

F. SPALAZZI.
ELECTRICAL DEVICE FOR TRANSMITTING TO A DISTANCE CONTINUOUS OR INTERMITTENT
ANGULAR MOVEMENTS.

APPLICATION FILED SEPT. 17, 1910.

Patented July 1, 1913.

1,066,159.

2 SHEETS—SHEET 1.

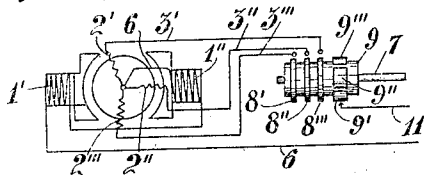


Fig. 1.

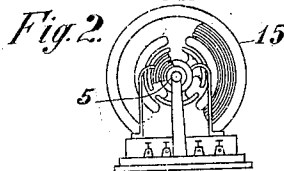


Fig. 2.

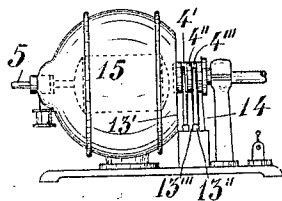


Fig. 3.

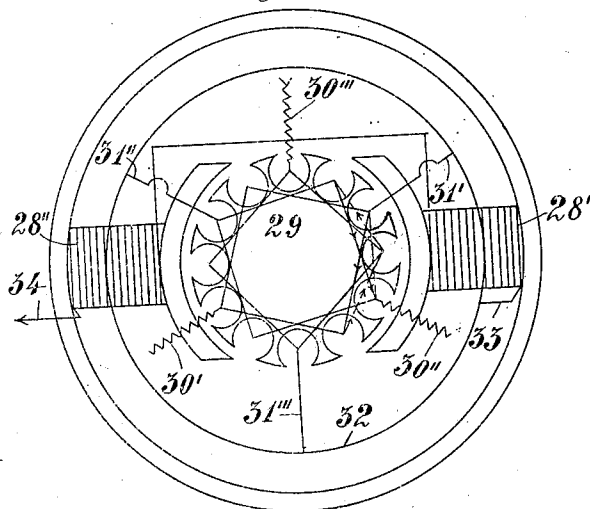


Fig. 4.

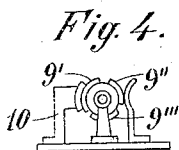


Fig. 5.

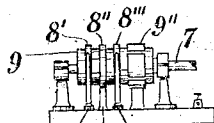
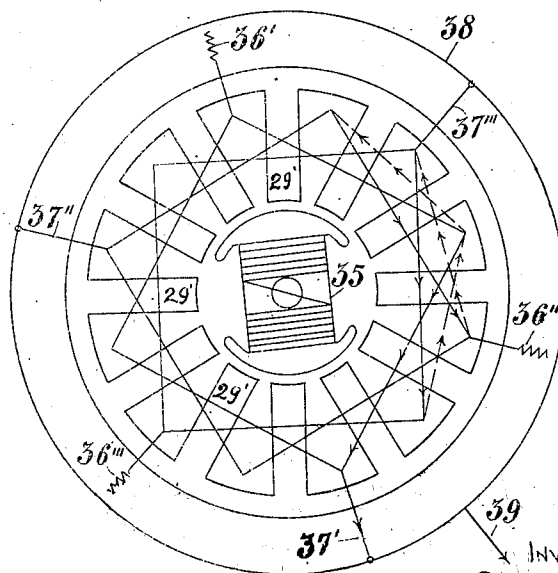


Fig. 6.



WITNESSES: 12' 12'' 12'''
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2 SHEETS-SHEET 2.

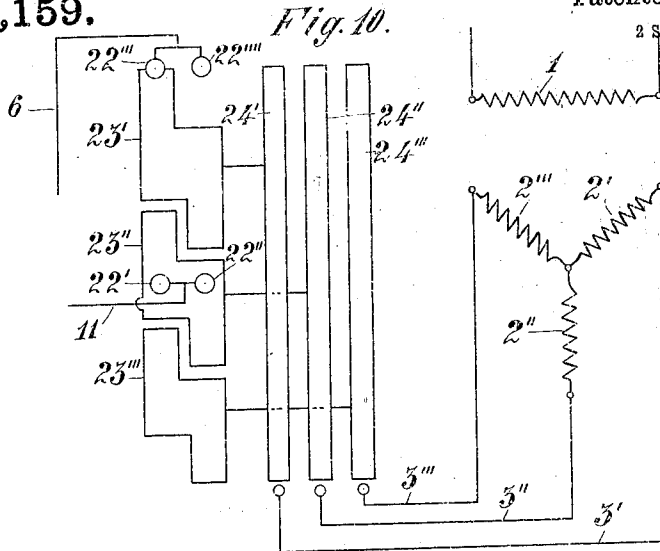


Fig. 6.

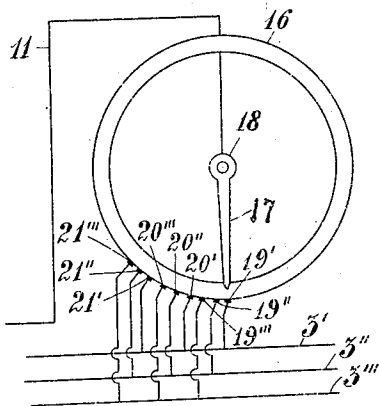


Fig. 9.

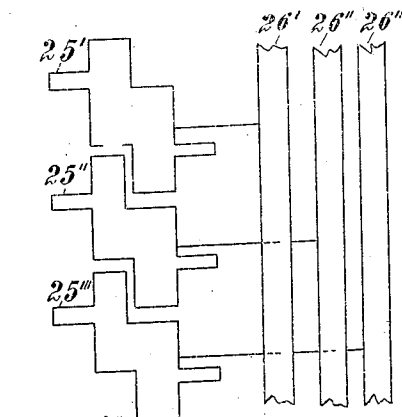
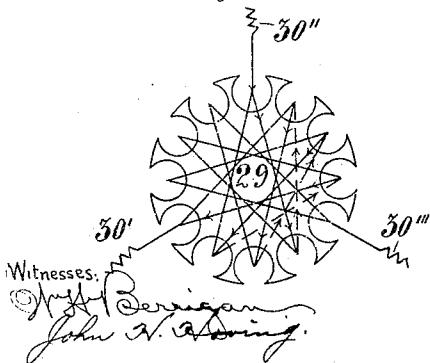
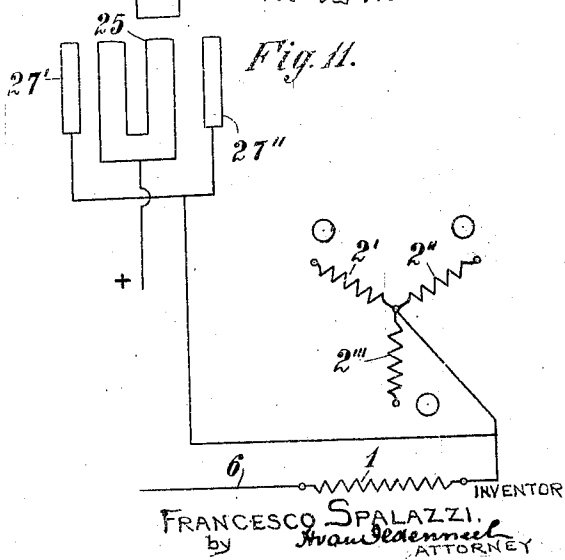


Fig. 11.



UNITED STATES PATENT OFFICE.

FRANCESCO SPALAZZI, OF NAPLES, ITALY.

ELECTRICAL DEVICE FOR TRANSMITTING TO A DISTANCE CONTINUOUS OR INTERMITTENT ANGULAR MOVEMENTS.

1,066,159.

Specification of Letters Patent.

Patented July 1, 1913.

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To all whom it may concern:

Be it known that I, FRANCESCO SPALAZZI, lieutenant in the Royal Navy, a subject of the King of Italy, and residing at Naples, in the Kingdom of Italy, have invented certain new and useful Improvements in Electrical Devices for Transmitting to a Distance Continuous or Intermittent Angular Movements, of which the following is a specification, reference being had therein to the accompanying drawing.

The present invention refers to an electrical device of the class described in the specification of patent application Serial N. 435523, by means of which the angular movements of a turning piece are transmitted to a shaft situated far away, which repeats exactly whether it is the case of continuous or intermittent movements. This effect is obtained by means of a motor comprising a fixed field, in which a flux of constant direction is produced, and a movable field comprising a plurality of coils, in which by changing the path of the current through the windings, a change of the direction of the resulting flux is obtained. The variation of the path of the current through the windings is produced by the movement of a special switch which is put into action by the turning piece.

The device according to the present application refers particularly to improvements in the construction of the repeating motor, and in order that said improvements may be fully understood the original form of the motor will be illustrated again in the drawings and briefly explained in the description.

The improved motor comprises an armature with a closed coil winding, which may be either multipolar or bipolar and permits of obtaining any desired value of the driving torque within a given range, of minimizing the variations thereof, increasing the efficiency by reducing the air gap and maintaining the reluctance approximately constant for all the positions, at the same time allowing a larger number of positions for a given number of transmitting wires. Further provisions are made which allow the motor to work with a strong current while avoiding damage due to excessive sparking in the commutator.

This device can be advantageously utilized in many cases. For instance it can be

utilized for transmitting to a distance the indications of a mariner's compass, for regulating the sighting gear of the guns, for transmitting the data for the fire to the guns of a distant battery, for actuating the devices of range finders with two observing stations, for controlling the position of the rudder of a ship, et cetera.

In the annexed drawings, Figures 1 to 6 show diagrammatically the form of the device described in the specification above referred to, in which the fixed field is formed by two electro-magnets and the movable field by a drum armature with 3 coils at 120°. The other figures show diagrammatically the modifications now introduced. Fig. 1 is a plan view of the arrangement of the circuits of the motor and of its connections with the switch. Figs. 2 and 3 are respectively an end view and a side elevation of the motor. Figs. 4 and 5 are respectively an end view and a side elevation of the switch. Fig. 6 shows the diagrammatic disposition of a switch with liquid resistance. Fig. 7 shows a motor of the same type, but in which the armature has a slotted cylindrical drum with smooth surface. Fig. 8 shows a motor in which the disposition is reversed, viz. the rotor has two poles, in the windings of which current continuously flows, while the movable field is produced in the stator. Fig. 9 is another form of armature for the motor shown in Fig. 7. Figs. 10 and 11 show the developed surface of two forms of the transmitting switch.

The fixed field of the motor shown in Figs. 1 to 6 is formed by two poles —1'—1''—, which can have a series or a shunt excitation. Between said poles is placed a drum armature with 3 coils —2'—2''—2'''— at 120° from each other and each one of these 3 coils by means of a wire —3'—3''—3'''— is connected with a metallic ring —4'—4''—4'''—, Fig. 3, mounted upon the shaft —5— of the motor. It will be understood that mesh connected winding without a return wire can be adopted. In this motor particular shapes are given to the pole-shoes of the field magnets and the core of the armature. As is clearly shown in the drawing, (Fig. 2), the pole shoes of the armature expand outside the coils assuming a mushroom shaped appearance and form together a nearly continuous cylindrical surface interrupted only by the slots necessary

for placing the windings of the coils in position. The pole-shoes of the magnets of the field are also shaped in such a way as to leave a cylindrical recess, the diameter of which is a little larger than the diameter of the armature drum so that the air-gap is very small, and when one of the pole-shoes of the armature is leaving the field of action of one of the pole-shoes of the field magnets, the following pole-shoes of the armature has already entered the said field. In the motor shown in the drawing the excitation of the field and the windings of the armature are connected in series, therefore there is only one wire —6— which leads the current to the magnets of the fixed field wherefrom it goes to the connecting point of the windings of the 3 coils of the armature. The switch which produces the variation of the current circulating in the 3 coils of the armature consists of an insulating cylinder —9— mounted on a shaft 7 which either directly, or by means of suitable transmission mechanism, is connected with the turning piece, the angular movements of which are to be transmitted, so that it either rotates through the same angle or through a proportionally larger or smaller angle according to the circumstances of the case. Upon the insulating cylinder —9— are placed 3 continuous metallic rings —8'—8''—8'''—, and a ring divided into three segments —9'—9''—9'''— each one of which communicates electrically with one of the continuous rings. Against the interrupted ring rests a large brush —10—, to which the current is fed by the wire —11—. The contact surface of said brush is smaller than a segment of the ring, but it can keep in contact with two adjacent segments, so that the brush passes from one segment to the other after having for a certain interval allowed the passage of the current through both segments. When the current to be transmitted is of considerable strength, then, in order to diminish sparking, two or more brushes can be used acting on a like number of interrupted rings, the corresponding segments of which communicate with the same continuous ring. Against the three continuous rings —8'—8''—8'''—, rest three brushes —12'—12''—12'''—, from which start the wires —3'—3''—3'''—, ending at the brushes —13'—13''—13'''—, of the collector of the motor. From the fourth collar —14— of the collector of the motor starts the return wire —6—. It will be easily understood that by turning the shaft —7— of the switch, the same angular movement is repeated by the shaft —5— of the motor —15— and thus a rotation through 120° is produced each time the brush —10— passes from one segment to the other; however, when the brush begins to cover the succeeding segment and before it has left

the preceding one, so that the current is circulating in two adjacent coils, the armature is turned through 60°. When it is a case of making use of an armature with star or mesh connected winding without the 4th wire, a path for the return of the current is provided by means of a brush at 180° from that by which it enters. Fig. 10 shows developed the cylindrical surface of a switch of this form; the current enters the system by the two brushes —22'—22''—, which are connected together, and the return wire —6— extends to a second pair of brushes —22'''—22''''— which are diametrically opposite the brushes connected with the wire —11—. The contact segments —23'—23''—23'''—, are in this case of the special shape shown, and the current reaches the windings —2'—2''—2'''—, of the armature through the wires —3'—3''—3'''— starting from the rings —24'—24''—24'''—.

For series wound motors of the class shown in Fig. 1 switches having the arrangement shown in Fig. 11 may also be conveniently used. This arrangement offers the advantage of suppressing sparks and of braking the armature in each successive position. Fig. 11 shows the developed cylindrical surface of the switch and clearly illustrates how the segments —25'—25''—25'''— are connected with the rings —26'—26''—26'''—. The current reaches the switch through the double brush —25—, and —27'—27''— are the shunting brushes.

The action of the rotary switch in combination with the armature having three coils at 120° movable in a fixed field between a pair of opposite poles is as follows: During the rotation of the switch current is sent alternatively through two wires to the three coils so that either in one or two of same the current circulates in the same manner, while in the remaining coils or coil the current either flows in opposite direction or is altogether cut off from same. It ensues that for a given position of the brush —10— relative to the segmental ring of the switch the armature will remain fixed in a certain position until another step is made by the switch, because contact is maintained at the collector ring and therefore the current still flows in the same manner in the coils of the armature. At the instant however in which the brush —10— either begins to touch two adjacent segments or passes completely on one of same the armature rotates through a further 60°. Therefore during the rotation of the armature with three coils there are six stopping positions at 60° from each other.

When it is desired to obtain a really continuous movement, it will be convenient to make use of a liquid resistance switch arranged as shown in Fig. 6, and in this case in order to avoid the electrolysis of the

liquid, either alternating or inverted current should be preferred. This liquid resistance switch consists of a circular channel —16— having insulating walls and filled with a liquid of low conductivity. Into the liquid contained in this channel dips a metallic pin, which is carried by an arm —17— mounted upon a shaft —18— passing through the center of the circular channel —16—. The shaft —18— is in the same way as the shaft —7— of the switch described hereinbefore, either directly or indirectly connected with the rotating piece, of which it repeats, either enlarged or reduced, the angular movements. In one of the walls of the circular channels —16—, for instance, on the outer one, are inserted metallic plates the 1st, the 4th, the 7th... of which are in communication with the wire —3'—, the 2nd, the 5th, the 8th... with the wire —3''—, and the 3d, the 6th, the 9th... with the wire —3'''— that is with the three wires which go to the collector of the motor. It will be understood that when the pin carried by the arm —17— is in front of the segment —19'—, the whole current coming from the wire —11— passes into the wire —3'—, and during the motion of the arm a portion of the current begins to pass through the segment —19''— until, when the pin carried by same has arrived in front of the segment —19'''—, the whole current passes through the wire —3'''— and so on. In this way the variation of the strength of the current in two successive windings of the armature is a continuous one and thus also the continuous rotation of the armature is obtained. In the walls of the channel can be fixed any number of groups of plates, but it will be understood that when the rotating piece, the angular movements of which are to be repeated is the shaft —18—, then for the purpose of rendering sensible even small deviations it becomes necessary to diminish the interval between successive plates, and to increase accordingly the resistance of the liquid in which dips the pin, if the same accuracy is to be obtained. It will also be apparent that a switch of this class will be particularly useful in all cases in which the power acting on the shaft —18— and causing the rotation of same is very weak and not sufficient for overcoming even a very small mechanical resistance, as for instance in the case of the transmission at distance of the indication of a mariner's compass. In this case when the contact plates are inserted at short intervals the motor described acts as an amplifier of the movement.

Although in the drawing is shown a motor the armature of which has 3 coils it will be understood that a greater number of coils, five for instance, can be adopted, the number of the brushes being increased accordingly.

Thus any kind of closed coil armature winding wound on a slotted drum with smooth cylindrical surface as shown in Fig. 7, can serve for the purpose, provided that the usual commutator be replaced by a ring collector (similar to the collector shown, Fig. 3), each ring being connected with one of the sections of the armature winding. By adopting this disposition the return path of the current is always by way of a brush resting against the segmental ring of the switch, and displaced by 180° relative to that through which the current enters. Fig. 7 illustrates a motor of this class with two field poles —28'—28''—, a closed coil armature —29— having a smooth external surface and three sections —30'—30''—30'''—, communicating with the three rings of the collector. The return path of the current is by way of the wires —31'—31''—31'''—, all ending at a ring connection —32— from which starts the wire —33— leading the current to the series wound field windings. The return of the current takes place through the wire —34—. Another armature of this kind with closed coil winding but without return wire is illustrated in Fig. 9. The advantages of this kind of armature are apparent: The air-gap is reduced very small, the wire is better utilized, greater power is obtained and moreover the torque and the magnetic reluctance are practically constant for all positions of the armature. This feature is of great importance, because in those motors where the reluctance of the magnetic circuit varies considerably for the various positions of the armature, the torque, beside overcoming the resistance of the driven shaft, has to overcome also the resistance which the armature, under the action of the field magnets, opposes to displacement when it occupies one of those positions for which the reluctance of the magnetic circuit is a minimum. Further a motor of the type shown in Figs. 7, 8 and 9 has the advantage that the angle between two successive resting positions of the armature can be kept as small as desired. Further it is clear that a synchronous movement can be obtained by reversing the position of the parts, viz., by forming the armature with a coil wound on a conveniently shaped core and providing a multipolar field either with several coils or with a closed coil winding wherein the current is circulated, and in this case the collector is no longer necessary and it will suffice to connect directly the windings of each coil or each section of the closed coil winding with the brushes on the rings of the switch. Fig. 8 shows a motor of this kind with an armature —35— formed by a coil the core of which has two mushroom shaped pole shoes, and closed coil field winding 29' to which the current enters directly from the rings

of the switch through the three wires—36'—36''—36'''— while return takes place through the wires —37'—37''—37'''—, which end at the ring connection —38— from
 5 which starts the return line —39—. It will be seen that irrespective of the particular arrangement of the parts the present invention substantially includes a switch connected to a turning piece which during the rotation of the latter sends successively the current through a series of wires each one of which ends at one of the rings of a ring collector, and a motor connected to the repeating device and consisting of a fixed and a
 10 movable field formed either by a certain number of coils or by a closed coil winding, the winding of each coil, or each section of the armature winding being connected with a ring of the collector which must therefore
 15 possess as many rings as there are coils or sections of the winding so that on the turning of the switch, the armature of the motor turns synchronously through angles corresponding to the rotation of the field. In
 20 other words the switch in combination with the motor of the kind described provides for the production of a rotating field capable of rotating the armature and generated by means of continuous current, in such a manner that the positions of rest of the armature
 25 can be made to differ by angles as small as desired.

In all the repeating motors used in connection with devices of this kind, the constant field may include a plurality of pairs
 35 of poles, and armatures with multipolar windings, that is the sections of which form each as many poles as there are pairs of poles in the constant field, so that the switch
 40 will perform two three, or more revolutions for each complete revolution of the motor. Further in order to secure a constant magnetic reluctance it will be convenient to incline either the surface of the armature, or
 45 the magnetic cores of the excitation. Lastly the efficiency of a motor of this class can be notably increased by forming the stationary excitation according to Fig. 8 by means of

perforated metal sheets with holes near the outer periphery, with slots for introducing
 50 the conductors in them from the outer edge, and long slits extending to the inner edge between two successive holes in order to better direct the magnetic flux against the armature.

Having thus described my said invention I declare that what I claim is:

In devices for repeating in a distant place angular movements performed by a rotating shaft connected to a switch which successively sends current in a plurality of line
 60 wires ending in the repeating motor, the combination in said motor of a plurality of coils wound so as to form a constant field, a closed coil winding in said motor, comprising as many sections as there are line wires,
 65 each section forming as many poles of a variable field, the shoes of said closed coil winding forming a complete cylindrical surface which corresponds to the cylindrical
 70 surface limiting the pole shoes of the first constant field, a shaft carrying one of said windings, the other being stationary; continuous rings and electrical connections on
 75 said shaft feeding in the same manner the winding carried by the shaft irrespective of the position of the latter, each section of the closed coil winding being in communication with one of the line wires, and the coils
 80 of the constant field being in communication with the return line, so that all of them are energized in the same manner and produce a magnetization, the direction of which in respect of the coils is constant, the sections
 85 of the closed coil winding being energized in a manner cyclically variable with the rotation of the switch and producing a rotating variable field, thus compelling the movable winding mounted on the shaft to rotate
 90 by the same angle as the variable field.

In testimony whereof I have affixed my signature in presence of two witnesses.

FRANCESCO SPALAZZI.

Witnesses:

LETTERIO LABOCCETTA,
 ANTONIO LABOCCETTA.