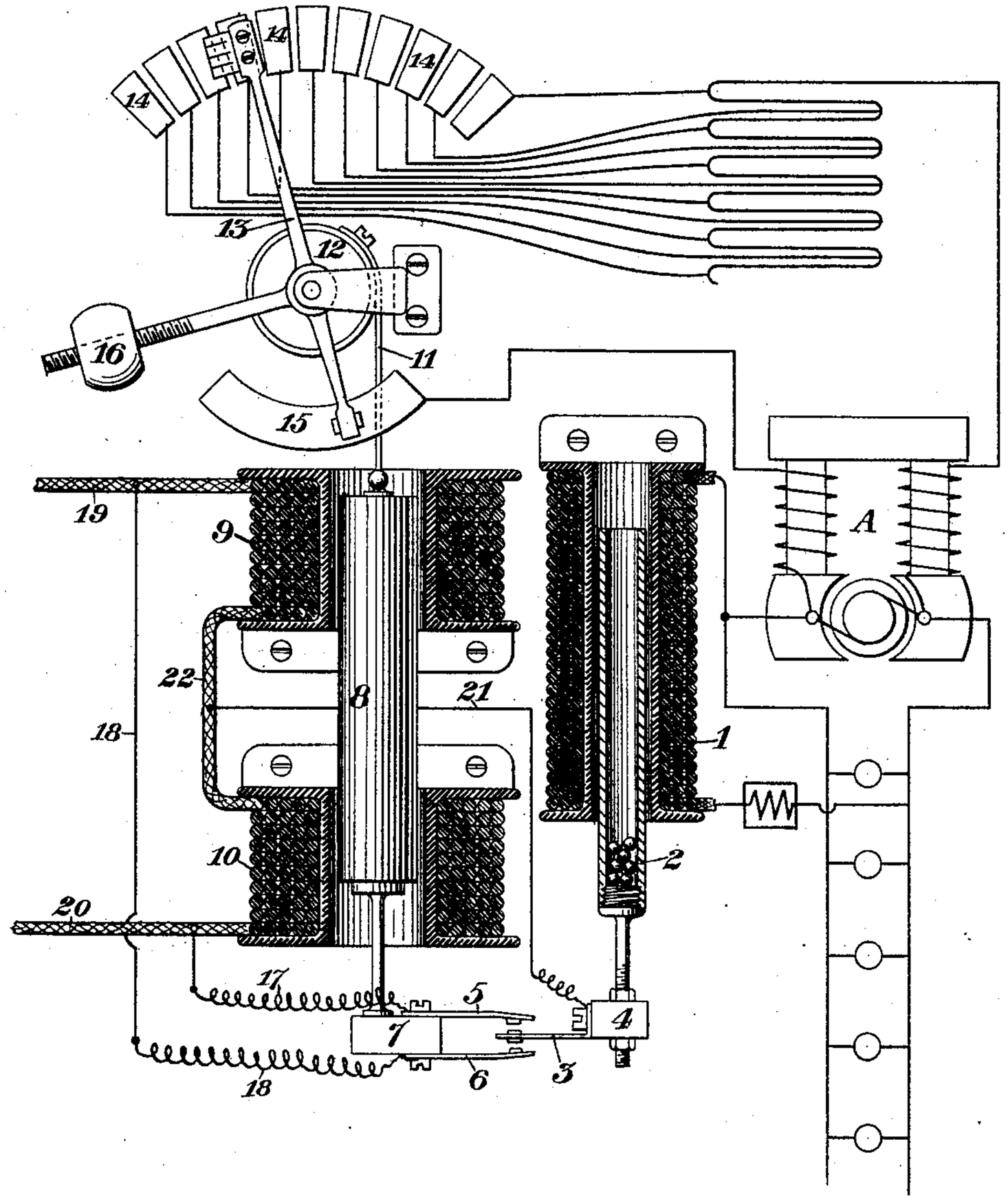
(No Model.)

# O. B. SHALLENBERGER.

## ELECTRIC REGULATOR.

No. 359,101. Patented Mar. 8, 1887.




WITNESSES:

H. B. Connin

W. S. Murphy.

INVENTOR,

*Oliver B. Shallenberger.*

Dawin & Wolcott Att'y.

# UNITED STATES PATENT OFFICE.

OLIVER B. SHALLENBERGER, OF ROCHESTER, PENNSYLVANIA.

## ELECTRIC REGULATOR.

SPECIFICATION forming part of Letters Patent No. 359,101, dated March 8, 1887.

Application filed October 4, 1886. Serial No. 215,244. (No model.)

*To all whom it may concern:*

Be it known that I, OLIVER B. SHALLENBERGER, residing at Rochester, in the county of Beaver and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful Improvements in Electric Regulators, of which improvements the following is a specification.

In the accompanying drawing, which makes part of this specification, the figure is a view in elevation of my improved automatic regulator for electric currents and its connections, the regulator proper being shown in section.

The object of the invention herein is to provide means whereby a constant current or a constant electro-motive force may be maintained in an electric generator by a gradual step-by-step movement of the regulating mechanism, and thereby avoid the excessive oscillations incident to usual form of automatic regulators when a change of resistance or other cause in the work-circuit produces a large movement of the contact-arms of the regulators. This excessive oscillation of most of the regulators now in use is due partly to the inertia of the moving parts, but principally to the sluggish change of the magnetic field of the generator. The effect of this latter cause is to allow the regulator to move too far before equilibrium is established, so that the contact-arm continues to oscillate above and below the proper position, thereby causing great fluctuations of the current. The solenoid 1 is connected either in direct or shunt circuit with the dynamo A, dependent upon the purpose for which the regulator is to be used—*i. e.*, maintain a constant current or a constant electro-motive force. Within the solenoid 1 is arranged the core 2, which is supported by the attraction of the solenoid. A contact-plate, 3, is secured to a block, 4, of non-conducting material attached to the lower end of the core, said core being adjusted, by means of weights, to hold the contact-plate 3 midway between the contact-plates 5 and 6 under normal conditions of current. The spring contact-plates 5 and 6 are secured in any suitable way to opposite sides of a block, 7, of insulating material, said block being attached to the lower end of core 8, which is so arranged in the solenoids 9 and 10 as to be acted upon by each of said solenoids in opposite directions, respectively. The solenoids 9 and 10 are traversed by a current from suitable source and sufficient in quantity to operate the core 8. To the upper end of the core 8 is attached one end of a flexible band, 11, the opposite end of said band being connected to the periphery of a drum or wheel, 12, mounted in suitable bearings above the solenoids 9 and 10. An arm, 13, is attached to the shaft of the wheel 12, one end of said arm arranged to traverse the contact-plates 14, electrically connected to suitable resistances which are in the circuit of the field-coils of the dynamo A, the opposite end of said arm traversing the contact-plate 15, which is included in the circuit of the coils of the dynamo, and to the shaft of the wheel 12 is attached a counter-weight, 16, which serves to balance the weight of the core 8, thereby allowing the core perfect freedom of movement proportional to the strength of the current passing through the solenoids 9 and 10.

The contact-plates 5 and 6 are electrically connected by flexible wires 17 and 18 to the conductors 19 and 20, in whose circuit the solenoids 9 and 10 are included, and the contact-plate 3 is connected by a flexible wire, 21, to the conductor 22, connecting the central or inner poles of two solenoids.

As above stated, the solenoids may be connected to any suitable electric generator, or they may be connected to the terminals of the dynamo A. In either case they are so wound that when traversed by the same or equal currents they will tend to pull the core in opposite directions, and will exactly counterbalance each other; or the solenoids may be in separate circuits, in which case the contact-plate 3 will have independent connections with the solenoids.

While the current in the work-circuit of the dynamo remains normal the core 2 remains suspended, holding the contact-plate 3 between the contact-plates 5 and 6; but if the current in the work-circuit should fall below normal, the core 2 would fall, causing the contact-plate 3 to make contact with the plate 6, thereby short-circuiting the solenoid 9 and allowing the solenoid 10 to act and pull down the core

8. This movement of the core 8 causes the arm 13 to move to the right, throwing out some of the resistances, and in consequence increasing the field strength of the dynamo and bringing the field strength back to normal. As soon, however, as the core 8 moves down the contact between the plates 3 and 6 is broken, thus throwing the solenoid 9 into action and arresting the movement of the core 8 and its connections. If, however, the normal field strength has not been restored by the first movement of the core 8, the core 2 will again move down, causing a second contact between the plates 3 and 6, which will again throw the solenoid 9 out of action, thereby allowing the solenoid 10 to impart another downward movement to the core 8 and a further movement to the right of the arm 13. This gradual step-by-step movement of the parts is continued until the field strength has been restored to normal. As each movement of the core 8 is quite small—*i. e.*, approximately equal to the normal distance between the contact-plates 3 and 6—a large and sudden throw of the arm 13 is prevented, and a gradual change is produced for comparatively small changes of current in the work-circuit. If, however, there should be a sudden and very great change of current, the core 2 would follow the contact-plates of the core 8 either up or down, dependent upon a rise or fall of the current in the work-circuit, thus keeping the plate 3 in contact with one or the other of the plates 5 and 6 until the current in the work-circuit is normal—as, for example, if the regulator is adjusted to maintain a constant current in the work-circuit and a sudden decrease of resistance should occur, the current in the work-circuit would at once rise abnormally; then the core 2 would be drawn up strongly, causing contact between the plates 3 and 5, thereby throwing the solenoid 10 out of action and permitting the solenoid 9 to pull the core 8 up and allow the counter-weight 16 to move the arm 13 to the left, thus bringing in more resistances into the circuit of the coils of the dynamo; but as the core 8 moves up the core 2 will also move up, thus keeping the plates 3 and 5 in contact until the current in the work-circuit is again normal. It is thus seen that while the regulator will act slowly and gradually under ordinary circumstances, it is also capable of rapid movement when necessary.

In lieu of the solenoid 1 and core 2, any suitable means—*e. g.*, an electro-magnet whose armature shall have sufficient range of movement—may be employed for moving the contact-plate 3 to correspond with changes of current, the contact-plate 3 being in such case connected to the armature.

It will be observed that the core 8 is practically two cores rigidly connected together. In lieu of the arrangement of solenoids above described, the solenoid 10 may be arranged alongside of the solenoid 9, in which case the core of the solenoid 10 would be connected to the drum 12 in the same manner as the core 8, but on the opposite side of said drum, and in such an arrangement the two cores would counterbalance each other, and thereby avoid the use of the weight 16.

I claim herein as my invention—

1. In electric regulators, the combination of two oppositely-acting solenoids, cores for said solenoids connected to dynamo-regulating devices, a make-and-break mechanism located in the circuit of the solenoids and operated by the movement of the core to break the circuit of the solenoids, and means operated by changes of current in the work-circuit of the dynamo for closing the circuit of either of the solenoids, substantially as set forth.

2. In electric regulators, the combination of two oppositely-acting solenoids normally in the same circuit, cores for said solenoids connected to dynamo-regulating devices, contact-points operated by the cores, one of said contact-points being electrically connected to one pole of one solenoid and the other similarly connected to the opposite pole of the other solenoid, and a contact-plate arranged between the contact-plates of the solenoids and connected to the neutral poles of the solenoids and operated to make connection with either of the other contact-plates by changes in the current of the work-circuit of the dynamo, the above parts being so arranged that the current is caused to pass through both solenoids while the contact-plates are apart, but will cut out one of the solenoids when the contact-plates are in contact, substantially as set forth.

3. In electric regulators, the combination of two oppositely-acting solenoids normally in the same circuit, cores for said solenoids connected to dynamo-regulating devices, contact-points operated by the cores, one of said contact-points being electrically connected to one pole of one solenoid and the other contact-point similarly connected to the opposite pole of the other solenoid, a solenoid in the work-circuit of the dynamo, a core located in said solenoid, and a contact-plate operated by said core by changes of current in the work-circuit of the dynamo to make connection with either of the other contact-plates, substantially as set forth.

In testimony whereof I have hereunto set my hand.

OLIVER B. SHALLENBERGER.

Witnesses:

W. B. CORWIN,

DARWIN S. WOLCOTT.