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ELECTRICAL RECORDER

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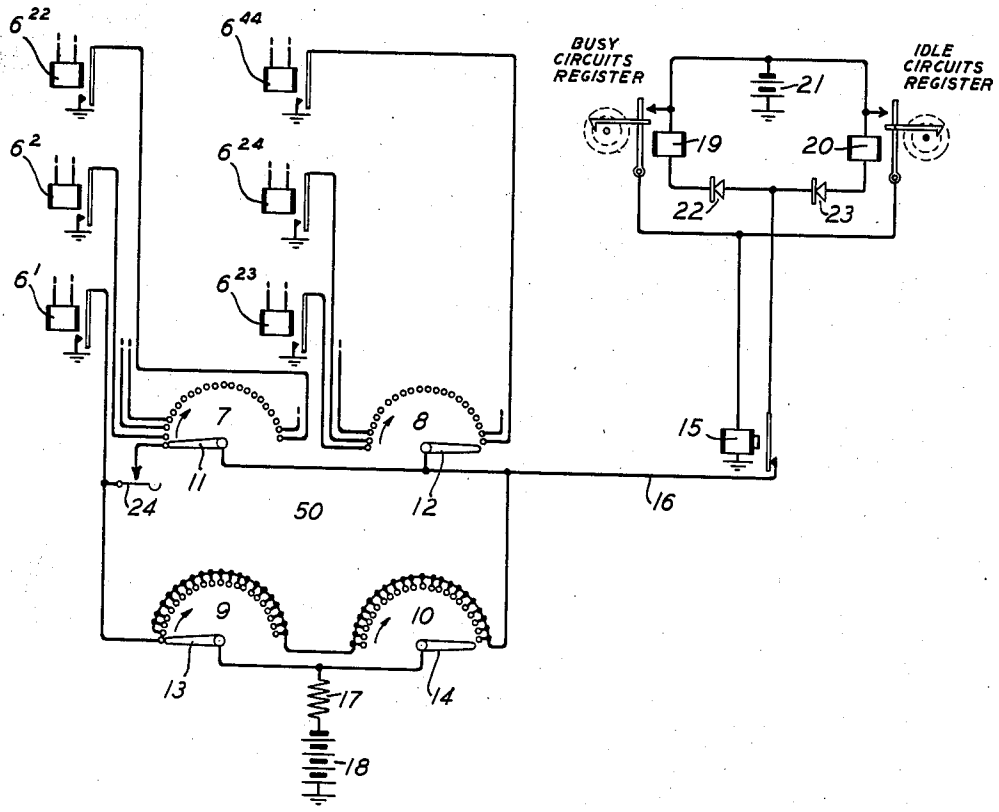

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ELECTRICAL RECORDER

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5 Claims. (Cl. 179—8)

This invention relates to electrical counting systems and more particularly to holding time recorders adapted for use in a telephone system.

In the operation and maintenance of telephone exchange systems it is necessary to obtain the holding time of a group of circuits as an adjunct in making traffic studies in order that a determination may be made as to the adequacy of the circuits to handle the traffic load. Heretofore it has been the practice to obtain the holding time of each circuit individually and from the individual records to compute the holding time of a group of circuits and thereby determine the adequacy of the group of circuits to handle the traffic load. It is the object of the present invention to provide facilities for obtaining the average holding time for a group of circuits with less apparatus and no more clerical effort than has heretofore been required.

In accordance with the present invention the holding time recorder for a group of forty-four circuits comprises a rotary step-by-step selector switch, a start key, two peg count registers and two oppositely poled copper oxide rectifiers. The selector switch when started by the operation of the start key successively tests the circuits of the group being observed and during each cycle thereof one of the registers will be operated once for each idle circuit tested and the other register will be operated once for each busy circuit tested. On successive cycles the two sets of idle and busy registrations will be added on the two registers. The sum of the registrations thus made, divided by 44, or the number of circuits tested during each cycle, will thus give the number of cycles made during the period of the observation or test. Since the selector switch will continue in operation so long as the start key is operated and will complete the last cycle after the key is released, by dividing the registration on the busy circuit register by the number of completed cycles, the average number of circuits which were busy during the observation period will be obtained. This figure multiplied by the elapsed time of the observation period and divided by the total number of calls made during the period, as indicated by the usual peg count register, will give the average holding time per call.

For a more complete understanding of the invention reference may be had to the following detailed description taken in connection with the drawing.

Each circuit to be tested for its busy or idle condition is represented by a relay 6 of which only six of the group of forty-four which may be tested by the single holding time recorder have been shown. When any one of the circuits is busy its corresponding relay 6 will be energized and will apply ground over its contacts to a terminal in either bank 7 or bank 8 of the rotary step-by-step selector switch 50.

The selector switch 50 is provided with a stepping magnet 15 and four wipers 11, 12, 13 and 14, the wipers 11 and 12 being both connected to conductor 16 and positioned 180 degrees apart on the switch shaft and the wipers 13 and 14 being both connected through resistance 17 to 48-volt battery 18 and similarly positioned 180 degrees apart on the switch shaft. As previously stated, the terminals of banks 7 and 8 with which wipers 11 and 12 are associated, are connected to contacts of the relays 6 and with the exception of the first terminal in bank 9, all of the terminals of banks 9 and 10 are strapped together and connected to conductor 16.

Two peg count registers 19 and 20 are provided, the register 19, which functions to count the number of circuits found to be busy, being connected in a circuit from 24-volt battery 21 through the copper oxide rectifier 22 and the back contact of stepping magnet 15 to conductor 16 and the register 20, which functions to count the number of circuits found to be idle, being connected in a circuit from 24-volt battery 21 through copper oxide rectifier 23 and the back contact of stepping magnet 15 to conductor 16. Either register upon operating establishes over its armature contacts an operating circuit for the stepping magnet 15.

Normally, the switch 50 is at rest with its wipers standing in the positions illustrated. To start a test a reading is first taken from each of the registers 19 and 20 and the key 24 is operated. It will be assumed that the first circuit of the group to be observed is busy as indicated by the operated condition of relay 6'. Upon the operation of key 24 a circuit is established over which current tends to flow from the positive or grounded terminals of the central office batteries 18 and 21, over the contacts of the operated relay 6', contacts of key 24, the first terminal of bank 7 and wiper 11 engaged therewith, conductor 16, back contact of magnet 15 to a point between the rectifiers 22 and 23, and thence in parallel through rectifier 22 and winding of register 19 and through rectifier 23 and winding of register 20 to the negative terminal of 24-volt battery 21. Rectifier 22 is so poled as to offer a low resistance to the flow of current over the branch of the circuit traced therethrough and consequently the busy register 19 is operated, but since rectifier 23 is poled op-

positely and therefore offers a high resistance to the flow of current over the branch of the circuit traced therethrough, the idle register 20 is not operated at this time.

The operation of key 24 also establishes a second circuit over which current tends to flow from the positive or grounded terminal of 24-volt battery 21, through battery 21, thence in parallel through the winding of register 19 and rectifier 22 and through the winding of register 20 and rectifier 23, thence over the back contact of magnet 15, conductor 16, wiper 11 and the first terminal of bank 7 with which it is in engagement, contacts of key 24, the first terminal of bank 9 and wiper 13 engaged therewith, through resistance 17 and the 48-volt battery 18 to ground, but since the relay 6' of the circuit under observation has been assumed to be operated, battery 18 is shunted by the connection of ground over wiper 13 and therefore no effective current flows over the second circuit.

Register 19 upon operating makes a registration of the fact that the first circuit tested is busy and closes its contacts thereby establishing an operating circuit for stepping magnet 15 extending from battery 21 over the contacts of register 19 to ground through the winding of magnet 15. Magnet 15 thereupon operates preparatory to advancing the wipers of switch 50 and opens its back contact thereby releasing the operated register 19 which in turn opens the operating circuit of magnet 15. Magnet 15 upon releasing now advances the wipers of switch 50 one step, in which position wiper 11 engages a terminal of its bank connected to the contacts of relay 6^2 of the second circuit under observation.

It will now be assumed that the second circuit is also busy as indicated by the operated condition of its associated relay 6^2. The first circuit above traced is now established and current flows from ground over the contacts of relay 6^2, the second terminal of bank 7 and wiper 11 in engagement therewith, and thence through rectifier 22 and the winding of register 19 to the negative terminal of 24-volt battery 21, again operating register 19. The second circuit above traced is also reestablished, but at this time from battery 21, as traced to conductor 16, thence over the strapped terminals of banks 10 and 9, wiper 13 in engagement with the second terminal of bank 9, through resistance 17 and battery 18. This circuit is, however, ineffective since with relay 6^2 operated, battery 18 is shunted by ground applied over the contacts of relay 6^2, wiper 11, conductor 16, terminal of bank 9 and wiper 13. Register 19 upon operating registers the fact that the second circuit tested is busy and again causes the operation of magnet 15 which opens the operating circuit of register 19 and thereby causes the release of magnet 15 and the advance of the wipers of switch 50 another step. Wiper 11 now engages a terminal of its bank 7 connected to the contacts of the relay (not shown), corresponding to relay 6^2, of the third circuit under observation.

It will be assumed that all of the succeeding circuits up to and including the twenty-first circuit are busy and that in the manner previously described, the switch 50 is advanced step by step to test these circuits and to register their busy condition on the busy register 19. When the switch has thus been advanced to position wipers 11 and 13 on the twenty-second terminals of their respective banks 7 and 9, a test is made to determine the busy or idle condition of the twenty-second circuit, the relay 6^{22} of which is disclosed. It will now be assumed that this circuit is idle and that therefore relay 6^{22} is not operated. The first circuit above traced extending over wiper 11, conductor 16 and thence in parallel through the windings of registers 19 and 20 to the negative terminal of 24-volt battery 21, is not now effective since no ground is connected to the twenty-second terminal of bank 7 with which wiper 11 is now engaged and therefore register 19 does not operate.

The second circuit above traced is effective, however, since the 48-volt battery 18 is not now shunted by ground over wiper 11 and contacts of relay 6^{22} and current therefore flows from the positive or grounded terminal of battery 21, through battery 21, winding of register 20 and rectifier 23 and in parallel through the winding of register 19 and rectifier 22, back contact of magnet 15, conductor 16, bank terminals of banks 10 and 9, wiper 13 engaged with the twenty-second terminal of bank 9, through resistance 17 and battery 18 to ground. Rectifier 23 is so poled as to offer a low resistance to the passage of current over the branch of the circuit extending through the winding of register 20 and register 20 operates, but rectifier 22 now offers a high resistance to the passage of current over the branch of the circuit extending through the winding of register 19 and register 19 does not operate. Register 20 upon operating, registers the fact that the twenty-second circuit under test is idle and at its contacts establishes the operating circuit of magnet 15. Magnet 15 now operates preparatory to advancing the wipers of switch 50 and at its contacts opens the operating circuit of register 20 which thereupon releases and opens the operating circuit of magnet 15. Magnet 15 upon releasing now advances the wipers of switch 50 one step. Wipers 12 and 14 now engage the first terminals of their respective banks 8 and 10 in which position a test is made for the busy or idle condition of the circuit represented by relay 6^{23}.

In a similar manner, circuits twenty-three to forty-four inclusive are tested in succession, wipers 11 and 13 being advanced into engagement with the first terminals of their banks after the forty-fourth circuit, represented by relay 6^{44}, has been tested. The recorder will now have completed one cycle of operation and if the key 24 is still operated, a second cycle of operation will be started during which the forty-four circuits will again be tested. If during any cycle the start key 24 is released, the switch 50 continues to advance to complete the cycle, but will come to rest when its wiper 11 engages the first terminal of its bank. With key 24 released, no testing circuit will be completed through either register 19 or register 20 and consequently the circuit of stepping magnet 15 will not be closed to further advance the wipers of switch 50.

To compute the average holding time for each call initiated over the circuits under observation it will be assumed as an example, that at the beginning of the observation period the reading taken of the busy register 19 and idle register 20 are 1536 and 1421, respectively, and that at the end of the observation period the readings are 2031 and 1586, respectively. The busy register 19 will have therefore registered 495 busy circuits and the idle register 20 will have registered 165 idle circuits, or the sum of the advance of the two registers will be 660 indicating that 660 circuit tests have been made. Since the recording circuit tests 44 circuits during each

cycle thereof, by dividing 660 by 44 it follows that the recording circuit will have completed 15 cycles. During the testing period the busy register has recorded, as assumed, 495 busy circuit conditions and thus by dividing this registration by the number of completed cycles, or 15, it is thereby determined that an average of 33 circuits were found to be busy during the observation period. If it now be assumed that the elapsed time of the observation period was 55 seconds and that during that period the regular peg count register (not shown) has indicated that fifteen calls have been initiated, then the elapsed average holding time for each call may be computed by multiplying the average number of circuits busy during the observation period, or 33, by the elapsed time or 55 seconds, and dividing the product by 15, or the number of calls initiated, thus giving an average holding time of 121 seconds per call.

The formula by which the holding time H can be computed is derived as follows:

Let n=number of circuits to be observed
t=elapsed time of observation
f=number of cycles performed by the recorder
B=number of busy circuits observed
I=number of idle circuits observed
A=average number of circuits busy during the observation period
C=number of calls initiated during the observation period
H=average holding time.

(1) Then

$$\frac{B+I}{n}=f$$

(2) $$\frac{B}{f}=A$$

(3) $$\frac{tA}{C}=H$$

(4) and substituting (2) into (3)

$$H=\frac{\frac{tB}{f}}{C}=\frac{tB}{fC}$$

and again substituting (1) into (4)

$$H=\frac{tB}{\frac{(B+I)C}{n}} \text{ or } H=\frac{tBn}{C(B+I)}$$

In the foregoing discussion a group of forty-four circuits was assumed. If, however, there are less than forty-four circuits in the group, terminals of the banks 7 and 8 not associated with circuits may be left vacant in which case the idle register 20 will be operated each time one of the wipers 11 or 12 engages a vacant terminal, but the method of obtaining the holding time will be unchanged. If only twenty-two or less circuits are to be observed they may be multiplied to corresponding terminals of banks 7 and 8 in which case the circuits would be tested twice per cycle which is an advantage since the smaller the group the greater is the percentage difference caused by one call more or less. If more than forty-four circuits are to be observed as a group, either two separate recorder circuits, one for each group of forty-four circuits may be employed, or the capacity of the recorder may be doubled by the addition of banks and wipers and suitable switching equipment.

What is claimed is:

1. In a traffic recorder for recording the traffic conditions in a group of circuits, a selector switch for successively testing the idle or busy condition of said circuits, a register for counting the number of idle circuits tested, a register for counting the number of busy circuits tested, an operating circuit for said registers extending through their windings in parallel and over the test wiper of said switch, means for selectively operating said registers in accordance with the idle or busy condition of the circuits tested, and a stepping circuit for said switch controlled by the operation of either one of said registers.

2. In a traffic recorder for recording the traffic conditions in a group of circuits, a selector switch for successively testing the idle or busy condition of said circuits, a register for counting the number of idle circuits tested, a register for counting the number of busy circuits tested, a polarizing device connected in series with the winding of each of said registers, an operating circuit for said registers extending over the test wiper of said switch and thence by parallel paths through the windings of said registers and serially connected polarizing devices whereby said registers are selectively operated in accordance with the idle or busy condition of the circuits tested, and a stepping circuit for said switch controlled by the operation of either one of said registers.

3. In a traffic recorder for recording the traffic conditions in a group of circuits, a selector switch for successively testing the idle or busy condition of said circuits, a register for counting the number of idle circuits tested, a rectifier connected in series with the winding thereof, a register for counting the number of busy circuits tested, an oppositely poled rectifier connected in series with the winding of said second register, an operating circuit for said registers extending over the test wiper of said switch and thence by parallel paths through the windings of said registers and serially connected rectifiers whereby said registers are selectively operated in accordance with the idle or busy condition of the circuits tested, and a stepping circuit for said switch controlled by the operation of either one of said registers.

4. In a traffic recorder for recording the traffic conditions in a group of circuits, the idle condition of any circuit being signified by an open-circuit condition on its test terminal and the busy condition being signified by ground on its test terminal, a selector switch for successively testing the test terminals of said circuits, a first register for counting the number of idle circuits tested, a rectifier connected in series with the winding thereof, a register for counting the number of busy circuits tested, an oppositely poled rectifier connected in series with the winding of said second register, an operating circuit for said registers including oppositely poled batteries of different potential and extending by parallel paths through the windings of said registers and serially connected rectifiers, a shunt circuit for one of said batteries extending over the test wiper of said switch, the non-completion or completion of which in each position of said selector switch, in accordance with the idle or busy condition of the circuit being tested, causes the operation of said first or said second register, and a stepping circuit for said switch controlled by the operation of either one of said registers.

5. In a traffic recorder for recording the traffic conditions in a group of circuits, a selector switch for successively testing the idle or busy condition of said circuits during each operating cycle

thereof, a register for counting the number of idle circuits tested, a register for counting the number of circuits tested, means for selectively operating said registers in accordance with the idle or busy condition of the circuits tested, a stepping circuit for said switch controlled by the operation of either one of said registers, and a start key operative to initiate the advance of said switch and to cause said switch to advance through one or more complete cycles so long as key is maintained operated.

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