

Dec. 24, 1935.

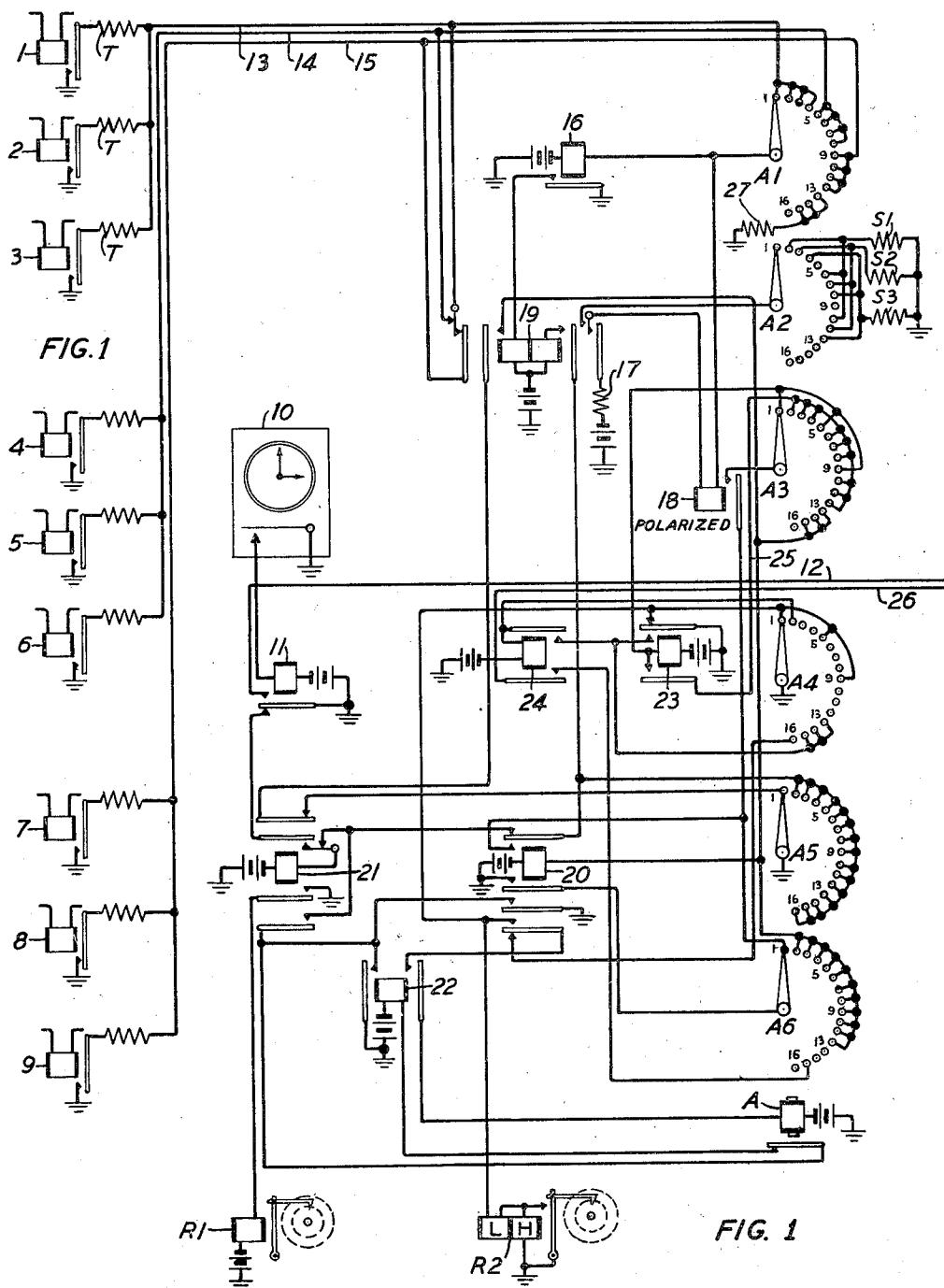
S. B. WILLIAMS

2,025,407

ELECTRICAL RECORDER

Filed April 21, 1933

2 Sheets-Sheet 1



INVENTOR
S. B. WILLIAMS
BY *E. W. Williams*
ATTORNEY

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FIG. 2

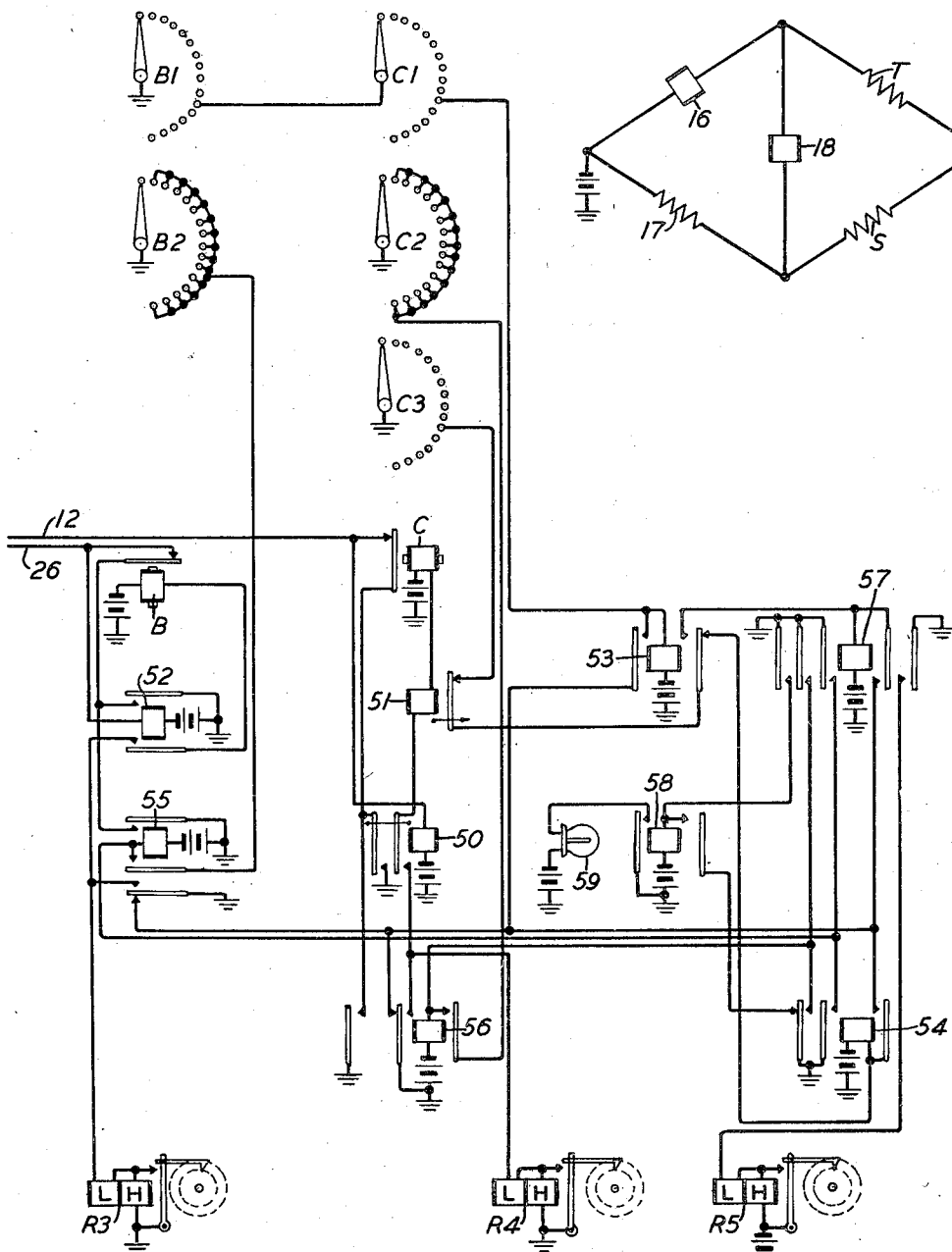
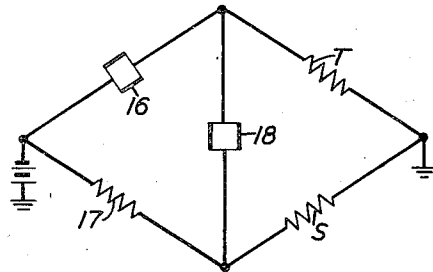


FIG. 3



INVENTOR
S. B. WILLIAMS
BY *E. W. Adams*
ATTORNEY

UNITED STATES PATENT OFFICE

2,025,407

ELECTRICAL RECORDER

Samuel B. Williams, Brooklyn, N. Y., assignor
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

Application April 21, 1933, Serial No. 667,227

9 Claims. (Cl. 179—8)

This invention relates to electrical counting systems and is particularly adapted for use in a telephone system.

Specifically, this is an improvement of my invention shown in U. S. Patent 1,835,737 issued December 8, 1931. That patent relates to an integrating timing circuit having as its principal object the production of a composite and single record of the number of simultaneous occurrences of a certain event counted at a particular time, the count being repeated at frequent and regular intervals. In the embodiment of the invention which was disclosed, the event was the use of a telephone trunk circuit and was manifested and illustrated by the closing of a contact point.

An object of the present invention, in addition to the objects mentioned in the above patent, is to record the occurrence and duration of an unstandard condition, the presence or absence of said condition being determined at frequent and regular intervals.

An additional object is to make a further record when said unstandard condition endures for a predetermined period of time and to give a signal of such an occurrence.

A feature of the present invention, whereby the above stated objects are achieved, resides in an arrangement of stepping switches and relays hereinafter to be described.

In the drawings:

Figs. 1 and 2 laid side by side with Fig. 1 to the left of Fig. 2 shows a system according to my invention; and

Fig. 3 shows the manner in which certain parts of the circuits shown in Fig. 1 are related in a Wheatstone bridge during operation of this system.

The specific system here shown is especially applicable to toll telephone offices. Because of the relatively high cost of toll plant, the trunks between stations are kept so limited in number that during heavy traffic periods, calls are sometimes delayed several minutes before free trunks are available for interconnection. At present, the supervising operators in toll offices learn when the demand for connections exceeds the supply of trunks by observing the number of toll tickets waiting at operators' positions. When calls are delayed for a predetermined time additional circuits may be arranged for by patching sections over alternate routes. It is desirable, therefore, to inform the supervising operators of an "all trunks busy" condition automatically when such a condition occurs in order that ar-

rangements for additional channels may be made immediately, when necessary.

At the left edge of Fig. 1 are shown nine relays, numbered from 1 to 9, inclusive, which are included in, or are associated with nine telephone trunk circuits which may or may not have common places of origin and termination. Relays 1 to 9 are so associated with their respective trunk circuits that each will operate and remain operated during any period in which its individual trunk is in use and will release at the end of such periods of use and remain unoperated during idle periods.

Relays 1 to 9 are arranged in groups of three relays each. Each relay of a group in operating connects ground through a resistance to a conductor common to the group. All the resistances such as resistances T associated with each of relays 1, 2 and 3 are of equal value. The resistance between the common conductor, such as conductor 13 associated with relays 1, 2 and 3, and ground will depend, therefore, upon the number of T resistances connected in parallel to ground and hence on the number of relays operated.

Associated with bank A2 of stepping switch A are three resistances S1, S2 and S3 slightly greater, respectively, than one T resistance, two T resistances in parallel and three T resistances in parallel. In operation, a Wheatstone bridge will be formed by resistances T, resistance S1, S2 or S3, relay 16 and resistance 17, with polarized relay 18 in the detector arm as shown in Fig. 3. Stepping switch A is arranged to step its brush over bank A2 connecting in turn resistances S1, S2 and S3 in the S arm of the bridge. Polarized relay 18 will operate and remain operated in the galvanometer arm of the bridge until an S resistance is reached which is not greater than the resistance in the T arm of the bridge whereupon relay 18 releases. The bridge is balanced in turn for each group of T resistances, such as those associated with each of conductors 13, 14 or 15. By dividing the T resistances into groups, accurate operation is obtained with less sensitive bridge balance than would be required if all the resistances were in one group. The resistances might be grouped on a basis other than three and a greater or less number of trunks might be associated with the system depending only on the practical limitations of the system.

Operation

The operation of the system shown in the drawings will now be described: Assuming that the system is thrown into operation at a time when

all the trunks associated with relays 1 to 9 are idle nothing occurs until clock 10 next momentarily closes its contacts, an event which takes place periodically at regular and frequent intervals (every six seconds, for example).

Relay 11 then operates momentarily and closes a circuit for the operation of relay 50 (Fig. 2) traced from battery, through the winding of relay 50, conductor 12, through contacts of relay 11 to ground.

Relay 50 operates and locks up on a circuit through its own contacts and contacts of stepping magnet C. Relay 50 also closes a circuit extending from battery through magnet C, relay 51 and register magnet R4 to ground. Current passing through the low and high resistance windings of register magnet R4 (marked L and H) causes it to operate and step the register ahead one unit. The register armature, on being attracted, closes a short circuit around the high resistance winding thus providing a low resistance circuit for the operation of magnet C and relay 51. Magnet C opens the locking circuit for relay 50. Relay 50 thereupon releases, releasing magnet C, relay 51 and register magnet R4. Magnet C, in releasing, steps its switches C1, C2 and C3 ahead one step. Relay 51 in operating at this time served no function.

Henceforth, at each periodic interval, clock 10 will momentarily close its contacts and cause register R4 and stepping switch C to move ahead one step.

Assume, now, that several of the trunks are made busy as evidenced by the operation of certain of relays 1 to 9. For example, we shall assume that relays 1, 2, 3, 5 and 6 operate immediately after clock 10 has closed and opened its contacts. Relay 16 operates on a circuit from battery, through the winding of relay 16, brush and first terminal of switch bank A1, conductors 13 and 14 and resistances T to ground. Relay 16 closes a circuit to operate relay 19 through that relay's left-hand winding.

Relay 19 in operating (1) opens the common connection of conductors 13, 14 and 15, thus conductively separating the groups of T resistances, (2) closes an operating circuit for relay 20 from battery, through relay 20, left-hand inside contacts of relay 19, upper back contacts of relay 21, first terminal and brush of switch bank A5 to ground, (3) prepares a locking circuit for itself through its right-hand winding and (4) prepares the Wheatstone bridge circuit through resistance 17 and polarized relay 18 at its outer right-hand contacts.

Relay 20 operates (1) closing the locking circuit for relay 19 through its upper and lower inside front contacts and the brush and first terminal of switch bank A6, (2) closing an operating circuit for relay 22 at its lower middle contacts and (3) preparing an operating circuit for stepping magnet A at its lower outside contacts.

Since the S arm of the bridge is still open, current flows through the galvanometer arm in such direction as to operate polarized relay 18. Relay 18 closes at its contacts an operating circuit for relay 23 through the first terminal and brush of switch bank A3, contacts of relay 18, first terminal and brush of switch bank A6 and lower inside front contacts of relay 20 which are now being closed as just described. Relay 23 operates preparing locking paths for itself and (not yet operated) relay 24.

Relay 22 operates in the circuit closed by relay 20 completing through its contacts a path from

battery through magnet A, contacts of relay 20, the first terminal and brush of switch bank A4 to ground. Stepping magnet A operates opening the operating and locking circuit of relay 22 which releases. Relay 22 in releasing deenergizes magnet A which thereupon releases stepping the brushes to the second terminals of banks A1 to A6 and again closing the circuit for relay 22.

The stepping ahead of brush A2 connects resistance S1 in the S arm of the Wheatstone bridge. The bridge will, in this case, not be balanced, however, since S1 will be of higher resistance than the three T resistances of the first group grounded in parallel.

The locking circuit for relay 23 is completed over conductor 25, through the second terminal and brush of bank A3, contacts of relay 18, upper front contacts of relay 20, second terminal and brush of bank A5 to ground.

Relay 24 operates on a circuit through second terminal and brush of bank A4 to ground and immediately locks up through its own upper contacts and contacts of relay 23. It also prepares a path for the operation of relay 52 over conductor 26. This path will be closed when brush A6 reaches its fifteenth contact provided relay 24 has not yet released.

The locking circuit for relay 19 is held at bank A5 independently of relay 20. Relay 20 is also locked up independently of relay 19 through its own contacts and the terminals and brush of bank A5.

Upon release of magnet A relay 22 again operates, operating register R2 which was shunted at switch bank A4 on the first step. The magnet steps the register R2 ahead one unit after which magnet A operates over a circuit through the low resistance winding of R2 and opens the circuit of relay 22, releasing it and thereby releasing magnet A, thus stepping the switch brushes to the third terminals. Resistance S2 is thus connected in the bridge in place of S1 but it likewise does not balance the bridge. Hence, the brushes are stepped to the fourth terminals, resistance S3 thereby being connected in the bridge. Since the resistance S3 is also greater than the three T resistances in parallel, polarized galvanometer relay 18 does not yet release.

Upon the brushes being stepped to the fifth terminals, the second group of T resistances, i. e. those associated with conductor 14, replace the first group in the Wheatstone bridge. We have assumed relays 5 and 6 of this group to be operated. Relay 16 remains operated over the new circuit. The S arm of the Wheatstone bridge is opened and relay 18 remains operated.

Register R2 is shunted by the brush of A4 on the fifth contact, thus being prevented from operating on the next step.

When the brushes are stepped to the sixth terminals resistance S1 is again connected in the bridge. The system will now operate to balance the bridge for the second group of T resistances, register R2 operating at each step. Balance is passed when the brushes reach the eighth terminals since S3 is of less resistance than the parallel resistance of the two T resistances of relays 5 and 6 associated with conductor 14. Polarized relay 18 thereupon releases, thus releasing relays 23 and 24. Relay 23 closes at its upper back contacts a shunt circuit for register magnet R2 thereby allowing magnet A to step the switch brushes ahead without operating register R2.

When the brushes are stepped to the ninth terminals, the third group of T resistances associated

with conductor 15 would ordinarily be connected in the bridge but since none of the associated trunks of this group are busy the T arm will be opened. Thus, the brushes are stepped to the thirteenth terminals without further operation of R2.

On the brushes reaching the thirteenth terminal relay 18 again operates, the S arm of the bridge being opened and low resistance 27 being inserted in the T arm. Thus relay 20 will now be held operated through the terminals and brush of bank A3 and contacts of relay 18. The brushes are thereupon stepped to the sixteenth terminal where relays 18 and 20 release. Relay 20, in releasing, opens the operating circuit for relay 22 and closes, at its upper back contact, an initial operating circuit for relay 21 through bank A5.

Relay 21 in operating (1) locks up to the back contacts of relay 11, (2) closes a circuit for the operation of register R1 and (3) closes an operating circuit for relay 22.

Relay 22 closes an operating circuit for magnet A through the back contacts of relay 20 and terminals and brush of bank A4. Thus relay 22 and magnet A cooperate to step the switches A1 to A6 to the first terminal again without again operating register R2. On reaching the first terminals the circuits shown on Fig. 1 are returned to normal.

If all the trunks are busy during a measuring interval, relay 23 remains operated until the thirteenth terminal is reached and relay 24 is thus held operated by relay 23 until the thirteenth terminal and by ground on the brush of bank A4 until the sixteenth terminal. On reaching the fifteenth terminal, therefore, brush A6 connects ground, from contacts of relay 20, through contacts of relay 24 to conductor 26. Thus for each interval when all the trunks are busy conductor 26 is momentarily grounded.

Relay 52 operates when conductor 26 is grounded and locks up on a circuit through its own contacts and contacts of stepping magnet B. Relay 52 also closes a circuit through magnet B and register magnet R3. R3 operates, stepping the register ahead one unit after which magnet B operates releasing relay 52. R3 and B thereupon are released stepping the brushes of B1 and B2 ahead one step.

At each time interval, measured by clock 10, magnet C operates as previously described to move its brushes ahead one step. On the tenth step, marking the end of ten time intervals, the brushes will reach the eleventh terminals. The brush of bank C3 will then connect ground through contacts of relays 51 and 53 to operate relay 54. Relay 54 operates when relay 51 releases closing operating circuits for relays 55 and 56 which operate and lock up to ground on brushes B2 and C2, respectively. Relays 55 and 56 close operating circuits for relays 52 and 50 and stepping magnets B and C, and connect shunts for register magnets R3 and R4 whereby the brushes of the stepping switches B and C are stepped around to their first terminals without operating the registers. On reaching the first terminals ground is removed from the holding circuits for relays 55 and 56 releasing them. Ordinarily, therefore, brushes of switches B and C start together on the first contact. Should all the trunks 1 to 9 remain busy during a testing cycle in which the brushes of switches B and C are stepped ahead from the first terminal for ten steps (if an interval is six seconds a cycle would

be one minute) the brushes of the banks B1 and C1 will cooperate to close a circuit to operate relay 53. Since slow release relay 51 has not yet released when the brushes complete the tenth step relay 53 will operate, lock up to the back contact of relay 55, and open the operating circuit for relay 54. When relay 51 releases, a circuit is closed from brush C3 through contacts of relays 51 and 53 to operate relay 57.

Relay 57 in operating (1) closes a circuit for alarm relay 58, (2) operates register R5 and (3) closes circuits for relays 55 and 56 to return the switches B and C to the first contacts.

Relay 58 lights alarm lamp 59 (other kinds of alarms or signals may be used instead of a lamp) and locks up under control of the operation of relay 54. Thus, lamp 59 will light and remain lighted for as many cycles as all trunks remain busy. Should any trunk become idle, magnet B will not step its brushes ahead as often as magnet C and thus relay 54 will operate on switch C making the tenth step of a cycle and release relay 58 extinguishing lamp 59.

The system, therefore, performs the following functions:

(1) Register R1 records the total number of time intervals during which the system has operated;

(2) Register R2 records the total number of trunks busy times the number of time intervals during which they are busy;

(3) Register R3 records the total number of time intervals in which all trunks are busy;

(4) Register R4 (like register R1) records the total number of time intervals;

(5) Register R5 records the total number of cycles in which all trunks have been found to be busy;

(6) Lamp 59 gives a visual signal to an attendant when all trunks are found to be busy during a measuring cycle.

What is claimed is:

1. In an electrical recorder, a system having a plurality of elements, timing means, means responsive thereto for periodically counting the number of elements in a given condition, means progressively affected by said counting means upon finding all of said elements in said given condition, a second means progressively affected by said timing means, a signal, both said progressively affected means cooperating to operate said signal upon each being affected a predetermined equal number of times.

2. In an electrical counting system, a plurality of contacts variously open and closed at different times, timing means, counting means responsive to said timing means to count the number of contacts closed at regular intervals, a stepping switch progressively moved one step at each of said regular intervals, a second stepping switch progressively moved one step at each of said regular intervals in which all of said contacts are closed, and a signal, said two stepping switches cooperating to operate said signal on both having moved a predetermined equal number of steps.

3. In an electrical counting system, a plurality of contacts variously open and closed at different times, timing means, counting means responsive to said timing means to count the number of contacts closed at regular intervals, a stepping switch progressively moved one step at each of said regular intervals, a second stepping switch progressively moved one step at each of said

regular intervals in which all of said contacts are closed, and a counting device, said two stepping switches cooperating to operate said device on both having moved a predetermined equal number of steps.

4. In combination, a system variously existing in a first condition and in other conditions at different times, timing means, testing means responsive thereto to determine the condition of said system at regular intervals, a first means progressively altered by said timing means at said regular intervals, a second means progressively altered by said testing means only at the regular intervals in which the system exists in said first condition, and a signal, the operation of said signal being initiated by said first and second means on both having been progressively altered a predetermined equal number of times.

5. In combination, a system variously existing in a first condition and in other conditions at different times, timing means, testing means responsive thereto to determine the condition of said system at regular intervals, a first means progressively altered by said timing means at said regular intervals, a second means progressively altered by said testing means only at the regular intervals in which the system exists in said first condition, and a counting device, the operation of said device being initiated by said first and second means on both having been progressively altered a predetermined equal number of times.

6. In combination, a system variously existing in a first condition and in other conditions at different times, timing means, testing means responsive thereto to determine the condition of said system at regular intervals, a first stepping switch, said timing means causing said switch to move one step ahead at each said regular interval, a second stepping switch, said testing means causing said second switch to move one step ahead at each said regular interval in which the system exists in said first condition, and a signal, said first and second switches cooperat-

ing to close a circuit for said signal on both having simultaneously reached predetermined corresponding contacts.

7. In combination, a system variously existing in a first condition and in other conditions at different times, timing means, testing means responsive thereto to determine the condition of said system at regular intervals, a first stepping switch, said timing means causing said switch to move one step ahead at each said regular interval, a second stepping switch, said testing means causing said second switch to move one step ahead at each said regular interval in which the system exists in said first condition, and a counting device, said first and second switches cooperating to close a circuit to operate said device on both having simultaneously reached predetermined corresponding contacts.

8. In a counting system, a plurality of telephone circuits, variously busy at different times, timing means, counting means responsive thereto to count the number of circuits busy at regular intervals, a first stepping switch moved ahead one step at each said interval, a second stepping switch moved ahead one step at each said interval in which all said circuits are busy, and a signal, said two stepping switches cooperating to initiate operation of said signal on both having moved a predetermined equal number of steps from their respective first terminals.

9. In a counting system, a plurality of telephone circuits variously busy at different times, timing means, counting means responsive thereto to count the number of circuits busy at regular intervals, a first stepping switch moved ahead one step at each said interval, a second stepping switch moved ahead one step at each said interval in which all said circuits are busy, and a counting device, said two stepping switches cooperating to initiate operation of said device on both having moved a predetermined equal number of steps from their respective first terminals.

SAMUEL B. WILLIAMS.