April 19, 1949. N. E. LINDENBLAD 2,467,758

MOVABLE CIRCUIT CLOSURE

Filed Sept. 22, 1944 3 Sheets-Sheet 1

Fig. 1.

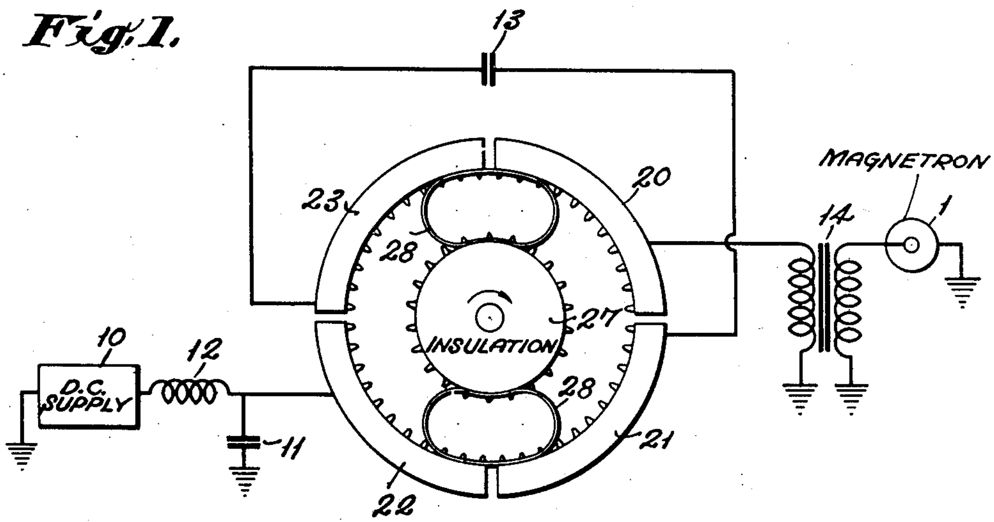

Fig. 1a.

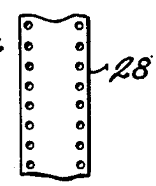

Fig. 2.

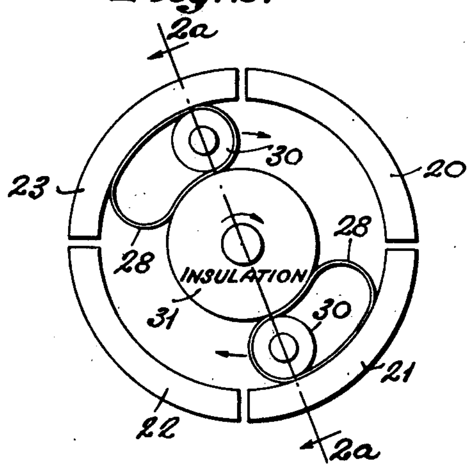

Fig. 2a.

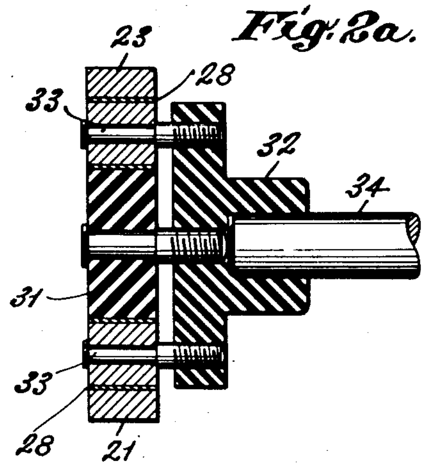

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Fig. 3.

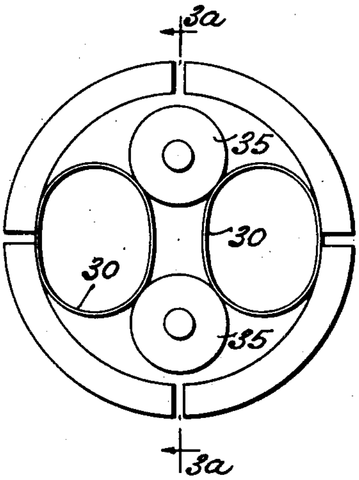

Fig. 3a.

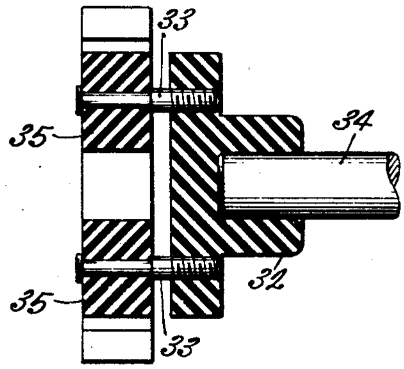

Fig. 4.

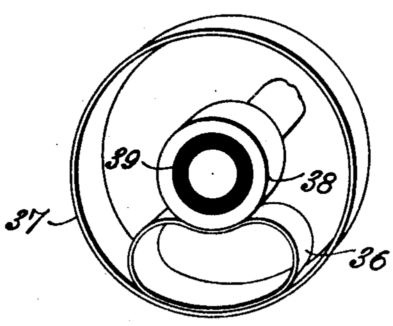

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Fig. 5a.

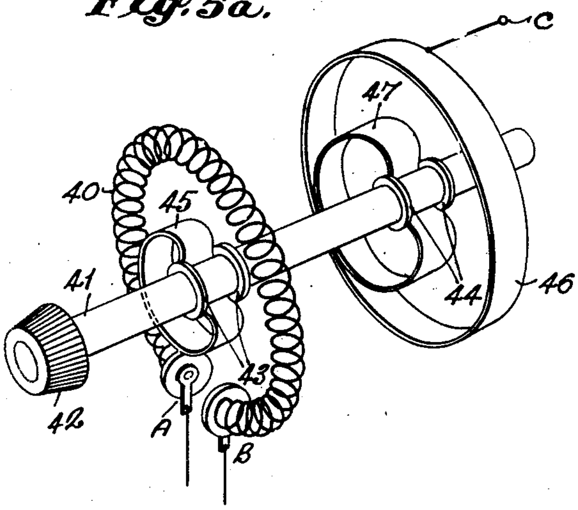


Fig. 5b.

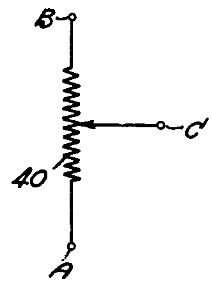


Fig. 6a.

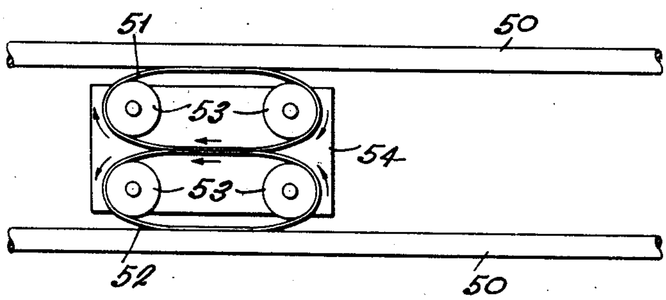
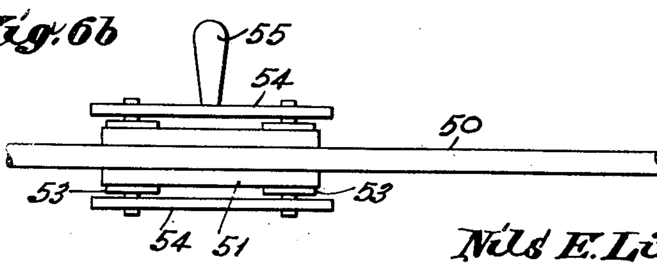


Fig. 6b



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2,467,758

MOVABLE CIRCUIT CLOSURE

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Application September 22, 1944, Serial No. 555,263

15 Claims. (Cl. 200—155)

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The present invention relates broadly to movable circuit closures and has for its primary object to provide an improved circuit closure which wears longer and has a wider contact surface area than conventional arrangements.

Another object of the invention is to provide a circuit closure which utilizes a rolling contact arrangement in contrast to the conventional form of friction or sliding contact.

A further object is to provide a rotatable contact scheme which utilizes an endless contact band which is rotatable as it moves in a circular path between two stationary elements to be electrically connected together.

The following embodiments of the invention employing my improved contact making device are described herein by way of example only and not by way of limitation. These embodiments comprise a commutator, a potentiometer, a rheostat and a slip ring.

A more detailed description of the invention follows in conjunction with a drawing wherein:

Figs. 1, 2 and 3 illustrate the improved circuit disclosure of the invention as adapted particularly for a reverser type of commutator suitable in pulse generator systems. Fig. 1 illustrates the improved circuit closure in connection with a pulse generator circuit;

Fig. 1*a* illustrates a portion of the perforated metal band employed in the circuit closure of Fig. 1;

Figs. 2*a* and 3*a* are cross-sections along the lines 2*a*—2*a* and 3*a*—3*a* of Figs. 2 and 3, respectively;

Fig. 4 illustrates the invention applied to a slip ring adaptable for use with an alternating current motor;

Fig. 5*a* illustrates the invention applied to a potentiometer or rheostat arrangement;

Fig. 5*b* shows the equivalent circuit arrangement for Fig. 5*a*;

Fig. 6*a* illustrates, by way of example, how a pair of endless rotatable bands may be used to tune a Lecher wire or parallel conductor system; and

Fig. 6*b* is a plan view of Fig. 6*a* showing the details of the unicontrol scheme for moving the endless bands over the lengths of the conductors.

Referring to Fig. 1 in more detail, there is shown the improved circuit closure of the invention used in a reverser type of commutator of a pulse generator circuit of the type described in more detail in my copending applications Serial Nos. 479,220, filed March 15, 1943, now Patent No. 2,449,078, issued September 14, 1948, and 481,682, filed April 3, 1943, now abandoned. The circuit closure comprises four stator segments of equal length, **20**, **21**, **22** and **23**.

These stator segments are insulated from each other and are mounted in the four quadrants of a

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circle in such manner as to provide small air or insulation gaps between adjacent segments. The rotating contact devices are in the form of a pair of perforated metal bands **28** which are arranged to rotate on the inside diameter of the circle on which the stator bars lie. A drive roller of suitable insulation material **27** is positioned between the metallic bands **28** and is provided with pins which together with the pins on the arcuate segments **20** to **23**, inclusive, register with the spaced holes in the perforated contact bands to prevent slipping for synchronized operation between the bands **28** and the roller **27** and the stator segments. The bands **28** are flexible cylinders when seen removed from the contact device and are easily squeezed in place between the centrally located insulating drive roller **27** and the stator segments. These bands, it should be noted, are mounted at diametrically opposite sides of the rotating insulating drive roller **27**, the latter in turn being driven by a motor through the intermediary of a drive shaft. The bands **28** are of such length that as they roll around the circle in response to the motion of the drive roller, they will simultaneously bridge oppositely located gaps of the stator segments on the interior surface of the segments.

The generator of Fig. 1 in which the improved contact making device of the invention is employed is utilized to produce extremely short pulses of high power. For this purpose, there is provided a magnetron oscillator **1** to whose cathode electrode is supplied high voltages from the contact making device through a transformer **14**. The anode of the magnetron oscillator is shown connected to ground. To supply these high power pulses to the magnetron, there is provided a source of direct current power **10** which is coupled to a storage condenser **11** through a choke coil **12**. This direct current source **10** may be a rectifier, a direct current generator or a large battery. A condenser **13** of relatively small capacity compared to the capacity of the storage condenser **11** is adapted to be charged and subsequently discharged periodically through the load in the same direction. The load in this case is the step-up transformer **14** whose primary winding is connected to the stator segment **20** of the commutator arrangement and whose secondary winding is connected to the cathode of the magnetron oscillator. The condenser **13** is connected between stator segments **21** and **23** while the storage condenser **11** is connected to the stator segment **22**. The perforated metal bands **28** are mounted on opposite sides of the rotary insulation drive roller **27** which is driven in the direction of the arrow by the centrally located shaft. This drive roller may be made of fibre, Bakelite or other suitable material. The two bands **28** are identical and mounted in similar fashion. As the drive roller revolves, the metallic bands 28 are caused to rotate around a circle in fixed relation to each other and are caused to bridge opposite spaces simultaneously as the drive roller moves.

In the operation of the circuit of Fig. 1, the direct current supply 10 stores a charge on the condenser 11 which preferably has a capacity at least ten to fifteen times as large as condenser 13. On first connecting the circuit as shown in Fig. 1, the condenser 13 will be charged over a path including storage condenser 11, stator segment 22, metal band 28, stator segment 21, condenser 13, stator segment 23, the other metal band 28, stator segment 20, and the primary winding of the step-up transformer 14. There is thus produced a pulse of current through the primary winding of transformer 14 corresponding to the charge placed on condenser 13 at the voltage of the charging source 10, which, let us assume for purpose of illustration, is 1000 volts. As the bands 28 rotate, however, the connections of the condenser 13 are periodically reversed. Thus, in the position where the metal bands 28 bridge the gaps between stator segments 23 and 22, and 20 and 21, a path will be completed from the storage condenser 11 through segments 22 and 23 to the left hand side of condenser 13 through the condenser 13 and through stator segments 21 and 20 to the primary winding of transformer 14. In fact, condensers 13 and 11 are now placed in series because the polarities of both of these condensers are additive at the moment the circuit connections are reversed, as described. The pulse is thus produced across the primary winding of transformer 14 with an initial voltage of about 2000 volts. This initial pulse voltage will diminish according to the time constant of the circuit. Actually, as the pulse with the initial voltage double that of direct current source 10 dies away the condenser 13 is completely discharged through the primary winding of transformer 14 and is then recharged in the opposite direction to assume the polarity which the condenser possessed before the connections were reversed. The whole complete pulse of double voltage through the transformer therefore includes both the discharge and the charge of the condenser 13 as one continuous or uninterrupted phenomenon. As the drive roller 27 continues to rotate, the connections of the condenser 13 to the transformer and storage condenser are again reversed in an obvious manner and again there is produced a pulse through the load having an initial voltage of 2000 volts. Thus, subsequent to the first pulse caused by first connecting the circuit together, all subsequent pulses will have a voltage across the primary of the transformer which is twice the voltage of the direct current source. If the transformer 14 is a step-up transformer having a voltage transformation of one to ten, the 2000 volt pulse across the primary will produce a 20,000 volt pulse across the secondary which is applied momentarily to the electrode of the oscillator 1 to cause the oscillator to break out into oscillations. This mode of operation is substantially similar to that described in my copending application Serial No. 479,220, filed January 15, 1943 supra.

One advantage of the improved contact making device of Fig. 1 over the contact making device of my prior application is that I now use a rolling contact in contrast to the sliding or friction contact previously employed. In this way I am able to obtain a wider contact surface area, thus assuring better contact, and also less wear than in previous arrangements.

Fig. 2 shows a modification of my improved contact making device which differs from the contact making device of Fig. 1 primarily in not requiring driving pins or beads either on the drive roller or on the stator segments. In Fig. 2 the metal contact bands 28 are driven from separate drive rollers 30 positioned on opposite sides of an idler roller of insulation material 31. The flexible cylinders constituting the metal contact bands 30 have no perforations in Fig. 2. They are driven by rollers 30 of smaller diameter located inside the flexible metal contact bands. The rollers 30 are fastened to the driving hub as shown in more detail in Fig. 2*a*. The central insulating drum 31 is an idler which rotates freely, so to speak, in this case. This drum can be made of Bakelite or fiber or other suitable insulation material.

Fig. 2*a* shows a cross section of the commutator of Fig. 2 along the line 2*a*—2*a*. It will be seen that the drive rollers 30 are secured to an insulation stub 32 by means of pegs or pins 33. This insulation stub is fastened to a rotating drive shaft 34, in turn driven by a motor (not shown).

Fig. 3 illustrates another modification of the contact making device of Figs. 1 and 2. In Fig. 3, which is a preferred arrangement, there are employed a pair of drive rollers 35 located externally of the metal contact bands 30. These drive rollers are of insulation material such as fiber, and squeeze the flexible metal cylinders into the general configuration shown in the drawing. The metal bands 30 are positioned on diametrically opposite sides of the inside diameter of the stator segments and are caused to rotate as the drive rollers 35 rotate. The bands 30 are unperforated and are similar to those shown in Fig. 2.

Fig. 3*a* shows a cross section of the commutator of Fig. 3 along the lines 3*a*—3*a*. It will be seen that both drive rollers are secured to the insulation hub 32 by means of pins or pegs 33, which are screwed into the stub 32. Stub 32 is driven from the rotating drive shaft 34.

In circuit embodiments tried out in practice and mentioned herein by way of example only, the flexible metallic bands of Figs. 1, 2 and 3 had a diameter of about one and one-quarter inches before being squeezed into position into the commutator and had a width of about one-half of an inch. The stator segments had a width on their inner surfaces of about one-half of an inch. The insulation drive rollers were made of fiber.

Fig. 4 illustrates how the principles of the present invention can be applied to a slip ring for an alternating current motor. The flexible metallic band 36 is shown in this figure as being squeezed between a metallic track 37 and a metal drive roller 38, the latter in turn being driven from a drive shaft from which it is insulated by means of an insulating bushing 39. Thus contact is maintained between track 37 and metal roller 38 via the metal band 36 as the roller 38 drives the metal band 36 in its circular path of travel.

The metal band 36 will be caused to rotate and make rolling contact in response to the movement of the roller 38. By placing several slip rings of the type shown in Fig. 4 along the length of the same drive shaft, adjacent each other, so as to be coaxially arranged, there is provided a method of utilizing the improved rolling contact arrangement of the invention in an alternating current motor.

Fig. 5*a* illustrates the application of the improved rolling contact making device of the invention to a potentiometer and/or rheostat arrangement. The equivalent electrical circuit for the mechanical embodiment of Fig. 5*a* is shown in Fig. 5*b*. In Fig. 5*a* the potentiometer is shown in the form of a stationary coil 40 wound in a circle and having a pair of terminals A and B. These terminals may extend to a suitable source of potential. A metallic drive shaft 41 controlled at one end by a knob 42 passes through the center of the coil 40 and is provided with pairs of metallic flanges 43 and 44. Rolling contact between the coil 40 and the rotatable shaft 41 is provided by means of a flexible metallic band 45 squeezed between the coil 40 and the shaft 41. A pair of stops or lugs are provided adjacent the terminals A and B to prevent movement of the endless rotatable band 45 past these stops. The flanges 43 serve to guide or restrict movement of the band 45 over the limited portion of the shaft located between the flanges 43. Shaft 41 thus acts as a tract for band 45. Concentrically positioned around the shaft 41 and to one side of the coil 40 is a stationary metallic track 46 to which is connected the terminal C. Another rotatable endless metallic band 47 is positioned between the shaft 41 and the track 46. The flanges 44 serve to restrict movement of the band 47 to that portion of the shaft located between the flanges 44. It will thus be seen that the band 45 makes rolling contact between the coil 40 and the shaft 41, while the band 47 makes rolling contact between the track 46 and the shaft 41. As the knob 42 is rotated, both of the bands 45 and 47 will be caused to rotate simultaneously by virtue of being squeezed between the shaft and the elements 40 and 46. The metallic bands will thus change position and move around the coil 40 and the track 46 in response to movement of the shaft 41. The metallic bands, the shaft 41 and the track 46 should be made of highly electrical conducting material. By way of example, the bands may be made of steel coated with silver or copper while the shaft and the metallic track can be made of brass or of material similar to the bands. The coil 40 can be made of any suitable resistor wire such as Nichrome, etc. If the arrangement of Fig. 5*a* is used as a potentiometer, a source of unidirectional potential can be connected to the terminals A and B while a utilization circuit can be connected to the terminal C. If it is desired to use the arrangement of Fig. 5*a* as a rheostat, however, only one of the terminals A or B can be used with the terminal C. It should be noted that the band 45 contacts several turns of the coiled resistor wire 40 at the same time.

Fig. 6*a* shows a rotary (rolling) contact arrangement in accordance with the invention employed for tuning a pair of Lecher wires or parallel conductors 50. The tuning or short circuiting elements include a pair of endless metallic bands 51 and 52 which are positioned side by side between the two conductors 50. In each of the endless bands there are provided a pair of rollers 53 for driving the bands. The rollers of both bands 51 and 52 are unicontrolled in a manner shown in more detail in Fig. 6*b*. Each roller 53 and each band 51 and 52 preferably has a width which is wider than the conductor 50 which it contacts. It should be noted that the two endless bands 51 and 52 contact each other along a plane substantially midway between the parallel conductors 50. Assuming motion of the bands in a direction toward the right, it will be observed from the arrows of Fig. 6*a* that both endless bands rotate together and provide rolling contact between the two parallel conductors 50. The rollers of both endless bands are provided with centrally located shafts which are supported by parallel plates 54, the latter in turn being linked to a handle 55 for causing movement of the rollers and bands over the lengths of the conductors 50. Note Fig. 6*b*. The plates 54 and the handle 55 are preferably made of suitable insulating material. The rollers are preferably made of insulating material such as fiber, Bakelite or wood.

A salient feature of all embodiments of the invention described above lies in the rolling contact which is achieved by driving an endless metallic element over the surfaces to be electrically connected together. In this way I am able to avoid the wear and tear which is characteristic of conventional rotatable contact making devices and I provide a much better contact because of the wider surface area obtainable by the rotatable endless metallic element.

It should be understood that the invention is not limited to the precise arrangements hereinabove illustrated and described, but is applicable in any scheme wherein a contact making device is useful.

What is claimed is:

1. A circuit closure arrangement comprising a pair of concentrically arranged elements adapted to be electrically connected together, a one turn rotatable, flexible and endless metallic contactor positioned between and electrically connecting together said pair of elements, and a drive roller for revolving said contactor in an orbital path over the length of said pair of elements, said contactor being normally cylindrical but assuming a generally elliptical form when positioned in said circuit closure arrangement.

2. A circuit closure arrangement comprising a pair of concentrically arranged elements located on a circle and adapted to be electrically connected together, a drive shaft, a one turn rotatable endless and flexible metallic band engaging said pair of elements, said shaft driving said contactor in an orbital path over said pair of elements, said band being normally cylindrical but assuming a generally elliptical form when positioned between said shaft and said elements in said arrangement.

3. A rotary contact arrangement comprising a plurality of equal length arcuate shaped metallic segments insulatingly spaced from one another around a circle by gaps, drive roller means within said circle, and a pair of endless one turn metallic bands which are spaced from each other and normally circular and squeezed between said drive roller means and said segments and positioned on the inside diameter of said segments as a result of which said bands assume a generally elliptical form, said drive roller means causing said pair of bands to rotate as they are driven in an orbital path around said segments, the dimensions and positions of said bands being such that they simultaneously bridge the gaps between different segments as the bands move in said orbital path.

4. A rotary contact arrangement comprising four equal length arcuate shaped metallic segments insulatingly spaced from one another around a circle by gaps, drive roller means within said circle, and a pair of endless one turn metallic bands which are spaced from each other and normally circular and squeezed between said drive roller means and said segments and positioned on opposite sides of the inside diameter of said segments as a result of which said bands as-

sume a generally elliptical form, said drive roller means causing said pair of bands to rotate as they are driven in an orbital path around said segments, the dimensions and positions of said bands being such that they simultaneously bridge the oppositely located gaps between different segments as the bands move in said orbital path.

5. A rotary contact arrangement comprising four equal length arcuate shaped metallic segments insulatingly spaced from one another around a circle by gaps, a pair of off-centered similarly dimensioned drive rollers of insulation material within said circle and positioned on a straight line passing through the center of said circle, a pair of normally one turn metallic bands which are normally circular but squeezed between said rollers and the inside diameter of said segments as a result of which said bands assume a generally elliptical form, said bands being positioned on opposite sides of the circle and each contacting both rollers and a segment, said drive rollers causing said bands to rotate as they are driven in an orbital path around said segments, the dimensions of said bands being such that they simultaneously bridge oppositely located gaps as the bands move in said orbital path.

6. A rotary contact arrangement as defined in claim 3, characterized in this that said drive rollers are of insulation.

7. A rotary contact arrangement in accordance with claim 3, characterized in this that said drive roller means is a centrally located roller of insulation material provided with drive pins, and said bands are perforated with holes registering with said drive pins.

8. A rotary contact arrangement as defined in claim 5, wherein said drive roller means comprises a pair of rollers each positioned inside a different band, the centers of said rollers being on a line passing through the center of said circle.

9. A rotary contact arrangement comprising a coil wound in a circle, a concentrically positioned metallic track, an endless rotatable metallic electrical conductor positioned entirely to one side of said track and located between and contacting said coil and track, and means for rotating the entire endless conductor around said circle to thereby change the position of contact between said coil and track.

10. A rotary contact arrangement comprising a coil wound in a circle, a concentrically positioned metallic track of smaller diameter than said coil, an endless rotatable metallic electrical conductor positioned entirely to one side of said track and located between and contacting said coil and track, and means for rotating the entire endless conductor around said circle to thereby change the position of contact between said coil and track.

11. A rotary contact arrangement comprising a coil wound in a circle, a concentrically positioned rotatable metallic track of smaller diameter than said coil, an endless rotatable metallic electrical conductor positioned entirely to one side of said track and located between and contacting said coil and track, the turns of said coil being broken at a point in its length, a terminal for said coil, means including said track for rotating the entire endless conductor around said circle to thereby change the position of contact between said coil and track, and a terminal for said track.

12. A potentiometer comprising a coil wound in a circle, a pair of terminals for said coil, a concentrically positioned metallic drive shaft, an endless rotatable metallic electrical conductor positioned entirely to one side of said track and located between and contacting said coil and shaft, means for driving said shaft to thereby rotate the entire endless conductor around said circle to thereby change the position of contact between said coil and shaft, and another terminal in circuit with said drive shaft.

13. A potentiometer comprising a coil wound in a circle, a pair of terminals for said coil, a concentrically positioned metallic drive shaft, an endless rotatable metallic electrical conductor positioned between and contacting said coil and drive shaft, a stationary circular metallic track positioned along the axis of said shaft, another endless rotatable metallic electrical conductor positioned between said stationary track and said drive shaft, another terminal in circuit with said stationary track, and means for driving said shaft to thereby change the positions of said endless rotatable conductors relative to said drive shaft.

14. A rotary contact arrangement for a pair of spaced parallel conductors comprising a pair of endless rotatable metallic electrically conducting bands positioned side by side between said spaced conductors, each of said bands engaging a different conductor of said pair, a pair of spaced rollers located inside each of said endless bands, and unicontrol means for driving the rollers of both bands to thereby cause said bands to rotate as they move over the lengths of said conductor.

15. A rotary contact arrangement comprising a coil wound in a circle, a concentrically positioned metallic track, an endless rotatable metallic electrical conductor positioned entirely to one side of said track and located between and contacting said coil and track, and means for rotating the entire endless conductor around said circle to thereby change the position of contact between said coil and track, said endless rotatable conductor being a flexible band or ribbon which is normally circular when removed from said contact arrangement but is squeezed into a generally elliptical form between said coil and track.

NILS E. LINDENBLAD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
916,649	Backe	Mar. 30, 1909
1,444,445	Bailey	Feb. 6, 1923
1,676,050	Rhodus	July 3, 1928
1,677,288	Newman	July 17, 1928
1,731,003	De Giovanni	Oct. 8, 1929
1,740,640	Austin	Dec. 24, 1929
2,000,177	Kenney	May 7, 1935

FOREIGN PATENTS

Number	Country	Date
112,849	Great Britain	Jan. 31, 1918
134,748	Germany	Dec. 4, 1914