

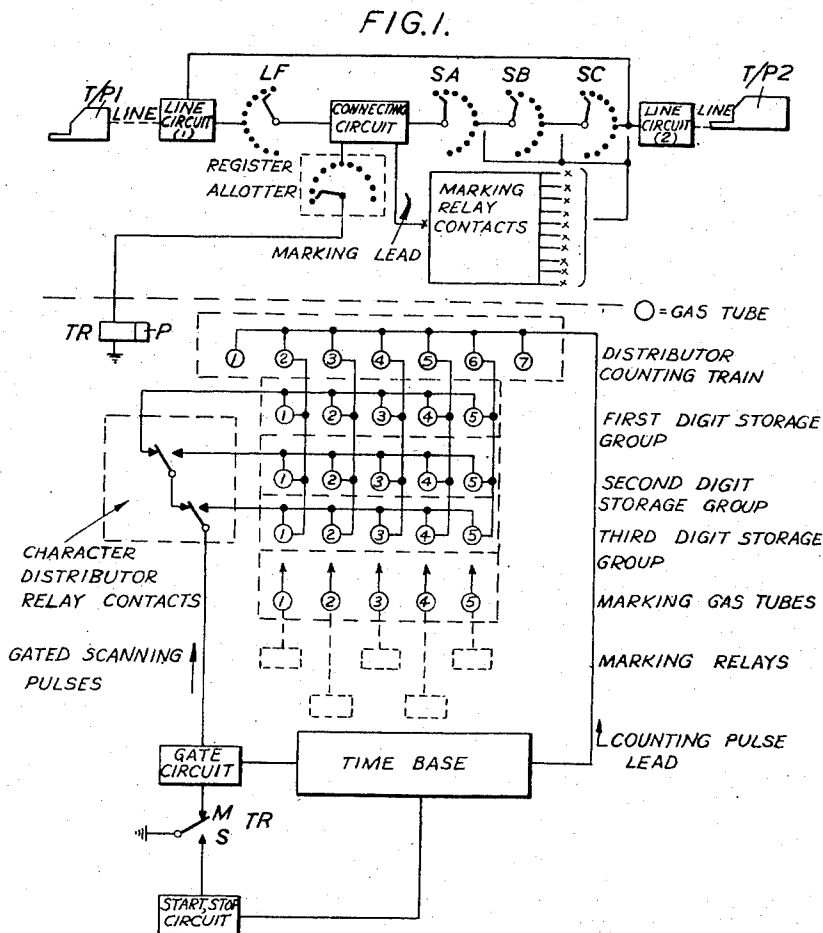
Oct. 9, 1951

D. S. RIDLER ET AL
ELECTRIC SIGNALING SYSTEM

2,570,279

Filed April 6, 1949

6 Sheets-Sheet 1



INVENTORS
DESMOND S. RIDLER
LESLIE R. BROWN
BY *RPM*
ATTORNEY

Oct. 9, 1951

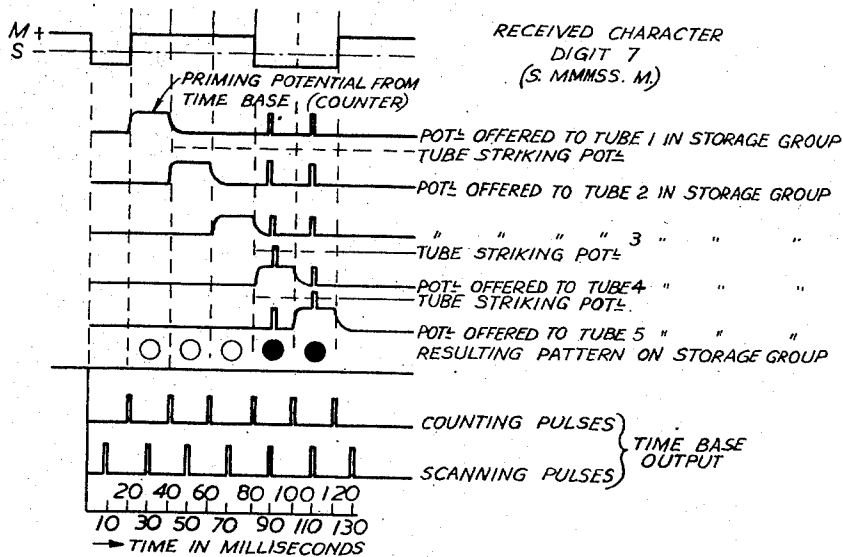
D. S. RIDLER ET AL
ELECTRIC SIGNALING SYSTEM

2,570,279

Filed April 6, 1949

6 Sheets-Sheet 2

FIG. 2.



INVENTORS
DESMOND S. RIDLER
LESLIE R. BROWN
BY *R. P. Morris*
ATTORNEY

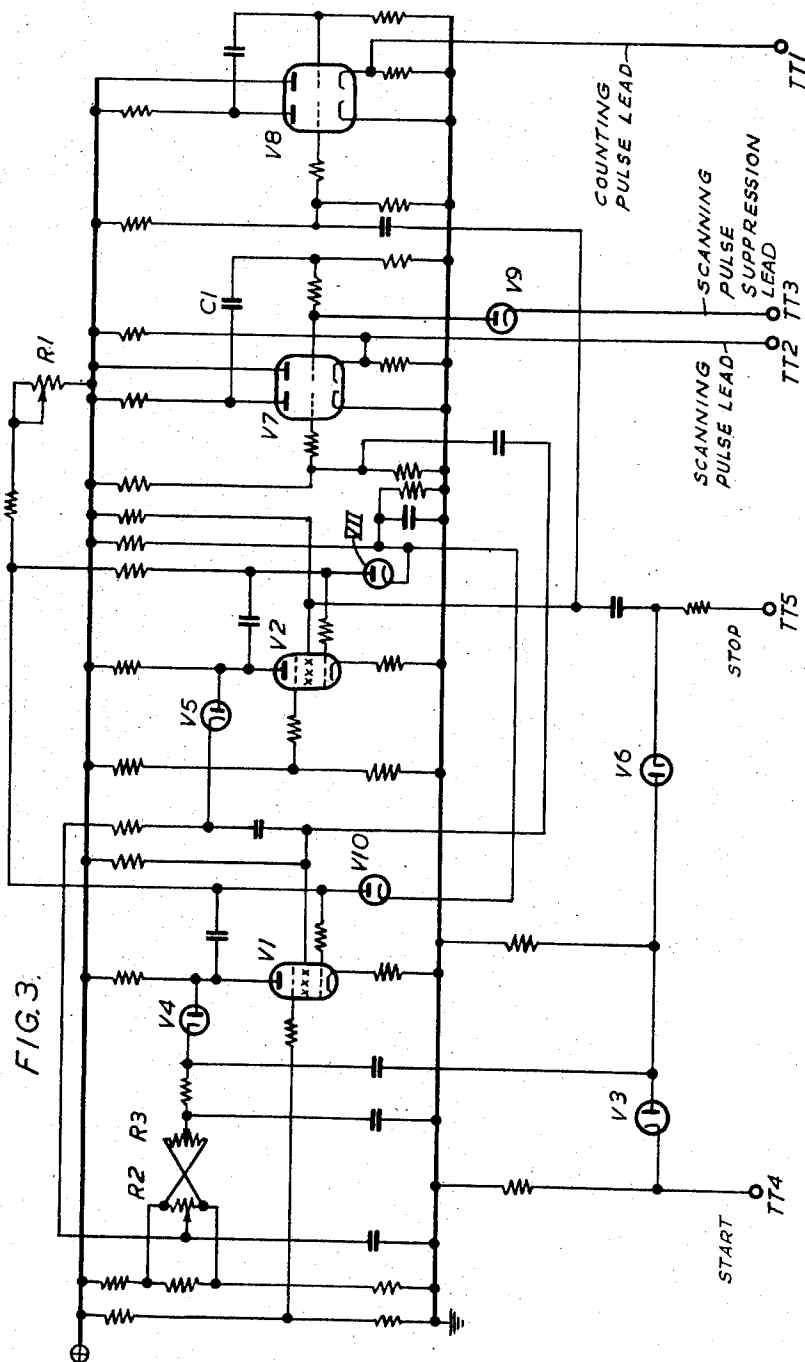
Oct. 9, 1951

D. S. RIDLER ET AL
ELECTRIC SIGNALING SYSTEM

2,570,279

Filed April 6, 1949

6 Sheets-Sheet 3



INVENTORS
DESMOND S. RIDLER
LESLIE R. BROWN
BY *RP Monio*
ATTORNEY

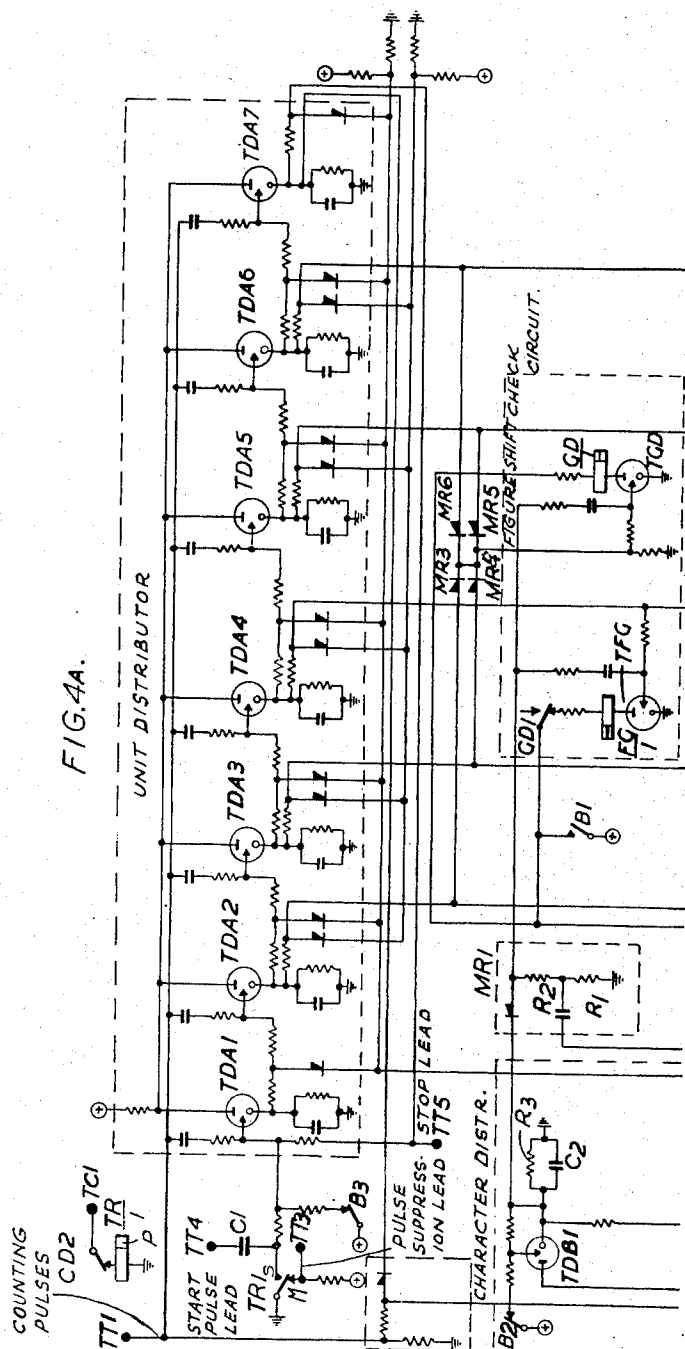
Oct. 9, 1951

D. S. RIDLER ET AL
ELECTRIC SIGNALING SYSTEM

2,570,279

Filed April 6, 1949

6 Sheets-Sheet 4



INVENTORS
DESMOND S. RIDLER
LESLIE R. BROWN
BY *RPM*
ATTORNEY

Oct. 9, 1951

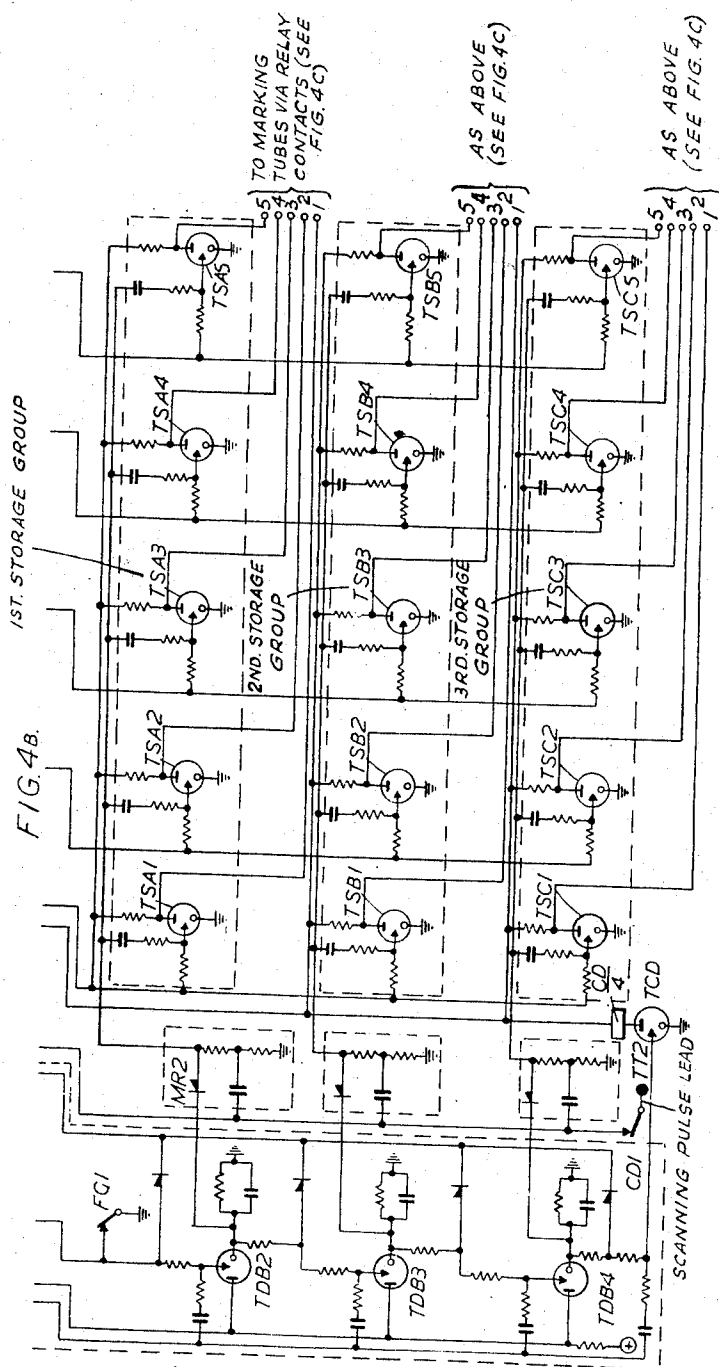
D. S. RIDLER ET AL

2,570,279

ELECTRIC SIGNALING SYSTEM

Filed April 6, 1949

6 Sheets-Sheet 5



INVENTORS
DESMOND S. RIDLER
LESLIE R. BROWN

BY *RP Morris*

ATTORNEY

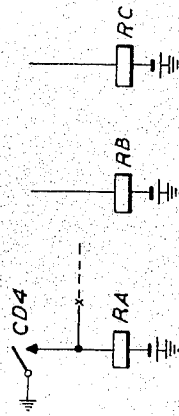
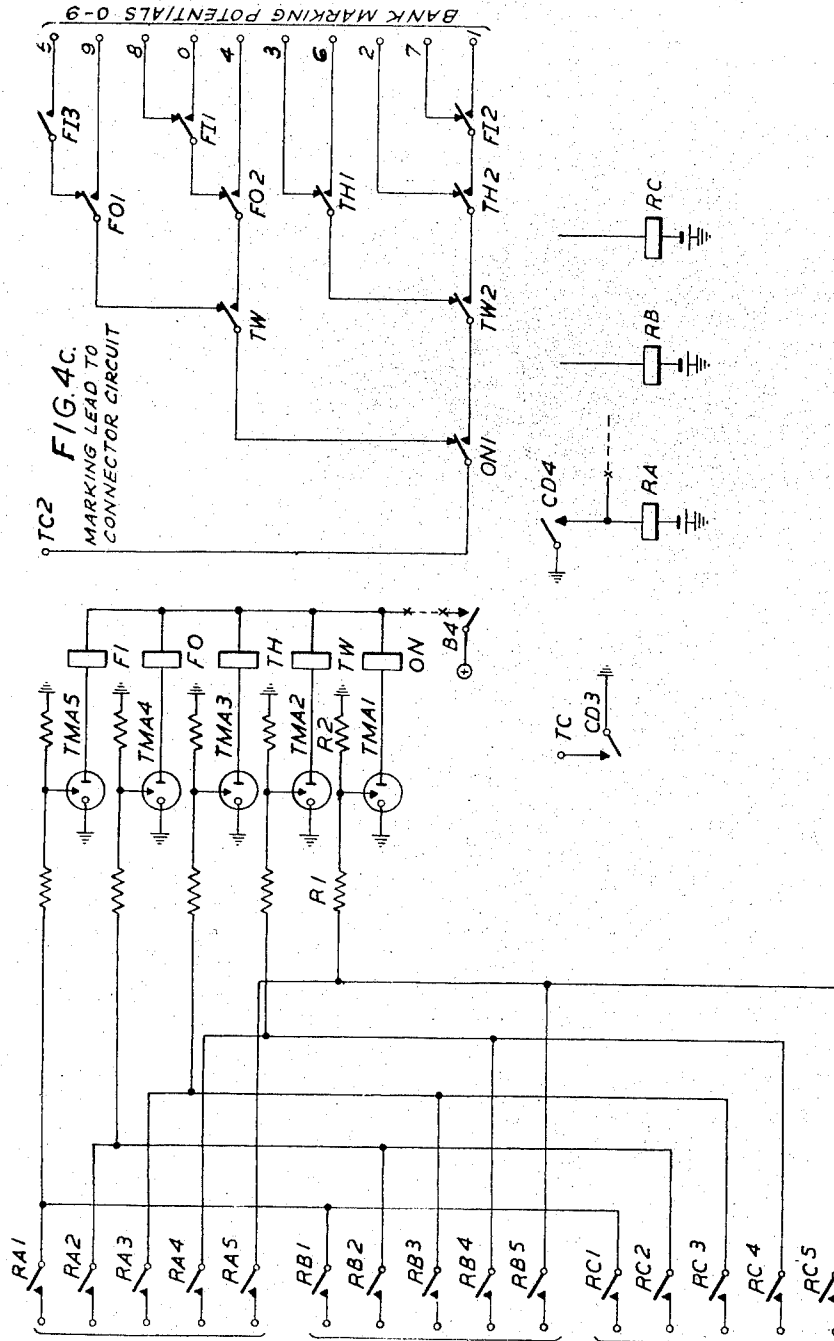
Oct. 9, 1951

D. S. RIDLER ET AL
ELECTRIC SIGNALING SYSTEM

2,570,279

Filed April 6, 1949

6 Sheets-Sheet 6



INVENTORS
DESMOND S. RIDLER
LESLIE R. BROWN
BY *RP Monio*
ATTORNEY

UNITED STATES PATENT OFFICE

2,570,279

ELECTRIC SIGNALING SYSTEM

Desmond Sydney Ridler and Leslie Ronald Brown,
London, England, assignors to International
Standard Electric Corporation, New York, N. Y.,
a corporation of Delaware

Application April 6, 1949, Serial No. 85,789
In Great Britain April 7, 1948

7 Claims. (Cl. 178—2)

1

This invention relates to electric signalling system and its object is to provide improved signal storage means.

The use of storage registers in automatic switching systems generally is well known where, by their use, selection information in one form or another may be stored and subsequently retransmitted in the same or a different form. Considerable operational advantages result from their use in the accuracy and flexibility thereby provided in such signalling systems, and the limitations which formerly were imposed by the necessity to employ mechanical relays in registers, with their attendant disabilities, have been mitigated by previous proposals to carry out many of the functions hitherto performed by relays by means of gas discharge tubes, with consequential circuit simplifications and other improvements, including improved reliability and longer life.

According to the present invention, there is provided a signal storage device for constant total permutation code signals which comprises means for registering successive signal codes on successive rows of gas discharge tubes synchronously with the receipt of such signal codes.

The invention will be particularly described with reference to the accompanying drawing which relates to keyboard selection, but is by no means limited to such an application.

The use of automatic selection signals set up in teleprinter code directly on the keyboard by an operator has considerable technical and operational advantages over dialling or manual selection techniques, and a system will be described herein whereby registers are called in to store the selection signals and to set up a potential-marking scheme for subsequent operation of selector switches.

The equipment to be described with reference to the accompanying drawing is in the nature of a model, and is consequently somewhat simplified compared with that required for a fully equipped system.

However, the register, which is the equipment mainly concerned in this description, is much the same whether the system as a whole is simple or complex, and the principles involved are therefore understandable from the workings of such a simplified model.

In the accompanying drawing:

Fig. 1 shows in block diagrammatic form the overall circuit arrangements adapted for the model;

Fig. 2 shows diagrammatically the potential pattern set up in a storage group for the digit 7;

2

Fig. 3 shows a hard tube time-base circuit for providing the necessary pulses for controlling the register; and

Fig. 4 in its several sections, A, B, C, shows a complete register circuit for a three figure selection code.

In the drawings relays have been designated by a letter or letters placed over a horizontal line and having a number thereunder, the number representing the number of contacts which are physically controlled by the relay. These contacts are shown distributed over the various figures in the circuits which they control, rather than in close association with the relays to which they belong. The contacts are designated by the letter or letters of the relay to which they belong followed by a number to differentiate the contacts of the same relay. This arrangement avoids a complex wiring diagram and makes the drawing easier to read and understand.

GENERAL DESCRIPTION

Referring now to Fig. 1 of the drawing, the upper portion, above the dashed line, shows the simplified trunking arrangements used in the model. A teleprinter (T/P1) operator calls in the exchange equipment by depressing a Call key which causes a line finder switch (L. F.) to associate a connecting circuit with the calling line in the conventional manner for automatic telephone working. Normally an allotter switch (shown in the dashed outline) would be used to associate the register with the connecting circuit, but since only two substations are involved in the model, the allotter has been omitted. A visual audible "proceed to keysend" signal is returned to the operator who then keys "figures shift" followed by the called substation number which consists of three digits.

These digits are electronically registered on gas tubes in the register circuit and, after the last digit has been received, a marking group of five gas tubes examines such storage groups in turn. Five relays in the anode circuits respectively of these five tubes serve to translate the intelligence stored in each group into a marking which is used to set up the selection switches. In a complete exchange system, one of the known multipotential marking schemes would be used, but for this simple case, simple earth marking has been adopted.

The storage tube arrangement comprises a set of five tubes per digit which, according to whether they are normal or fired (triggered), register respectively a mark or a space.

The standard 5-element permutation code actually comprises seven elements, the characteristic 5-element code portion being sandwiched between an initial space and a final mark in all cases. The common initial and final elements are not stored, and hence only five tubes per digit are required to store the intelligence contained therein.

The operation of the register, in outline, is as follows.

The key-sent digits are received on the polarised relay TR, the first change-over from mark to space starting the time base, in a manner somewhat as described in the United States Patent No. 2,433,362, issued on December 30, 1947, to G. C. Hartley and W. J. Reynolds. This time base delivers two outputs of pulses known as "scanning" and "counting" pulses respectively, each having a basic period of 20 milliseconds and being displaced from one another by 10 milliseconds, the pulse width being one-half millisecond.

The time base runs for seven cycles and is then shut off by the distributor which comprises principally the bank of gas tubes numbered 1-7 and the dashed square containing two relay contact sets. Counting pulses, the first of which occurs 20 milliseconds after the start, drive the distributor gas tube counting train in known manner and in consequence, potentials corresponding in time to the units of the received character are offered from the cathode resistances of distributor tubes to the corresponding tube of a storage group. At the same time, scanning pulses, which are admitted through the "gate" circuit only when relay TR is operated to space, are added to the distributor potentials to trigger the appropriate storage tubes. Potentials corresponding to the digit "7" are shown in the diagram of Fig. 2, which is self-explanatory. Switching between groups as each digit is received is by means of relay contacts, as shown, but wholly electronic means can be, and have been, used for this purpose.

When the last digit has been received, the marking gas tubes commence to read off the stored digits in turn. This is achieved by connecting the control electrodes of the marking tubes by means of relay contacts to the anodes of storage tubes of each group in sequence. A fan of contacts on these marking relays connects an appropriate one of ten markings to a marking lead. The first numerical switch SA is then driven to a similarly marked output. The second and third switches are positioned in the same way from information stored on the second and third storage groups respectively. When the connection is complete, the register is released and communication may commence.

DETAILED DESCRIPTION

The invention will now be described in rather more detail with reference to the detailed circuits of Figs. 3 and 4.

Time base

Referring first to Fig. 3, this shows a hard valve time base circuit based on well-known phantastron principles. The form of time base generator used is not an essential feature of the invention, and this circuit may be replaced by any suitable circuit producing the required pulse trains.

For satisfactory reception, teleprinter signals should be examined in the centre of each unit or

element period, which is nominally 20 milliseconds in duration. The time base therefore provides one output of positive pulses, known as the scanning output, which has a basic period of 20 milliseconds and displaced 10 milliseconds from the start of the signal. A second similar output is also available having the same basic frequency but displaced by 20 milliseconds from the scanning output. This is known as the counting output and is used for switching and counting purposes.

The circuit is based on two 10 millisecond phantastron delay circuits arranged to feed pulses one into the other such that, once started, the pair is self-running. The arrangement lends itself to electronic starting and stopping since a single pulse applied to the first delay circuit will start the time base and the suppression of a pulse will cause it to stop.

Tube V1 with associated elements comprises one phantastron delay circuit and tube V2 with associated elements comprises the second. The circuits are normally quiescent with both valves taking screen current. If a negative starting pulse is applied to terminal TT4, the anode of V1 is driven instantaneously negative through the diodes V3 and V4 and the characteristic reduction of anode volts observed in the phantastron takes place. After 10 milliseconds a negative pulse derived from the screen of V1 is applied to the anode of V2 through the diode V5. The second delay circuit is thus brought into operation and, after a further 10 milliseconds delay, a pulse is again applied to the anode of V1 through V6 and the cycle is repeated. In order to stop the time base, a positive potential is applied to terminal TT5. This so biases the diode V6 so that the next screen pulse from V2 is prevented from triggering V1 once again and the time base comes to rest. Two double triodes (V7 and V8) are used in their separate sections for pulse shaping and for giving low impedance cathode follower outputs for the two sets of pulses respectively in known manner. Means are also provided via TT3 for suppressing scanning pulses by an earth from the line condition if required. Terminal TT3 is connected to the receiving relay contact and is normally maintained at a high positive potential so that diode V9 is non-conducting and pulses pass forward from the shaper section anode of V1 via condenser C1 to the grid of the cathode follower section. If an earth potential is applied by the contact to TT3, however, any pulse is short circuited and no output is developed across the cathode resistance.

Fine adjustments to time-base speed can be made by means of variable resistance R1. The position in time of one pulse with respect to the other may be adjusted by means of the ganged variable resistors R2 and R3.

The pulse width is about 1/2 millisecond. This gives sufficient time for the operation of gas tubes and represents the unit scanning time. Greater distortion can thus be allowed on incoming signals than in the mechanical case where the scanning time is normally a few milliseconds.

Signal storage circuit

The signal storage circuit comprises Figs. 4A and 4B intended to be placed one above the other, in that order.

It is necessary for the register to guard against false signals which might occur, for instance, if

a connection were broken down during the transmission of a message or through faulty operation at the teleprinter substation. A wrong connection would be set up involving waste of line time and of operator's time. The register is therefore designed to receive numerical information only when it is preceded by a "figures shift" character.

In the general description given above, the precautionary use of "figures shift" was not referred to, and Fig. 1 does not show the "figures shift check circuit." However, Fig. 4A includes such a circuit, the functioning of which will now be described.

Fig. 4A shows the relevant part of the register circuit. Polarised relay TR is connected to the substation teleprinter through the allotter, when provided, connecting circuit, line finder switch and subscriber's line. "Proceed to key-send" signal is sent back from the connecting circuit and the operator then key-sends "figures shift" followed by three digits. Let it be assumed for the purpose of description that these digits are 719.

The unit distributor counting train is a scale of seven counter consisting of gas tubes TDA1—7. The character distributor counting train is a scale-of-four counter consisting of tubes TDB1—4, extending vertically downwards into Fig. 4B.

Before seizure, the first tubes in each counting train TDA1 and TDB1 are triggered over contacts B3 and B2 respectively of a relay B (not shown), which operates in well-known manner on seizure of the register. All other tubes are normal. The operation of B relay on seizure removes the triggering potential at B2 and B3, and frees the distributor trains. When a character is received, the first changeover to "space" of relay TR at TR1 discharges to earth the condenser C1 in the TT4 start lead and thereby creates a negative pulse to start the time base, Fig. 3, in the manner previously described. Counting pulses received over lead TT1 drive the unit distributor train from TDA1 to TDA7 in well-known manner, each tube as it fires sending a pulse out, priming the next tube and extending the previous tube, as described, for example, in United States Patent No. 2,421,005, issued on May 27, 1947 to F. H. Bray and L. R. Brown and a positive gating potential is applied from the cathode of TDA7 via TT5 stop lead to stop the time base. The final pulse triggers tube TDA1 and restores the train to normal. The cathodes of tubes TDA2—6 are connected to other tubes via voltage limiting rectifiers for priming functions.

The first character to be received should be "figures shift" which is S.MMSMM.M. Tubes TGD and TFG are used to check the reception of this character. Priming potentials are applied from the cathodes of tubes TDA2, 3, 5 and 6 to tube TGD via the coupling rectifiers MR3—MR6. The timing of these potentials corresponds to the timing of the second, third, fifth and sixth mark units. At the same time, scanning pulses are applied over the lead from terminal TT2 (Fig. 4B) to the first character distributor R1—R3, and condenser C2. This gate circuit allows a pulse to pass to the trigger electrodes of TFG and TGD only when the controlling tube TDB1 is conducting and MR1 is a high resistance.

When tube TDB1 is conducting the cathode end of R3, which is a high resistance, is at high

positive potential, thus biasing MR1 strongly positive on its positive side and causing it to present a high resistance to positive pulses on its negative side. The pulses are therefore gated off to the right, to tubes TFG and TGD.

Conversely, when TDB1 is normal, the positive potential on MR1 is very low, or earthy, and positive scanning pulses are easily shunted away to earth via MR1 instead of going in the other direction.

Tube TGD will trigger only when a priming potential and a scanning pulse are applied at the same time. Since scanning pulses are normally suppressed by contact TR1 in the mark condition via lead TT3, as explained in the description of the time base circuit, it follows that if there is a space (where there should be a mark) among the second, third, fifth or sixth units, tube TGD will trigger and operate guard relay GD to disconnect the circuit for relay FG. For similar reasons tube TFG will trigger only if the centre unit is a space and relay GD has not already operated. The operation of relay FG can only be maintained by the "figures shift" character. All the other characters except "letters shift" (S.MMMMM.M) will eventually operate the guard relay GD and so disable relay FG and the operator must clear down and recall the exchange to set up a connection. "Letters shift" does not fire tube TGD, but, on the other hand, neither does it fire tube TFG and the register must still await a figures shift signal before storage can proceed.

If the first character has been satisfactorily checked by the operation of FG relay, contact FG1, Fig. 4B, removes a short circuit from the priming lead of the character counter and a counting pulse applied via TT1 and gated by the last unit distributor tube TDA7 when in the triggered condition, triggers tube TDB2. Further scanning pulses will thus be switched to the first storage group of tubes TSA1—5 through the gate circuit comprising MR2 and associated components.

The second character, which is the first numerical digit, starts the time base in the same way and the unit counter runs as before. Priming potentials are applied in turn to each storage tube corresponding in time to the second, third, fourth, fifth and sixth signal units. If the contact of TR relay is at mark during priming the tube remains normal. If the contact is at space, a scanning pulse is admitted and the primed tube triggers. For digit seven (S.MMMSS.M) the tubes TSA1, 2 and 3 remain normal and TSA4 and 5 trigger. As before, a counting pulse is switched to the character counter at the end of each cycle of the unit counter. Thus tube TDB3 is triggered and the second storage group is prepared for the second digit. This is stored in a similar way on tubes TSB1—5. The third digit is stored on tubes TSC1—5.

Finally tube TCD triggers having been primed by tube TDB4 to operate relay CD. Contact CD1 disconnects further scanning pulses and contact CD2 disconnects relay TR. The selection information is now stored on the storage group of tubes and the register is ready to set up the connection.

Marking circuit

Fig. 4C which is intended to be placed to the right of Fig. 4B shows the relevant parts of the marking circuit. Contact CD4 operates the first selection digit relay RA which connects the con-

control electrodes of the five marking tubes TMA1—5 to the anodes of the first group of storage tubes TSA1—5. If a storage tube is normal the potential on the anode is the full supply volts and if the tube is conducting the potential is the sustaining potential for the tube. These potentials, suitably divided by two resistances associated with each marking tube, respectively trigger or leave normal a marking tube. In this way the code stored on the first storage group is transferred to the marking tubes although in a complementary pattern, e. g. in the case of digit seven, storage tubes TSA1, 2 and 3 were normal and TSA4 and 5 triggered. On transfer the marking tubes TMA1, 2 and 3 conduct, and TMA4 and 5 remain normal. Five relays ON, TW, TH, FO, and FI, one in the anode of each tube, operate in the same combination. A fan of contacts of these relays connects one of ten discrete marking potentials to a marking lead which is, in turn, connected by the allotter switch to the connecting circuit. The closure of CD3 starts the first selector switch hunting for a similar marking potential on the switch bank as is common in potential marking systems.

When the first switch has been positioned, relay RA is released and relay RB is operated to enable the marking tubes to examine and translate into a potential marking the code on the second storage group of tubes TSB1—5. The transfer from RA to RB and the de-ionisation of the tubes TMA1—5 is effected by relay switching in a conventional manner not really relevant to the functioning of the register and marker as such. The second selector switch is positioned through the medium of the marking lead in the same way as the first. Relay RB is then released and relay RC is operated and the third storage group is examined. The third switch is positioned and the connection established. At this stage, the register would normally be released and the allotter switch would be free to find another connecting circuit for the purpose of setting up another call.

In any practical circuit, the functions of the mechanical relays shown could in many or all cases be replaced by gas tube relays; this applies particularly to the RA, RB and RC relays.

The extremely simple gate circuits provided and the "figures shift" check circuit offer considerable advantages and safeguards over earlier circuits.

Also the use of a short scanning pulse of the order of one-half millisecond increases the distortion margin which can be allowed on incoming signals to extremely high values. In the case of the model described the theoretical distortion that can be allowed on the TR contact is 48.75%, a figure perhaps impossible to achieve in a practical mechanical system, while the speed variation in the hard tube time base is less than 0.5% for a wide range of operating voltages, and it is anticipated that a much better figure than this may be achieved in future designs.

While the principles of the invention have been described above in connection with specific embodiments, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What is claimed is:

1. A signal storage device for constant total permutation code signals which comprises a bank of gas discharge tubes arranged in rows of character code register tubes each such row being responsive to one character code to be stored (a

"character code" being defined as one code arrangement of signals in the constant total permutation code and indicative of that "character," e. g. MMMSS for the character "7" in a 5-unit code), a row of character code distributor tubes arranged to distribute the received character codes in order among the said rows of register tubes, means for rendering the register tubes in a row synchronously responsive to pulses representative of the character code being received, thereby to fire or to maintain unfired such tubes according to the nature of such code, means coupled between said bank of character code register tubes and the first of said character code distributor tubes responsive only to a particular and predetermined character code of dissimilar elements, thereby to allow or prevent the registration of succeeding character codes according to the first character code actually received, and means to change, at the end of the storage of each character code as it is received, the condition of the next tube in the row of character code distributor tubes, thereby to direct the pulses representative of the next received character code into the next register row.

2. A signal storage device as claimed in claim 1 and in which the said first-named means comprises a time-base generator for generating interlaced trains of equally spaced pulses, each train thereof having a spacing equal to that of the nominal spacing of the character codes to be stored, and the first train thereof being initiated under the control of the first element of a received signal comprising at least a start element and a character code, whereby each tube in a register row may be primed in turn synchronously with the elements of a received character code by means of the first, or "counting" train of pulses in preparation for the reception of pulses from the second, or "scanning" train of pulses transmitted to such register row, or suppressed, in accordance with the elements of the character code being received.

3. A signal storage device as claimed in claim 1 and comprising a train of counting tubes adapted to be fired and quenched in turn by the said first train of pulses, thereby to provide pulses for priming the tubes in the said register rows and the said character row in due order.

4. A signal storage device as claimed in claim 3 in which said tube condition changing means comprises the priming pulse generated in the last tube of the said train of counting tubes by each discrete train of counting pulses.

5. A signal storage device for constant total permutation code signals comprising a bank of gas discharge tubes arranged in rows of character code register tubes, each row being responsive to one character code to be stored, a row of character code distributor tubes arranged to distribute the received character codes in order among the said rows of register tubes, means for rendering the register tubes in a row synchronously responsive to pulses representative of the character code being received, thereby to fire or to maintain unfired such tubes according to the nature of such codes, a pair of gas discharge tubes, each coupled to a different one of said character code register tubes and the first of said character code distributor tubes, each of the tubes of said pair adapted to be primed from its associated character code register tube, control means associated in the discharge path of the first of said pair of tubes, said control means

9

adapted to control operation of the second of said pair of tubes, whereby operation of said first character code distributor tube is under joint control of said pair of tubes and the distribution of succeeding character codes by said character code distributor tubes is dependent upon receipt of said character code register tube of a predetermined character code of dissimilar elements, and means to change, at the end of the storage of each character code as it is received, the condition of the next tube in the row of character code distributor tubes, thereby to direct the pulses representative of the next received character code into the next register row.

6. A signal storage device for constant total permutation code signals as claimed in claim 5, further comprising a gate circuit coupled between said pair of tubes and the first of said character code distributor tubes, said gate circuit comprising a rectifier biased by a potential derived from a current flow in the first of said character code distributor tubes, whereby a high resistance is presented to the first of said pair of tubes and rendering effective pulses applied to

10

the first of said pair of tubes to fire same in accordance with the predetermined character code.

7. A signal storage device for constant total permutation code signals as claimed in claim 5, further comprising a plurality of gate circuits, each of said gate circuits comprising a poled rectifier, one associated with each of said character code register tubes, selected of said gate circuits coupled to the first of said pair of tubes, another of said gate circuits coupled between another of said character code register tubes and the second of said pair of tubes.

DESMOND SYDNEY RIDLER.
LESLIE RONALD BROWN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,193,967	Kleinschmidt	Mar. 19, 1940
2,456,825	Fitch et. al	Dec. 21, 1948
2,465,355	Cook	Mar. 29, 1949