

Jan. 18, 1955

R. F. GOODE
ELECTROMECHANICAL COUNTER

2,700,076

Filed June 30, 1952

2 Sheets-Sheet 1

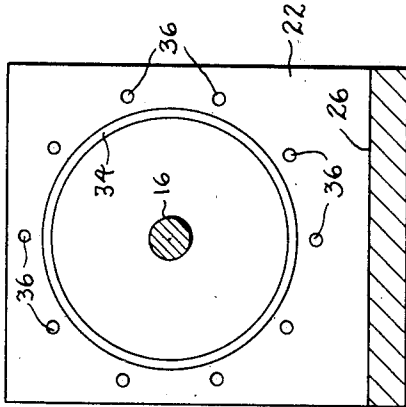


Fig. 1

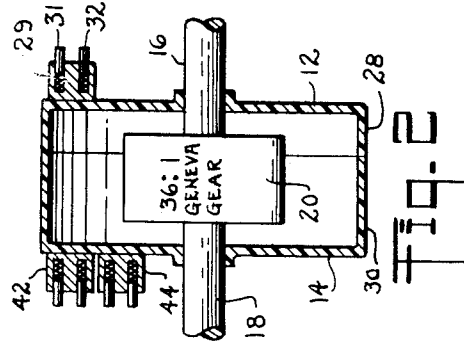


Fig. 2

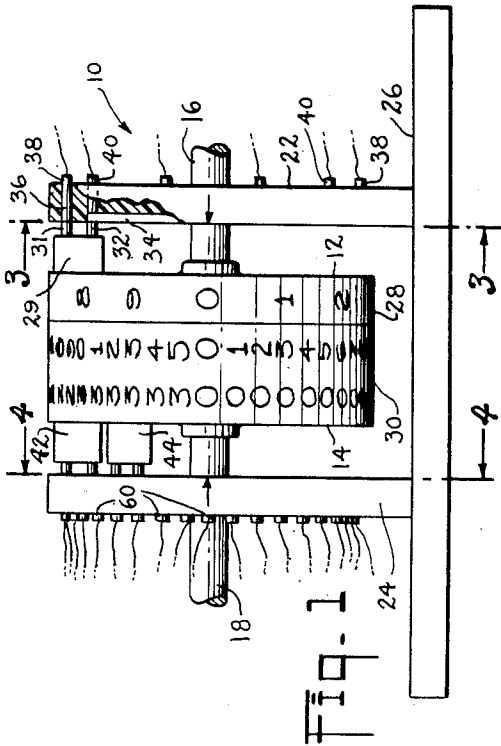


Fig. 3

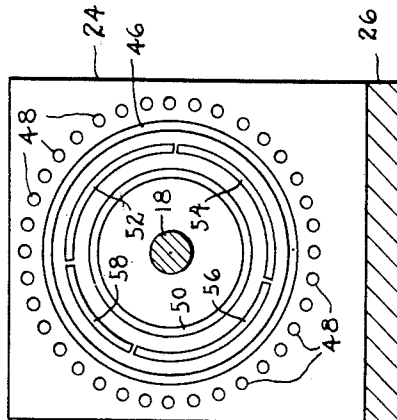


Fig. 4

INVENTOR.
REXFORD F. GOODE
BY

Roderick B. Jones
HIS ATTORNEY

Jan. 18, 1955

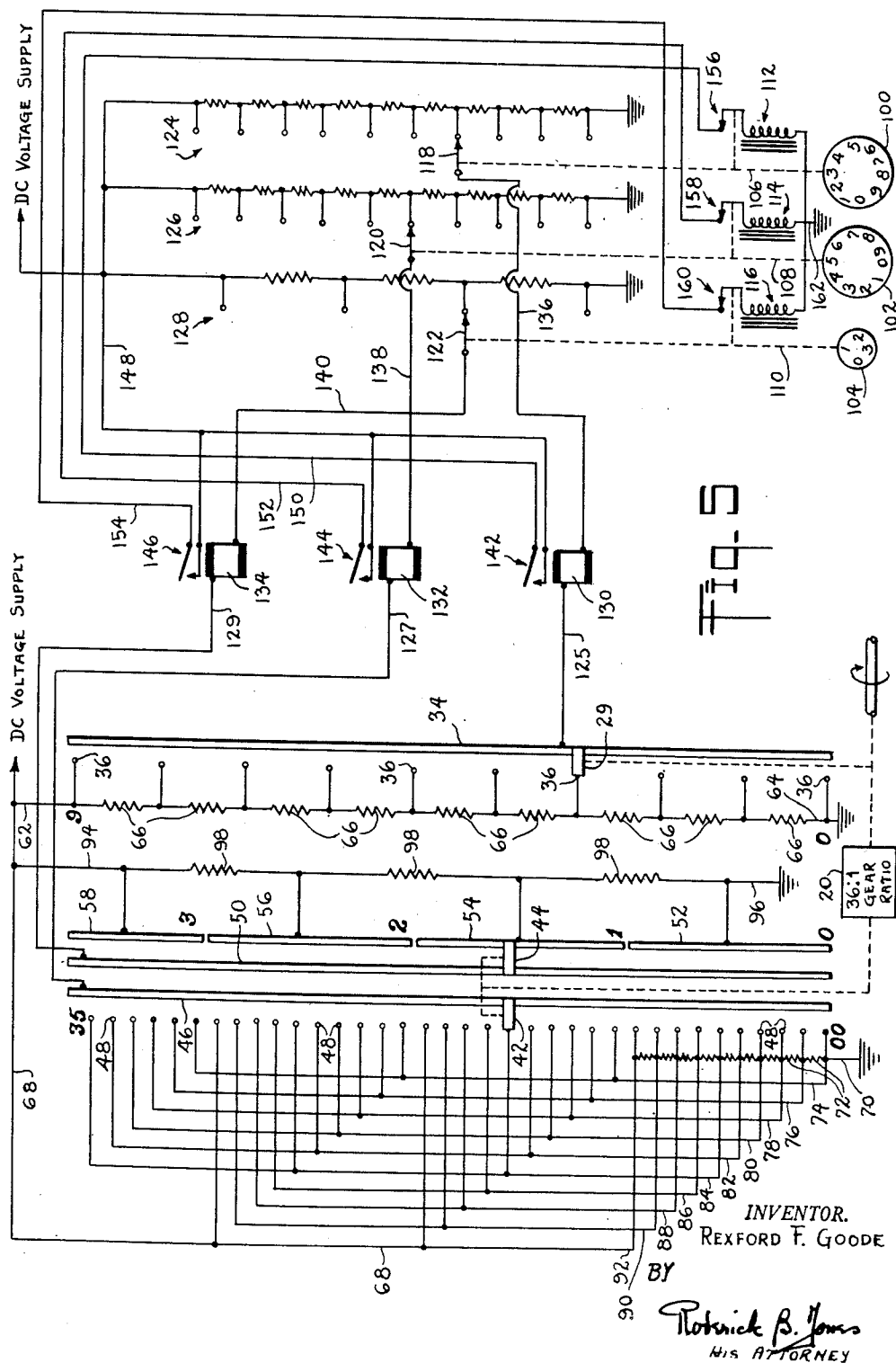
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ELECTROMECHANICAL COUNTER

Rexford F. Goode, Danboro, Pa., assignor to the United States of America as represented by the Secretary of the Navy

Application June 30, 1952, Serial No. 296,520

5 Claims. (Cl. 200—24)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to improvements in remote control and indicating systems and is directed particularly to a rotary electro-mechanical switch for the transmission of intelligence indicative of the angular position of its drive-shaft in degrees.

In the co-pending U. S. patent application of Rexford F. Goode and Walter R. Gustafson, entitled Data Transmission and Indicating System, Serial No. 285,527 filed May 1, 1952, there is described a system for the transmission of the angular position of a shaft to a remote point and for the indication thereof of such position as a number proportional to the angle of shaft rotation. The present invention is concerned with a rotary electro-mechanical switch for the transmission of intelligence resolvable at the receiving end of its system to indicate directly the angular position, in degrees, of the rotor thereof.

One object of the invention is to provide a 360° electro-mechanical counter incorporating switch mechanism whereby electrical data in the form of discrete sets of switch positions are provided for each degree of rotation of the counter shaft.

Another object is to provide a device of the character described embodying means to indicate visually the angular position in degrees of the switch shaft.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a side elevational view of the electro-mechanical counter, with a section broken away.

Fig. 2 is a vertical cross-sectional view of the counter wheels, showing the construction of the electrical contact brushes and the reduction gear mechanism interconnecting the "units" and the "tens-hundreds" wheels.

Fig. 3 is a vertical cross-sectional view taken along the line 3—3 of Fig. 1.

Fig. 4 is a vertical cross-sectional view taken along the line 4—4 of Fig. 1, and

Fig. 5 is an electrical schematic drawing of a typical system for the transmission and reception at a remote point of data set up by the electro-mechanical counter.

In the drawings, wherein like reference numerals denote corresponding parts throughout the several views, the numeral 10 designates generally the electro-mechanical switch and counter unit embodying the invention, the same comprising the coaxial "units" and "tens-hundreds" wheels 12 and 14 respectively, fixed to their respective coaxial shafts 16 and 18.

Shaft 16 is the driver or input, and is mechanically interconnected with shaft 18 by the Geneva gear mechanism 20, Fig. 2, which provides a 36-to-1 gear ratio between the driving and driven shafts. For each complete revolution of the input shaft 16, shaft 18 is rotated a thirty-sixth part of a revolution, or 10°. Shafts 16 and 18 are journaled in the respective upright brackets 22 and 24, both of which are supported by the base 26 and hold shafts 16 and 18 in coaxial alignment.

Wheels 12 and 14 constitute rotors of a plurality of sets of switches, of which the respective brackets 22 and 24 are stators or contact members. Wheels 12 and 14,

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and brackets 22 and 24, constitute dielectric bases that support electrical conductors, and are of suitable insulating material, such as plastic for example.

The "units" wheel 12 is provided with a short, inwardly-extending peripheral skirt 28, and around the outer or peripheral surface of the skirt, ten single-digit numerals are marked, which are equi-distantly spaced circumferentially, and which comprise a scale of digits "0" through "9" in succession. Similarly, the "tens-hundreds" wheel 14 is provided with a somewhat larger inwardly-extending peripheral skirt 30, of the same diameter as, and in horizontal registry with the peripheral skirt 28. Around its outer surface, skirt 30 is marked peripherally with a set of double-digit numbers from "00" through "35," which are spaced equidistant circumferentially. The two-digit members of skirt 30 are located to register with the single-digit numbers of skirt 28 to form a scale of three-digit numbers along the line of the opposed arrows in Fig. 1, and serve to indicate angular displacement at an input source from 0° to 360° in increments of one degree, the indication being continuous for any number of revolutions at the input source.

Rotation of input shaft 16 by the input source is indicated on the composite peripheral scale of the two sets of numbers of skirts 28 and 30, the indication on the scale of skirt 28 being stepwise in increments of 36° angular displacement of shaft 16. Since the speed reduction between shafts 16 and 18 is 36 to 1, by reason of the Geneva gear mechanism 20, it will be apparent that, as the shaft 16 is rotated, beginning at "0" on the peripheral scale of skirt 28, the indications will be from "0" to "9." Continued rotation to the indication of "0" completes one revolution of shaft 16 and wheel 12. By this completion of a revolution of wheel 12, wheel 14 is rotated by shaft 16 the distance of one step on the peripheral scale of skirt 30 through operation of Geneva gearing 20.

Each numeral of the peripheral scale of skirt 30 indicates ten degrees displacement at the data source of input shaft 16, and the complete scale, i. e., a complete revolution of wheel 14, indicates a complete revolution of the data source. By continued rotation of wheel 14 driven through Geneva gearing 20 during continued rotation of shaft 16, the number of revolutions of wheel 14 indicates the number of revolutions of the data source.

The outer side of the "units" wheel 12 has fixed thereto, in any convenient manner, a brush member 29, comprising a metallic block provided with cylindrical openings within which are slidably disposed the spring-pressed, cylindrical, carbon brushes 31 and 32. The brush member 29 operates opposed to slip ring 34 and a concentric circle of ten "units" electrical contact points or heads 36. Slip ring 34 and contact points 36 are contained in the dielectric material of bracket 22 and are exposed flush with the surface thereof that is opposed to the wheel 12. Brush mount 29 holds carbon brushes 31 and 32 respectively in circular alignment with the circularly disposed contact heads 36 and the slip ring 34. As wheel 12 is rotated, brush 31 engages the several points 36 in succession, and closes or shorts circuit with slip ring 34 through brush mount 29 and brush 32. Thus, each point 36, brush mount 29 and slip ring 34 cooperating, constitutes a switch, and the several points constitute a circle of switches spaced apart equidistantly 36° circumferentially.

The contact heads 36 extend through the switch contact member 22 and terminate in terminal lugs 38 for connection to the hereinbelow-described electrical circuit. Electrical connection to the slip ring 34 is made by connection to a similar outwardly extending terminal lug 40 which is electrically joined at its inner end against the inside surface of the slip ring.

The outer side of the "tens-hundreds" wheel 14 has fixed thereagainst, in radial alignment, the "tens" and "hundreds" brush-mount members 42 and 44, respectively, similar in construction to the brush-mount member 29, hereinabove described in connection with the "units" wheel 12.

Brush-mount member 42 operates opposed to slip ring 46 and a concentric circle of thirty-six "tens" electrical

contact points or heads 48, which are set within the dielectric material of the bracket or switch contact member 24 and exposed flush with respect to the inside surface thereof. As wheel 14 is rotated, one brush of mount 42 engages the contacts 48 in succession and closes or shorts circuit with companion slip ring 46 through mount 42 and its other brush. Thus, each contact point 48, brush mount 42 and slip ring 46 cooperating, constitutes a switch, and the several points 48 constitute a set of circularly disposed switches spaced apart equidistant ten degrees circumferentially.

The other brush-mount member 44 of wheel 14 opposes slip ring 50 and the concentric circle of arcuate segments 52, 54, 56, 58 comprising the "hundreds" electrical contacts or points, which are set in the dielectric material of bracket 24 and flush with the surface thereof. As wheel 14 is rotated, one brush of brush mount 44 engages the arcuate segments 52, 54, 56, 58 in succession, closing or shorting with slip ring 50 through brush mount 44 and its other brush. Thus, each of the segments 52, 54, 56, 58, brush mount 44 and slip ring 50 cooperating, constitutes a switch, the several segments constituting a circular set of switches.

Whereas the contact points 48 are spaced apart ten degrees of the circumference of wheel 14, each of the arcuate segments 52, 54 and 56 spans ten of the points 48, constituting 100° of the circumference of wheel 14. Arcuate segment 58 spans the remaining sixty degrees of the 360° circumference, and spans the remaining six of the thirty-six points 48.

Slip ring 46, contact heads 48, slip ring 50 and arcuate segments 52, 54, 56 and 58, all are provided with electrical terminal lugs 60, as in the case of the "units" contact heads 36 and their associated slip ring 34.

The brush member 29, rotating with "units" wheel 12, makes contact with a different contact head 36 each time the "units" wheel is rotated 36°. Brush-mount member 42, rotated with "tens-hundreds" wheel 14 under drive from shaft 16 through 36-to-1 Geneva gearing 20, makes contact with a different "tens" contact head 48 each time the "units" wheel 12 is rotated 360°, and wheel 14 is driven 10° correspondingly. Brush-mount member 44, also rotated with "tens-hundreds" wheel 14, makes contact with a different "hundreds" segment 52, 54 or 56 each time the "units" wheel 12 is driven ten turns. The corresponding angular displacement of wheel 14 is 300°, and corresponding readings of the numerals of skirts 30 and 28 are from "001" to "300." During the remaining sixty degrees of angular displacement of wheel 14 that completes a revolution thereof, wheel 12 makes six revolutions, brush mount 44 engages segment 58 and brush mount 42 engages six points 48, and the reading of the numerals on skirts 30 and 28 have been from "301" through "359" in succession to "000."

In view of the foregoing it will be evident that if input shaft 16 is driven from any suitable source of data input, the switch counter 10 is adapted to produce electrical signals, including as high as 360 signals in a complete cycle, the several signals being in unit increments. The switch counter may be connected electrically through terminal lugs 40 and 60 for the transmission of discrete sets of electrical data in the form of voltage potentials for example.

Markings of skirts 30 and 28 may be used to represent suitable intervals of a cycle at the data source of data-input shaft 16, for example displacement intervals. More particularly, the consecutive numerals "001" through "359" to "000" suggest angular displacement at the data source in a cycle that constitutes a complete revolution.

Wheel 12 constitutes a main rotor, of which bracket 22 is the stator embodying the set of switches of contact points 36. In terms of angular displacement at the data source, the switches of points 36 indicate displacement in equal increments of one degree through a total of ten degrees. Wheel 14 constitutes a second and auxiliary rotor of which bracket 24 is the stator, and of which contact points 48 constitute a set of switches that indicate angular displacement at the data source in equal increments of ten degrees through a cycle of a complete revolution. The mechanism of the Geneva gearing 20 coordinates indications by the two sets of switches of contact points 48 and 36 through a cycle at the data source of a complete revolution, in 360 equal increments of one degree, the indication being continuous for a plurality of consecutive cycles at the data source by con-

tinued rotation of rotor 14 for a like plurality of revolutions thereof under drive by the input shaft 16 through reduction gearing 20.

A different set of indications is afforded by the third set of switches embodying the arcuate segments 52, 54, 56 and 58, which, in terms of angular displacement at the data source, indicate varying fractional increments of a cycle constituting a complete revolution, and providing like indications for successive cycles in continued successive revolutions of rotor 14 driven by input shaft 16 through reduction gearing 20. Specifically, the switches of segments 52, 54, 56 and 58 indicate three successive equal increments of 100°, followed by an increment having the different value of 60° that makes the total of 360°, indications of succeeding cycles being the same and constituting each three equal increments of 100° followed by an increment of 60°.

Thus, the switch counter 10, with its several circular sets of differently arranged switches 36, 48 and 52, 54, 56, 58 severally, plus the speed reducing gearing 20, affords different indications of functional intervals of the cycle of the source data.

Fig. 5 is a schematic drawing of a typical electrical circuit of a system for receiving and indicating the electrical data set up by the electro-mechanical switch herein disclosed.

The contact heads 36 of the switch contact member 22 corresponding to the 9 and 0 digits on the "units" wheel 12 are connected between a source of D. C. voltage and ground by the wires 62 and 64, respectively. The remaining intermediate contact heads 36 are interconnected in series therewith, in order, by a string of similar resistors 66, whereby a voltage divider of equal successive potential steps between the contact heads corresponding to the digits 0 through 9 is provided.

The contact heads 48 of the switch contact member 24 corresponding to the 00 and 09 digit sets on the "tens-hundreds" wheel 14 are connected between the source of D. C. voltage and ground by the wires 68 and 70, respectively. Interconnecting said contact heads in series are the string of similar resistors 72, whereby a voltage divider of equal successive potential steps between the contact heads corresponding to the digit sets 00 through 09 is provided.

The contact heads 48 of the switch contact member 24 corresponding to the 10 through 19 digit sets, and those corresponding to the 20 through 29 digit sets, are interconnected, as by wires 74, 76, 78, 80, 82, 84, 86, 88, 90 and 92, respectively, to the contact heads 48 corresponding to the digit sets 00 through 09, respectively. Similarly, the contact heads 48 corresponding to the 30 through 35 digit sets are interconnected to the contact heads 48 corresponding to the digit set 00 through 06, by the respective wires 74, 76, 78, 80, 82 and 84.

The arcuate segments 58 and 52 are connected by wires 94 and 96 between the source of D. C. voltage and ground, respectively, in order, to the segments 58 and 52 through the similar resistors 98, whereby potential differences of equal voltage will be provided between adjacent arcuate segments 52 through 58.

The indicating dials 100, 102 and 104 of the receiving station are fixed to shafts 106, 108 and 110 (schematically shown), which are rotated by the stepping relays 112, 114 and 116, respectively. These shafts control the positions, respectively, of the contact arms 118, 120 and 122 associated with the "units," "tens," and "hundreds" receiving station voltage dividers 124, 126 and 128. As in the transmitting station, the voltage dividers are connected in parallel across a supply of D. C. voltage the potential of which is the same as that of the transmitting station, so that corresponding voltage tap contacts of the receiving and transmitting station voltage dividers are at the same potential.

The slip rings 34, 46 and 50 are interconnected by wires 125, 127 and 129, respectively to one terminal each of the energization windings of the relays 130, 132 and 134, respectively. The remaining energization terminals of said relays are each connected, by wires 136, 138 and 140, to the contact arms 118, 120 and 122, respectively.

Each of the relays 130, 132 and 134 has associated with it a switch 142, 144 and 146, respectively, normally open, but adapted to be closed-circuited when its particular relay winding is energized. Since any one of the relay switches will be open only when its relay-

energization winding is at zero potential difference, it follows that if the contact arm and brush member in circuit with said relay are at different potentials, its associated switch will be closed-circuited.

One terminal of each of the relay switches 142, 144 and 146 is connected to the common wire 148, which, in turn, is connected to the source of D. C. voltage. The remaining terminal of each of said switches is connected by wires 150, 152 and 154, respectively, to the commutating switches 156, 158 and 160 of the stepping relays 112, 114 and 116, respectively. The remaining terminal of each of said commutating switches is connected to its respective relay-energizing coil; and the remaining terminals of each of said energization coils is connected to ground through a common ground wire 162.

To consider operation of the system, assume that the "units" brush member 29 at the transmitting station and the "units" contact arm 118 at the receiving station are not contacting taps of equal potential along their respective voltage dividers. Then a circuit is completed to energize the relay 130, said circuit being from ground, through the energized voltage divider 124 to the particular contact or tap contacted by the contact arm 118, through said contact and wire 136 to one energization-coil terminal of said relay, thence, from the other energization-coil terminal thereof, through wire 125, the slip ring 34, the brush 29 to the particular contact head 36 contacted, through the "units" voltage divider and wire 64 back to ground. Since the potentials at the voltage divider taps contacted are assumed to be different, the differential voltage will result in current flowing through the relay 130, consequently closing its switch 142.

The closure of switch 142 completes a circuit for energizing the stepping relay 112, said circuit being from ground, through the common ground wire 162 to one energization-coil terminal of said relay, thence, from the other energization-coil terminal thereof, through its commutating switch 156, wire 150, now-closed switch 142, through wire 148 to the D. C. voltage supply. The energization of the stepping relay 112 causes it to "step" or turn its shaft 106 intermittently so that the contact arm 118 is advanced one voltage step, or contact on its divider, at a time until it assumes, as shown in the drawing, the same relative position as that of the brush member 29 on its voltage divider, at which position the potentials supplied to the energization coil of the relay 130 will be equal and cancel one another to deenergize said relay and allow its switch 142 to open. The opening of switch 142 opens the energization circuit of the stepping relay 112, detailed above, whereby the shaft 106 and its associated indicator dial 100 will be definitely oriented with respect to the "units" wheel 12 controlling the brush member 29.

The operation of the stepping relays 112, 114 and 116 is well-known in the art, and it is therefore deemed not necessary to present herein a more detailed explanation of their construction and operation.

The operation of the "tens" and "hundreds" circuits is the same as the above-detailed for the "units" circuit. In connection with the "tens-hundreds" wheel 14, it will be noted that the "hundreds" brush member 44 moves to a different segment upon the traversal of the "tens" brush 42 past the contact heads 48 corresponding to the digit sets 09, 19, 29 and 35. Thus, at the receiving station, dial 104 reads the "hundreds" digit, dial 102 reads the "tens" digit, and dial 100 reads the "units" digit to in-

dicare in degrees the instant angular disposition of the input shaft at the transmitter.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention can be practiced otherwise than as specifically described.

I claim:

1. In an electromechanical counter, the combination comprising an input shaft, a "units" wheel having rim markings of the 0 to 9 numerical sequence at equal intervals carried on said shaft, a "tens-hundreds" wheel having rim markings of the 00 to 35 numerical sequence at equal intervals driven by said "units" wheel through a 36:1 ratio gear mechanism, a "units" switch plate having contacts separated radially by 36° and a first slip ring, a first brush driven by said "units" wheel to contact said "units" plate contacts successively and said first slip ring, a "tens-hundreds" switch plate having contacts separated radially by 10°, a second slip ring, a series of arcuate collector segments of substantially 100°, 100°, 100°, and 60°, and a third slip ring, a second brush driven by said "tens-hundreds" wheel to contact said "tens-hundreds" contacts successively and said second slip ring, and a third brush driven by said "tens-hundreds" wheel to contact said segments successively and said third slip ring.

2. The invention as defined in claim 1 wherein said gear mechanism comprises a Geneva movement.

3. In an electromechanical switch, the combination comprising a rotatable input shaft, a first wheel fixed to said shaft, a first contact plate having a plurality of circularly disposed first electrical contacts and a first slip ring which is coaxially oriented with respect to said first wheel, means controlled by said first wheel for successively shorting said first electrical contacts to said first slip ring, a second wheel, means interconnecting said first and second wheels for rotating said second wheel at a reduced speed, a second contact plate having a plurality of circularly disposed second electrical contacts and a second slip ring which is coaxially oriented with respect to said second wheel, means controlled by said second wheel for successively shorting said second electrical contacts to said second slip ring, said second contact plate further having a plurality of circularly disposed arcuate contacts and a third slip ring which is coaxially oriented with respect to said second wheel, and means controlled by said second wheel for successively shorting said arcuate segments to said third slip ring.

4. The invention as defined in claim 3 wherein said interconnecting means comprises a Geneva movement.

5. The invention as defined in claim 3 wherein said first electrical contacts are ten in number spaced 36° apart, wherein said second electrical contacts are thirty-six in number spaced 10° apart, and wherein said arcuate contacts are four in number, substantially of the arcuate lengths 100°, 100°, 100° and 60°.

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