet, is well known in academic circles for his numerous books on electronics and mathematics. Imaginary calculus is one of his subjects, as can easily be ascertained by glancing at this book. Not only does the author really feel at home in this subject, but he also has the rare ability to make the reader feel equally at ease. The book is divided into three parts. Part I establishes the mathematical foundations of imaginary calculus. Part II applies this knowledge to electrical circuits. Part III deals with radio and electronic circuits.

This fourth edition of the book has been entirely revised and considerably expanded. Worthy of mention is the appearance of several new theorems on circuits. Typography is good and errors are few.

A. V. J. MARTIN

Werkstoffe Für Elektrische Kontakte (Materials for Electrical Contacts)

By A. Keil. 340 pp. Medium 8vo. Springer-Verlag, Berlin. 1960.

THIS book contains information on physical and chemical phenomena during switching, mechanism of contact wear, technology of contact materials, and choice of materials in practice. The electrical contact is one of the most important technical components. In many cases its existence will, nevertheless, only become obvious when it fails during operation. The problem of assessing the physical and chemical influences which can have an effect when current flows between metallic surfaces presupposes a theoretical introduction. This has been written on the lines of available standard works. The metallurgical part presumes that there is no such thing as an 'ideal' contact material. A multitude of alloys is commonly used for different operating conditions and their properties are described. The following part tries to deepen the theoretical knowledge by systematic examinations of ranges of alloys and to formulate a uniform explanation to the effects hitherto known. A technological survey is given in conclusion, facilitating the designer's choice of the relative expensive contact materials.

Fundamentals of Electricity

By K. C. Graham. 337 pp. 244 Figs. Demy 8vo. The Technical Press Ltd. 1960. 4th Edition. Price 40s.

THIS new edition has been fully revised and expanded to keep pace with developments being made in the field. Each electrical principle is well defined and its applications fully explained. Supplementing the text are many illustrations, including many diagrams and schematics, all of which conform to ASA Graphical Standards.

Progress in Automation Vol. 1

Edited by A. D. Booth. 226 pp. 89 Figs. Demy 8vo. John F. Rider Inc. New York. Chapman & Hall, London. 1960. Price 42s.

AS its title suggests, this is a number of papers on British developments in the automation field. The book is divided into two parts, the first on fundamental techniques and the second on applications. It would seem that a large part of the first section could also have been included as applications, in fact only the first and last papers deal with techniques only.

The introduction and historical note are in Dr. Booth's well-known style, and this is followed by a description of up-to-date Analogue to Digital Conversion Techniques including bidirectional counters.

The next five chapters deal with various Process Control Techniques applied to the Petroleum industry, machine tools and the use of Nucleonic Measuring Devices.

Now follow two papers on the subject of control applied to metal cutting machines, discussing the two major control systems for contouring available in this country at the present time.

Lastly, there is a chapter by John Sargrove on the Automatic Inspection of Manufactured Parts, and a short examination of the methods used in the E.C.M.E. machine producing automatically printed circuit assemblies for Radio Receivers.

Though there is, as the title implies, little that is new or published for the first time, it is useful to have collected together a number of reports on applications to date in this rapidly expanding field, and no doubt engineers in other fields will find much to interest them and help them in solving problems of similar types.

The reviewer was pleased to note the very comprehensive Bibliography which follows each chapter and the clear manner in which the very considerable achievements are outlined.

A. W. PEARSON

Selected Semiconductor Circuits Handbook

Edited by S. Schwartz. 503 pp. 308 Figs. Medium 8vo. John Wiley & Sons Publishers Ltd. Chapman & Hall Ltd. 1960. Price 96s.

THE hidden assumption in any book of selected circuits is that a practising electronic engineer can order the specified components, connect them according to the instructions and obtain the desired result. If this were really so, then the book under review would be of little use to British readers, since all the circuits but one specify components made in U.S.A., and no attempt is made anywhere to give a list of close equivalents for European readers.

It is rare, however, to find a circuit which is designed by one team of engineers and which exactly satisfies another application, mainly because of power supply and environment differences. Why then do designers study collections of circuit diagrams? In most cases they wish to find a circuit which approximates to their need and read a list of its properties particularly any second-order effects which are not obvious. This background will enable a similar circuit for the different environment, perhaps using different components, to be designed.

Examined from this point of view, the

book under discussion is well worth reading. The circuits are divided into eight classes, each division having a section on design philosophy, followed by the precise circuit diagrams. Semiconductor tetrodes, pnpn devices and unijunctions will be found in the circuits, although the majority of examples use transistors and diodes only.

The sections on design philosophy take up about one third of the book. They are quite practical in nature, but have enough theory to be read alone as a general text on semiconductor circuit design. A copious list of references (almost exclusively from U.S.A. sources) ends each design philosophy section.

In the selected circuits, the component supply position is not quite as bad as it seems at first. In some few cases the text gives a design method which can be applied to the transistor parameters, so that British transistors could be used. Further, a random sample of semiconductor types specified through the book showed that just over 50 per cent of the circuits use devices which are marketed in Britain by branches of the original American firm, presumably to identical test schedules.

A worse situation exists for inductances. Although in some cases these were given in millihenries, many circuits only specify an American ferrite core number and the winding details, which cannot be regarded as satisfactory. Similarly it is very difficult to find equivalents for thermistors and non-linear resistors, such as are used in temperature compensation arrangements.

One or two circuits stand out for their excellent performance No. 3-8 combines a voltage gain of 100 with an input impedance greater than 7MΩ from $-55°C$ to $+125°C$. No. 4-9 is a feedback amplifier with 34dB gain, flat (within 0·1dB!) out to 16Mc/s, and the remarks end with this understatement: "Considerable care was exercised in the physical layout because of the need to control the loop gain to over 200Mc/s".

The type style will perhaps not please everyone, but the diagrams are very easy to follow, employing the I.R.E. standard letter symbols and graphical symbols. The reader has to tolerate a certain amount of electronic jargon, rising to the heights in circuit No. 11-7, which is simply entitled BUS DRIVER.

F. G. Heath

Medical Electronics—Proceedings of the Second International Conference, Paris, 1959

614 pp. 400 Figs. Medium 8vo. Iliffe & Sons Ltd. 1960. Price 145s

ELECTRONIC techniques are becoming increasingly important in the medical sphere because they provide extremely sensitive and versatile means of measuring or examining physiological effects which often cannot be detected by other means. The growing importance of medical electronics was first recognized on a world scale when the First International Conference was held in Paris in 1958. This was an exploratory meeting, which led to the organization of the first full-scale conference to be held on the subject, at the U.N.E.S.C.O. Building in Paris in 1959. This book is the record of the proceedings. At the conference a large number of papers were presented and delivered in 16 sessions as follows: Special Lectures, General Medicine, Electrophysiological Instruments, New Instruments and Biochemistry, Neurophysiology, Manometry and Blood Flow, Electroencephalography Processing, Respiration, Computers, Cardiology, Oculography, Electroencephalography, Radiology and Isotopes, Obstetrics and Antenatal Pediatrics, Ultrasonics, and Miscellaneous Subjects. For convenience in publication, however, the papers have been regrouped into eight broad sections: Electrophysiological Techniques, Electroencephalography, Cardiology, Manometry and Flow Measurement, Acoustic Techniques, Automation in Medicine, Radiology and Isotopes, and Chemical Instrumentation. It is hoped that this rearrangement will be helpful to the reader by keeping together papers which are related by similar electronic techniques.

The new techniques discussed in this book will be of interest not only to members of the medical profession, but also to electronic engineers who are likely to find that many of the sensitive methods of measurement specially designed for use in medical work have applications in other fields.

Paramètres hybrides des transistors

By J. P. Seurot. 32 pp. 23 Figs. Medium 8vo. Chiron, Paris. 1960. Price 8.8 NF.

THIS booklet has been published in a series of brochures devoted to electronic subjects by Chiron. The author is applications engineer in one of the laboratories of the Philips group in France. His aim has been to give a simple treatment of hybrid parameters, and to make the study comprehensive enough for immediate usefulness in transistor circuit design. The book is divided into two parts. Part I introduces the equivalent four pole circuit of the transistor and derives the hybrid parameters, with applications at low frequencies. Part II deals with high frequency hybrid parameters and establishes practical design expressions.

Printing is probably done through a varitype-offset process and gives the book the general appearance of an internal laboratory report.

A. V. J. Martin

Hi-Fi Amplifier Circuits

By E. Rodenhuis. 116 pp. 64 Figs. pott 4to. Cleaver-Hume Press Ltd. 1960. Price 15s.

THIS book which has been produced by Philips' Technical Library can be described as a sequel to the author's previous book entitled *Valves for A.F. Amplifiers*. It describes a number of preamplifier circuits which give high quality results and can be built at a reasonable price by anyone who has acquired the minimum skills. The book contains much practical information and tips necessary for the best results, and is intended for those who are interested in building and experimenting with high quality amplifiers; for the manufacturer of Hi-Fi equipment on a modest scale; for sound engineers and service engineers; in short for all whose business or pleasure it is to make use of these exciting new techniques.

Dynamic Programming and Markov Processes

By R. A. Howard. 131 pp. 129 Figs. Medium 8vo. John Wiley & Sons Inc, New York; Chapman & Hall Ltd. London. 1960. Price 46s.

THIS book is the first to explore exhaustively the relation between dynamic programming and Markov processes, and defines discrete- and continuous-time Markov processes, provides a physical insight into their behaviour, and shows how to solve them by means of operational transformations.

It presents a new method for making optimum decisions in processes of long duration. This policy-iteration method is applicable to processes with either discrete- or continuous-time dependence, and either with or without discounting as an important element. The book also works out detailed illustrations in baseball strategy, automobile purchasing, taxicab operation, and industrial maintenance and indicates how the models may be applied in industrial equipment replacement, hydroelectric scheduling, inventory control, and other decision-making areas.

LETTERS TO THE EDITOR

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

A Transistor Motor-Speed Control Circuit

DEAR SIR,—The circuit described here uses transistors to control the field current and hence torque of a split-field d.c. motor. The halves of the split-field act as the collector loads of two transistors which are connected as a multivibrator. As the multivibrator oscillates, the transistors pass collector current alternately into the halves of the field winding, and the effective field current is the difference between the time averages of the two collector currents.

The base currents of the transistors are made high enough to ensure that each transistor is 'bottomed' during the conduction period, so that the collector currents are fixed by the field impedance and the supply voltage.

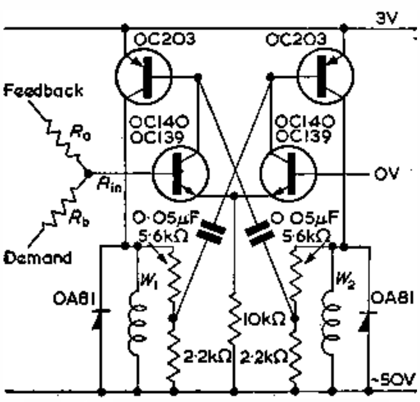


Fig. 1. Transistor motor speed control

R_a, R_b chosen to suit application

$R_{in} \simeq 1k\Omega$. 100mV required at input for full output

W_1, W_2 field winding of type 88 motor generator

If the period of the multivibrator is much less than the mechanical time-constant of the motor, smoothly varying motor torque can be produced by changing the ratio of the conducting times of the two transistors. This may be conveniently achieved by adjusting the ratio of the transistor base currents.

Since each transistor is either passing a high collector current with a low collector voltage or is cut-off, the average power dissipated in the transistors is kept very low.

In the circuit shown in Fig. 1 the pnp transistors VT_1 and VT_2 form the multivibrator with C_1 and C_2 as coupling elements. W_1 and W_2 are the motor field windings and diodes MR_1 and MR_2 suppress the negative pulse, caused by the field inductance, which occurs at the collectors when the transistors switch off.

The base currents of VT_1 and VT_2 are provided by the collector currents of npn transistors VT_3 and VT_4, which are connected as a 'long-tailed pair'. The sum of these collector currents is fixed by the tail resistance R_4 and their ratio is controlled by V_{in}.

Voltage breakdown at the collectors of VT_3 and VT_4 is prevented by attenuating the collector voltage variations of the multivibrator by the potential dividers R_1 and R_2.

A negative feedback voltage from a generator attached to the motor shaft is added to a demand voltage representing the desired speed to form the input voltage V_{in}.

The values of the summing resistors R_a and R_b depend upon the particular application and are chosen with reference to the input resistance and sensitivity at the base of VT_3.

The input resistance is about 1kΩ and a change of about 100mV at the base of VT_3 is sufficient to change the field current from one limit to the other.

In the case of the type 88 motor-generator these limits are ±40mA.

This work was carried out as part of the research programme of the National Physical Laboratory and is published by permission of the Director of the Laboratory.

Yours faithfully,

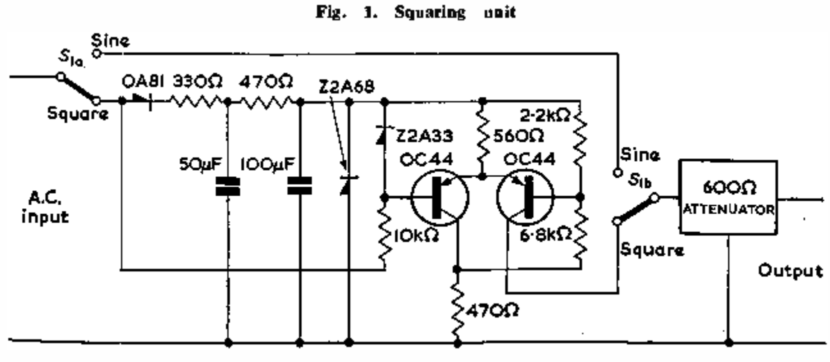
D. L. A. BARBER,
National Physical Laboratory.

Simple Rectangular Wave Shaper

DEAR SIR,—A number of popular inexpensive audio frequency generators give a sinusoidal output of about ½W into a load of 600Ω. The usefulness is much increased if they can be adapted to give a rectangular waveform as well. It is often difficult to do this by modifying the internal circuit, and an auxiliary squaring unit must be used. It does not seem possible to make a satisfactory unit incorporating only resistors and Zener diodes. A simple transistor circuit gives an excellent waveform, but normally involves the complication of either a relatively bulky mains supply or batteries with their attendant disadvantages.

This difficulty can be overcome by using the output of the sinusoidal generator to provide both an input signal and an h.t. supply for the squaring unit.

Fig. 1. Squaring unit



The circuit shown in Fig. 1 gives a rectangular output of about 1V peak-to-peak with a mark-to-space ratio of between 0·8 and 1·2, and rise-and-fall times of about 0·2μsec. The lower frequency limit of satisfactory operation is set by C_1 and C_2 at about 10c/s; the upper frequency limit has not been determined for lack of a suitable oscillator, but it is certainly greater than 50kc/s. The input voltage requirements from a generator of finite impedance are not easily specified, as the load is non-linear, but any oscillator with an available output of ¼W into 600Ω should be adequate. The prototype is built in the same case as a 600Ω wideband attenuator, the switch S_1, giving a choice of sine or square wave output. Because of its small size, the unit can easily be incorporated in a probe if desired. Extension of the basic technique to the generation of different waveforms from different sources is obvious.

Yours faithfully,

J. C. S. RICHARDS,
Aberdeen University.

Some Performance Parameters of Silicon Junction Power Rectifiers

DEAR SIR,—In the article in your February 1960 issue by Mr. D. R. Coleman the disadvantageous effect of minority carrier storage was stated to be the generation of reverse voltage transients on being swept out, due to the presence of stray inductance in the circuit. A further effect was noticed by the author which, unless guarded against, can prevent effective use of these rectifiers in series when the supply frequency is above about 1 000 cycles per second. This was reported in a letter which appeared in *Electronic and Radio Engineer*, August 1959.

Briefly, the effect of the minority carrier storage is to cause very unequal distribution of reverse voltage across a series stack of rectifiers, in some cases almost the total reverse voltage appearing across one rectifier. The explanation is that when inverse voltage is applied following forward conduction the rectifiers continue to conduct in the reverse direction for a time due to carrier storage, however this reverse current commences to rapidly 'sweep out' the minority carriers. Since the storage time varies from rectifier to rectifier, one rectifier in a stack first assumes a high back resistance, the current through the stack almost ceases, and consequently the remaining rectifiers stay in the low impedance condition for a considerable fraction of the reverse cycle, allowing almost the full peak inverse voltage to build up across the rectifier with the shortest storage time.

The remedy is to connect a small capacitor across each rectifier. This allows a current to by-pass the rectifier when the voltage across it suddenly rises due to cessation of conductance due to minority carriers.

Yours faithfully,

M. A. WESTON,
Ministry of Aviation,
Signals Research and
Development Establishment,
Christchurch, Hants.

The Author Replies:

DEAR SIR,—I am grateful to Mr. Weston for raising this issue, which can be of some importance in particular circumstances such as those reported by his letter appearing in *Electronic and Radio Engineer*, August 1959. Two general comments firstly arise:

(1) As Mr. Weston mentions, this effect only occurs with series-connected rectifiers where unequal voltage sharing can overstress one rectifier of the chain. No such difficulties arise with one rectifier per arm of a connexion.

(2) Not all types of rectifier exhibit a significant minority carrier storage under rated operating conditions; furthermore, operation under conditions that reduce the stored charge (for example, at low forward currents) will reduce the effects quoted.

Second thoughts are more particular: the 'recovery' of any one rectifier in a series chain is dictated by the natural recombination of the minority carriers and/or the equalizing charge from the reverse current fed by the circuit. There is thus a 'natural' recovery time for the rectifier when unassisted by the flow of reverse current, and should the circuit (reverse) voltage not rise in that time above the rated value for one rectifier, no danger will result. Conversely, there is clearly a limit to the useable supply voltage frequency with, for example, a single-phase connexion.

Following from the above, more attention is required with polyphase connexions where a considerable fraction of the circuit crest voltage is applied at the instant of commutation from forward conduction. This is the situation presumably existing in Mr. Weston's description of August 1959. The reason given there for preferring capacitive to resistive shunts ignores the existence of the paralleled rectifier in a recovering state (and as given is more cogently applied to polyphase circuits), but nevertheless justifies the use of capacitors as Mr. Weston's measurements show.

Capacitive shunts are also valuable in series chains of rectifiers to compensate for inequalities of junction capacitances and capacitances to earth. I would refer Mr. Weston to an informative article on the general subject by Edward J. Diebold in the winter issue 1959 of *Rectifier News* (International Rectifier Corporation).

Yours faithfully,

D. R. COLEMAN,
Standard Telephones &
Cables Ltd.,
Harlow, Essex.

C.R.O. Recorder for Digital Information

DEAR SIR,—It may sometimes be convenient to display digital information in graphical form. If a normal digital to analogue convertor is used and the resulting analogue voltage applied to a plotting table, the results will be accurate but can only be obtained rather slowly. If a c.r.o. display is used high speed plotting can be achieved but the accuracy will be limited by the known distortions (e.g. barrel or pincushion distortion) of the c.r.o. and also by the imperfections (e.g. emulsion shrinkage) of any subsequent photographic process used to secure a permanent record.

These defects of c.r.o. presentation may be eliminated, while still retaining a speed substantially greater than that of a plotting table in the following manner:

The c.r.o. is provided with a graticule of fine lines normal to each other and spaced uniformly (or as required) to represent the axes and graduations of the desired graph.

A photo-electric cell, preferably a photomultiplier, views the spot of the c.r.o. which is obscured by the graticule lines. If the spot is moved therefore a series of pulses, one for each crossing of a line, will be produced at the output of the photocell. If the spot starts from a defined zero position, therefore, the pulses may be counted and compared with the numerical (digital) value of the quantity to be measured. When the two counts are equal the spot is stopped.

This process is carried out simultaneously on both axes—the lines in the graticule being suitably coloured, and suitable filters provided over the photocells for each axis so that the pulses for line crossing of each axis may be distinguished.

When the spot is in its final position it is intensified so that its position can be recorded on a photographic film in a suittable camera focused on to the face of the c.r.o. As the graticule can also be recorded on the film, problems of emulsion shrinkage during photographic processing will not introduce errors as all subsequent readings can be taken from the graticule.

The spot then returns, at low intensity to its zero position ready to record the next pair of values.

Instead of an optical method of detection an electrical method can be used by placing two gratings of fine wires, normal to each other and insulated from each other immediately in front of the phosphor to intercept the electron beam within the tube.

A logical diagram is shown in Fig 1 and mechanical details are shown in Fig. 2.

Yours faithfully,

W. D. GILMOUR,
E.M.I. Electronics Ltd,
Hayes, Middlesex.

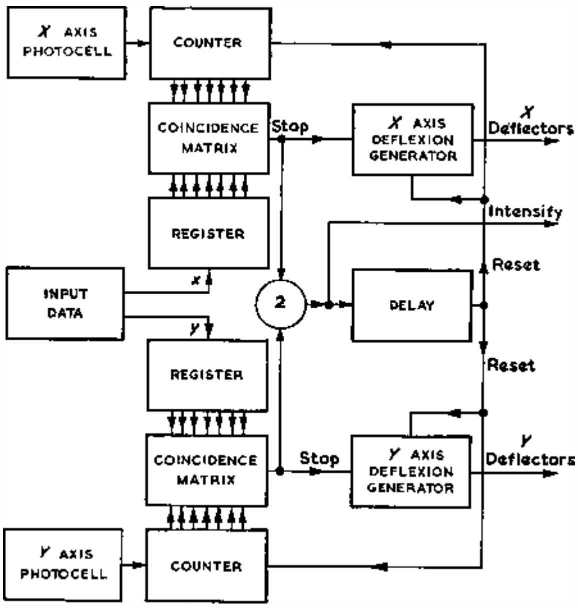


Fig. 1. Logical diagram

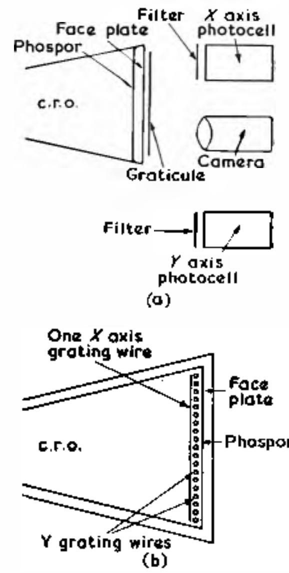


Fig. 2 (a) Optical detection
(b) Electrical detection

Short News Items

Mr. H. Stanesby has been appointed Deputy Director of Research at the Post Office. He is at present Staff Engineer in the Radio Planning and Provision Branch of the GPO Engineering Department. Mr. Stanesby was intimately concerned with the development of the first long-wave transatlantic radio telephone system, and with radio receivers for long distance communications. Later he played an important part in developing coaxial cable systems for multi-channel telephony. In this connexion he made valuable contributions to the art of quartz-crystal filter design, which were brought to practical fruition in the first London-Birmingham multi-channel telephony coaxial cable system. In 1951 Mr. Stanesby took charge of the Radio Laboratories at Dollis Hill, and in 1952 became responsible for the Radio Planning and Provision Branch of the Engineering Department. Mr. Stanesby has been closely connected with the work of the Institution of Electrical Engineers, and was Chairman of the Radio and Telecommunications Section in 1955-56.

The Postmaster General has approved in principle a proposal by the BBC to build a low-power television station near Ballachulish, Argyllshire. The station already approved for Kinlochleven will receive its television programme from the existing BBC station at Rosemarkie via the satellite station to be built at Fort William. This plan necessitates the use of a relay point at Ballachulish to feed the programme to the Kinlochleven station. The BBC has decided that, rather than provide a point-to-point link over this part of the route, it would be better to build a small satellite station at Ballachulish that would not only serve the main purpose of providing the feed of the programme to Kinlochleven, but would also give direct television reception to some 1 500 people in the immediate neighbourhood of Ballachulish.

The British Broadcasting Corporation has ordered a new 50kW medium frequency sound broadcasting transmitter from the Marconi Company for use at the Brookman's Park station to replace the original transmitter, built and installed by Marconi's no less than 31 years ago. The new transmitter will not only be much cheaper to run but will also be capable of being operated by remote control. The Marconi Type BD228 which is to be installed is a completely new design. It consists of two free-standing cabinets bolted together; the left-hand cabinet contains the modulator, the main high tension rectifier and the low voltage and distribution supplies. The right-hand one houses the complete radio frequency stages, excepting, in this case, the drive. The latter, which is being provided by the BBC, will be external to the transmitter. The radio frequency stages, three in number, use only three valves to obtain the final output of 50kW. A driving power of 2W is used for the input to the first stage which is a tetrode mounted in a single ended circuit. This valve drives a triode which is followed by a triode final amplifier. The output stage uses a high efficiency circuit patented by the Marconi Company which gives the transmitter an overall efficiency of 66 per cent at carrier, 60 per cent at 30 per cent modulation and 62·5 per cent at 100 per cent modulation.

James Scott (Electronic Engineering) Ltd, Glasgow, have just completed an order for four Microwave Spectrum Analysers, valued at over £17 000, for the United States Navy. These analysers provide a panoramic display with a resolution of 70c/s of residual f.m. or a.m. modulation components superimposed on a highly stable carrier at microwave frequencies. Signal to noise ratios of the order of 135dB can be accurately determined at modulation frequencies from 1c/s to 130c/s removed from the carrier frequency.

Elliott Brothers (London) Ltd, a member of the Elliott Automation Group, have announced that a team of scientists in the Research Laboratories have been working for sometime in conjunction with the Royal Aeronautical Establishment, Farnborough, on certain vital aspects of a British Space Research Project. Permission to release this information has now been given by the Air Ministry. The project is classified and no further information is available.

A new microwave radio link consisting of eight terminal stations and 18 both-way repeater stations between St. John in New Brunswick and Sydney in Nova Scotia has been completed and is now in operation. Radio and multiplexing equipment for the system was manufactured by the General Electric Company Ltd, of England, and installed by Canadian General Electric Company for The New Brunswick Telephone Company and Maritime Telegraph and Telephone Company. The installation is the second stage of a scheme to provide an extensive microwave network on the East Coast of Canada. The first stage between St. John and Moncton has been operating since last December and work is already well advanced towards extending the network from Moncton to Campbellton.

Professional Group on Information Theory of the Institute of Radio Engineers in co-operation with the Centre of Communication Sciences, Research Laboratory of Electronics, M.I.T., is planning to hold an International Symposium on the Transmission and Processing of Information on 6-8 September 1961, at the Massachusetts Institute of Technology. The Symposium will provide an occasion for the presentation of significant new research contributions of either a theoretical or experimental nature. In order to provide opportunity for creative and thorough discussion, the Symposium Transactions will be distributed at least two weeks prior to the meetings. Papers for this Symposium are invited and authors are requested to submit 500-1 000 word abstracts by 1 January and full papers by 1 April 1961, to The Chairman of the Programme Committee, Peter Elias, R.L.E., M.I.T., Cambridge, Massachusetts.

The Annual Report of the Atomic Energy Authority for 1959/60 stated that an experiment, called the Intermediate Current Stability Experiment, was being designed. The purpose was to study the stability of a toroidal or ring-shaped sheath of hot ionized gas carrying a large electrical current and subjected to applied magnetic fields which should keep the sheath stable. The design studies, supported by experimental and theoretical work, have now shown that to construct this very large apparatus at this time is an undertaking which would take more effort and resources than the Authority consider they are justified in devoting to a single experiment in the present state of knowledge of plasma physics. The Authority are not, therefore, now proceeding with the construction of I.C.S.E., but intend to broaden the fusion programme with a number of smaller but important research experiments, improved methods of diagnostic measurements, and the further development of the advanced techniques needed to produce high temperature plasmas.

Cable & Wireless Ltd have recently placed contracts to the value of £1·8 million (approx.) with Standard Telephones and Cables Ltd, London, for the supply of a complete multi-circuit telephone cable system between the United States and Bermuda to be owned jointly by Cable & Wireless Ltd and the American Telephone and Telegraph Company. This is believed to be the first time that a complete submarine telephone cable system terminating in the United States will be wholly manufactured elsewhere. Terminal equipment, 750 nautical miles of submarine coaxial cable, 34 submerged repeated and three submerged equalizers constitute the bulk of the contract which is due for completion late next year. The frequency bandwidth used on the cable will permit 80 two-way simultaneous telephone calls using new high-efficiency channel equipment. The cable will terminate at Manahawkin, New Jersey; and Flatts, Bermuda, linking the U.S. trunk network and the Bermuda local network. The two-way rigid-type repeaters will be of a similar type to those used for the U.K.-Sweden cable this year and CANTAT, the U.K.-Canada cable next year.

A Solid State Physics Division has been formed at the Atomic Energy Research Establishment, Harwell. Its initial terms of reference will be to carry out basic research leading to greater knowledge and understanding of the structure and behaviour of solids. Dr. W. M. Lomer, at present Head of the Theoretical Physics Division, has been appointed Head of the new Division. Dr. W. C. Marshall has been appointed to succeed Dr. Lomer as Head of the Theoretical Physics Division.

Decca Radar Ltd have announced the receipt of the 10 000th order for their marine radar. This order is for the Icelandic trawler *Lundinn VE 110* and was received in September. The sale of 10 000 sets represents business of some £18M of which £11M has been exported.

Plannair Ltd, of Leatherhead, Surrey, have signed a licence agreement with the Lear-Romec Division of Lear Incorporated, Elyria, Ohio, manufacturers of pumps, valves and aircraft accessories. Under its terms the American company will be able to make the full range of Plannair blowers for use in the U.S.A. and Canada, particularly in the aircraft industry.

The United Kingdom Atomic Energy Authority has published a revised edition of its 'Guide to U.K.A.E.A. Documents' which explains to the public how the Authority publish information about their research, development, design and other work and where new publications are announced; how the Authority is organized into various autonomous Groups, and by which of their establishments information is published; and where the public can obtain free access to read the publications—at depository libraries in Great Britain and 36 foreign and Commonwealth countries—or where they can buy them. A good deal of background information about various series of technical reports, from the early days of the Ministry of Supply, is also given for the many libraries with collections of them. The Guide has been edited by the Chief of Library and Information Services of the Development and Engineering Group at Risley, Warrington. Copies may be purchased from H.M. Stationery Office, or from any bookseller at 1s. 6d. net.

The Minister of Aviation, with the agreement of the Secretary of State for Air, has appointed Air Vice-Marshal T. U. C. Shirley, C.B.E., M.I.E.E., F.R.Ae.S., to be Deputy Controller of Electronics in succession to Air Vice-Marshal G. P. Chamberlain, C.B., O.B.E., who is retiring from the Royal Air Force. Air Vice-Marshal Shirley took up his new duties at the beginning of September. In 1951 he was made Director of Radio Engineering in the Air Ministry, and in 1953 he went to Fighter Command as Chief Signals Officer. In 1957 he passed out of the Imperial Defence College, Henlow. Since early 1959 he has been Senior Technical Officer Fighter Command.

Lord Hailsham, the Minister for Science, has appointed Professor D. Bleaney, F.R.S., and Dr. James Cook, F.R.S., to be members of the council for Scientific and Industrial Research. Together with a third member yet to be appointed, they succeed Professor P. M. S. Blackett, F.R.S., Sir Eric Ashby and Mr. H. Douglass, who have retired on completion of their period of service.

Associated Transistors Ltd which is chiefly held by the Automatic Telephone and Electric Co. Ltd, the English Electric Co. Ltd and Ericsson Telephones Ltd, have just completed plans for the construction of an £850 000 factory at Basingstoke for the manufacture of transistors. The factory which will cover 120 000ft² is expected to be finished in 1963 and the annual output of transistors will be of the order of 15 million.

H.R.H. Prince Philip, Duke of Edinburgh, has been graciously pleased to become Patron of the Society for Visiting Scientists. The Society, which came into existence during the war, offers at its house, 5 Old Burlington Street, London, W.1, a centre at which foreign and overseas scientists visiting the United Kingdom may meet informally with other visitors and with British scientists. The work of the Society is made possible by the subscriptions of its British Council and donations and covenanted subscriptions from industrial and other bodies interested in fostering a closer understanding between scientists of all countries.

Blackburn Electronics Ltd, manufacturers of digital data handling equipment, announce that agreement has been reached between themselves and the Clary Corporation of U.S.A. for the marketing in Great Britain of the range of Clary printers and arithmetic centres. This range includes both parallel and serial entry printers, with or without arithmetic units, capable of addition, subtraction and totalizing. These printers accept both decimal and binary coded decimal information, decoding being performed during the printing cycle. The Clary digital arithmetic centre is a compact and versatile general purpose computer employing transistorized diode logic and a magnetic drum memory element.

Racal Engineering Ltd, of Bracknell, Berkshire, have recently secured a contract of value approximately £100 000 from Supreme Headquarters Allied Powers Europe for a quantity of single sideband air transportable h.f. radio stations. The radio stations are of advanced design and are among the first of their type in Europe designed to permit highly accurate setting of frequencies against an integrated single high-stability frequency standard. The stations are entirely self-contained and include their own power supply, aerial systems and a comprehensive centralized control system.

Microcell Ltd have manufactured twenty-seven digital recorders which are being installed on the Colchester and Clacton electrification scheme of British Railways. The recorders are being installed in electric trains and locomotives and at points along test sections of electrified line to record such data as the speed and position of trains, the variations in electrical voltage and current consumption under varying load conditions and the general effect throughout the power supply and in other related services. The recorders can be synchronized and operated remotely through a specially adapted master recorder. Coded time signals, issued by an electrical synchronous clock fitted to each recorder, will ensure that groups of readings can be accurately compared.

The Scientific Instrument Manufacturers' Association, of 20 Queen Anne Street, London, W.1, will hold their Ninth Annual Convention at the Grand Hotel, Eastbourne, on 17-20 November. The theme of this year's Convention will be productivity in relation to the coming of the European Free Trade Area.

The Mobile Radio Committee have again made recommendations for increasing the number of v.h.f. channels for mobile radio users in its 4th Report recently published by H.M. Stationery Office. Last year the Committee drew up a programme for reducing the width of channels in the low-band to 25kc/s; now the same channel width is to be adopted as standard for the high-band (165-173Mc/s). This will produce 90 more channels in the high-band during the five-year changeover period specified in the 4th Report. The Committee has also revised the distribution of high-band channels among the various categories of users, and a diagram showing the new allocations is included in the Report.

ELECTRONIC EQUIPMENT

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

(Voir page 729 pour la traduction en français : Deutsche Übersetzung Seite 734)

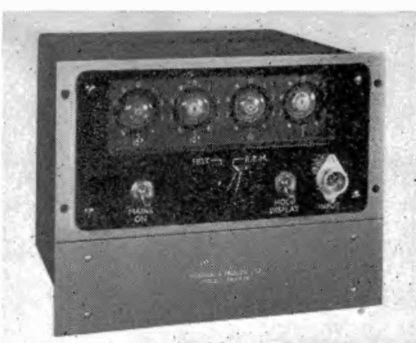
ELECTRONIC TACHOMETER

Pentechnique Ltd, Imperial Lane, Cheltenham Gloucestershire

(Illustrated below)

Utilizing simplified circuits and adaptable metalwork, Pentechnique Ltd have so designed their four and five Dekatron tachometers that they can be supplied in a variety of forms to suit customers' applications.

The illustration shows a tachometer modified in this way to measure (to an accuracy of ±1rev/min) the shaft speed of an a.c. generator by counting the 15 cycles per revolution electrical output of the generator for an accurate 4sec period. The readings are repetitive and after a 2sec display period the Dekatrons automatically reset and proceed



to take a further count. The display period can be extended indefinitely by means of the 'hold display' switch which can be operated at any time during the counting or display process.

The simplified circuit uses only 12 valves and three selenium diodes (in addition to the Dekatrons) and results in a compact equipment. When removed from the case the three hinged subunits can be opened out for complete access for all components. Special quality valves and high-stability resistors are used for reliability.

Photo-electric and magnetic transducers are available for use with these tachometers.

EE 27 751 *for further details*

REMOTE CONTROL EQUIPMENT

Brush Electrical Engineering Co. Ltd, Loughborough, Leicestershire

(Illustrated on right)

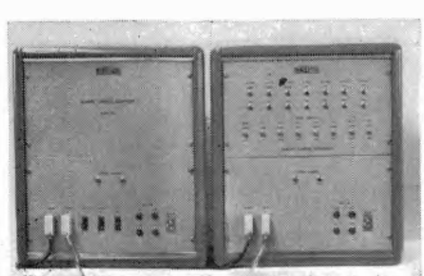
Normal multi-channel two-way signal links over long distances or over difficult terrain require a large number of conductors between the control centre and the remote location which tends to make the cost prohibitive. Brush remote control equipment utilizes a time division multiplex system and uses only two pairs of conductors, thus greatly reducing cable cost and making such systems economical. Alternatively, the equipment can be used with carrier or v.h.f. radio links, providing the necessary bandwidth is available. In certain cases bandwidth requirements can be altered to overcome restriction placed upon the equipment by the type of link employed.

The system which has been developed by Brush engineers uses digital computer techniques to produce a fast, safe and reliable signalling service. It is designed for long periods of operation without attention and employs junction transistors and germanium diodes throughout, thus not only saving power and space but also costly cooling equipment. In order to ensure additional reliability of operation all components have been selected to operate well below their maximum limit and all relays where fitted can be hermetically sealed types. Construction is on the plug-in unit principle, each unit consisting of printed circuit boards with associated components. The number of different types of board is kept to a minimum and in the event of a failure, fault location is simple; a faulty board being quickly replaced and repaired at leisure.

A master unit is required at the control centre with a slave unit at each remote location.

The master unit contains a pulse (clock) generator and a synchronizing circuit which ensures that the counting circuits in the slave and the master are in time synchronism. The operating time of the equipment is determined by the clock frequency and the number of channels involved, although in a number of cases this time is lengthened by summating circuits which are fitted to eliminate the effects of random pulses picked up on the line. Typical uses of the equipment include supervisory control and indication, for power stations of all types; nuclear and process control applications; railway signalling; or telemetry of variable quantities such as voltage, power, pressure, flow, etc.

Where telemetry facilities are required each variable can be scanned in sequence and digitized, the digitizer output consisting of a number of digits arranged in binary coded decimal. The coded signal is then transmitted via the required number of channels and decoded at the receiving end.



The equipment can operate from mains supply or batteries, or both as required and is designed to provide 'fail safe' conditions in the event of a failure of either power supply or equipment.

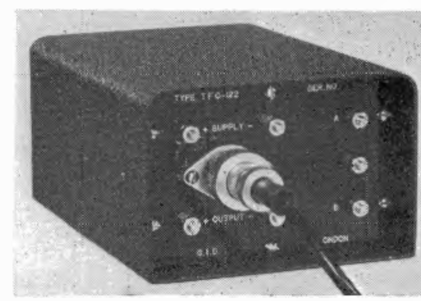
EE 27 752 *for further details*

TACHOMETER

Grunther Industrial Developments Ltd, 14 Oriental Street, London E.14

(Illustrated below)

This equipment consists basically of a type FC-121 frequency to direct current convertor fitted with an integral



oscillator suitable for operating a type CTD-023 capacitance transducer.

Repetitive events occurring in proximity to the transducer probe, such as the continuous passing of an irregularity on a rotating shaft, results in variations in transducer output level with a frequency exactly identical to that of the event. These signals are fed to the convertor section of the TFC-122 which delivers a d.c. output of a value proportional to the signal frequency, and therefore the speed of revolution of the shaft.

This d.c. output is substantial and, coupled with the frequency range of the convertor section, forms a tachometer system capable of measuring from creep speeds up to 180 000rev/min without contacting or loading the shaft, and providing an output suitable for simultaneously feeding a number of large indicators.

Although the convertor section requires a minimum of 5p/s to function (equivalent to 300rev/min) very low speeds can be measured by arranging for the probe to "see" a number of events per revolution. This is accomplished by placing the probe in proximity to a gear and obtaining an output pulse every time a tooth passes, in this manner a 60-tooth gear on a shaft running at 10rev/min would appear to the unit to be running at 600rev/min and the correcting factor can be applied at the indicator.

As on the FC-121 frequency to d.c. convertor, tappings are provided to allow full scale outputs to be obtained for a wide range of input frequencies, and these, together with the use of meter shunts and multiple counts per revolution, will enable any required speed range to be monitored, controlled or recorded.

Operation is not affected by the mark-space ratio of the shaft irregularities, and the TFC-122 can be used equally well to measure the frequency of other recurring events which cause capacitance changes at the transducer probe, such as vibration, passing objects etc.

EE 27 753 *for further details*

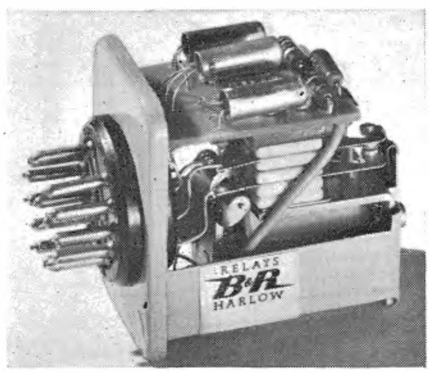
RELAY AMPLIFIER

B and R Relays Ltd, Temple Fields, Harlow, Essex

(Illustrated below)

A three-stage transistor amplifier has been produced by B & R Relays for fitting integrally with their M.01 relay, thus providing a single compact plug-in unit.

An operating sensitivity of the order of 5μA may be achieved, and the power



consumption is 0·5W at a nominal 6V or 12V d.c. The complete unit weighs only 6oz, and it provides for multiple ancillary circuit operation on receipt of a signal as low as 10mW at the input.

EE 27 754 *for further details*

DIRECT WRITING OSCILLOGRAPH

Savage and Parsons Ltd, Watford, Hertforshire

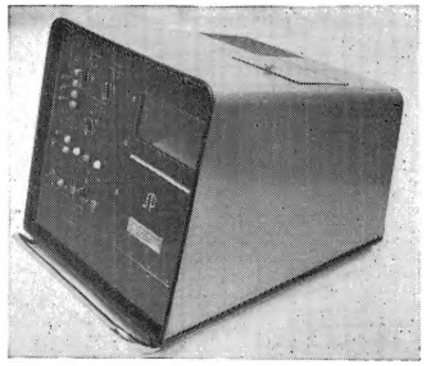
(Illustrated above right)

This direct-writing oscillograph is capable of recording at frequencies from d.c. to 1kc/s and above, and provides a choice of eight paper speeds, from 5in/min to 150in/sec. It gives a well defined trace at writing speeds in excess of 12 000in/sec.

Designed as a 12-channel unit, the recorder is available with matched amplifiers and power supply units if required, and is able to record any varying function which can be translated into an electrical signal within the frequency range.

The magnet block carries 15 pencil-type mirror galvanometers, specially made for the recorder, the additional three channels serving for time or event marking, or as extra recording channels if desired. By the operation of a switch, two of these three galvanometers can be connected with the mains supply to give a reference frequency.

The oscillograph employs a compact-



source ultraviolet lamp, recording up to 15 traces on 6in wide sensitized paper. The images are developed spontaneously within a few seconds.

Rolls of recording paper containing up to 200ft can be loaded through a front panel, and feeding is automatic once the edge of the paper has been placed in contact with the drive roller. A footage selector switch is provided which stops the drive after 2ft, 5ft or 10ft of paper have been exposed, or to allow continuous running.

Paper speeds are selected by push-buttons on the front panel which operate solenoid clutches. The running speed is indicated by a light opposite the appropriate button. All the gears are permanently meshed, so that speeds may be changed during recording and there is a minimum of delay in reaching even the highest speeds.

The position of each trace on the paper can be simply adjusted through an opening in the top cover, using a screwdriver, while the resultant change on the paper is observed through the front window. If less than the full number of channels are in use, unwanted traces can be directed off the edge of the paper. To identify the traces, a sequential interruption of each trace provides identification of each channel at two-foot intervals, irrespective of paper speed.

EE 27 755 *for further details*

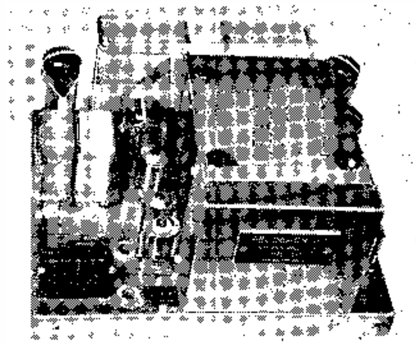
STABILIZED POWER SUPPLY

Feedback Ltd, Crowborough, Sussex

(Illustrated below)

The SD 97 is a general purpose power supply, providing plus and minus 300V d.c. stabilized, 0 to 100mA, and 6·3V a.c., 6A, unstabilized.

It is built as a chassis unit, so that



it can be incorporated in cabinets with other equipment, or supported on a front panel for mounting in a bench rack, and it is also suitable for bench use as there are no live terminals above the chassis.

The outputs can be taken from solder lugs underneath the chassis or from a 6-pin socket on top of the chassis.

The power supply is chokeless. The stabilization factor is better than 300, the output impedance less than 1Ω and the ripple less than 2mV.

EE 27 756 *for further details*

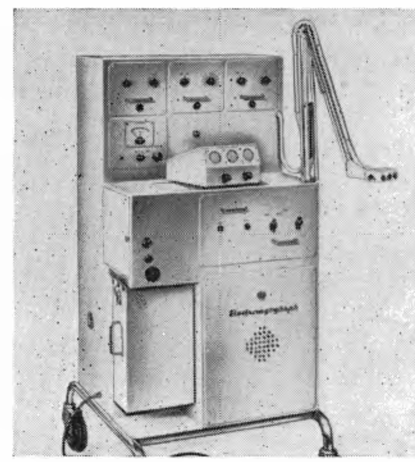
ELECTROMYOGRAPH

Disa Elektronik A/S

27 Teglvoerkagade, Copenhagen, Denmark

(Illustrated below)

The Disa electromyograph has three independent electrode-amplifier circuits, permitting the muscle action potentials



to be recorded simultaneously from three different points of the same or different muscles. The action potentials are picked up from the muscle by needle or surface electrodes, amplified, and displayed on three cathode-ray tubes placed for observation. The action potentials can at the same time be made audible by a built-in loudspeaker, which may be connected to any of the three amplifier outputs. A continuous film camera employing 10cm wide paper is provided to photograph the trace of three additional cathode-ray tubes, operating in parallel with those used for observation.

The amplifiers of the electromyograph employ a special input circuit which permits the action potentials to be recorded without appreciable distortion. They have a very low noise level 1·5μV r.m.s. and a wide frequency range 2c/s to 10kc/s. Their high input impedance (100MΩ, 50pF) and large in-phase rejection ratio permits the taking of electromyograms without screening of the patient, in almost all installations, thus eliminating the need of use of a shielded room. The electromyograph is completely mains operated. Provided with smoothly running ball bearing castors, it can be easily placed in a convenient position beside or behind the patent's bed. The electrode plug box is mounted on a movable arm, and can be readily positioned near the muscle to be tested. The cathode-ray tubes for observation can be turned for viewing by the operator.

Recordings are made by pressing a foot switch. Continuous or sweep traces may be recorded, at any of six time-bases. The intensity of the cathode-ray spot is automatically adjusted to the proper value for recording with the setting of the time-base. A legend giving the patient's name, number, etc., can be photographed directly on the record. The simplicity of operation permits a single person to operate the instrument while simultaneously attending the patient.

EE 27 757 *for further details*

TELEVISION TUNER

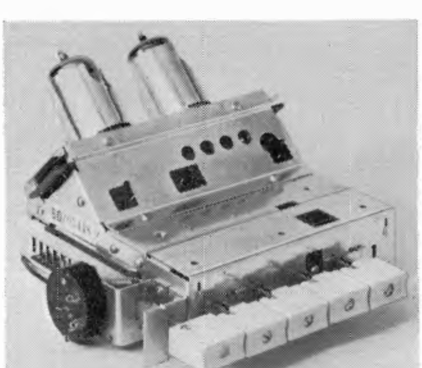
Sydney S. Bird and Sons Ltd, 3 Palace Mansions, Palace Gardens, Enfield, Middlesex

(Illustrated below)

The PC 60 provides push-button tuning in a convenient form. Shaped to the cone of a tube it occupies space which is virtually unusable by any other component, and offers a choice of any 4 from 13 channels, in any order, with the pre-set fine tuner for each button available from the front. The tuner has been designed to ensure that under operating conditions accurate reset obtains, coupled with long life, stability and low thermal drift. Extensive use is made of printed circuits.

The tuner is of the incremental type. Tuning being obtained when a shorting contact is placed across adjacent rivets. By this method all channels are provided in the tuner. The shorting contacts are supported on plastic cross slides which are located by a transverse mechanism to the buttons. The slides are positioned in slots, each slot being marked clearly with a channel number. To preset any channel it is only necessary to insert the plastic slide, coupled to the button to be used, in the slots bearing the correct channel number. As switching is by a shorting link, wide variation in the precise position of that shorting link will not change the electrical length between the two appropriate contacts. Therefore, any variations will not change the frequency.

Mounted on the oscillator coil board is a concentric capacitor fine tuner. The operating capacitance of this trimmer is determined when a button is in the depressed position. The capacitor adjustment is via a captive nylon screw mounted inside the button. The fine



tuner range, approximately 3Mc/s over all bands, is covered by seven turns of the screw, giving smooth and controlled adjustment.

EE 27 758 *for further details*

NULL INDICATOR

Honeywell Controls Ltd, Greenford, Middlesex

(Illustrated below)

This instrument is the equivalent of a sensitive galvanometer but without many of the disadvantages associated with a conventional galvanometer. It is not affected by vibration and comes to rest very quickly. It is suitable for use as a null indicator for bridges, etc.

In operation, a d.c. signal is applied to the input and converted to a.c. by the convertor and transformer. It is then amplified and applied to the output stage. This stage is essentially a grid-controlled rectifier whose output is applied to the indicator. The polarity of the input signal determines the phase of amplified a.c. voltage, and the output of the full-wave rectifier passes current in a direction determined by this phase. Each positive

signal will impress an a.c. voltage on the grids of the output valves of such phase that one pair of triodes passes current during each positive half of the line voltage cycle: and on the negative half of the cycle, little or no current is passed by the valves. Consequently, one pair of cathodes becomes positive with respect to the other pair, and the capacitor between the two acquires a charge. This charge is measured by the indicating meter, which deflects in one direction. A negative input signal results in the opposite action.

When the input signal is zero and the bridge is in balance, both pairs of triodes pass equal current of opposite phase, the net charge on the capacitor being zero, and hence the meter indication is also zero.

The sensitivity of the instrument is continuously variable and at maximum is 1μV/mm; the input resistance in 1kΩ.

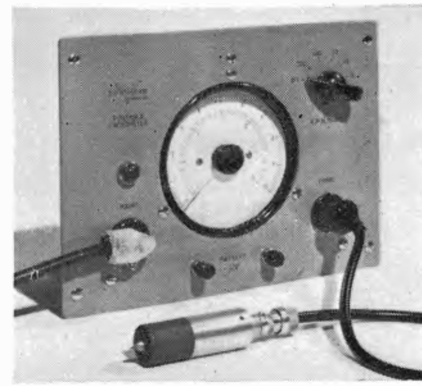
EE 27 759 *for further details*

PORTABLE TACHOMETER

Southern Instruments Ltd, Frimley Road, Camberley, Surrey

(Illustrated above right)

This fully transistorized, mains or battery operated instrument has been developed for the accurate measurement



of the speed of revolution of shafts of all types and sizes over a wide range of speeds.

Two versions of the instrument are available, one covering low frequencies from 0 to 30 000rev/min and the other high frequencies from 30 000 to 300 000 rev/min. The overall accuracy of these instruments is better than $\pm$1·5 per cent and both photo-electric and magnetic transducers are available for use with them.

EE 27 760 *for further details*

V.H.F. STANDARD

The Wayne Kerr Laboratories Ltd, Roebuck Road, Chessington, Surrey

(Illustrated above right)

With the reduction in the carrier spacing of v.h.f. stations it becomes more than ever essential that the operation of portable transmitters and receivers shall be maintained at the allocated frequency. This instrument has been designed to meet the need for a compact and portable frequency standard. It provides a wide selection of crystal-controlled frequencies and enables both transmitters and receivers to be checked to a high order of accuracy.

Basically the instrument consists of an oscillator which can be switched to operate with any one of up to twelve crystals, thermostatically-controlled plug-in ovens (up to six in number, each capable of housing two crystals), up to three multiplier units, a wide-band detector and rectifying circuits for operation from a.c. supplies of 100 to 130V and 190 to 240V.

The crystals employed can be selected for operation at any frequency within the range 7·5 to 9·7Mc/s. A central 12-position control switches the desired crystal into an aperiodic Colpitts oscillator circuit. Trimmers are provided to permit slight 'pulling' of each crystal frequency. Six lamps, each associated with the thermostat of an oven, are disposed round the dial of the 12-position switch and are illuminated while the oven is on. The oven temperature is thermostatically controlled at 80°C.

Three types of multiplier unit are available and, if required, all three can be fitted in the instrument. Each operates over a portion of the total crystal frequency coverage of 7·5 to 9·7Mc/s and provides outputs at fre-

quency multiples of ×3, ×9 and ×18 thus providing full coverage up to 175Mc/s.

At a constant ambient temperature, and after a 45-minute warming-up time, the variation in the crystal frequency and the corresponding multiples is not greater than 3 parts per million.

A socket is provided for feeding in a signal from a transmitter whose frequency is to be checked. The amplitude of the signal applied should be greater than 100mV. The transmitter signal and the selected crystal frequency and its multiples are fed to the wide-band detector. The output from this circuit is applied to a jack socket on the front-panel. Zero beat is detected by means of high impedance headphones connected to this socket.

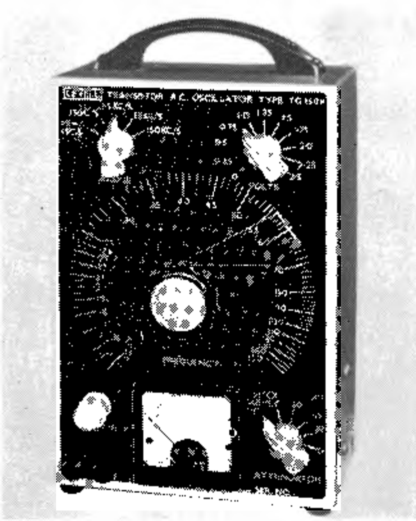
EE 27 761 *for further details*

L.F. OSCILLATORS

Levell Electronics Ltd, 10-12 St. Albans Road, Barnet, Hertfordshire

(Illustrated below)

These *RC* oscillators use transistors as the active components with the advantage of freedom from many of the defects which exist in comparable valve oscillators. The much lower power consumption of the transistor results in the elimination of slow drifts of frequency and amplitude that are characteristic of valve oscillators during the warm-up period. The low power consumption also permits long life batteries to be used as the supply with the complete elimination of hum modulation.



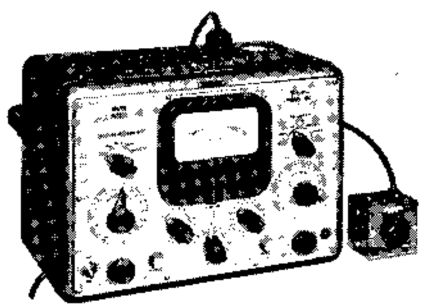
The circuit of the oscillator comprises a transistor amplifier with positive feedback applied via a Wien bridge selective network and negative feedback applied via a thermistor amplitude stabilizing network. Type TG150M differs from type TG150 by the addition of an output meter.

The resonant frequency of the Wien bridge network is continuously variable over one decade by a calibrated frequency control. Five ranges are provided to give a coverage from 1·5c/s to 150kc/s with an effective total scale length of 50in.

Two transistors are used in the output stage in a feedback linearized circuit such that the output of the oscillator is negligibly distorted although the supply current is low.

A considerable degree of negative feedback is applied via the amplitude stabilizing network to ensure that the output is constant over the entire frequency range and is negligibly affected by variations of the supply voltage and ambient temperature.

EE 27 762 *for further details*



TRACE SHIFTER

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

(Illustrated above)

The Cawkell trace shifter is a new instrument designed to allow the user of an oscilloscope to display, in sequence, up to ten signals coming from the same source. Each signal is displaced vertically relative to its predecessor so that comparison may be made.

The trace shifter finds its main application in conjunction with transient storage oscilloscopes, such as the Remscope, and with its aid cycle-by-cycle variations in a recurring signal or a series of transients may be studied. The interval between successive signals is unimportant as the shifter is triggered at the end of the oscilloscope time-base. It is suitable for use with almost any oscilloscope with differential inputs.

The unit is self-contained, battery operated and uses transistors throughout.

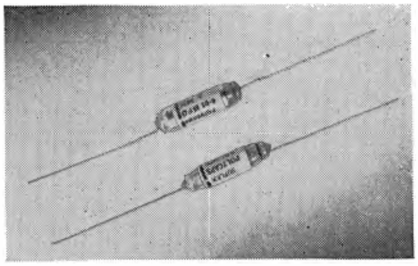
EE 27 763 *for further details*

POLYESTER CAPACITORS

Suflex Ltd, Bilton House, 54-58 Uxbridge Road, Ealing, London W.5

(Illustrated above right)

This range of capacitors, known as 'Polycaps', provides a reasonably cheap capacitor which is intended as an alternative to the normal paper dielectric types.



In addition, they have the advantage of a high operating temperature (100°C) and very high insulation resistance (greater than 100 000MΩ). The range available is 0·01μF to 0·05μF, ±20 per cent tolerance, 350V d.c.

EE 27 764 *for further details*

TELEVISION TRANSLATOR

Marconi's Wireless Telegraph Co. Ltd, Marconi House, Chelmsford, Essex.

(Illustrated below)

This equipment is used to repeat television transmissions over districts where the field strength is weak, so filling gaps in a service area. It is suitable for operation in Bands I and III and consists essentially of frequency changing and amplifying equipment. The power output is nominally 3W and can be increased to 50W by means of an additional amplifier.

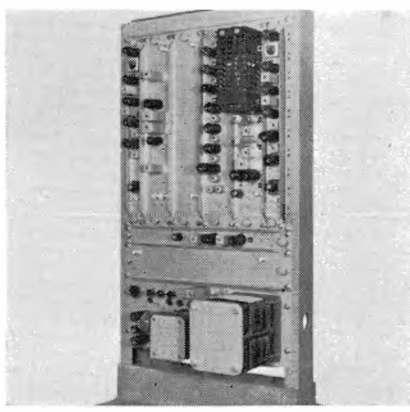
The equipment may be used as a repeater from an existing transmitter, or as a low-power transmitter. A combination of transmitter and repeater provides the facility of either relaying signals from a main transmitter or transmitting locally originated material as required.

Due to the vision signal being amplitude-modulated and the sound signal being frequency-modulated, common amplifiers are used for vision and sound without the deterioration caused by cross-modulation.

The equipment is normally housed in a standard 19in (48cm) rack. If necessary, special cubicles for outdoor mounting can be supplied to suit requirements.

No dangerous voltages are accessible on the equipment when the unit covers are in position. Adequate overload protection is provided, and important valve feeds can be fully metered from the front panel.

This equipment is suitable for use on 525 or 625 line standards.



EE 27 765 *for further details*

Meetings this Month

THE BRITISH INSTITUTION OF RADIO ENGINEERS

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

Radar Group

Date: 2 November.
Discussion: Radar—Pulse or C.W. Medical and Biological Electronics Group.
Date: 9 November.
Lecture: Diagnostic Applications of Ultrasonics.
By: T. G. Brown.

Computer Group

Date: 16 November.
Lecture: Digital Computing Elements for Industrial Use.
By: I. W. Peck.

Electro-Acoustics Group

Date: 23 November.
Lecture: Objective and Subjective Requirements for Loudspeakers.
By: F. H. Brittain.

Southern Section

Date: 22 November. Time: 7 p.m.
Held at: Farnborough Technical College.
Lecture: Radio Aids for Automatic Landing developed by the Blind Landing Experimental Unit.
By: J. S. Shayler.

THE INSTITUTE OF NAVIGATION

Date: 18 November. Time: 10 a.m.
Held at: The Royal Geographical Society, 1 Kensington Gore, London S.W.7.
Lecture: Navigation for the Early Exploration of the Moon.
A one day Symposium of papers, held jointly with the British Interplanetary Society.
Contributors will include: Dr. S. Herrick, D. J. Cashmore, W. Maxwell Noton, and D. O. Fraser.

THE INSTITUTION OF ELECTRICAL ENGINEERS

East Anglian Sub-Centre

Date: 14 November. Time: 6.30 p.m.
Held at: The Technical College, Cambridge.
Lecture: The Oral Presentation of Scientific Material.
By: A. Clow.
Date: 28 November. Time: 6.30 p.m.
Held at: Electric House, Ipswich.
Lecture: An Introduction to Electronic Computers.
By: R. C. M. Barnes.

Mersey and North Wales Centre

Date: 8 November. Time: 6.15 p.m.
Held at: The Engineers' Club, Manchester.
Lecture: Submersible Pumping Plant.
By: H. H. Anderson and W. G. Crawford.
Date: 14 November. Time: 6.30 p.m.
Held at: Town Hall, Chester.
Lecture: Teaching and Learning Machines.
By: C. E. G. Bailey.
Date: 28 November. Time: 6.30 p.m.
Held at: The Royal Institution, Colquitt Street, Liverpool.
Lecture: Thermistors—their Theory, Manufacture, and Application.
By: R. W. A. Scarr and R. A. Setterington.

Cambridge Electronic and Measurement Group

Date: 15 November. Time: 8 p.m.
Held at: The Cavendish Laboratory, Cambridge.
Chairman's Address: Channelling—A Sketch.
By: T. B. D. Terroni.
Date: 24 November. Time: 8 p.m.
Held at: Cavendish Laboratory, Cambridge.
Lecture: Television Recording—A Survey of the Problems and Methods Currently in Use.
By: J. Redmond.

Sheffield Sub-Centre

Date: 21 November. Time: 7 p.m.
Held at: The Angel Hotel, Brigg.
Lecture: Subscriber Trunk Dialling.
By: D. A. Barron (to be read by H. E. Francis).

THE INSTITUTION OF ELECTRONICS

Date: 18 November. Time: 7 p.m.
Held at: The London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London W.C.1.
Lecture: Magslips, Synchros and their Applications.
By: J. H. Batchelor.
Date: 23 November. Time: 7 p.m.
Held at: The Technical College, Reading.
Films: Electronic Topics.

THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Date: 8 November. Time: 5 p.m.
Held at: Institution of Electrical Engineers, Savoy Place, London W.C.2.
Lecture: Control and Telemetering of the British Grid.
By: P. F. Gunning.

THE SOCIETY OF ENVIRONMENTAL ENGINEERS

Date: 23 November. Time: 6 p.m.
Held at: Imperial College, London.
Lecture: Vibration Testing and Instrumentation of Large Stores.

THE SOCIETY OF INSTRUMENT TECHNOLOGY

All London Meetings will be held at Manson House, 26 Portland Place, London W.1 and, unless otherwise stated, commence at 7 p.m.

Data Processing Section

Date: 9 November.
Lecture: A Shaft Position Digitizer Using Synchros.
By: T. Roberts.
Date: 29 November.
Lecture: Symposium on Nuclear Temperature Scanning: Equipment for a large Nuclear Reactor.
By: C. Hall.
Lecture: Temperature Scanning Equipment for use in a Nuclear Power Station.
By: A. G. Blay, P. G. Davey, and F. C. Flint.

Cheltenham Section

Date: 22 November. Time: 7.30 p.m.
Held at: The Belle Vue Hotel, Cheltenham.
Lecture: The Operation and Control of ERNIE.

THE TELEVISION SOCIETY

All meetings, unless otherwise stated, are held at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.
Date: 10 November. Time: 7 p.m.
Lecture: Masers and Parametric Amplifiers: Their Use in Ultra Low Noise Receivers.
By: C. R. Russell.
Date: 25 November. Time: 7 p.m.
Lecture: Measurement Techniques for Television Broadcasting.
By: L. E. Weaver.

PUBLICATIONS RECEIVED

THE INDUCED CHARGE METHOD OF READING CONDENSER DOSIMETERS, by E. H. Cooke-Yarborough is a United Kingdom Atomic Energy Authority Research Group memorandum. The memorandum considers certain possible improvements to the pocket condenser-chamber dosimeter with the object of increasing its reliability and accuracy, and of allowing the dose received to be read as often as required without affecting the charge on the chamber. H.M. Stationery Office. Price 1s. 9d.

MICROWAVE VALVES lists, with concise technical data, the current ranges of magnetrons, klystrons and travelling wave tubes. It also contains a useful quick-reference chart showing the type required for a given output and frequency performance. The chart is colour coded for easy distinction between valves for pulse and c.w. operation. Published by the Government & Industrial Valve Division of Mullard Ltd requests for copies—on organization letterheading—should be addressed to the Division at Mullard House, Torrington Place, London W.C.1.

ON OFF CONTROL WITH PHOTOCELLS, is a guide to cadmium sulphide cells and their application. It lists the present range of cadmium sulphide photoconductive cells for industrial purposes, and describes their theoretical operation, and gives comprehensive data including spectral and sensitivity curves, and curves showing rise and decay times. Notes on circuit design and practical operating considerations are also included. Published by the Government & Industrial Valve Division of Mullard Ltd, requests for copies—on organization letterheading—should be addressed to the Division at Mullard House, Torrington Place, London W.C.1.

THE NATIONAL PHYSICAL LABORATORY REPORT for 1959, printed for the Department of Scientific & Industrial Research by H.M.S.O. is the latest annual report of the Laboratory, and covers a wide range of research topics in modern physics. Price 8s. 0d., plus 7d. postage.

A SENSITIVE DIRECT-READING POCKET-SIZE GAMMA DOSIMETER by J. H. Howes of the Electronics Division, Atomic Energy Research Establishment, Harwell, Berkshire, is published by H.M.S.O. Price 3s.

SYNCHRO ACCESSORIES AND MOUNTING INSTRUCTIONS is a new leaflet giving comprehensive details and illustrations on mounting and zeroing all types of synchros and servomotors, fixing gears or pinions. Tables give easy to read details on mounting panel drilling and recommend fixing screw sizes. It will prove most useful to every synchro user and will be sent free of charge on application to the publishers, Muirhead & Co. Ltd., Beckenham, Kent.

MECHANICAL WORLD ELECTRICAL YEAR BOOK 1960, published by Emmott & Co. Ltd, 31 King Street West, Manchester 3, and 158 Temple Chambers, Temple Avenue, London E.C.4, is the 53rd edition of a collection of electrical engineering notes, rules, tables, and data. Price 4s.

FLEXIBLE METALLIC COUPLINGS is a data book giving detailed information regarding Metastream couplings which are manufactured by Metaducts Ltd, Catherine Wheel Road, Brentford, Middlesex. This book can be obtained free of charge from this address upon application.

M & I GLASS BASED MATERIALS FOR ELECTRICAL INSULATION is a new publication by The Micanite & Insulators Co. Ltd which gives details of their wide range of glass based electrical insulating materials. This brochure can be obtained free of charge from this manufacturer by writing to their Empire Works, Blackhorse Lane, Walthamstow, London E.17.

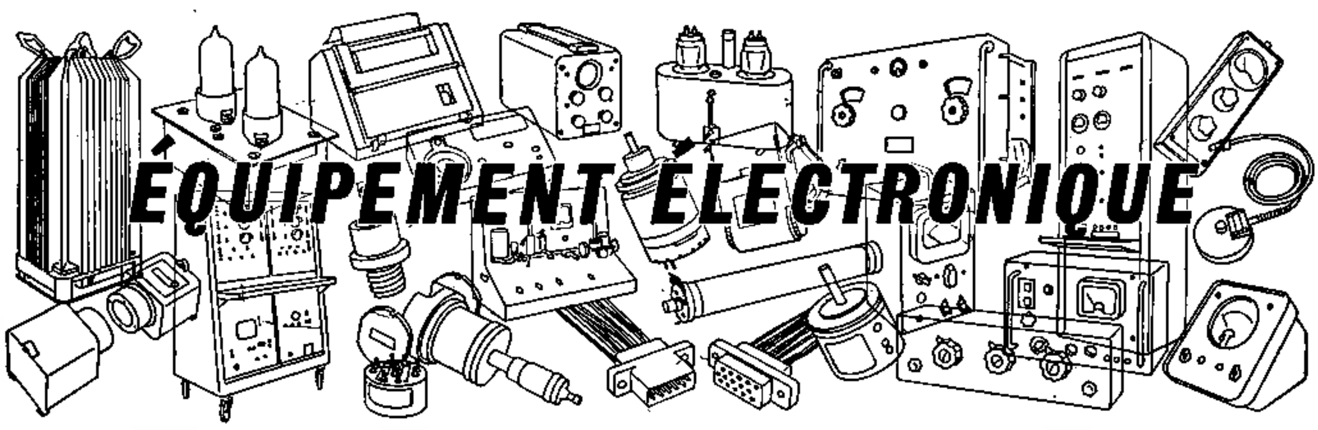
ODU-CONTACTS is a brochure giving details of a new and revolutionary range of plugs, sockets and couplings which are now marketed in this country. These products are well known on the Continent and have been in use by NATO and the German Navy for some time. Further details can be obtained from Arthur E. S. Matthews Ltd, 36 Victoria Street, London S.W.1.

MECHANICAL ENGINEERING RESEARCH 1959 is the report of the National Engineering Laboratory Steering Committee, with the Report of the Director of the National Engineering Laboratory. In this annual report a decision was taken to give priority to projects which are directed towards immediate industrial problems, or which promise application within a relatively short period. Three projects were selected as being particularly important. Investigations in the machine tool field, the development of hydrostatic power transmissions, and work on the cold extrusion of steel. The Report of the DSIR is published by H.M. Stationery Office. Price 4s. 6d., plus 5d. postage.

RESEARCH FOR INDUSTRY 1959 is a DSIR Report by the Committees of grant-aided Research Associations and draws attention to three important areas of research—creep, fatigue of metals, and shipbuilding. It also includes a special article by Dr. J. Thomson, Director of the British Scientific Instrument Research Association, on the progress of research on insrtumentation and automatic control in industry. Published by H.M.S.O. Price 8s., plus 7d. postage.

THE REFRACTIVE INDEX OF AIR FOR RADIO WAVES AND MICROWAVES is a booklet of tables giving the refractive index of air for a wide range of temperatures, pressures, and water vapour pressures issued by the National Physical Laboratory. The tables are based on formulae derived by Dr. L. Essen and Dr. K. D. Froome at the Laboratory. Copies of the tables are available on application to the National Physical Laboratory, Teddington, Middlesex.

(*Pages 729 to 738 French and German Section*)



ÉQUIPEMENT ÉLECTRONIQUE

Une description basée sur des renseignements fournis par les fabricants de nouveaux organes, accessoires et instruments d'essai *Traduction des pages 724 à 727*

TACHYMÈTRE ÉLECTRONIQUE

(Illustration à la page 724)

Pentechnique Ltd., Imperial Lane, Cheltenham Gloucestershire

Faisant usage de circuits simplifiés et de métal adaptable, la société Pentechnique Ltd. a réalisé ses tachymètres à quatre et cinq Dékatrons de façon à ce qu'ils puissent être fournis en divers modèles répondant aux applications particulières du client.

Notre gravure montre un tachymètre, modifié comme indiqué, pour mesurer (à un degré de précision de $\pm$ 1 tour/minute) la vitesse d'arbre d'un générateur à courant alternatif, en comptant les 15 cycles par tour de puissance de sortie électrique du générateur pendant une période exacte de 4 secondes. Les lectures se répètent, et après une période d'affichage de 2 secondes, les Dékatrons se réenclenchent automatiquement et reprennent un nouveau comptage. La durée d'affichage peut être prolongée indéfiniment au moyen du commutateur de "maintien d'affichage," qu'on peut actionner à n'importe quel moment au cours du processus de comptage ou d'affichage.

Le circuit simplifié ne comporte que 12 lampes et trois diodes au sélénium (en plus des Dékatrons), et se présente sous la forme d'un système compact. Lorsqu'on retire du coffret les trois sous-ensembles à charnières, ils peuvent être ouverts pour donner accès à toutes les pièces. Des lampes de qualité spéciale et des résistances à grande stabilité sont employées pour garantir la sûreté du fonctionnement.

Des transducteurs photoélectriques et magnétiques sont fournis sur demande pour être employés avec ces tachymètres.

EE 27,751 *pour plus amples renseignements*

ÉQUIPEMENT DE TÉLÉCOMMANDE

(Illustration à la page 724)

Brush Electrical Engineering Co. Ltd, Loughborough, Leicestershire

Les liaisons ordinaires de radiosignalisation bilatérale multivoies, sur grandes distances ou sur terrain défavorable, exigent un grand nombre de conducteurs entre le centre de commande et le lieu éloigné, ce qui tend à rendre leur coût prohibitif. Le matériel de télécommande Brush utilise un système multiplex par partage du temps, ne nécessitant que deux paires de conducteurs, réduisant ainsi considérablement le coût du réseau de câbles et rendant le système économique. En variante, l'équipement peut être utilisé avec des liaisons radioélectriques hyperfréquences ou par ondes porteuses, à condition d'avoir la largeur de bande voulue. Dans certains cas, les conditions de largeur de bande peuvent être modifiées pour éviter les restrictions imposées à l'équipement par le type de liaison employé.

Ce système, qui a été conçu par les ingénieurs de la société Brush, met en oeuvre des calculateurs numériques afin de produire un service de signalisation rapide, sûr et efficace. Il a été prévu pour de longues périodes de fonctionnement, sans entretien et il est entièrement muni de transistors à jonction et de diodes au germanium, économisant ainsi non seulement l'espace et l'énergie, mais rendant inutile également un matérial de refroidissement coûteux. De manière à garantir davantage la sûreté du fonctionnement, toutes les pièces ont été choisies pour une utilisation bien en deçà de leurs limites maxima et tous les relais, où il s'en trouve, sont du type hermétiquement scellé. L'équipement a été construit sur le principe des éléments à fiches, chaque élément se composant de plaquettes de circuits imprimés, avec les pièces s'y rattachant. Le nombre de différents types de plaquettes a été réduit au minimum et, en cas de dérangement, le dépannage se fait sans difficulté, une plaquette défectueuse pouvant être remplacée rapidement et réparée à loisir.

Un maître-élément doit être installé au centre de commande, avec un élément asservi à chaque emplacement éloigné.

Le maître-élément contient un générateur d'impulsions (à mouvement d'horlogerie) ainsi qu'un circuit de synchronisation qui assure le synchronisme dans le temps des circuits de comptage dans le maître-élément et l'élément asservi. La durée de fonctionnement de l'équipement est déterminée par la fréquence d'horlogerie et le nombre de voies utilisées, quoique, dans maints cas, cette durée puisse être allongée par des circuits intégrateurs qu'on installe afin d'éliminer les effets d'impulsions erratiques captées sur la ligne. Les applications typiques de cet équipement comprennent la commande et les indications de supervision des centrales de tous genres, la signalisation ferroviaire, la télémesure de valeurs variables telles que la tension, la puissance la pression, le débit, etc.

Lorsque des services de télémesure sont nécessaires, chaque variable pourra être analysée et chiffrée, la sortie chiffrée se composant d'un nombre de chiffres disposés en décimales codées binaires. Le signal codé sera ensuite transmis au moyen du nombre requis de voies et décodé à l'extrémité réceptrice.

L'équipement fonctionne sur secteur ou piles, ou les deux, selon les besoins, et il a été doté d'un dispositif de protection en cas de panne du courant ou de l'équipement.

EE 27 752 *pour plus amples renseignements*

TACHYMÈTRE

(Illustration à la page 724)

Grouther Industrial Developments Ltd, 14 Oriental Street, London E.14

Cet instrument se compose en principe d'un convertisseur de fréquence en courant continu type FC-121, muni d'un oscillateur intégral servant à actionner un transducteur-capacité type CTD-023.

Une répétition d'incidents se produisant à proximité de la sonde du transducteur, tel que le passage continu d'une irrégularité sur un axe tournant, provoque des variations dans le niveau de sortie du transducteur, avec une fréquence exactement identique à celle de l'incident. Ces signaux sont injectés dans la section de conversion du TFC-122 qui fournit une sortie de courant continu d'une valeur proportionnelle à la fréquence des signaux et, par conséquent, la vitesse des tours de l'axe.

Cette sortie de courant continu est considérable et, alliée à la gamme de fréquences de la section de conversion, elle constitue un système tachymétrique pouvant mesurer des vitesses allant jusqu'à 180000 tours/minute sans toucher ou charger l'axe, et fournit une sortie pour l'alimentation simultanée d'un nombre de grands indicateurs.

Quoique la section de conversion nécessite un minimum de 5 impulsions par seconde pour fonctionner (équivalant à 300 tours/minute), des vitesse très réduites peuvent être mesurées en faisant en sorte que la sonde puisse "voir" un nombre "d'incidents" ou "d'événements" par tour. Ceci s'effectue en plaçant la sonde à proximité d'un engrenage et en obtenant une impulsion de sortie chaque fois qu'une dent passe. De cette façon, un engrenage à 60 dents d'un arbre tournant à 10 tours/minute apparaîtrait à l'appareil comme tournant à 10 tours/minute et le facteur de correction peut alors être appliqué à l'indicateur.

Ainsi qu'il en est pour le convertisseur de fréquence en courant continu FC-121, des prises de courant sont prévues pour permettre d'obtenir des sorties totales pour une gamme étendue de fréquences d'entrée. Ces dernières, alliées à l'emploi de shunts de mesure et de comptages multiples par tour, permettront de contrôler ou d'enregistrer n'importe quelle gamme de vitesses.

Le fonctionnement n'est pas affecté par le rapport repère/espace des irrégularités de l'arbre, et le TFC-122 peut être employé également bien pour mesurer la fréquence d'autres faits périodiques pouvant provoquer des changements de capacité de la sonde du transducteur, tels que les vibrations, les objets passants, etc.

EE 27 753 *pour plus amples renseignements*

AMPLIFICATEUR DE RELAIS

(Illustration à la page 725)

B and R Relays Ltd, Temple Fields, Harlow, Essex

La société B & R Relays a réalise un amplificateur à transistors à trois étages, destiné à faire partie intégrante de leur relais M.01 et ne former ainsi qu'un seul élément compact à prises.

Une sensibilité de fonctionnement de l'ordre de 5μA peut être atteinte avec cet amplificateur dont la consommation électrique est de 0,5W à une tension nominale de 6 ou 12 volts c.c. L'appareil complet ne pèse que 170 grammes et il prévoit la mise en oeuvre d'un circuit auxiliaire multiple à la réception d'un signal ne dépassant pas 10 microwatts à l'entrée.

EE 27 754 *pour plus amples renseignements*

OSCILLOGRAPHE À LECTURE DIRECTE

(Illustration à la page 725)

Savage and Parsons Ltd, Watford, Hertfordshire

Ces oscillographe à lecture directe peut enregistrer des fréquences allant du courant continu à 1 kHz et davantage, et il offre un choix de huit vitesses d'avance du papier, de 12.7cm/min. à 381cm/min. Il produit une trace bien définie à des vitesses d'écriture dépassant 304,8m/sec.

Réalisé sous forme d'appareil à 12 voies, il est fourni sur demande, avec amplificateurs accordés et blocs d'alimentation, et il peut enregistrer n'importe quelle fonction variable pouvant être traduite en un signal électrique dans la gamme de fréquences.

Le bloc magnétique porte 15 galvanomètres à miroir du type crayon, spécialement faits pour l'enregistreur, les trois voies additionnelles servant au marquage du temps ou d'opérations, ou encore comme voies d'enregistrement de réserve. En actionnant un commutateur, on branche deux de ces trois galvanomètres sur le secteur de façon à obtenir une fréquence de référence.

L'oscillographe emploie une lampe ultraviolette à source compacte, enregistrant jusqu'à 15 traces sur papier sensibilisé de 152,4mm de large. Les images sont développées spontanément, en quelques secondes.

Des rouleaux de papier enregistreur, dont la longueur peut atteindre jusqu'à 60,96m, peuvent être chargés par le panneau frontal, cette charge se faisant automatiquement une fois le bord du papier placé en contact avec le rouleau d'entraînement. Un sélecteur de longueur permet l'arrêt de l'entraînement après la pose de 60,9cm, 152,4cm ou 304,8cm de papier, ou la marche continue.

Les vitesses d'avance du papier sont choisies par boutons-poussoirs sur le panneau frontal qui utilise des embrayages solénoïdaux. La vitesse est indiquée par un voyant lumineux près du bouton approprié. Tous les engrenages sont engrenés de manière permanente, afin qu'on puisse changer de vitesse pendant l'enregistrement, les plus grandes vitesses pouvant être atteintes dans un minimum de temps.

La position de chaque trace sur le papier peut être réglée aisément au moyen d'un tourne-vis par une ouverture sur le couvercle supérieur, le changement qui en résulte sur le papier pouvant être observé à travers la fenêtre frontale. Si l'on utilise moins de voies que le nombre total, les traces superflues peuvent être dirigées hors du bord du papier. L'identification des traces se fait par interruption séquentielle de chaque trace, ce qui assure l'identification de chaque voie à intervalles de 60cm, quelle que soit la vitesse du papier.

EE 27 755 *pour plus amples renseignements*

ALIMENTATION STABILISÉE

(Illustration à la page 725)

Feedback Ltd, Crowborough, Sussex

Le bloc d'alimentation universel SD97 fournit une alimentation stabilisée de + et −300 V c.c., 0 à 100mA, et une alimentation non stabilisée de 6,3V c.a., 6A.

Il est construit sous forme d'élément à châssis afin qu'il puisse être incorporé dans des armoires avec d'autres appareils, ou soutenu sur un panneau frontal pour être monté dans une baie d'établi. Il peut également être utilisé sur banc d'essai car il n'y a pas de bornes sous tension au-dessus du châssis.

Les sorties peuvent être prises de cosses à souder sous le châssis ou d'une prise à 6 broches au-dessus du châssis.

L'alimentation s'effectue sans bobine de choc. Le facteur de stabilisation est supérieur à 300, l'impédance de sortie inférieure à 1 ohm et le bourdonnement inférieur à 2mV.

EE 27 756 *pour plus amples renseignements*

ELECTROMYOGRAPHE

(Illustration à la page 725)

Disa Elektronik A/S

27 Teglvoerkagade, Copenhagen, Denmark

L'électromyographe Disa est muni de trois circuits amplificateurs à électrodes indépendants, permettant d'enregistrer simultanément les potentiels d'action musculaire, à partir de trois points différents, des mêmes muscles ou de muscles différents. Les potentiels d'action du muscle sont relevés par des électrodes de surface ou à aiguille, puis amplifiés et présentés sur trois tubes cathodiques aux fins d'observation. Les potentiels d'action peuvent être rendus audibles en même temps par un haut--parleur incorporé, qui peut être relié à n'importe laquelle des trois sorties de puissance d'amplificateur. Une caméra à film continu utilisant un papier de 10 cm de large est fournie afin de pouvoir photographier la trace de trois tubes cathodiques supplémentaires, fonctionnant en parallèle avec ceux utilisés pour l'observation.

Les amplificateurs de l'électromyographe utilisent un circuit d'entrée spécial qui autorise l'enregistrement des potentiels d'action sans distorsion marquée. Leur niveau de bruit est très bas, soit 1,5 μV efficaces, et leur gamme de fréquences est fort étendue, soit 2 Hz à 10 kHz. Leur impédance d'entrée élevée (100 mΩ 50 pF) et leur grand quotient de réjection en phase permettent d'obtenir des électromyogrammes sans devoir abriter le malade, dans presque toutes les installations, évitant ainsi le recours à une chambre protégée. L'électromyographe fonctionne entièrement sur secteur. Etant muni de roulettes à roulements à billes, roulant silencieusement, il peut être aisément placé dans une position commode à côté ou derrière le lit du malade. Le boîte à fiches à électrodes est montée sur un bras mobile et peut être placée facilement près du muscle soumis à l'examen. Les tubes cathodiques d'observation peuvent être tournés pour la vision par l'opérateur.

Les enregistrements se font en pressant un interrupteur à pédale. On peut enregistrer des traces continues ou de balayage, sur n'importe laquelle des six bases de temps. L'intensité du spot cathodique est automatiquement ajustée à la valeur voulue pour l'enregistrement avec le réglage de la base de temps. Une légende donnant le nom, le numéro, etc., du malade peut être photographiée directement sur l'enregistrement. La simplicité du fonctionnement permet l'utilisation de l'appareil par une seule personne s'occupant en même temps du malade.

EE 27 757 *pour plus amples renseignements*

BLOC D'ACCORD DE TÉLÉVISION

(Illustration à la page 726)

Sydney S. Bird and Sons Ltd. 3 Palace Mansions, Palace Gardens, Enfield, Middlesex

Le PC-60 assure l'accord par bouton-poussoir de façon commode. Ayant la forme d'un cône de tube, il occupe un espace qui ne pourrait virtuellement pas être utilisé par aucune autre pièce. Il offre un choix de n'importe quelles quatre voies d'un total de treize voies. dans n'importe quel ordre, avec le bloc préréglé d'accord précis pour chaque bouton placé à l'avant. Le bloc d'accord a été conçu de manière à garantir un réenclenchement précis en cours d'utilisation, de même qu'une longue durée, une grande stabilité et une faible dérive thermique. Un emploi étendu a été fait des circuits imprimés.

Le bloc d'accord est du type différentiel, l'accord se faisant lorsqu'un contact de court-circuit est placé à travers des rivets adjacents. Par cette méthode, tous les canaux sont inclus dans le bloc d'accord. Les contacts de court-circuit sont soutenus par des guides transversaux en matière plastique, reliés aux boutons par un mécanisme transversal. Les guides sont logés dans des rainures, dont chacune est clairement marquée par un numéro de voie. Pour prérégler une voie, il suffit d'insérer le guide plastique, accouplé au bouton devant être employé, dans les rainures portant le numéro de voie voulu. Etant donné que la commutation se fait par raccord de court-circuit, une variation étendue dans la position précise du raccord de court-circuit ne changera pas la longueur électrique entre les deux contacts appropriés. Par conséquent, les variations ne changeront pas la fréquence.

Un bloc d'accord précis à condensateur concentrique est monté sur la plaquette de bobines oscillatrices. La capacité de fonctionnement de ce trimmer est déterminée lorsqu'un bouton se trouve dans la position de pression. Le réglage du condensateur se fait par vis prisonnière en nylon, montée à l'intérieur du bouton. La gamme du bloc d'accord précis qui est d'environ 3MHz sur toutes les bandes est "couverte" en sept tours de vis, donnant un réglage doux et contrôlé.

EE 27 758 *pour plus amples renseignements*

INDICATEUR DE ZÉRO

(Illustration à la page 726)

Honeywell Controls Ltd, Greenford, Middlesex

Cet instrument est l'équivalent d'un galvanomètre sensible sans en avoir, cependant, certains des désavantages. Il n'est pas affecté par les vibrations et se remet au point mort très rapidement. Il se prête à l'emploi comme indicateur de zéro pour ponts, etc.

En fonctionnement, un signal de courant continu est appliqué à l'entrée et converti en courant alternatif par le convertisseur et le transformateur. Il est alors amplifié et appliqué à l'étage de sortie. Ce dernier consiste essentiellement en un redresseur commandé par la grille dont la sortie est appliquée à l'indicateur. La polarité du signal d'entrée détermine la phase de la tension alternative amplifiée, cependant que la sortie du redresseur à deux alternances fait passer le courant dans une direction déterminée par cette phase. Chaque signal positif imprime une tension alternative sur les grilles des lampes de sortie, dont la phase est telle qu'une paire de triodes fait passer le courant pendant chaque moitié positive du cycle de tension de ligne. Par contre, peu ou pas de courant n'est transmis par les lampes sur la moitié négative du cycle. Il en résulte qu'une paire de cathodes devient positive par rapport à l'autre et que le condensateur entre les deux reçoit une charge. Cette dernière est mesurée par l'instrument indicateur qui dévie dans une direction. Un signal d'entrée négatif produit l'action inverse.

Lorsque le signal d'entrée est de zéro et que le pont est en équilibre, les deux paires de triodes font passer un courant égal de phase opposée, la charge nette sur le condensateur étant de zéro, et l'indication de l'instrument est donc également de zéro.

La sensibilité de l'instrument est à variation continue jusqu'à un maximum de $1\mu V$/mm; la résistance d'entrée est de 1 kiloohm.

EE 27 759 *pour plus amples renseignements*

TACHYMÈTRE PORTATIF

(Illustration à la page 726)

Southern Instruments Ltd, Frimley Road, Camberley, Surrey

Cet instrument entièrement transistorisé, fonctionnant sur secteur ou batterie, a été étudié pour mesurer avec précision la vitesse des tours d'arbres de toutes sortes et de toutes grandeurs, dans une gamme étendue de vitesses.

Il est fourni en deux modèles, dont l'un pour les fréquences basses de 0 à 30 000 tours/minute et l'autre pour les hautes fréquences de 30 000 à 300 000 tours/minute. La précision totale de ces instruments est supérieure à $\pm 1,5\%$ et des transducteurs photo-électriques ou magnétiques peuvent être fournis pour être utilisés conjointement.

EE 27 760 *pour plus amples renseignements*

ETALON DE FRÉQUENCE VHF

(Illustration à la page 727)

The Wayne Kerr Laboratories Ltd, Roebock Road, Chessington, Surrey

En raison de la réduction de l'espacement des courants porteurs de stations VHF, il devient plus que jamais indispensable de pouvoir maintenir le fonctionnement de émetteurs et récepteurs portatifs à la fréquence assignée. Cet étalon a donc été conçu pour répondre à la demande des utilisateurs exigeant un étalon de fréquence compact et portatif. Il fournit un choix étendu de fréquences pilotées par quartz et permet de vérifier les émetteurs, aussi bien que les récepteurs, à un degré élevé de précision.

L'instrument se compose essentiellement d'un oscillateur pouvant être commuté pour fonctionner avec n'importe quel cristal d'un maximum de douze cristaux, des fours à prises à commande thermostatique (jusqu'à un maximum de six pouvant chacun loger deux cristaux), jusqu'à trois éléments multiplicateurs, un détecteur à large bande et des circuits redresseurs pour le fonctionnement à partir de sources d'alimentation de 100 à 130V et de 190 à 240V.

Les cristaux utilisés peuvent être choisis pour fonctionner à n'importe quelle fréquence dans la gamme de 7,5 à 9,7 MHz. Une commande centrale à douze positions commute les cristaux voulus sur un circuit oscillateur apériodique Colpitts. Des trimmers sont prévus pour permettre une légère "traction" de chaque fréquence de cristal. Six lampes, chacune reliée au thermostat d'un four, sont disposées autour du cadran de la commande à 12 positions et elles s'éclairent lorsque le four est allumé. La température du four est thermostatiquement contrôlée à 80°C.

Il existe trois types d'éléments multiplicateurs et, si nécessaire, ils peuvent tous trois être montés sur l'appareil. Chacun d'eux fonctionne dans un secteur de la gamme totale de fréquences de cristaux allant de 7,5 à 9,7 MHz, et assure des puissances de sortie à des multiples de fréquence de X3, X9 et X18, couvrant ainsi toute l'étendue de la gamme jusqu'à 75MHz.

A une température ambiante constante, et après une durée de chauffage de 45 minutes, la variation de fréquence de quartz et les multiples correspondants ne dépassent pas 3 parties par million.

Une prise est prévue pour l'introduction d'un signal d'émetteur dont la fréquence est soumise à la vérification. L'amplitude du signal appliqué doit être supérieure à 100mV. Le signal de l'émetteur, la fréquence de quartz choisie et ses multiples sont introduits dans le sélecteur à large bande. La sortie de ce circuit est appliquée à une prise de jack sur le panneau frontal. Le battement nul est décelé au moyen d'écouteurs à impédance élevée reliés à la susdite prise.

EE 27 761 *pour plus amples renseignements*

OSCILLATEURS BASSE-FRÉQUENCE

(Illustration à la page 727)

Levell Electronics Ltd, 10-12 St. Albans Road, Barnet, Hertfordshire

Ces oscillateurs résistance-capacité utilisent des transistors comme pièces actives, ce qui les rend exempts des nombreux défauts qu'on trouve dans les oscillateurs à lampe. La consommation électrique nettement inférieure du transistor a pour effet d'éliminer les glissements graduels de fréquence et d'amplitude caractérisant les oscillateurs à lampe pendant la période de chauffage. Cette faible consommation électrique permet également d'employer des batteries de longue durée pour l'alimentation en courant, ce qui exclut complètement la modulation de ronflement.

Le circuit de l'oscillateur comprend un amplificateur à transistor, avec réaction positive appliquée au moyen d'un circuit sélectif à pont de Wien, et réaction négative appliquée au moyen d'un circuit de stabilisation d'amplitude à thermistance. L'oscillateur type TG 150M se distingue du type TG150 par son appareil de mesure de sortie supplémentaire.

La fréquence de résonance du circuit à pont de Wien est à variation continue dans une décade, s'effectuant à l'aide d'une commande de fréquence étalonnée. Cinq gammes sont prévues et elles s'étendent de 1,5Hz à 150kHz, avec une longueur totale efficace d'échelle de 1270 mm.

Deux transistors sont utilisés dans l'étage de sortie d'un circuit à réaction linéarisée, de sorte que la puissance de sortie de l'oscillateur n'est que légèrement déformée en dépit du courant d'alimentation réduit.

Une proportion considérable de réaction négative est appliquée au moyen du circuit de stabilisation d'amplitude afin d'assurer la constance de la puissance de sortie sur toute la gamme de fréquences, et elle n'est que faiblement affectée par les variations de tension d'alimentation et de température ambiante.

EE 27 762 *pour plus amples renseignements*

DÉCALEUR DE TRACE

(Illustration à la page 727)

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

Le décaleur de trace Cawkell est un nouvel instrument étudié pour permettre à l'utilisateur d'un oscilloscope d'afficher en série, jusqu'à dix signaux provenant de la même source. Chaque signal est déplacé verticalement par rapport au précédent afin de faciliter la comparaison.

Le décaleur de trace trouve sa principale application lorsqu'il est utilisé en liaison avec des oscilloscopes à enregistrement transitoire, tels que le Remscope. Grâce au décaleur on peut, en effet, étudier les variations de cycle en cycle dans le signal périodique d'une série de phénomènes transitoires. L'intervalle de temps entre les signaux successifs est sans importance car le décaleur est déclenché à la fin de la base de temps de l'oscilloscope. Il se prête à l'emploi avec presque n'importe quel oscilloscope à entrées différentielles.

Il est autonome, fonctionne sur batterie et il est entièrement transistorisé.

EE 27 763 *pour plus amples renseignements*

CONDENSATEURS EN POLYESTER

(Illustration à la page 727)

Suflex Ltd, Bilton House, 54-58 Uxbridge Road, Ealing, London W.5

Cette gamme de condensateurs, dénommés "POLYCAPS," offre des pièces d'un prix fort raisonnable et constitue une variante des modèles diélectriques courants au papier. Ils offrent, en outre, l'avantage de pouvoir être utilisés à une température élevée (100°C) et d'avoir une très grande résistance d'isolement (supérieure à 100000 Mégohms). Les condensateurs POLYCAPS vont de 0,01µF à 0,05µF, leur tolérance est de ±20% et ils sont prévus pour un courant continu de 350 volts.

EE 27 764 *pour plus amples renseignements*

TRADUCTEUR DE TÉLÉVISION

(Illustration à la page 727)

Marconi's Wireless Telegraph Co. Ltd, Marconi House, Chelmsford, Essex.

Cet appareil est employé pour la répétition d'émissions de télévision dans les régions de faible intensité de champ, comblant ainsi les discontinuités dans une zône à desservir. Il convient à la mise en service dans les bandes I et III et se compose essentiellement d'appareillage de changement et d'amplification de fréquence. La sortie de puissance nominale est de 3W et elle peut être portée à 50W à l'aide d'un amplificateur supplémentaire.

L'appareil peut être utilisé comme répéteur à partir d'un émetteur en place, ou comme émetteur de faible puissance. Une combinaison de l'émetteur et du répéteur permet soit de relayer des signaux d'un émetteur principal soit d'émettre un programme produit localement, selon le choix.

Etant donné que le signal de vision est modulé en amplitude et que le signal sonore est modulé en fréquence, des amplificateurs ordinaires sont utilisés pour la vision et le son, sans que ne se produisent les perturbations causées par l'intermodulation.

L'appareil est normalement logé dans une baie standard de 48cm. Si nécessaire, des cabines spéciales pour montage extérieur peuvent être fournies en fonction des besoins particuliers.

Aucune tension dangereuse n'est accessible sur l'appareil lorsque les couvercles des éléments sont en place. Une protection adéquate est assurée contre les surintensités et d'importantes alimentations de tubes peuvent être pleinement mesurées à partir due panneau frontal.

L'appareil peut être utilisé sur standards de 525 ou 625 lignes.

EE 27 765 *pour plus amples renseignements*

Résumés des Principaux Articles

Une fermeture à combinaison électronique par K. A. Steele

Résumé de l'article aux pages 676 à 679

L'auteur décrit une fermeture à combinaison électronique binaire utilisant une paire de tubes polyodes Dékatron comme relais à cascade. Il étudie certains aspects de la théorie des probabilités concernant les combinaisons binaires. Un essai de combinaison, effectué avec une source binaire aléatoire, a produit des résultats s'accordant avec la théorie.

Un compteur d'histogrammes pour données de bande magnétique par Peter Dawe

Résumé de l'article aux pages 680 à 684

L'emploi de bandes magnétiques au lieu de bandes de papier, pour l'enregistrement des résultats du type d'expérience entraînant une distribution de fréquence, présente certains avantages en ce qui concerne la mesure et le triage des données enregistrées. Cet article décrit précisément un syèstme utilisant des circuits électroniques pour la mesure automatique et le triage des données d'une expérience nécessitant des résultats sous forme statistique.

Les circuits de ce système sont à transistors, lampes et tubes sélecteurs Dékatron, et l'article montre comment les impulsions peuvent être enregistrées sur bande magnétique multivoies et reproduites à partir de cette bande, de manière comparable par sa simplicité au marquage à l'encre d'une bande de papier.

Un générateur de parasites commandé par W. E. Matthews et P. L. Mothersole

Résumé de l'article aux pages 685 à 688

Des essais pratiques approfondis sont généralement nécessaires pour étudier la tenue d'un télérécepteur dans des emplacements défavorables. Le générateur décrit dans cet article produit des signaux réalistes de parasites à partir d'un moteur électrique et d'un simulateur d'allumage d'automobile, permettant ainsi d'effectuer des essais étendus en laboratoire.

Une matrice à mémoire intermédiaire à noyau magnétique de 1MHz pour perforatrice de cartes ou appareil imprimeur de lignes par J. B. James

Résumé de l'article aux pages 689 à 695

L'auteur décrit une matrice à mémoire tampon, à action rapide, capable de recevoir des données d'une calculatrice à la vitesse d'un caractère par microseconde et de fournir, ensuite, une série de signaux de sortie parallèles décodés, utilisables par un appareil imprimeur ou par une perforatrice de cartes. Les éléments de mémoire sont formés par les noyaux magnétiques à antenne-cadre d'un système à un seul noyau par chiffre binaire. Ces noyaux sont aussi employés dans les circuits de commande, afin de réduire le nombre d'éléments actifs. Les circuits de décodage et de contrôle de parité, qui font un usage inédit de noyaux aux dimensions de dispositifs à mémoire, sont également décrits.

Un multiplicateur analogique à effet Hall par H. Fuchs et D. G. Flockhart

Résumé de l'article aux pages 696 à 699

Les auteurs décrivent un multiplicateur analogique à effet Hall qui a été conçu pour être utilisé avec des calculateurs analogiques. Ils examinent en détail la construction de cet appareil ainsi que les résultats qu'on peut en escompter.

Un amplificateur de tension continue magnétique à transistors de grande puissance. par G. Sarkar

Résumé de l'article aux pages 705 à 711

Cet article décrit un amplificateur de tension continue utilisant un obturateur rupteur à transistors dans l'étage d'entrée, deux amplificateurs à transistors comme étage intermédiaire et un amplificateur magnétique dans l'étage de sortie final. Cet appareil a été prévu pour une impédance d'entrée élevée et pour amplifier des signaux d'entrée de tension continue de l'ordre de quelques millivolts, afin de donner une puissance de sortie de plusieurs centaines de watts.

Un récepteur de mesure de fréquence par C. F. Meakes

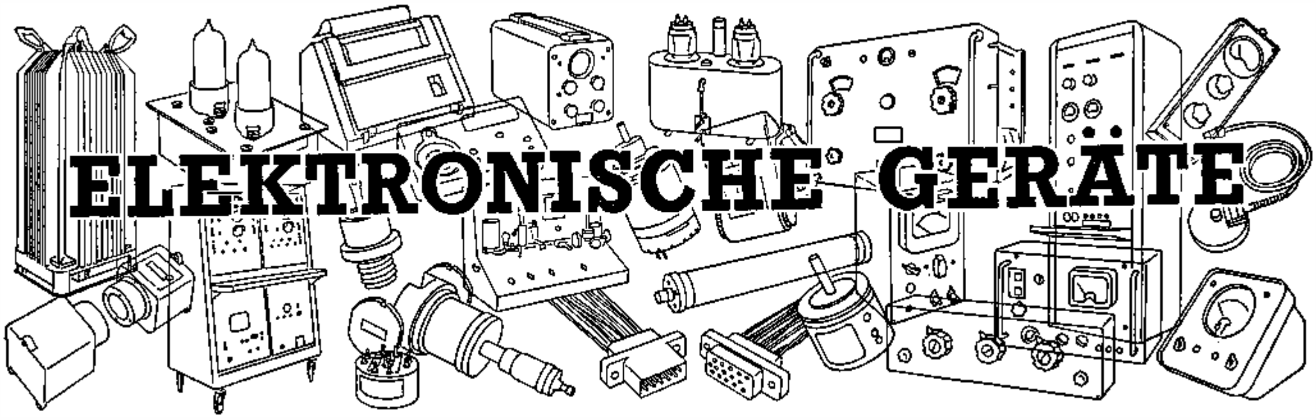
Résumé de l'article aux pages 712 à 713

La combinaison d'un récepteur à grande stabilité et d'un fréquencemètre numérique permet de mesurer rapidement et avec précision la fréquence porteuse de transmissions. La précision de cet instrument n'est nullement affectée par la modulation ou par un faible rapport signal/bruit et on peut donc effectuer des mesures avec des niveaux de courants porteurs de signaux inférieurs à un millivolt.

Multiplicateurs et diviseurs de calculateurs à courant alternatif par C. H. Smith et A. Prabhakar

Résumé de l'article aux pages 714 à 716

Un simple multiplicateur ou un simple diviseur peuvent être fabriqués en utilisant la forme exponentielle de la partie initiale de la caractéristique de nombreux dispositifs électroniques. Cet article décrit brièvement un diviseur à lampes, un multiplicateur à transistors et un diviseur à transistors, réalisés selon le susdit principe.



ELEKTRONISCHE GERÄTE

Beschreibung neuer Bauelemente, Zubehörteile und Prüfgeräte auf Grund der von Herstellern gemachten Angaben. *Übersetzung der Seiten 724 bis 727*

ELEKTRONISCHER DREHZAHLGEBER

(Abbildung Seite 724)

Pentechnique Ltd., Imperial Lane, Cheltenham Gloucestershire

Durch Verwendung vereinfachter Schaltungen und anpassungsfähiger Metallteile haben Pentechnique Ltd ihre Drehzahlgeber mit vier und fünf Dekatrons so durchgebildet, dass sie in verschiedenen Ausführungen entsprechend Kundenwünschen lieferbar sind.

Die Abbildung zeigt einen auf diese Weise abgewandelten Drehzahlgeber, der die Geschwindigkeit eines Wechselstromgenerators mit einer Genauigkeit von ±1 UPM misst, indem er die elektrische Abgabe des Generators von 15 Perioden pro Umdrehung während eines genau vier Minuten langen Intervalls zählt. Die Anzeige wiederholt sich, und die Dekatrons werden nach 2 s automatisch zurückgestellt, so dass neu gezählt werden kann. Durch den jederzeit während Zählen oder Anzeige bedienbaren Schalter "Feststehende Anzeige" kann die Anzeigezeit unbegrenzt ausgedehnt werden.

Die vereinfachte Schaltung benutzt ausser den Dekatrons nur 12 Röhren und 3 Selen-Dioden und führt zu gedrängtem Aufbau. Aus dem Gehäuse ausgebaut, können die drei Bausteine auseinandergeklappt werden und machen alle Bauelemente zugänglich. Betriebssicherheit wird durch Wahl von Qualitätsröhren und hochstabilen Widerständen erhöht.

Fotoelektrische und magnetische Wandler für Verwendung mit diesen Gebern sind lieferbar.

EE 27 751 *für weitere Einzelheiten*

FERNSTEUERUNGSGERÄTE

(Abbildung Seite 724)

Brush Electrical Engineering Co. Ltd, Loughborough, Leicestershire

Übliche mehrkanalige, wechselseitige Signalverbindungen über weite Entfernungen oder schwieriges Terrain benötigen viele Leitungen zwischen Zentrale und entfernter Stelle, die zu unerschwinglichen Kosten führen. Brush-Fernsteuergeräte benutzen ein Zeitmultiplexsystem und brauchen nur zwei Leitungspaare, wodurch die Kabelkosten verringert und solche Systeme wirtschaftlich werden. Wahlweise kann das System auch mit Trägerfrequenz oder UKW-Richtfunk betrieben werden, solange die notwendige Bandbreite zur Verfügung steht. In bestimmten Fällen können die Bandbreitenforderungen geändert werden, um die den Geräten durch die Verbindungstype auferlegten Beschränkungen zu überwinden.

Brush-Ingenieure haben das System unter Benutzung der Digitalrechnertechnik für schnelles, sicheres und zuverlässiges Signalisieren entwickelt. Die Geräte sind für lange Betriebsdauer ohne Wartung konstruiert und benutzen durchgehend Flächentransistoren sowie Germanium-Dioden, wodurch nicht nur Strom und Raum, sondern auch teure Kühlanlagen gespart werden. Um zusätzliche Betriebssicherheit zu gewährleisten, arbeiten alle Bauelemente wesentlich unter ihren oberen Grenzwerten. Für die Konstruktion wurde das Einschub-Bausteinprinzip gewählt, wobei jeder Baustein aus gedruckten Schaltungsplatten mit zugehörigen Bauelementen besteht. Die Anzahl der Plattentypen wird so klein wie möglich gehalten. Beim Auftreten von Fehlern ist die Fehlereingrenzung einfach - eine fehlerhafte Platte kann schnell ausgewechselt und in Ruhe repariert werden.

Für die Zentrale wird ein Hauptgerät und für jede entfernte Stelle ein Nebengerät benötigt.

Das Hauptgerät enthält einen Taktgeber und eine Synchronisierungsschaltung, die den Gleichlauf der Zählschaltungen in Haupt- und Nebengeräten gewährleistet. Der Arbeitstakt der Anlage wird durch die Taktfrequenz und die Kanalzahl bestimmt, jedoch wird in bestimmten Fällen der Arbeitstakt durch Summenschaltungen verlängert, die eingebaut werden, um den Einfluss regelloser, in der Leitung aufgenommener Impulse aufzuheben. Unter den typischen Anwendungsbeispielen befinden sich: Überwachungssteuerung und -anzeige für Kraftwerke aller Art; Kerntechnik und Verfahrenssteuerung; Eisenbahnsignalwesen; Fernmessung von variablen Quantitäten wie Spannung, Leitung, Druck, Durchströmung usw.

Für Fernmesseinrichtungen kann jede Variable hintereinander abgetastet und digital dargestellt werden, wobei der Ausgang des Digitalwandlers aus einer Anzahl von Digits besteht, die als binärverschlüsselte Dezimalzahlen angeordnet sind. Das verschlüsselte Signal wird dann über die gewünschte Anzahl von Kanälen gesandt und an der Empfängerseite entschlüsselt.

Die Geräte können vom Netz oder Batterien oder von beiden Quellen nach Wunsch betrieben werden. Falls Geräte oder Stromquellen ausfallen, werden sie durch Schutz automatisch sichergestellt.

EE 27 752 *für weitere Einzelheiten*

DREHZAHLMESSER

(Abbildung Seite 724)

Grauther Industrial Developments Ltd, 14 Oriental Street, London E.14

Dieses Gerät besteht im wesentlichen aus einem Frequenz-Gleichspannungsumsetzer Typ FC-121 mit eingebautem Oszillator, der für Betrieb eines Kapazitätenwandlers Typ CTD-023 geeignet ist.

Sich wiederholende Vorgänge in der Nähe des Wandlerfühlers, wie z.B. das dauernde Vorbeilaufen einer Ungleichförmigkeit auf einem umlaufenden Schaft, rufen Schwankungen des Wandlerausgangspegels mit einer Frequenz hervor, die mit der des Vorgangs identisch ist. Diese Signale werden zum Umsetzerteil des TFC-122 gespeist, der eine Gleichspannung abgibt, die der Signalfrequenz und damit den UPM des Schaftes proportional ist.

Diese Ausgangsgleichspannung ist beträchtlich und bildet, mit dem Frequenzbereich des Umsetzerteils gekoppelt, ein Drehzahlmessersystem, das ohne Berührung oder Belastung des Schaftes von Kriechgeschwindigkeiten bis zu 180 000 UPM messen kann und eine Ausgangsspannung abgibt, die gleichzeitig mehrere Grossanzeigen speisen kann.

Trotzdem der Umsetzerteil eine Mindesttaktfrequenz von 5 Hz (300 UPM entsprechend) zum Arbeiten benötigt, können sehr niedrige Geschwindigkeiten dadurch gemessen werden, dass der Fühler mehrere Vorgänge pro Umdrehung „sieht". Dazu wird der Fühler in der Nähe eines Zahnrads angebracht und ruft, wenn ein Zahn vorbeiläuft, einen Ausgangsimpuls hervor. Auf diese Weise würde ein Rad mit 60 Zähnen bei 10 UPM dem Gerät wie ein mit 600 UPM umlaufender Schaft erscheinen. Die notwendige Anspassung wird am Anzeiger eingestellt.

Wie am Frequenz-Gleichspannungsumsetzer FC 121 sind Abgriffe vorgesehen, um von einem grossen Eingangsfrequenzbereich volle Ausgangsspannungen zu erhalten, die zusammen mit Messnebenwiderständen und Mehrfachzählung von Umdrehungen die Überwachung, Regelung und Aufzeichnung des erforderlichen Frequenzbereiches ermöglichen.

Der Betrieb wird durch Impulsbreitenmodulation der Schaftungleichförmigkeiten nicht beeinflusst, und der TFC-122 kann genau so gut zur Frequenzmessung anderer regelmässig wiederkehrender Vorgänge benutzt werden, die am Wandlerfühler Kapazitätsänderungen wie Schwingungen, vorbeilaufende Gegenstände usw, hervorrufen.

EE 27 753 *für weitere Einzelheiten*

RELAISVERSTÄRKER

(*Abbildung Seite 725*)

B and R Relays Ltd, Temple Fields, Harlow, Essex

B and R Relays stellen einen dreistufigen Transistor - Verstärker zum Zusammenbau mit ihrem M.01 Relais her, wodurch ein einziger, kompakter Einschub-Baustein zur Verfügung steht.

Eine Betriebsempfindlichkeit in der Grössenordnung von 5 μA kann erreicht werden; der Stromverbrauch ist 0,5 W bei 6 V oder 12 V Nenn-Gleichspannung. Der Baustein wiegt insgesamt 170 g und kann bei Zuführung eines so niedrigen Eingangssignals wie 10 μW mehrere zusätzliche Schaltungen bedienen.

EE 27 754 *für weitere Einzelheiten*

DIREKTSCHREIBENDER OSZILLOGRAF

(*Abbildung Seite 725*)

Savage and Parsons Ltd, Watford, Hertfordshire

Dieser Oszillograf kann Frequenzen von Gleichstrom bis 1 kHz und darüber direkt aufzeichnen. Acht Vorschübe zwischen 12,7 cm/min und 381 cm/min stehen zur Verfügung. Selbst bei Schreibgeschwindigkeiten über 305 m/min ist der Linienzug genau begrenzt.

Der Schreiber ist als 12-Kanal-Gerät ausgelegt und kann auf Wunsch mit angepassten Verstärkern und Netzgeräten geliefert werden. Er kann die verschiedensten Funktionen aufzeichnen, die in elektrische Signale innerhalb des Frequenzbereiches umgewandelt werden können.

Auf dem Magnet-Block sind 15 Strahltyp-Spiegelgalvanometer montiert, die speziell für den Schreiber hergestellt werden. Die zusätzlichen drei Kanäle stehen für Zeit- und Vorgangsmarkierung zur Verfügung, können auf Wunsch aber auch als Schreibkanäle benutzt werden. Zwei dieser drei Galvanometer können an das Netz geschaltet werden, um eine Bezugsfrequenz aufzuzeichnen.

Der Oszillograf arbeitet mit einer ultravioletten Lampe als kompakte Quelle, mit der bis zu 15 Spuren auf einem 152,4 mm breiten lichtempfindlichen Papierstreifen aufgezeichnet werden können. Das Bild entwickelt sich innerhalb weniger Sekunden von selbst.

Registrierpapierrollen bis zu 60 m können durch die Frontplatte eingeführt werden. Der Vorschub erfolgt automatisch sowie die Papierkante mit der Antriebsrolle in Berührung kommt. Durch einen Längenschalter kann der Vorschub ausgeschaltet werden, sowie 61 cm, 1,50 m oder 3,05 m Papier belichtet sind, oder dauernd weiterlaufen.

Papiervorschübe werden durch Drucktasten auf der Frontplatte eingestellt, die Magnetspulenkupplungen betätigen. Die eingestellte Geschwindigkeit wird durch ein Signallicht gegenüber der entsprechenden Drucktaste angezeigt. Alle Getriebe stehen dauernd im Eingriff, so dass die Geschwindigkeit während der Aufzeichnung geändert werden und die höchste Geschwindigkeit ohne Zeitverlust erreicht werden kann.

Die Position jeder Spur auf dem Papier kann einfach durch eine Öffnung in der oberen Abdeckung mittels eines Schraubenziehers eingestellt und die sich ergebende Änderung auf dem Papier durch das Vorderfenster beobachtet werden. Zur Kennzeichnung der Linienzüge wird jede Spur nacheinander und unabhängig von der Papiergeschwindigkeit alle 60 cm zur Kanalkennzeichnung unterbrochen.

EE 27 755 *für weitere Einzelheiten*

HOCHKONSTANTES NETZGERÄT

(*Abbildung Seite 725*)

Feedback Ltd, Crowborough, Sussex

Typ SD 97 ist ein Universalnetzgerät für + und −300 V stabilisierte Gleichspannung, 0 ... 100 mA und 6,3 V nicht stabilisierte Wechselspannung, 6 A.

Als Chassisausführung konstruiert kann es in Gehäuse oder andere Geräte eingebaut werden. An eine Frontplatte montiert ist es für Gestelleinbau geeignet und kann auch auf dem Arbeitstisch benutzt werden, da sich keine stromführenden Klemmen über dem Chassis befinden.

Die Ausgänge können entweder von Lötösen unter dem Chassis oder von einem 6-poligen Sockel auf dem Chassis abgegriffen werden.

Das Netzgerät arbeitet ohne Drossel. Der Regelfaktor ist besser als 300, die Ausgangsimpedanz unter 1 Ω und die Restwelligkeit geringer als 2 mV.

EE 27 756 *für weitere Einzelheiten*

ELEKTROMYOGRAPH

(*Abbildung Seite 725*)

Disa Elektronik A/S, 27 Teglvoerkagade, Copenhagen, Denmark

Der Disa Elektromyograph hat drei unabhängige Verstärkerkreise und kann daher gleichzeitig bei der Muskelbewegung auftretende Spannungen an drei verschiedenen Punkten eines oder mehrerer Muskeln aufzeichnen. Die Bewegungsspannungen werden vom Muskel durch Nadel- oder Oberflächenelektroden abgegriffen, verstärkt und zur Beobachtung auf drei Elektronenstrahlröhren dargestellt. Die Bewegungsspannungen können zur gleichen Zeit mittels eines eingebauten Lautsprechers, der zu jedem der drei Verstärkerausgänge geschaltet werden kann, hörbar gemacht werden. Eine Filmkamera photographiert laufend auf 10 cm breitem Papier die Spuren dreier weiterer Elektronenstrahlröhren, die mit der Sichtanzeige parallel liegen.

Durch Verwendung einer Spezialeingangsschaltung für den Elektromyograph-Verstärker können die Bewegungsspannungen ohne merkbare Verzerrungen aufgezeichnet werden. Sie haben mit 1,5 μV_{eff} einen sehr geringen Geräuschpegel und ein breites Frequenzband von 2 Hz...10 kHz. Ihre hohe Eingangsimpedanz (100 MΩ, 50 pF) und das hohe phasenrichtige Schwächungsverhältnis ermöglicht in allen Anlagen Aufnahme von Elektromyogrammen ohne Abschirmung, so dass kein abgeschirmter Raum erforderlich ist. Der Elektromyograph wird mit vollem Netzanschluss betrieben und läuft auf Kugellager-Laufrollen, so dass er leicht in eine bequeme Position neben oder hinter dem Bett des Patienten abgestellt werden kann. Die Elektrodenanschlüsse befinden sich an einem beweglichen Arm, der ohne Schwierigkeit in die Nähe des zu prüfenden Muskels gebracht werden kann. Die Elektronenstrahlröhren können durch Drehen für Beobachtung durch den Benutzer eingestellt werden.

Aufzeichnungen werden durch Betätigung eines Fusschalters gemacht. Sie können fortlaufend oder als Ablenkspuren mit jeder beliebigen der sechs Kippgeschwindigkeiten erfolgen. Die Punkthelligkeit des Elektronenstrahls wird zur Aufzeichnung automatisch auf den für die Kippgeschwindigkeit geeigneten Wert geregelt. Angaben über den Namen des Patienten, Nummer usw. kann direkt auf die Aufzeichnung photographiert werden. Die einfache Bedienung ermöglicht, dass eine Person das Gerät bedienen und gleichzeitig den Patienten behandeln kann.

EE 27 757 *für weitere Einzelheiten*

FERNSEH-KANALWÄHLER

(Abbildung Seite 726)

Sydney S. Bird and Sons Ltd, 3 Palace Mansions, Palace Gardens, Enfield, Middlesex

Der PC60 gibt Druckknopfabstimmung auf bequeme Weise. Er passt sich in seiner Form dem Konus der Bildschirmröhre an und nimmt nur Raum in Anspruch, der für andere Bauelemente nicht geeignet ist. Jede 4 der 13 Kanäle können in jeder Reihenfolge eingestellt werden; die Feineinstellung für jeden Knopf erfolgt von vorn. Der Tuner wurde für genaue Reproduzierbarkeit unter Betriebsbedingungen, lange Lebensdauer und geringe Wärmedrift konstruiert. Gedruckte Schaltungen finden weitgehend Verwendung.

Der Kanalwähler ist nach dem „Zuwachs"-Prinzip ausgelegt. Abstimmung wird durch einen Kurzschlusskontakt über benachbarte Nieten vorgenommen. Durch diese Methode sind alle Kanäle im Tuner greifbar. Die Kurzschlusskontakte sind auf einem Schieber angebracht, der durch eine Quermechanik mit dem Druckknopf verbunden ist. Die Schieber laufen in Schlitzen, die jeweils klar mit der Kanalnummer markiert sind. Um den Knopf für den gewählten Kanal festzulegen, braucht lediglich der zum Druckknopf gekuppelte Kunststoffschieber in den Schlitz mit der richtigen Nummer eingeschoben zu werden. Da das Schalten durch Kurzschlussbrücke erfolgt, haben grössere Schwankungen in der genauen Lage der Kurzschlussbrücke keinen Einfluss auf die elektrische Länge zwischen den Kontakten, und diese Schwankungen führen somit nicht zu Frequenzänderungen.

Auf dem Oszillatorspulenbrett ist eine konzentrische Kapazitäts - Feinabstimmung vorgesehen. Die Betriebskapazität dieses Trimmers wird durch den eingedrückten Knopf bestimmt. Die Kapazitätseinregelung erfolgt über eine Polyamidschraube im Druckknopf. Der Feineinstellungsbereich ist für alle Bänder 3 MHz und wird durch sieben Drehungen der Schraube durchstimmt, wodurch glatte und positive Feinabstimmung gewährleistet wird.

EE 27 758 *für weitere Einzelheiten*

NULL-INSTRUMENT

(Abbildung Seite 726)

Honeywell Controls Ltd, Greenford, Middlesex

Dieses Instrument ist einem empfindlichen Galvanometer gleichwertig, ohne viele der herkömmlichen Galvanometern anhaftenden Nachteile aufzuweisen. Es wird nicht durch Vibration beeinflusst und kommt schnell zum Stillstand. Es ist als Null-Anzeige für Brücken usw. geeignet.

In Betrieb wird dem Eingang ein Gleichstromsignal zugeführt, in einem Zerhacker und Transformator in Wechselstrom umgewandelt und dann der Endstufe zugeführt. Diese Stufe besteht im wesentlichen aus einem gittergesteuerten Gleichrichter, dessen Ausgang an das Anzeigegerät gelegt wird. Die Polarität des Eingangssignals bedingt die Phase der verstärkten Wechselspannung, und der Ausgangsstrom des Doppelweggleichrichters fliesst in der durch die Phase bedingten Richtung. Jedes positive Signal beaufschlagt die Gitter der Endröhren mit einer solchen Phase, so dass während jeder positiven Hälfte der Netzspannungsperiode ein Triodenpaar Strom durchlässt; während der negativen Hälfte der Periode fliesst kein oder wenig Strom durch die Röhren. Dadurch wird ein Kathodenpaar gegenüber dem anderen Paar positiv, und ein zwischen den beiden liegender Kondensator wird aufgeladen. Diese Ladung wird mittels des Anzeigeinstruments gemessen, das in einer Richtung abgelenkt wird. Ein negatives Eingangssignal hat die umgekehrte Wirkung.

Wenn das Eingangssignal Null und die Brücke ausgeglichen ist, fliesst durch beide Triodenpaare ein gleicher Strom entgegengesetzter Phase, die Ladung des Kondensators ist Null, womit auch die Anzeige Null wird.

Die Empfindlichkeit des Instruments ist stufenlos regelbar und hat ein Maximum von 1 μV/mm; der Eingangswiderstand ist 1 kΩ.

EE 27 759 *für weitere Einzelheiten*

TRAGBARER DREHZAHLMESSER

(Abbildung Seite 726)

Southern Instruments Ltd, Frimley Road, Camberley, Surrey

Dieses volltransistorisierte netz- oder batteriegespeiste Instrument wurde zur genauen Messung der Umdrehungsgeschwindigkeit von Schäften aller Art und Grössen über einen umfangreichen UPM-Bereich entwickelt.

Das Gerät ist in zwei Ausführungen lieferbar, von denen eine den niederfrequenten Bereich von 0 ... 30 000 UPM und die andere den hochfrequenten von 30 000 ... 300 000 UPM überstreicht. Die Gesamtgenauigkeit des Gerätes ist besser als ±1,5%. Sowohl fotoelektrische als auch magnetische Geber sind für Verwendung mit dem Gerät lieferbar.

EE 27 760 *für weitere Einzelheiten*

UKW-FREQUENZNORMAL

(Abbildung Seite 727)

The Wayne Kerr Laboratories Ltd, Roebuck Road, Chessington, Surrey

Mit der Herabsetzung des Trägerabstandes für UKW-Stationen ist es wichtiger denn je, dass tragbare Sender und Empfänger im Betrieb die zugeteilte Frequenz einhalten. Das Gerät wurde entwickelt, um dem Bedarf für ein kompaktes und tragbares Frequenznormal gerecht zu werden. Es gibt eine weite Auswahl quarzgesteuerter Frequenzen und ermöglicht Überprüfung sowohl von Sendern als auch Empfängern mit grosser Genauigkeit.

Grundsätzlich besteht das Gerät aus einem Oszillator, in den jedes der bis zu 12 Quarze geschaltet werden kann, temperaturgeregelten Einsteckköfen (bis zu 6, die je zwei Quarze aufnehmen können), bis zu drei Vervielfältigern, einem Breitbanddetektor und Gleichrichterschaltungen für Betrieb vom 100... 130 V und 190...240 V Wechselstromnetz.

Die verwendeten Quarze können für jede Frequenz im Bereich von 7,5...9,7 MHz gewählt werden. Ein 12-Stufenschalter bringt das gewünschte Quarz in einen aperiodischen Colpitt-Oszillatorkreis. Trimmer, die ein geringes "Einziehen" der Quarzfrequenz erlauben, sind vorgesehen. Um die Skala des Stufenschalters herum sind sechs Signallampen angeordnet, die den Temperaturreglern der Öfen zugeordnet sind und aufleuchten, wenn der Ofen in Betrieb ist. Die Ofentemperatur ist auf 80°C eingeregelt.

Drei Vervielfältigertypen sind lieferbar und können auf Wunsch alle drei eingebaut werden. Jeder Typ arbeitet über einen Teil des gesamten Quarz-Frequenzbereiches von 7,5...9,7 MHz und gibt Frequenzvielfache von 3x, 9x und 18x ab, so dass eine volle Überstreichung bis zu 175 MHz zur Verfügung steht.

Bei konstanter Umgebungstemperatur und einer Anwärmezeit von 45 Minuten ist die Abweichung von der Quarzfrequenz und den entsprechenden Vielfachen nicht grösser als 3 Teile pro Million.

Zur Einspeisung eines Signals von dem zu prüfenden Sender ist ein Anschluss vorhanden. Die Amplitude des angelegten Signals soll nicht grösser als 100 mV sein. Das Sendersignal und die gewählte Quarzfrequenz mit ihren Vielfachen werden in den Breitbanddetektor gespeist. Der Ausgang dieses Kreises wird einer Klinke auf der Frontplatte zugeführt. Das Schwebungsnull wird mittels eines mit der Klinke verbundenen hochohmigen Kopfhörers festgestellt.

EE 27 761 *für weitere Einzelheiten*

NF-OSZILLATOREN

(Abbildung Seite 727)

Levell Electronics Ltd, 10-12 St. Albans Road, Barnet, Hertfordshire

Diese RC-Oszillatoren verwenden Transistoren als aktive Bauelemente und sind daher nicht mit den vielen Fehlern behaftet, die in vergleichbaren Röhrenoszillatoren auftreten. Der viel geringere Stromverbrauch führt zum Wegfall der langsamen Frequenz- und Amplitudendrift, die Röhrenoszillatoren während der Anwärmezeit kennzeichnen. Durch den geringen Stromverbrauch können auch Dauerbatterien als Stromquelle verwandt werden, wodurch die Brummmodulation ganz wegfällt.

Die Oszillatorschaltung besteht aus einem Transistor-Verstärker mit Mitkopplung über das Selektivnetzwerk einer Wien-Brücke und Gegenkopplung über ein amplitudenstabilisierendes Netzwerk mit Thermistor. Typ TG 150M unterscheidet sich gegenüber Typ TG 150 durch einen zusätzlichen Leistungsmesser.

Die Resonanzfrequenz des Wien-Brücken-Netzwerkes ist mittels einer geeichten Frequenzregelung über eine Dekade stufenlos regelbar. Der Bereich von 1,5 Hz...150 kHz wird in fünf Stufen überstrichen. Die effektive Gesamtskalenlänge ist 1270 mm.

In der Endstufe finden zwei Transistoren in einer Schaltung Verwendung, die durch Gegenkopplung linear gemacht wird, so dass die Ausgangsleistung des Oszillators trotz geringen Stromverbrauchs nur unwesentlich verzerrt ist.

Starke Gegenkopplung über das amplitudenstabilisierende Netzwerk gewährleistet eine konstante Leistung über den ganzen Frequenzbereich, die nur unwesentlich durch Schwankungen der Netzspannung und Umgebungstemperatur beeinflusst wird.

EE 27 762 *für weitere Einzelheiten*

SPURLAGENVERSCHIEBER

(Abbildung Seite 727)

Cawkell Research and Electronics Ltd. Scotts Road, Southall, Middlesex

Der Cawkell Spurlagenverschieber ist ein neues Gerät, das dem Benutzer eines Oszillografen ermöglicht, nacheinander bis zu 10 von derselben Quelle kommende Signale darzustellen. Jedes der Signale ist gegenüber dem vorhergehenden senkrecht versetzt, so dass Vergleiche angestellt werden können.

Der Verschieber findet seine Hauptanwendung mit Speicheroszillografen für Einschwingvorgänge, z.B. dem Remscope, und mit seiner Hilfe können von Periode zu Periode auftretende Schwankungen eines sich wiederholenden Signals oder einer Reihe von Einschwingvorgängen untersucht werden. Das Zeitintervall zwischen aufeinanderfolgenden Signalen ist nebensächlich, da der Verschieber am Ende der Kippschwingung des Oszillografen getriggert wird. Er ist für fast jeden Oszillografen mit Differentialeingang geeignet.

Das Gerät ist in sich geschlossen, batteriebetrieben und volltransistorisiert.

EE 27 763 *für weitere Einzelheiten*

POLYESTERKONDENSATOREN

(Abbildung Seite 727)

Suflex Ltd, Bilton House, 54-58 Uxbridge Road, Ealing, London W.5

Diese als "Polycaps" bekannten Kondensatoren sind verhältnismässig preisgünstig und als Alternative für Typen mit Papierdielektrikum gedacht. Sie haben den zusätzlichen Vorteil hoher Betriebstemperatur (100°C) und hohen Isolationswiderstandes (über 100 GΩ). Kapazitäten von 10 nF bis 50 nF sind mit ±20% Toleranz für 350 V Gleichstrom lieferbar.

EE 27 764 *für weitere Einzelheiten*

FERNSEHUMSETZER

(Abbildung Seite 727)

Marconi's Wireless Telegraph Co. Ltd, Marconi House, Chelmsford, Essex.

Diese Anlage wird für Ballsendungen von Fernsehübertragungen in Bezirken eingesetzt, in denen die Feldstärke zu gering ist, um Lücken im Ausbreitungsgebiet zu schliessen. Sie ist für Betrieb in Band I und III geeignet und besteht im wesentlichen aus Frequenzumsetzern und Verstärkern. Die Nennleistung ist 2 W, kann aber durch zusätzliche Verstärker auf 50 W erhöht werden.

Die Anlage kann für Ballsendung von einem bestehenden Sender oder als Sender geringer Leistung Verwendung finden. Eine Ballsender-Sender-Kombination ermöglicht je nach Wunsch entweder drahtlose Weitergabe der Signale des Hauptsenders oder Ausstrahlung vom Standort direkt.

Da das Bildsignal amplitudenmoduliert und das Tonsignal frequenzmoduliert wird, können für Bild und Ton gemeinsame Verstärker ohne Verschlechterung benutzt werden.

Üblicherweise wird die Anlage in 48 cm (19 Zoll) Gestelle eingebaut. Auf Wunsch können jedoch auch den besonderen Anforderungen entsprechende Schränke für Aussenmontage geliefert werden.

Mit den Abdeckungen an Ort und Stelle sind keine gefährlichen Spannungen am Gerät zugänglich. Ausreichende Überlastungsschütze sind vorgesehen, und alle wichtigen Röhrenspeisungen können durch Messgeräte auf der Frontplatte überwacht werden.

Die Anlage ist für 525 oder 625 Zeilenbetrieb geeignet.

EE 27 765 *für weitere Einzelheiten*

Zusammenfassung der wichtigsten Beiträge

Ein elektronisches Geheimschloss von K. A. Steele

Zusammenfassung des Beitrages auf Seite 676-679

Beschreibung eines binären elektronischen Geheimschlosses, das mit einem Paar Dekatron-Glimmübertragungsröhren als Stufenschalter arbeitet. Einige Gesichtspunkte der Wahrscheinlichkeitstheorie, soweit sie binäre Kombinationen betreffen, werden besprochen. Ein mit einer Quelle beliebiger Binärzahlen ausgeführter Test der Kombination ergibt gute Übereinstimmung mit der Theorie.

Ein rechteckendarstellender Zähler für Magnetbanddaten von Peter Dawe

Zusammenfassung des Beitrages auf Seite 680-684

Für Versuche, in denen Frequenzhäufigkeitsverteilung eine Rolle spielt, bringt Verwendung von Magnettonbändern anstelle von Registrierstreifen Vorteile bezüglich Messen und Sichten der aufgezeichneten Daten mit sich. Ein System wird beschrieben, das elektronische Schaltungen zum automatischen Messen und Sichten aufgezeichneter Daten in einem Versuch benutzt, für den Resultate in statistischer Form benötigt werden.

In den Schaltungen finden Transistoren, Röhren und Dekatron-Wählröhren Verwendung. Es wird gezeigt, wie die Impulse auf mehrkanaligen Magnettonbändern aufgezeichnet und von ihnen auf eine Art abgelesen werden können, die in ihrer Einfachheit mit der Tintenmarkierung von Registrierstreifen vergleichbar ist.

Ein gesteuerter Störgenerator von W. E. Matthews und P. L. Mothersole

Zusammenfassung des Beitrages auf Seite 685-688

Die Leistung eines Fernsehempfängers in ungünstiger Lage muss normalerweise in umfangreichen Geländetests untersucht werden. Der in diesem Beitrag beschriebene Generator gibt realistische Störsignale von einem elektrischen Motor und dem Simulator einer Kraftfahrzeugzündung ab, wodurch im Labor ausgedehnte Tests unternommen werden können.

Ein 1 MHz-Magnetkern-Zwischenspeicher für Einsatz mit einer Lochkartenstanze oder einem Zeilendrucker von J. B. James

Zusammenfassung des Beitrages auf Seite 689-695

In dem Beitrag wird ein schneller Zwischenspeicher beschrieben, der Daten mit einer Geschwindigkeit von einem Zeichen pro Mikrosekunde vom Rechner aufnimmt. Diese Ausgabe erfolgt in einer für Drucker und Lochkartenstanzen geeigneten Form durch entschlüsselte Parallelausgänge. Als Speicherelemente werden Rechteckmagnetkerne in Systemen benutzt, die einen Kern pro Bit verwenden. Diese Kerne werden auch in Treiberschaltungen eingesetzt, um die Zahl beweglicher Elemente herabzusetzen. Schaltungen für Entschlüsselung und Paritätskontrolle werden behandelt, die von gewöhnlich in Speichern verwendeten Kerngrössen auf neue Weise Gebrauch machen.

Halleffekt-Analogmultiplikator von H. Fuchs und D. G. Flockhart

Zusammenfassung des Beitrages auf Seite 696-699

Dieser Beitrag beschreibt einen Halleffekt-Analogmultiplikator, der für Betrieb mit einem Analogrechner entwickelt wurde. Die Konstruktionseinzelheiten eines solchen Bausteins werden besprochen und abschliessend die erreichte Leistung beschrieben.

Ein Transistor- und magnetischer Gleichstromleistungsverstärker von G. Sarkar

Zusammenfassung des Beitrages auf Seite 705-711

In diesem Beitrag wird ein Gleichstromverstärker beschrieben, in dem ein Transistor-Zerhacker in der Eingangsstufe, zwei Transistor-Verstärker in der Zwischenstufe und ein magnetischer Verstärker in der Endstufe Verwendung finden. Das Gerät wurde für hohen Eingangswiderstand konstruiert und verstärkt Eingangsgleichspannungen von wenigen Millivolt auf Endleistungen von mehreren hundert Watt.

Ein Frequenzmessempfänger von G. F. Meakes

Zusammenfassung des Beitrages auf Seite 712-713

Die Trägerfrequenz einer Sendung kann mit einer aus einem hochstabilen Empfänger und einem digitalen Frequenzzähler bestehenden Kombination schnell und genau gemessen werden. Die Instrumentgenauigkeit wird durch Modulation oder schlechten Geräuschabstand nicht beeinflusst, und Messungen mit Signalträgerpegeln von unter einem Mikrovolt sind möglich.

Multiplikatoren und Teiler in Wechselstrom-Analogrechnern von C. H. Smith und A. Prabhakar

Zusammenfassung des Beitrages auf Seite 714-716

Ein einfacher Multiplikator oder Teiler kann unter Benutzung der exponentiellen Form des Anfangsteiles der Kennlinien vieler elektronischer Elemente konstruiert werden. Ein Vakuumröhren-Teiler, ein Transistor-Multiplikator und ein Transistor-Teiler, die nach den obigen Grundsätzen entwickelt wurden, werden kurz beschrieben.