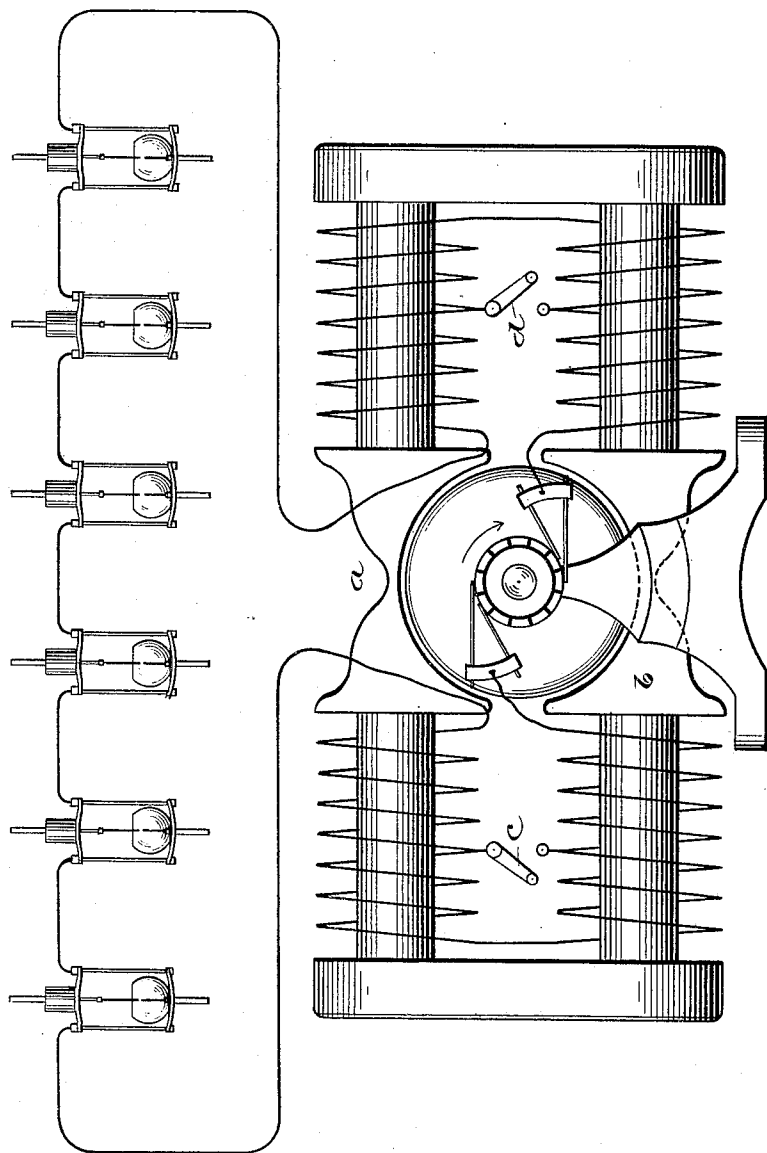


(No Model.)

E. P. WARNER.
COMBINATION DYNAMO.

No. 544,633.

Patented Aug. 13, 1895.



Witnesses.

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ERNEST P. WARNER, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN
ELECTRIC COMPANY, OF SAME PLACE.

COMBINATION-DYNAMO.

SPECIFICATION forming part of Letters Patent No. 544,633, dated August 13, 1895.

Application filed February 24, 1890. Serial No. 341,506. (No model.)

To all whom it may concern:

Be it known that I, ERNEST P. WARNER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Combination - Dynamos, (Case No. 28,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to dynamo-electric machines; and its objects are, briefly stated, first, to make the machine capable of regulation for constant current notwithstanding variations in the load or work being done—in other words, to make the machine capable of regulation throughout the entire range of load with a current of constant strength at all stages—and, second, to quickly change the machine from one current strength to another, as occasion may require.

It is a well-known fact that a series-wound machine having consequent-pole field-magnets and an armature, say, of sixteen coils, with collecting-brushes arranged to short-circuit the coils successively in their revolution, will, if connected with a circuit of a given resistance, give a certain strength of current when the brushes are at the non-sparking point, and that if a change is made in the resistance of the circuit it will be necessary to shift the collecting-brushes forward or backward, as the case may be, to a new non-sparking point. In this new position the current should be of the same strength as when the brushes were in their first position; but it has been found that in a machine of this character, having its poles of uniform cross-section throughout, when a reduction of resistance is made it becomes necessary to move the brushes forward in the direction of rotation in order to reduce the sparking, but upon reaching a new non-sparking position the current would be found to be of greater strength, and upon moving the brushes still farther forward, with the object of reducing the current strength, long sparks appear at the collecting-brushes, or even flashes extending clear around the commutator. I have discovered that if the outside of the poles be cut away, as hereinafter described, the brushes may be shifted backward or forward,

according to the load, so as to maintain a constant-current strength throughout the entire range of variations in the load. This cutting away of the pole-pieces causes the lines of force to be distributed in the field, so that the short-circuited coils will receive uniform inductive action at all positions of the brushes, and thus sparking is prevented, while at the same time the current will be maintained at uniform strength. With a given speed and length of armature-wire in a field of a given strength a certain electromotive-force will result. Now, when the circuit, including the dynamo, has a certain definite resistance the current strength will be determined. The non-sparking position of the brushes is determined by the strength of the field-magnets and the resistance of the circuit. Now, if we have a current of, say, ten amperes, with the brushes at a non-sparking point, we can, by simply reducing the strength of the field of force and bringing the brushes to a new non-sparking point, cause a corresponding reduction in the current strength, although the resistance of the circuit remains unchanged. I have discovered ready means for changing the strength of the field in machines of this character, thereby making them readily convertible from full-arc to what are known as "half-arc" machines. The change may be made in either direction while the machine is in operation.

My invention will be readily understood by reference to the accompanying drawing, in which I have shown a dynamo-electric machine with the pole-pieces cut away from the outside and means for changing the ampere-turns of the field-magnets to make the machine into a full arc or half arc, as may be desired, and arc-lamps connected therewith and adapted to burn at either strength of current without change of adjustment. Such a lamp is shown in Letters Patent No. 415,571, granted Charles E. Scribner, November 19, 1889. Machines of this character I usually construct to give a ten-ampere current for a full arc and a seven-and-one-half-ampere current for a half arc.

The pole-pieces *a* and *b* are cut away upon the outside, so as to be much reduced in cross-section at their centers. This cutting away of the pole-pieces results in such a distribu-

tion of the lines of force with respect to the armature as to permit the brushes to be rotated to maintain a constant-current strength without sparking, notwithstanding changes
5 in the resistance of the load. The armature may be wound and constructed after the manner described in my Patent No. 346,965, granted August 10, 1886, for armatures for dynamo-electric machines. The field-magnet coils are connected in series with each
10 other and with the armature. Now, in order to reduce the ampère-turns of the coil, it is only necessary to close the switches *c d*. Such a closing of these switches will convert
15 the machine into a half-arc machine, since a number of the turns of the field-magnet coils will be short-circuited by the closing of the switches, and thereby rendered inactive. When the switches *c d* are thus closed, the
20 shunted turns remain closed upon themselves, and by their self-induction sudden changes or surges in the magnetic field are prevented. The dynamo is thus rendered stable in action, although the field excitation be considerably
25 below saturation. Stability of action would be obtained to a certain extent though the pole-pieces were not cut away; but by cutting away the pole-pieces the machine becomes not only stable, but is adapted to be regulated
30 for constant current under all conditions of load, whether operating at the greater or reduced strength of current. My machine as thus constructed is adapted to give a constant current without sparking throughout the en-

tire range of load, and is readily convertible 35 from a full-arc to a half-arc or from a half-arc to a full-arc machine.

It is evident that it would not be practicable to cut away the pole-pieces of dynamos having salient poles—as, for example, in the 40 Edison with its single magnet—because the lines of force would not be readily conducted to the portion of the pole-piece beyond the point of least cross-section.

Having thus described my invention, I 45 claim as new and desire to secure by Letters Patent—

In an arc light dynamo, the combination with field magnet coils included in series with the working circuit, of a switch adapted to 50 short-circuit a portion of the field magnet coils to reduce the field strength, the coils being short-circuited instead of thrown on open circuit to thereby afford a counter electro motive force to prevent surges of the field at the 55 lesser strength, and brushes adapted to be moved about the commutator to a position of no spark under the new field strength, whereby the dynamo may be readily converted from a full arc to a half arc machine, substantially as described. 60

In witness whereof I hereunto subscribe my name this 13th day of June, A. D. 1889.

ERNEST P. WARNER.

Witnesses:

ELLA EDLER,

GEORGE P. BARTON.