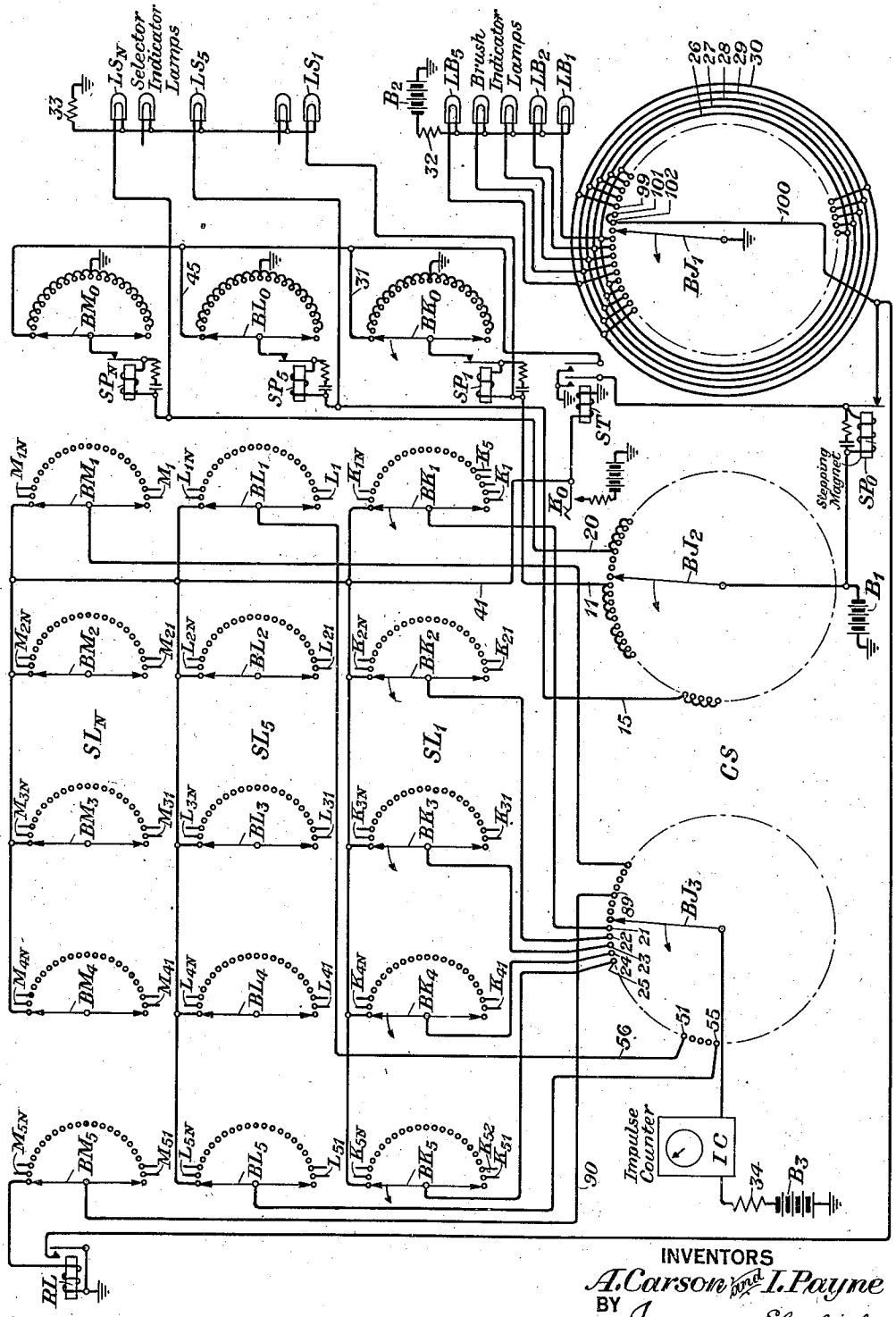
Aug. 28, 1945. A. CARSON ET AL 2,383,770

ELECTRICAL MEASURING SYSTEM

Filed Nov. 7, 1942



Patented Aug. 28, 1945 2,383,770

UNITED STATES PATENT OFFICE

2,383,770

ELECTRICAL MEASURING SYSTEM

Arthur Carson and Irving Payne, Richmond, Va., assignors to American Telephone and Telegraph Company, a corporation of New York

Application November 7, 1942, Serial No. 464,914

5 Claims. (Cl. 179—175.2)

This invention relates to electrical counting and testing systems and is particularly suitable for telephone and like systems which employ a large number of lines or circuits many of which may be in use at the same time.

In telephone and electrical systems generally and more particularly in systems of the telephone exchange type where a large number of lines or circuits are employed for purposes of communication, many of which are in use at the same time, it is necessary to ascertain at intervals how many of the various lines or circuits are in use at any one time. It has previously been the practice to send a number of attendants through the plant to observe how many of the switches associated with the various lines or circuits are in their operative positions. This practice furnishes information that is quite inaccurate, requires considerable personnel and is otherwise unsatisfactory.

In order to improve this situation an integrating system of a type disclosed in this application has been proposed by which it is possible to determine within a very brief interval of time how many of the various lines or circuits in a telephone or other system are operated or busy at substantially the same time. The apparatus of this invention may therefore be employed to indicate traffic conditions over many hundreds of lines or circuits.

In its more general aspects the invention comprises a master selector, a plurality of other selectors all of which are of the rotary type and a counter for indicating how many of the various lines or circuits have a predetermined electrical condition, as for example, a grounded condition. As is well known, such a condition develops when a telephone line becomes busy. Each of the selectors controlled by the master selector includes a brush and a plurality of contacts to which are connected a plurality of the lines or circuits to be tested or examined. The master selector is operated step-by-step and connects the counter to the brushes of the other selectors. The apparatus is arranged so that with each step-by-step operation of the master selector the other selectors are operated one by one in regular order. Thus the various lines or circuits connected to the various selectors will be connected one by one through the master selector to the counter, and the counter will register each time it is connected to a line or circuit exhibiting a predetermined electrical condition of, for example, ground.

This invention will be better understood from the more detailed description hereinafter following when read in connection with the accompanying drawing showing one embodiment of the invention merely for the purpose of illustration.

Referring to the drawing the master or control selector is designated CS and it comprises three brushes BJ_1, BJ_2 and BJ_3, all mounted on a common shaft. This master or control selector CS will be employed to control the operation of a plurality of additional selectors such as SL_1, SL_5 and SL_n, SL_1 being the first of the selectors controlled by the master selector CS, the selector SL_n the last of the selectors so controlled and SL_5 one of the intermediate selectors. The selectors SL_1, SL_5 and SL_n each comprise six brushes BK_0 to BK_5, BL_0 to BL_5, and BM_0 to BM_5, respectively, all of the six brushes of each selector being mounted on a common shaft so as to rotate in unison. Each of these brushes moves over a segment or arc in a well-known manner.

The brush BK_0 and its associated segment at the extreme right of the selector SL_1, for example, are employed to start the selector SL_1 in operation, while the other brushes BK_1 to BK_5 may be rotated so as to contact each of a plurality of lines or circuits, the lines K_1 to K_{1n} being contacted by brush BK_1, lines K_{21} to K_{2n} being contacted by brush BK_2, lines K_{31} to K_{3n} being contacted by brush BK_3, lines K_{41} to K_{4n} being contacted by brush BK_4 and lines K_{51} to K_{5n} being contacted by brush BK_5. The brushes of the other selectors are likewise connected to similar groups of lines or circuits.

The master or control selector CS and the additional selectors SL_1, SL_5 and SL_n are shown in their initial or starting positions. Brush BJ_2 of the control selector CS will contact a plurality of terminals which are arranged in groups of five, the first five terminals being connected by a conductor 11 to a stepping magnet SP_1, which is in turn connected to the brush BK_0 of the selector SL_1. Another or intermediate group of five terminals may be contacted by brush BJ_2 at a subsequent time, whereupon brush BJ_2 will be connected through a conductor 15 to the stepping magnet SP_5 which is wired to the brush BL_0 for starting the selector SL_5. Likewise a subsequent group of terminals are wired through a conductor 20 to the stepping magnet SP_n and brush BM_0 of the last selector SL_n. The brush BJ_2 may, therefore, be considered as the one which controls the starting and stepping action of the various selectors SL_1 to SL_n.

The brush BJ_3 of the master or control selector CS has its first five terminals, **21**, **22**, **23**, **24** and **25** connected respectively to the brushes BK_1, BK_2, BK_3, BK_4 and BK_5 of the first selector SL_1. Similarly two other groups of five terminals are wired to corresponding brushes of the other selectors SL_5 and SL_m as shown. The brush BJ_3 is also connected to an impulse counter IC so that as the brush BK_1, for example, of selector SL_1 contacts the various circuits K_1 to K_{1n}, a grounded condition on each of these circuits will cause the impulse counter IC to register the grounded condition, as will be explained hereinafter. The impulse counter IC will, therefore, indicate how many of these circuits are grounded, i. e., are busy. Thus the brush BJ_3 may be considered as the one employed for selecting the various brushes of the different selectors SL_1 to SL_m one at a time to register at the impulse counter IC the number of busy circuits contacted by the various brushes of the selectors.

The brush BJ_1 of the master or control selector CS will contact a plurality of terminals which are arranged in groups of five as are the other two brushes BJ_2 and BJ_3. The first terminals of each of these various groups are wired together by a conductor **26** and are connected in common to the lamp LB_1. Likewise the conductors **27** to **30** connect the other terminals of these groups to the lamps LB_2 to LB_5, as shown in the drawing. The brush BJ_1 may, therefore, be considered as that one which controls the illumination of one of the lamps LB_1 to LB_5, thereby indicating to the operator which one of the various brushes such as BK_1 of a particular selector such as SL_1 is being utilized in the counting process at a particular time. Another group of lamps LS_1 to LS_n is connected respectively to the various stepping magnets such as SP_1 to SP_n and these are illuminated when the respective stepping magnets are operated. These lamps indicate which of the various selectors SL_1 to SL_m are in operation.

The method of operation of the apparatus shown in the drawing is as follows: The operator will operate the key K_o momentarily. This will close an obvious circuit through a starting magnet ST which will become energized. The operation of the starting magnet ST will cause the stepping magnet SP_o of the master or control selector CS to become operated, the operating circuit including battery B_1, the winding of stepping magnet SP_o, the inner armature and make contact of starting magnet ST and ground. Upon the operation of the stepping magnet SP_o the brushes BJ_1, BJ_2 and BJ_3 of the control selector CS will be stepped in unison in a counter-clockwise direction through one step in a well known manner. When the brush BJ_2 contacts its first terminal, it will cause the operation of the stepping magnet SP_1 which controls the selector SL_1, the interconnected circuit including battery B_1, brush BJ_2, conductor **11**, the winding of the stepping magnet SP_1 and its armature and back contact, the brush BK_o, conductor **31**, the outer armature and make contact of starting magnet ST and ground. The stepping magnet SP_1, therefore, will step all of the brushes BK_o to BK_5 of selector SL_1 in a counter-clockwise direction through one step. At the same time the lamp LB_1 will become illuminated, the circuit for lamp LB_1 including battery B_2, resistor **32**, lamp LB_1, brush BJ_1 and ground. Lamp LB_1 will, therefore, indicate that the apparatus is proceeding to count the number of grounded or busy circuits connected to the terminals of the first testing arc of one of the switches, as for example, the circuits numbered K_1 to K_{1n}. Moreover, the lamp LS_1 will also become illuminated, the interconnecting circuit including battery B_1, brush BJ_2 of selector CS, conductor **11**, lamp LS_1, resistor **33** and ground. The lamp LS_1 will, therefore, indicate that the first selector SL_1 is in operation.

Immediately after the stepping magnet SP_1 of selector SL_1 operates, it breaks its own circuit established through its armature and back contact. However, this stepping magnet will be re-energized over a circuit which is completed through the other terminals of the first arc or segment of selector SL_1 which are connected together and grounded. Thus the circuit then established over stepping magnet SP_1 will include battery B_1, brush BJ_2, conductor **11**, the winding of magnet SP_1 and its armature and back contact, brush BK_o and the first contact of brush BK_o, together with the other contacts connected thereto and ground. Thus the stepping magnet SP_1 will be re-operated, thereby allowing the various brushes BQ_o to BK_5 to rotate through the rest of their arcs or segments.

As the brush BK_1 of selector SL_1 traverses the rest of its arc or segment, for example, it will contact the various lines or circuits K_1 to K_{1n} in regular progression. If, for example, the first of these circuits K_1 is grounded, the impulse counter IC will become operated, the operating circuit including battery B_3, resistor **34**, impulse counter IC, brush BJ_3 of selector CS, contact **21**, brush BK_1 and line K_1, which is now grounded. Each of the other lines K_2 to K_{1n} will be progressively contacted by brush BK_1, each such contact being of but a momentary duration, yet long enough to allow the impulse counter IC to register a grounded condition if such exists. The impulse counter IC will, therefore, register in an integrated form the number of lines of circuits which are busy.

When the brushes BK_o to BK_5 of selector SL_1 reach their last contact—which corresponds to the contact closed by these brushes when the selector SL_1 is back in its starting position, as shown in the drawing—the starting magnet ST will become re-operated. The new circuit for starting magnet ST includes the winding of starting magnet ST, the conductor **41**, the brush BK_1 of selector SL_1, contact **21** and brush BJ_3 of selector CS, impulse counter IC, resistor **34**, battery B_3 and ground. Although the starting magnet ST is re-operated by the completion of this circuit, the impulse counter IC will remain unoperated because of the large resistance present in the winding of relay ST. As the starting magnet ST becomes re-operated, it will again cause the re-operation of the stepping magnets SP_o and SP_1. The circuit for the magnet SP_o includes battery B_1, the winding of magnet SP_o, the inner armature and make contact of starting magnet ST and ground. The operated circuit for the magnet SP_1 will include battery B_1, brush BJ_2, conductor **11**, stepping magnet SP_1, brush BK_o, conductor **31**, the outer armature and make contact of starting magnet ST and ground. The stepping magnet SP_o will step the brushes BJ_1 to BJ_3 of selector CS to their next or second contacts in a counter-clockwise direction. Also the stepping magnet SP_1 will step the brushes BK_o to BK_5 of selector SL_1 to their first contacts as before. The stepping magnet SP_1 will then become re-operated, as already explained hereinabove. But as the brush BJ_1 leaves its

first contact it causes the lamp LB_1 to become extinguished. But upon closure of its second contact, brush BJ_1 causes the lamp LB_2 to become illuminated to indicate to the operator that the circuits connected to the second brush BJ_2 of the selector SL_1—which corresponds to lamp LB_2—is being driven over the contacts connected to lines K_{21} to K_{2n} for the testing or measurement of the condition of these lines. As the brush BK_2 contacts these various lines, any grounded condition encountered by the brush BK_2 will cause the impulse counter to operate and register that condition in integrated form as already explained. It is to be noted, of course, that the starting magnet ST will become released each time that the brushes BK_1 to BK_5 have left their starting positions. Moreover, as soon as the starting magnet ST becomes released, the stepping magnet SP_0 of the master or control selector CS will also become released.

The selector SL_1 will, therefore, be successively operated to allow its brushes BK_0 to BK_5 to sweep over their arcs a predetermined number of times. The apparatus is shown set up so that the brushes BK_0 to BK_5 will sweep over their arcs five times in succession. Each sweep will be utilized to effectively contact only the lines, such as K_1 to K_{1n} associated with but one of these arcs. It will be noted also that the five successive operations of selector SL_1 accompany five successive steps of the master selector CS. In setting up the apparatus the relays SP_0 and SP_1 to SP_5 should be so adjusted that the latter relays are somewhat slower to operate than relay SP_0 to insure the stepping of selector CS before the other selectors SL_1 to SL_n are stepped. Moreover, it is also necessary to have the testing brushes BK_1 to BK_5 of the non-bridging type to provide a momentary open-circuit condition to release the impulse counter IC when stepping from one busy terminal to another.

Upon reaching the last (or starting) contact of the selector SL_1 after its fifth cycle of operation, the starting magnet ST will become reoperated over the circuit including the winding of magnet ST, conductor **41**, brush BK_5, contact **25** and brush BJ_3 of selector CS, the impulse counter IC, resistor R_{34}, battery B_3 and ground. As the starting magnet ST becomes re-energized, the stepping magnet SP_0 of selector CS will also become re-operated. It may be assumed that the brush BJ_3 of selector CS has reached the contact **51** of the third arc of the selector and that brushes BJ_1 and BJ_2 have also reached corresponding positions. Upon the closure of contact **51** the stepping magnet SP_5 of selector SL_5 will become operated, the operating circuit including battery B_1, brush BJ_2, conductor **15**, stepping magnet SP_5 and its armature and back contact, brush BL_0, conductor **45**, the outer armature and make contact of starting magnet ST and ground. The brushes BL_0 to BL_5 of selector SL_5 will now be rotated in a counter-clockwise direction, as already described with regard to selector SL_1. As the brush BL_1 progressively contacts the circuits L_1 to L_{1n}, the impulse counter IS—which is connected through brush BJ_3, contact **51** and conductor **56** to brush BL_1—will allow the impulse counter IC to integrate into the previous record the number of grounded circuits encountered by the brush BL_1. Thereafter the stepping magnet ST will be reoperated a number of additional times to re-operate the stepping magnet SP_0 of the master selector CS a corresponding number of times so as to step the brushes BJ_1 to BJ_3 in a counter-clockwise direction. Each operation of the stepping magnet SP_0 will be accompanied by the re-operation of the stepping magnet SP_5 and the rotation of the brushes BL_0 to BL_5 over their corresponding arcs. Likewise selector SL_n will become operated thereafter a number of times to measure the number of grounded circuits M_1 to M_{1n} encountered by brush BM_1 and by the other brushes BM_2 to BM_5 of the selector SL_n. This need not be further described as it is in all respects similar to the description already given.

When the brushes BM_0 to BM_5 reach their last or starting contact in the last cycle of their operations, the brush BJ_1 of selector CS will contact terminal **99**, the other brushes BJ_2 and BJ_3, of course, being in corresponding positions. The relay RL will then be operated over a circuit which includes battery B_3, resistor **34**, counter IC, brush BJ_3 and contact **89** of selector CS, conductor **90**, brush BM_5 of selector SL_n, the winding of relay RL and ground. Thereupon stepping magnet SP_0 will become operated over a circuit which includes battery B_1, the winding of magnet SP_0, the armature and make contact of relay RL and ground. This will step selector CS to the position where brush BJ_1 closes contact **101**. When this happens, relay RL will be released. The stepping magnet SP_0 will be re-operated to step brush BJ_1 to contact **102**, the interconnected circuit including battery B_1, magnet SP_0, conductor **100**, contact **101**, brush BJ_1 and ground. As brush BJ_1 reaches contact **102**, the magnet SP_0 will be reoperated over a similar circuit to return the brushes BJ_1 to BJ_3 to their initial or starting positions, as represented in the drawing.

The operator will read his impulse counter IC and promptly determine how many of the numerous lines or circuits, such as K_1, are in grounded or busy condition. The operation is automatic and the record is accurate. The time required for this operation is quite small. The operator may press his key K_0 at other times of the day to obtain similar records of the circuit condition at those times. If he so desires, he may connect his key K_0 to a clock-controlled circuit of well-known type to obtain records of traffic conditions at regular or predetermined intervals during the day.

The operator is able to determine upon inspection of the lamps LS_1 to LS_n which particular selector is in operation. At the same time the lamps LB_1 to LB_5 will indicate to the operator which of the brushes of the operating selector is contacting the lines that are associated with it to determine their electrical condition.

Although the apparatus disclosed hereinabove is intended to operate rapidly to determine the number of circuits or lines that are grounded or busy, the operating time factor may be changed as may be desired. Rotary selectors of the type disclosed may be slowed down substantially by adjustments of their operating mechanism. Where readings of meter IC are required after any one selector, such as SL_1, has operated, the apparatus may be slowed down sufficiently so that the operator may observe from lamp LS_1 (as well as lamps LB_1—LB_5) when selector SL_1 has ended its cycle and then record the number of busy or grounded circuits or lines as indicated by meter IC. This is a feature of the apparatus in that it permits the operator to determine the number of busy lines connected to any one selector, or to any brush of any selector. The lamp LB_1, when il-

luminated with lamp LS_1, provides indicating means to apprise the operator when brush BK_1 has started and ended its portion of the cycle of selector SL_1.

In a telephone office it may be desired to connect all of the lines or circuits of one type to one of the selectors and other lines or circuits of a different type to another selector, and so on. The apparatus of this invention permits the operator, aided by lamps LB_1—LB_5 and lamps LS_1—LS_n, to determine how many of the lines or circuits of each type are busy or grounded and to do so promptly.

Although this invention has been described in regard to the determination of the number of lines or circuits, such as K_1, K_2, etc., that are grounded, the apparatus may also be employed for measuring any other electrical condition of the lines or circuits. For example, the apparatus may be employed to determine the number of circuits which are impressed with voltages of a predetermined or excessive value, or to determine how many have a capacitance which differs from a predetermined magnitude, or to determine the number having any other resistive or reactive property.

Although this invention has been described as employing rotary selectors which step with each operation of their stepping magnets, it will be understood that this invention may also employ selectors of the rotary or other types which step with each release of their stepping magnets, as will be well understood in the art.

While this invention has been shown and described in certain particular arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a measuring system for measuring the number of lines which exhibit a predetermined electrical condition, the combination of a master rotary selector, a plurality of auxiliary rotary selectors each having a plurality of contacts to each of which one of the lines is connected, means to operate said master selector step-by-step in regular order, means responsive to the step-by-step operation of the master selector to separately operate said auxiliary selectors in progression so that the lines connected to said auxiliary selectors may be contacted one at a time, an impulse counter, and means for directly connecting said counter through the master selector to the auxiliary selectors, said counter being operated whenever said predetermined electrical condition is encountered on any line to which it is connected, thereby to indicate how many of said lines exhibit said predetermined electrical condition.

2. A traffic counter for a plurality of lines which may carry currents, comprising a master rotary selector, a plurality of auxiliary rotary selectors each of which includes a plurality of brushes mounted on a common shaft and a corresponding number of arcs over which said brushes may rotate, the arcs of each auxiliary selector having a plurality of contacts to which a group of said lines are connected, means to operate the master selector step-by-step, means responsive to the step-by-step operation of the master selector to progressively operate the various auxiliary selectors, said means including means to operate each auxiliary selector a predetermined number of times which corresponds to the number of arcs in said selector, a counter, and means to directly connect said counter to the various arcs of the auxiliary selectors one at a time so that the counter may indicate the number of lines which exhibit a predetermined electrical condition.

3. In a counting apparatus for counting the number of lines which exhibit a predetermined electrical condition, comprising a master selector of the rotary type, a plurality of auxiliary selectors of the rotary type, each auxiliary selector having a plurality of brushes rotatable about a common shaft, each brush being movable over an arc, each arc having a plurality of contacts to which a different group of said lines are connected, means to operate the master selector step-by-step, means responsive to the step-by-step operation of the master selector to separately operate the auxiliary selectors in progression, said means including means to successively operate each auxiliary selector a predetermined number of times which correspond to the number of arcs in said selector before the next succeeding selector is operated, a counter, and means to directly connect said counter progressively to the various arcs of each selector to indicate and record the number of lines exhibiting the predetermined electrical condition.

4. Traffic counting apparatus for a plurality of lines which may carry current and become grounded when they do carry current, comprising a master rotary selector, means for operating said master rotary selector step-by-step a plurality of auxiliary rotary selectors each having a plurality of brushes rotatable in unison about a common shaft, each brush being movable over an arc which has a plurality of contacts to which a number of said lines are connected, means controlled by said master rotary selector for separately operating said auxiliary selectors in a predetermined order, said means including means for successively operating each auxiliary selector a predetermined number of times before the next auxiliary selector is operated, a counter, and means to directly connect each counter to the various brushes of each auxiliary selector in a predetermined order whereby the counter will determine integrally the number of lines which are grounded.

5. Traffic measuring and indicating apparatus for a plurality of lines which may at times exhibit a predetermined electrical condition, comprising a plurality of rotary selectors each including a plurality of brushes mounted on a common shaft so that they may rotate in unison, each brush being movable about an arc having a plurality of contacts to each of which one of said lines is connected, means to operate said selectors successively, said means including means for successively rotating the brushes of each operated selector over their arcs a predetermined number of times, said brushes being rotated successively over said arcs a number of times which correspond to the number of arcs in said selector, counting apparatus, means for separately connecting said counting apparatus to each of the various brushes of each selector, means for indicating which of the selectors is being operated, and further means for indicating which brush of any one selector is connected to said counting apparatus.

ARTHUR CARSON.
IRVING PAYNE.