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ELECTRICAL MEASURING SYSTEM

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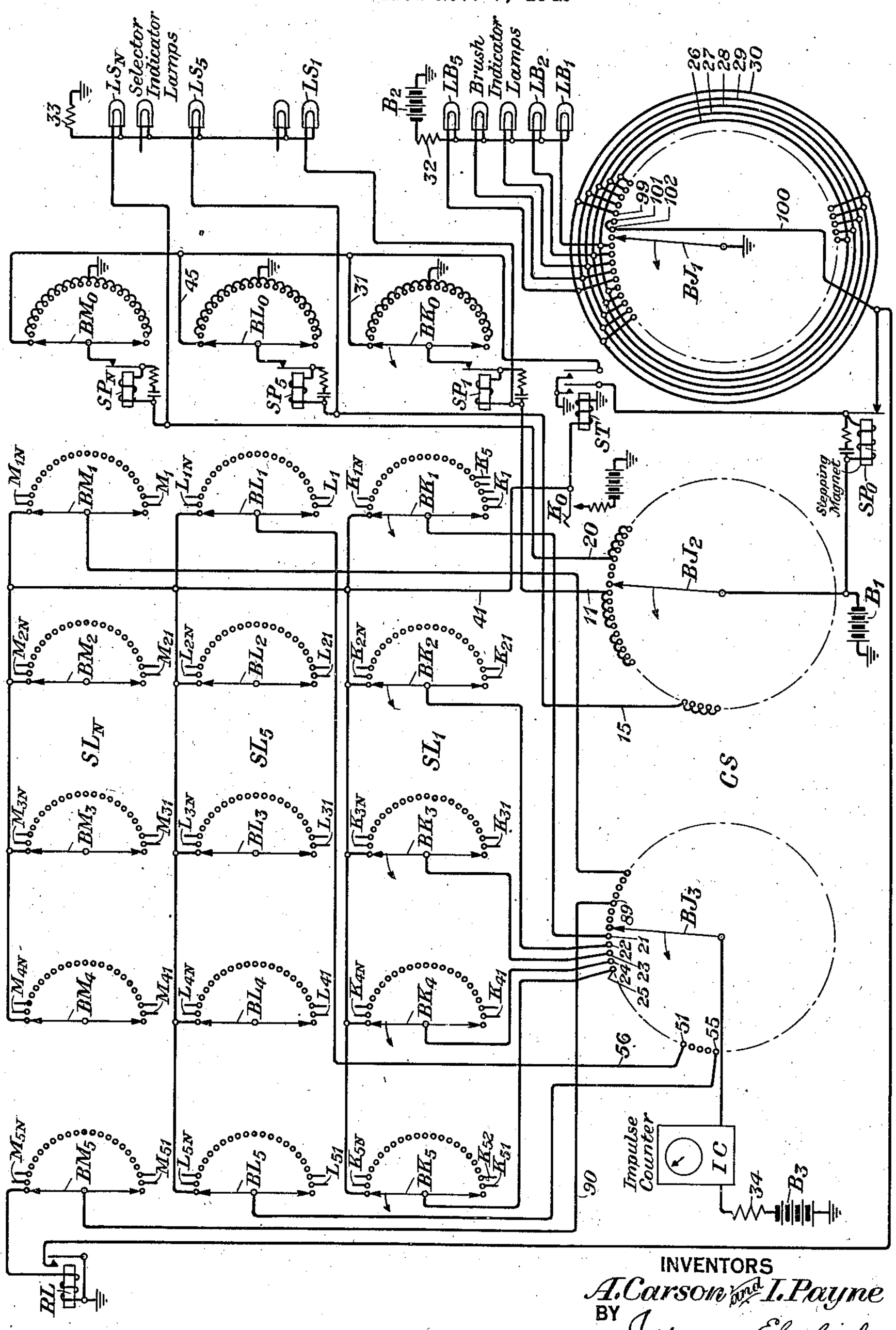


INVENTORS

A. Carson and I. Payne

BY Jefferson Ehrlich

ATTORNEY

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## ELECTRICAL MEASURING SYSTEM

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

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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 $SP_o$ of the master or control selector CS will also become released.

The selector $SL_1$ will, therefore, be successively operated to allow its brushes $BK_o$ to $BK_5$ to sweep over their arcs a predetermined number of times. The apparatus is shown set up so that the brushes $BK_o$ 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 $SP_o$ and $SP_1$ to $SP_5$ should be so adjusted that the latter relays are somewhat slower to operate than relay $SP_o$ 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 $SP_o$ 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 $BL_o$, conductor **45**, the outer armature and make contact of starting magnet ST and ground. The brushes $BL_o$ 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 $SP_o$ 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 $SP_o$ will be accompanied by the re-operation of the stepping magnet $SP_5$ and the rotation of the brushes $BL_o$ 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 $BM_o$ 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 $SP_o$ will become operated over a circuit which includes battery $B_1$, the winding of magnet $SP_o$, 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 $SP_o$ will be re-operated to step brush $BJ_1$ to contact **102**, the interconnected circuit including battery $B_1$, magnet $SP_o$, conductor **100**, contact **101**, brush $BJ_1$ and ground. As brush $BJ_1$ reaches contact **102**, the magnet $SP_o$ 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 $K_o$ 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 $K_o$ 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.