No. 786,416. PATENTED APR. 4, 1905.

H. H. CUTLER.

ALTERNATING CURRENT POWER TRANSMITTING APPARATUS.

APPLICATION FILED JAN. 28, 1904.

2 SHEETS—SHEET 1.

Fig. 2.

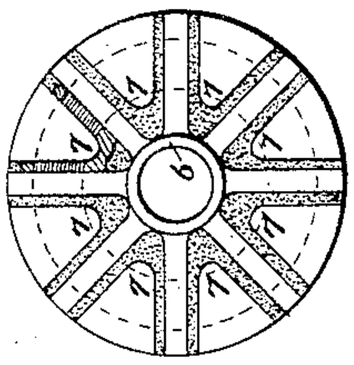
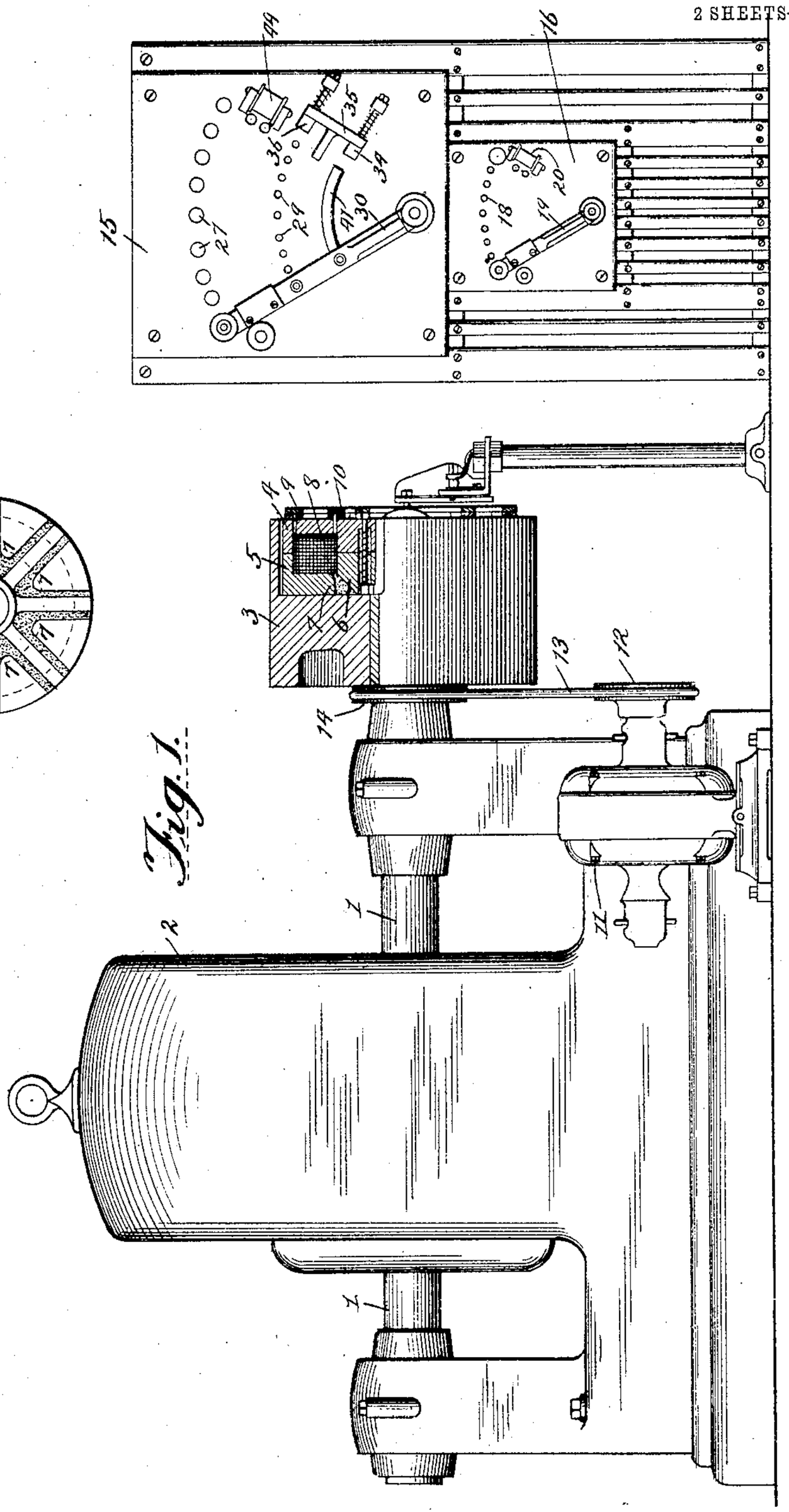


Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 4.

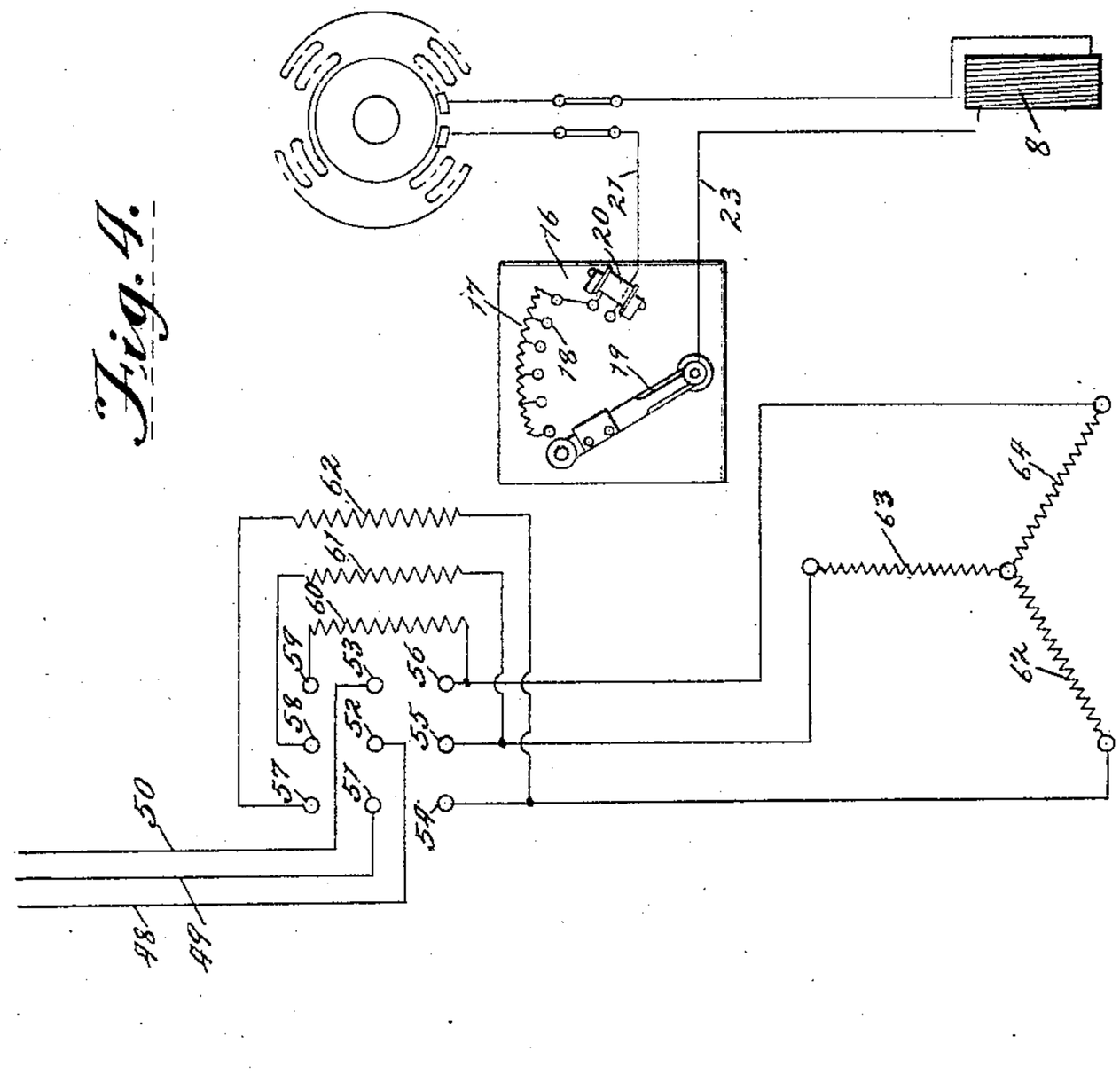
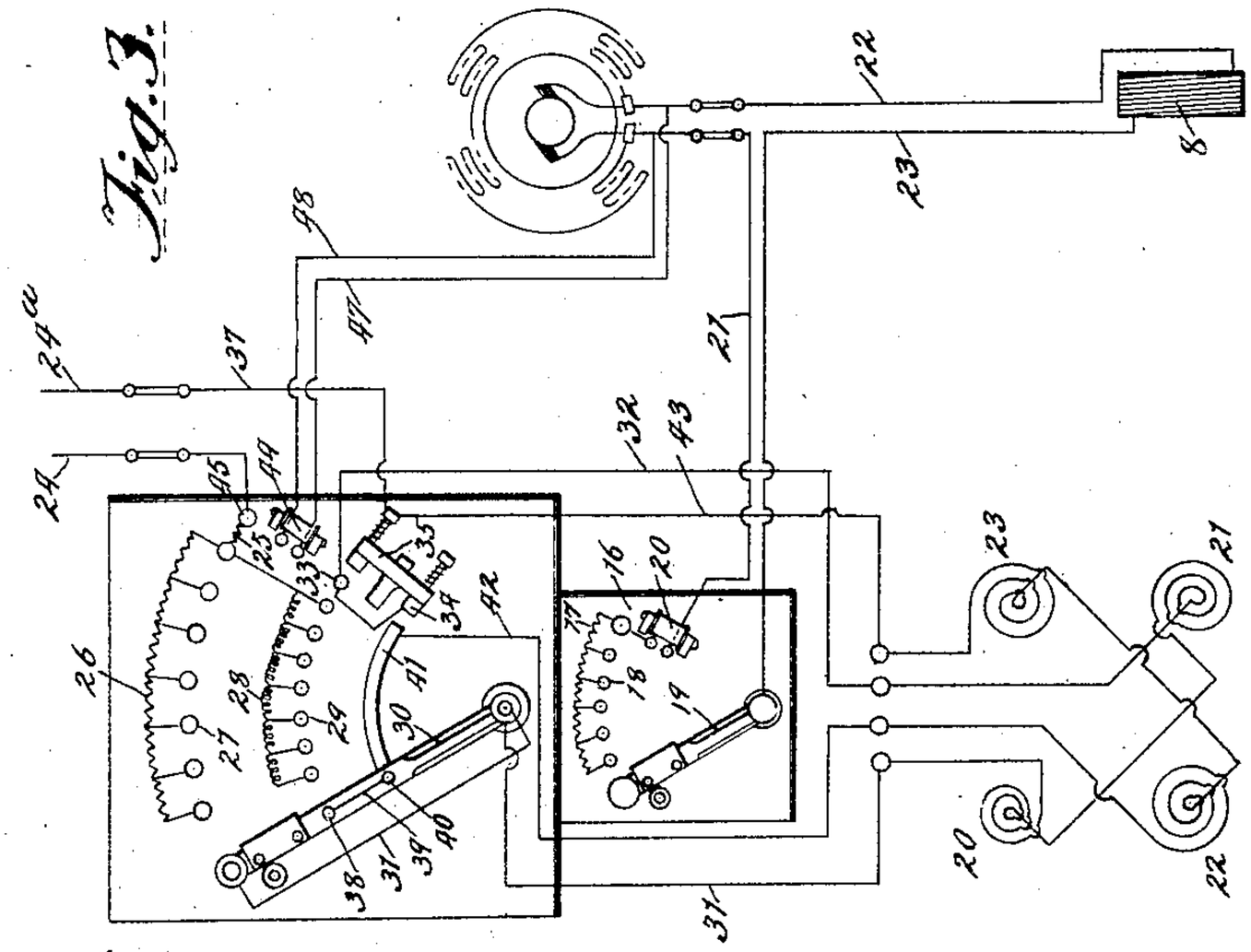


Fig. 3.



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UNITED STATES PATENT OFFICE.

HENRY H. CUTLER, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO THE CUTLER-HAMMER MANUFACTURING COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

ALTERNATING-CURRENT POWER-TRANSMITTING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 786,416, dated April 4, 1905.

Application filed January 28, 1904. Serial No. 190,968.

To all whom it may concern:

Be it known that I, HENRY H. CUTLER, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Alternating-Current Power-Transmitting Apparatus, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to improvements in alternating-power-transmitting apparatus, my object being to provide means for imposing the load upon an alternating-current motor, either single phase or polyphase, without causing undue strain upon said motor or upon the power-transmission system, and to this end I provide a controllable magnetic clutch interposed between the motor and its load and means for supplying a current suitable for operating the same.

The present invention is a modification of the apparatus set forth in my application filed October 22, 1903, Serial No. 178,117.

The present invention relates more particularly to non-synchronous motors, and in an application filed by me January 22, 1904, Serial No. 190,145, I have shown means for starting a synchronous motor and imposing the load thereon, which application is a companion to the present application.

I have illustrated the preferred embodiment of my invention in the accompanying drawings, in which—

Figure 1 is an elevation of the structure of my invention, showing the clutch partly in section, the regulating or governing device for the motor and clutch being shown on the right-hand side of the drawing. Fig. 2 is a face view of the primary member of my clutch or accelerator. Fig. 3 is a diagrammatic view showing the circuits employed in connection with a single-phase motor, and Fig. 4 is a diagrammatic view showing the circuits employed for a triphase motor.

Like numerals refer to like parts throughout the several figures of the drawings.

In constructing the preferred embodiment of my invention I provide upon the shaft 1 of the alternating-current motor 2 a loose pulley 3, which in the present instance constitutes the secondary or induced member of a magnetic clutch or accelerator, the primary member of which is keyed to the shaft 1. The primary or inducing member of this clutch is constructed in accordance with the invention of an application filed by me the 5th day of August, 1903, Serial No. 168,388, and consists, briefly, of a back plate 4, to which is secured a pair of rings 5 and 6, the ring 5 carrying inwardly-extending polar projections and the ring 6 carrying outwardly-extending polar projections, the two sets of poles being arranged in overlapping positions, as shown in Fig. 2. The spaces between the pole-pieces are filled with non-magnetic material 7, which may be Babbitt metal or other equivalent material. Inclosed within the primary member is the energizing-winding 8, which is shown of annular form. Due to the particular construction of the primary member of this clutch, I am enabled to provide a clutch in which the driven member is accelerated through the combined influence of induction and friction, the induction being to create in the secondary member torque-producing currents. Due to the fact that the frictional effect is a constant force during the period of acceleration and the inductive effect is a gradually-decreasing force as the driven member accelerates, it will be seen that I am enabled to provide a clutch in which the driven member will be automatically gradually accelerated and will operate without the jar or sudden starting which has been found so objectionable to magnetic clutches of the prior art. It is apparent that if just sufficient current is admitted to start the driven member the same will not attain full speed and can be driven at any desired speed less than the speed of the driving member until the current is increased sufficiently to bring the driven member to full speed. Therefore by controlling the amount of current which is admitted to the energizing-winding of the clutch I am enabled to provide a clutch which is gradually accelerating and under the full control of the operator.

The terminals of the winding 8 are con-

nected, respectively, with the contact-rings 9 10, upon which rest suitable brushes which serve to convey the current to the clutch-winding.

Direct current is supplied to the clutch-winding by a direct-current exciter 11, having a pulley 12, connected by a belt 13 with a pulley 14, mounted upon the shaft 1 of the motor 2, whereby as the motor 2 is operated the exciter is driven and supplies current to energize the winding 8 of the clutch.

The clutch is controlled by the regulator 16 and, as shown in Fig. 3, is connected in circuit with the resistance 17, the sections of which are connected with the contact-terminals 18, over which the contact-arm 19 is adapted to be moved by hand, a retaining-magnet 20 serving to normally hold the arm in the "on" position and a coiled spring mounted at the pivot of the lever serving to automatically return the contact-arm to the "off" position when the retaining-magnet is deënergized. The clutch-winding 8 is supplied with a direct current by the exciter 11, and to this end one terminal of the exciter is connected by the conductor 21 through the retaining-magnet 20 with the resistance 17. The opposite terminal is connected by the conductor 22 with one terminal of the clutch-winding 8 and the opposite terminal of the clutch-winding is connected by conductor 23 with the contact-arm.

Diagrammatically illustrated in Fig. 3 is the controlling apparatus, which may be used with a single-phase induction-motor having, say, four field-coils 20, 21, 22, and 23. I have selected this number of coils merely for the purpose of illustration and I have not illustrated the rotor or secondary member of the motor, although it will be understood that the usual secondary element in a single-phase motor is contemplated. With the supply-main 24 a resistance 25, subdivided into a plurality of sections, is connected, and likewise a resistance 26, subdivided into a plurality of sections, connected with the terminals 27. A second resistance 28 is also employed and is likewise subdivided into sections which are connected with the terminals 29. One of these resistances—as, for instance, the resistance 26—is non-inductive in character, while the resistance 28 is inductive in character. The resistance 25 may be non-inductive and is for the purpose of reducing the potential supplied to the field of the motor at starting. A contact-arm 30 is provided with a contact-brush connected by conductor 31 through the field-windings 20 and 21, thence by conductor 32 to terminals 33 and 34, thence across the bridge 35 to terminal 36, thence by conductor 37 to the opposite main 24[a] of the supply-circuit.

The contact-arm 30 carries a brush 38, adapted to sweep over terminals 29, this brush being connected by conductor 39 with a brush 40, adapted to sweep over a contact-bar 41, which bar is connected by a conductor 42 through the windings 22 and 23, thence by conductor 43 to conductor 37 and main 24[a].

When the contact-arm 30 has been moved to the extreme position to the right, the brush upon the end thereof engages terminal 45, the brush 38 engages terminal 33, and the bridge 35 is moved by means of the contact-arm out of engagement with the terminals 34 and 36. When the contact-arm is in its full on position, it is held by a retaining-magnet 44, which is connected with the terminals of the exciter 11 by conductors 47 and 48, respectively, and is supplied with a direct current thereby.

The operation of starting the motor is as follows: The parts being initially as shown in Fig. 3, the operator moves the contact-arm 30 to the right, accordingly cutting out the resistances 26 and 28. Circuit is closed from the main 24 through the resistance 25, resistance 26, conductor 31, field-windings 20 and 21, conductor 32, terminals 33 and 34, across the bridge 35 to terminal 36, and thence by conductor 37 to the opposite main 24[a]. Circuit is also closed from the main 24 through the resistance 25, resistance 28, brush 38, conductor 39, brush 40, contact 41, conductor 42, field-windings 22 and 25, conductors 43 and 37 to the opposite main 24[a]. Since the resistance 26 is non-inductive, while the resistance 28 is inductive, the current passing through the resistance 28 will be retarded in phase, and accordingly the field-windings are subjected to current of different phase, which produce a rotating magnetic field, thereby starting the armature or secondary member of the motor. As the contact-arm is moved to the right to cut out the resistance the armature gradually builds up in speed. While the contact-arm is moved over the series of terminals 27 29 the fields which are thus connected in two parallel paths are subject to practically one-half of the normal voltage of the supply-circuit, due to the interposition of the resistance 24. When the contact-arm has been moved to the extreme right—that is, to the full on position—the bridge 35 is moved out of engagement with terminals 34 and 36, and the fields are thereby connected in series, the resistance 25 being at the same time removed from the circuit, so that the full voltage of the supply-circuit is imposed upon the circuit containing the field-windings. This circuit may be traced from the main 24 to the terminal 45, thence by conductor 31, through the field-windings 20 and 21, conductor 32, terminal 33, brush 38, conductor 39, brush 40, contact 41, conductor 42, field-windings 22 and 23, conductors 43 and 37 to the opposite main 16 of the supply-circuit. The retaining-magnet 44 serves to retain the contact-arm 30 in the full on position and the current thereto may be traced from one ter-

minal of the exciter 11 through the conductor 48, through the magnet 44, and thence through the conductor 47 to the opposite terminal of the exciter. The motor is thus brought to full speed and operates the exciter 11 to supply a direct current to the clutch-winding 8. When it is desired to impose the load on the motor, the contact-arm 19 of the clutch-controlling resistance is moved to the first terminal, and current is thus closed through the clutch-windings with all the resistance in circuit. The circuit may be traced from one terminal of the exciter 11 through the conductor 21, the magnet 20, resistance 17, contact-arm 19, and thence through the conductor 23 to the opposite terminal of the exciter. The secondary member of the clutch is thus started from rest and is accelerated in speed as the resistance is removed from the circuit of the clutch-winding by moving the contact-arm 19 to the right. When the resistance has all been removed from the circuit, the clutch-winding is energized to the maximum extent, and the energization is sufficient to bring the driven part to full speed, which has been effected by the motor working at an effective speed with relatively high efficiency and power-factor, and the electrical pressure of the distributing-circuits has not been unduly disturbed. When the contact-arm reaches the full on position, it is grasped by the retaining-magnet 20 and held in this position during normal operation.

If for any reason the secondary supply-circuit containing the clutch-winding should become broken or if the potential for any reason should fall in value, the retaining-magnets 20 and 44 would be deënergized, and the motor would thus be brought to rest, and the circuit through the clutch-winding would be opened at the controller. When it is desired to shut down the machinery which the motor is driving, the clutch-winding may be deënergized by moving the contact-arm 19 to the off position. The motor continues to run at normal speed; but the clutch permits the load to be disconnected therefrom. Likewise if it be desired to operate the driven machinery at less than normal speed the contact-arm may be moved to a position to insert resistance in series with the clutch-winding to energize the same to the desired degree, and thereby produce the desired speed of rotation of the driven member while the motor continues to operate at its most effective speed. If it be desired to shut down the motor, the clutch may be first deënergized by moving the contact-arm 19 to the off position and then moving the contact-arm 30 to the off position, or the motor could be shut down, in which case the exciter 11 would stop and the magnet 20 be deënergized, allowing the arm 19 to fly back to its off position.

In Fig. 4 I have illustrated the circuit arrangement for a polyphase induction-motor, the circuit arrangement being designed for a three-phase motor. The supply-mains 48, 49, and 50 are connected, respectively, with the posts 51, 52, and 53 of a three-blade double-throw switch. When thrown in one direction, the blades engage terminals 57, 58, and 59 and when thrown in the other direction engage terminals 54, 55, and 56. Resistances 60, 61, and 62 are interposed between the upper set of terminals and the lower set, so that when the switch is in the up position these resistances are connected in circuit and when in the down position they are removed from the circuit. The field-windings 62, 63, and 64 are connected between the terminals 54, 55, and 56 in the usual manner, as illustrated.

In starting the motor the switch-blades are moved into engagement with the terminals 57, 58, and 59, respectively, and the currents of different phase which are supplied to the field-windings 62, 63, and 64 are reduced in amount due to the interposition of the resistances 60, 61, and 62. As the armature of the motor rises in speed the switch-blades are thrown into engagement with the terminals 54, 55, and 56, thus removing the resistances from circuit and permitting the motor to attain full speed. An exciter driven by the motor serves to supply a direct current to the clutch and also to the retaining-magnet of the clutch-controller, and the load may be applied to the motor after the same has attained full speed. In stopping the machinery to be driven by the motor the motor may be shut down, thus stopping the exciter and deënergizing the clutch, or the controller-arm may be moved to the off position and the clutch deenergized without stopping the motor.

While I have described the preferred embodiment of my invention, it will be understood that I do not wish to limit myself to the details of construction, as there are numerous changes which may be made without departing from the spirit of my invention. The exciter need not necessarily be driven by the motor, or it may be driven by power produced by the motor in other ways, and the clutch may be associated with the motor in a different manner from that shown and described by me. Moreover, the alternating-current motor and exciter may be of any type.

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

1. The combination with an alternating-current motor, of an inherently gradually accelerating magnetic clutch associated therewith, and means for generating a current for operating said clutch.

2. The combination with an alternating-current motor, of an inherently gradually accelerating magnetic clutch associated therewith, and means operated by said motor for supplying current to said clutch.

3. The combination with an alternating-cur-

rent motor, of an inherently gradually accelerating magnetic clutch associated therewith, and an exciter for supplying current to said clutch.

4. The combination with an alternating-current motor, of an inherently gradually accelerating magnetic clutch associated therewith, and an exciter operated by said motor for supplying current to said clutch.

5. The combination with an alternating-current motor, of an inherently gradually accelerating magnetic clutch associated therewith, means operated by said motor for supplying current to said clutch, and means for controlling said clutch.

6. The combination with an alternating-current motor, of a controllable magnetic clutch whose driven member is accelerated through the combined influence of induction and friction associated therewith, and means for generating a current for operating said clutch.

7. The combination with an alternating-current motor, of a controllable magnetic clutch whose driven member is accelerated through the combined influence of induction and friction associated therewith, and means operated by said motor for supplying current to said clutch.

8. The combination with an alternating-current motor, of a controllable magnetic clutch whose driven member is accelerated through the combined influence of induction and friction associated therewith, and an exciter for supplying current to said clutch.

9. The combination with an alternating-current motor, of a controllable magnetic clutch whose driven member is accelerated through the combined influence of induction and friction associated therewith, and an exciter operated by said motor for supplying current to said clutch.

10. The combination with an alternating-current motor, of a controllable magnetic clutch whose driven member is accelerated through the combined influence of induction and friction associated therewith, means operated by said motor for supplying current to said clutch, and means for controlling said clutch.

11. The combination with an alternating-current motor, of a clutch whose torque-producing power normally decreases as the driven member is accelerated, means for increasing the torque, and means for generating the current for operating said clutch.

12. The combination with an alternating-current motor, of a clutch whose torque-producing power normally decreases as the driven member is accelerated, controllable means for increasing said torque, and means for generating the current for operating said clutch.

13. The combination with an alternating-current motor, of a clutch whose torque-producing power normally decreases as the driven member is accelerated, controllable means for increasing said torque, and means operated by said motor for supplying current to said clutch.

14. The combination with an alternating-current motor, of a clutch whose torque-producing power normally decreases as the driven member is accelerated, controllable means for increasing said torque, and an exciter for supplying current to said clutch.

15. The combination with an alternating-current motor, of a clutch whose torque-producing power normally decreases as the driven member is accelerated, controllable means for increasing said torque, and an exciter operated by said motor for supplying current to said clutch.

16. The combination with an alternating-current motor, of a controlling device for starting said motor, a retaining-magnet for holding the operative element of said starting device in a prearranged position, and means operated by said motor for supplying a current to said retaining-magnet.

17. The combination with an alternating-current motor, of a controlling device for starting the same, a retaining-magnet for holding the operating element of said starting device in a prearranged position, and an exciter for supplying a direct current to said retaining-magnet.

18. The combination with an alternating-current motor, of a controlling device for starting the same, a retaining-magnet for holding the operating element of said starting device in a prearranged position, and an exciter driven by said motor for supplying a direct current to said retaining-magnet.

19. The combination with an alternating-current-supply circuit, of a motor associated therewith, a controlling device for starting the same, a magnetic clutch or accelerator associated with said motor, a retaining-magnet for the operating element of said starting device, and an exciter for supplying a direct current to said retaining-magnet and said clutch.

20. The combination with an alternating-current-supply circuit, of a motor associated therewith, a controlling device for starting the same, a magnetic clutch or accelerator associated with said motor, a retaining-magnet for the operating element of said starting device, and an exciter driven by said motor for supplying a direct current to said retaining-magnet and said clutch.

21. The combination with an alternating-current-supply circuit, of a motor associated therewith, a suitable starting device for said motor, a magnetic clutch or accelerator associated with said motor, a starting-box for said clutch, a retaining-magnet for the operating element of said starting-box, and an exciter for supplying a direct current to said retaining-magnet and to said clutch.

22. The combination with an alternating-current-supply circuit, of a motor associated

therewith, a suitable starting device for said motor, a magnetic clutch or accelerator associated with said motor, a starting-box for said clutch, a retaining-magnet for the operating element of said starting-box, and an exciter operated by said motor for supplying a direct current to said starting-box and said clutch.

23. The combination with an alternating-current-supply circuit, of a motor associated therewith, a suitable starting device for said motor, a magnetic clutch or accelerator associated with said motor, a suitable starting-box for said clutch, retaining-magnets for the movable elements of said motor-starting device and said clutch-starting box, and an exciter for supplying a direct current to said retaining-magnets and said clutch.

24. The combination with an alternating-current-supply circuit, of a motor associated therewith, a suitable starting device for said motor, a magnetic clutch or accelerator associated with said motor, a suitable starting-box for said clutch, retaining-magnets for the movable elements of said motor-starting device and said clutch-starting box, and an exciter driven by said motor for supplying a direct current to said retaining-magnets and said clutch.

In witness whereof I have hereunto subscribed my name in the presence of two witnesses.

HENRY H. CUTLER.

Witnesses:
F. S. WILHOIT,
L. D. ROWELL.