No. 854,831. PATENTED MAY 28, 1907.

R. D. MERSHON.

ALTERNATING CURRENT APPARATUS.

APPLICATION FILED OCT. 31, 1904.

4 SHEETS—SHEET 1.

Fig. 1

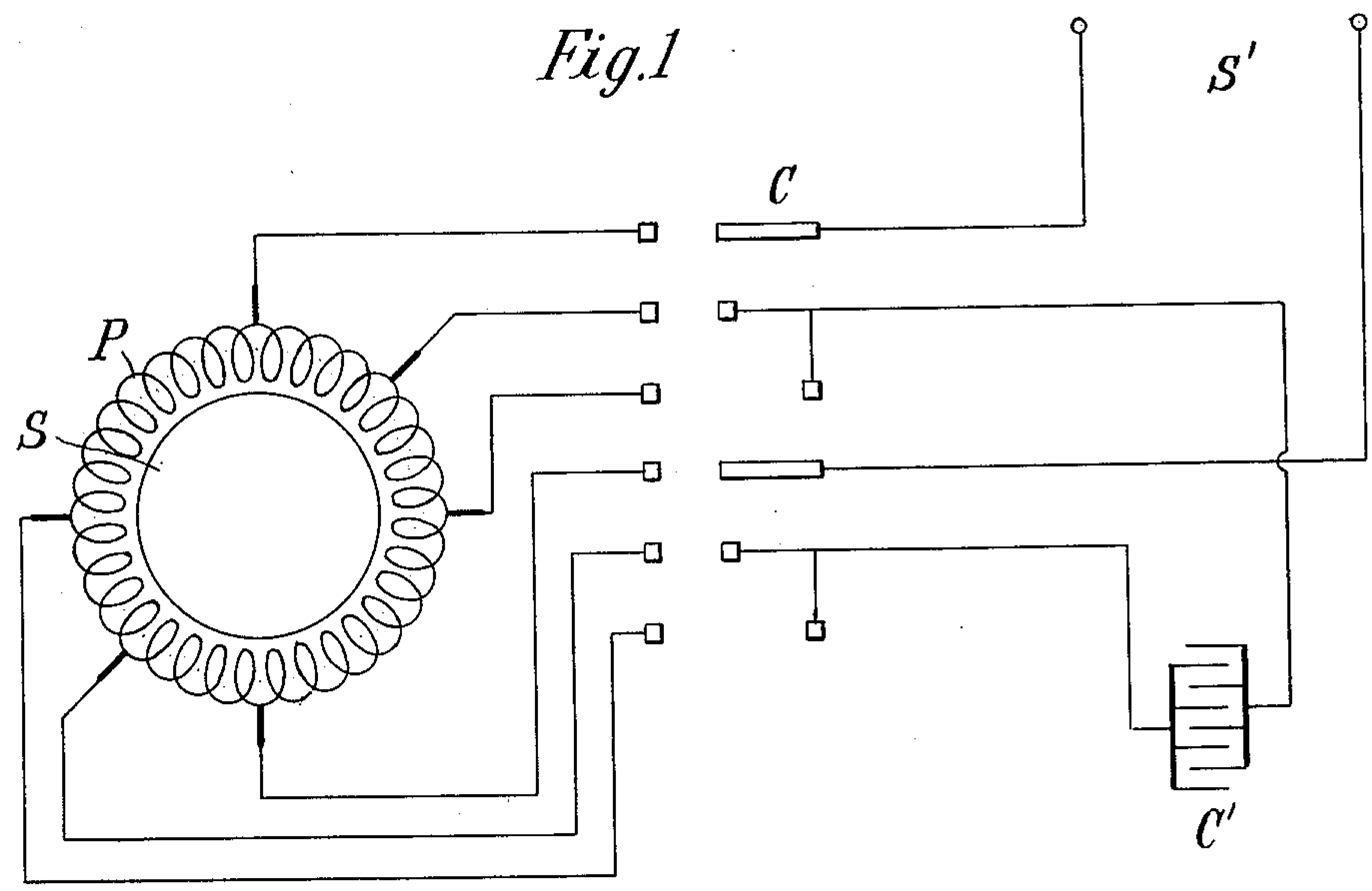
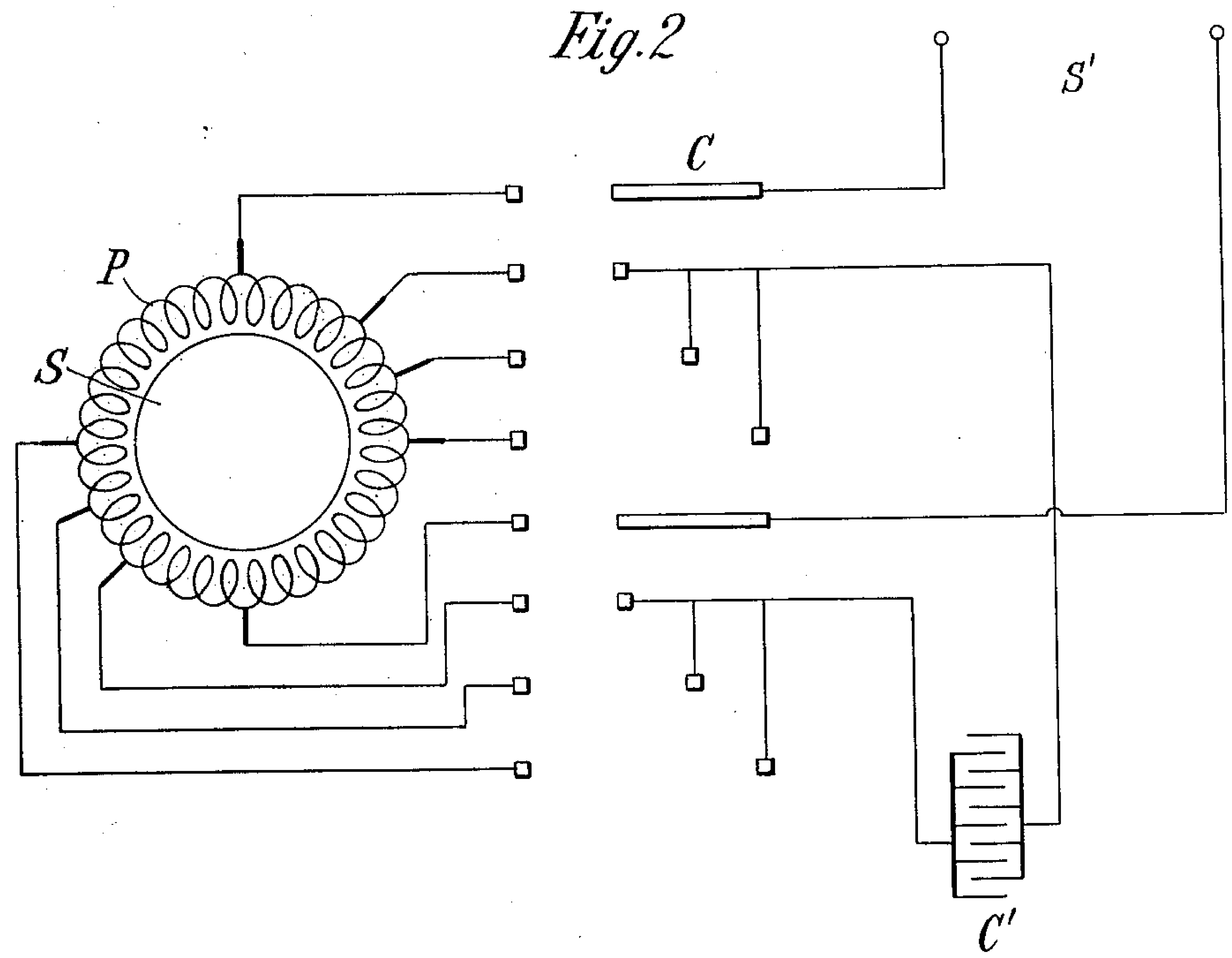


Fig. 2



Witnesses
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4 SHEETS—SHEET 2.

Fig. 3

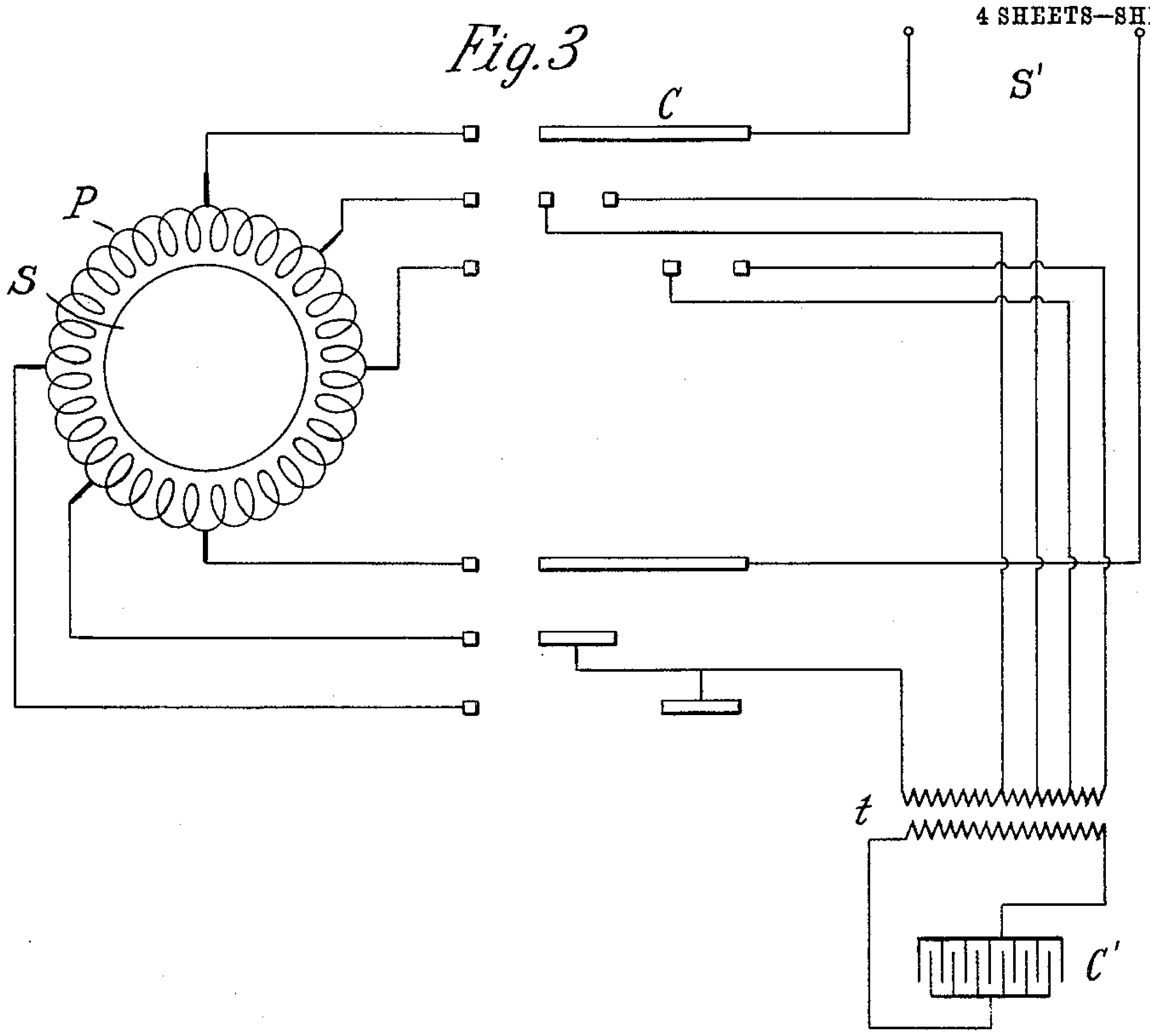
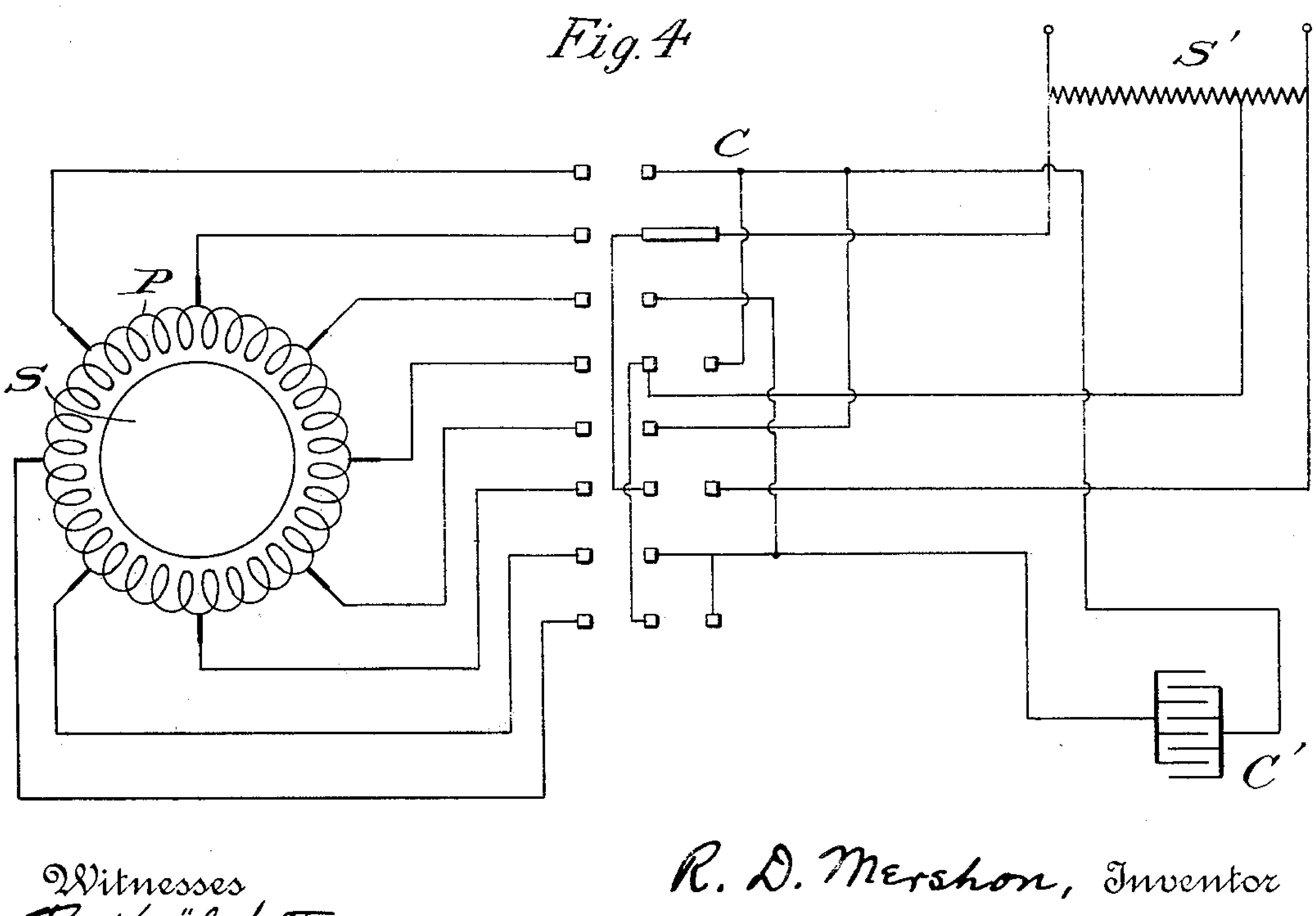


Fig. 4



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4 SHEETS—SHEET 3.

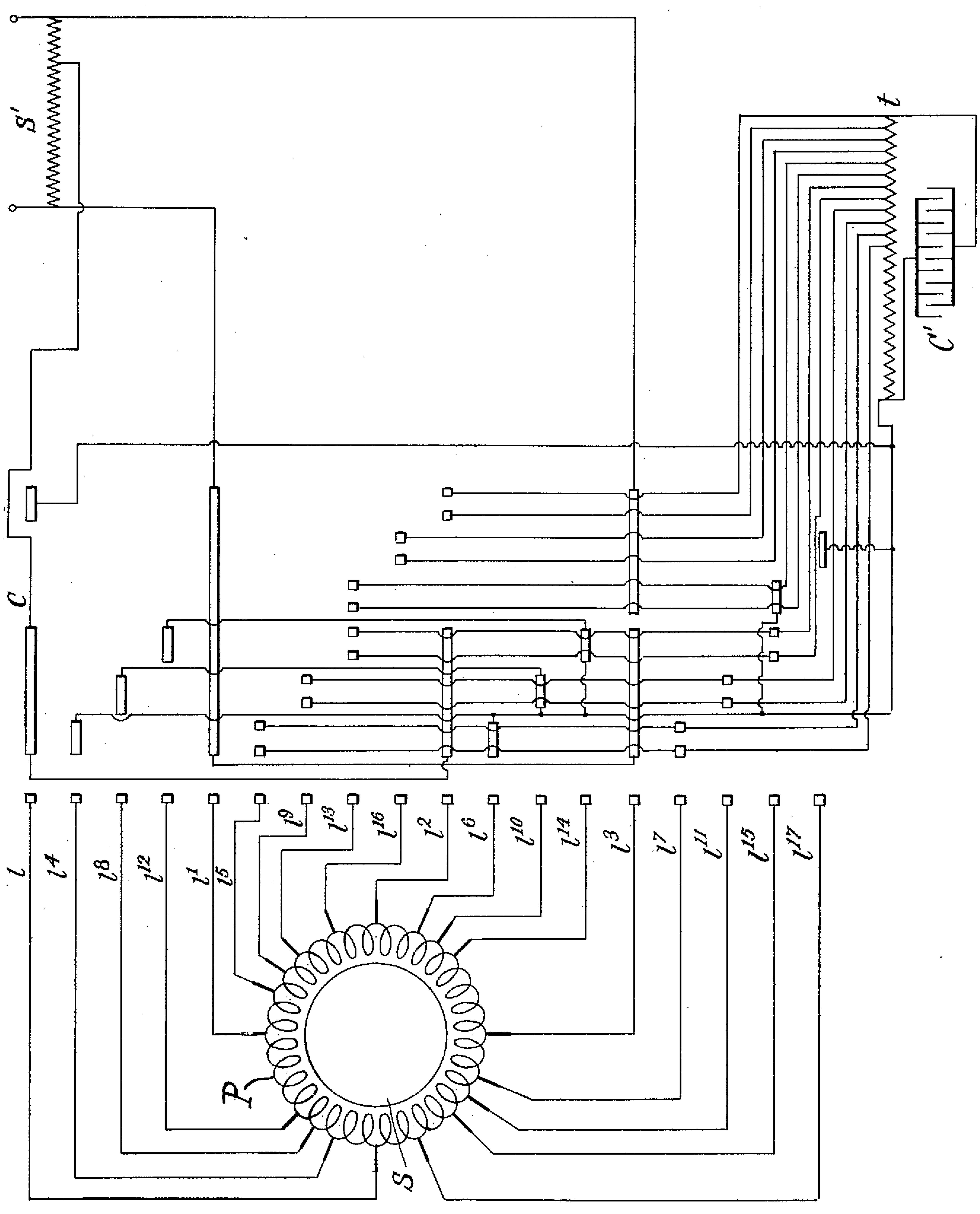

Fig. 5

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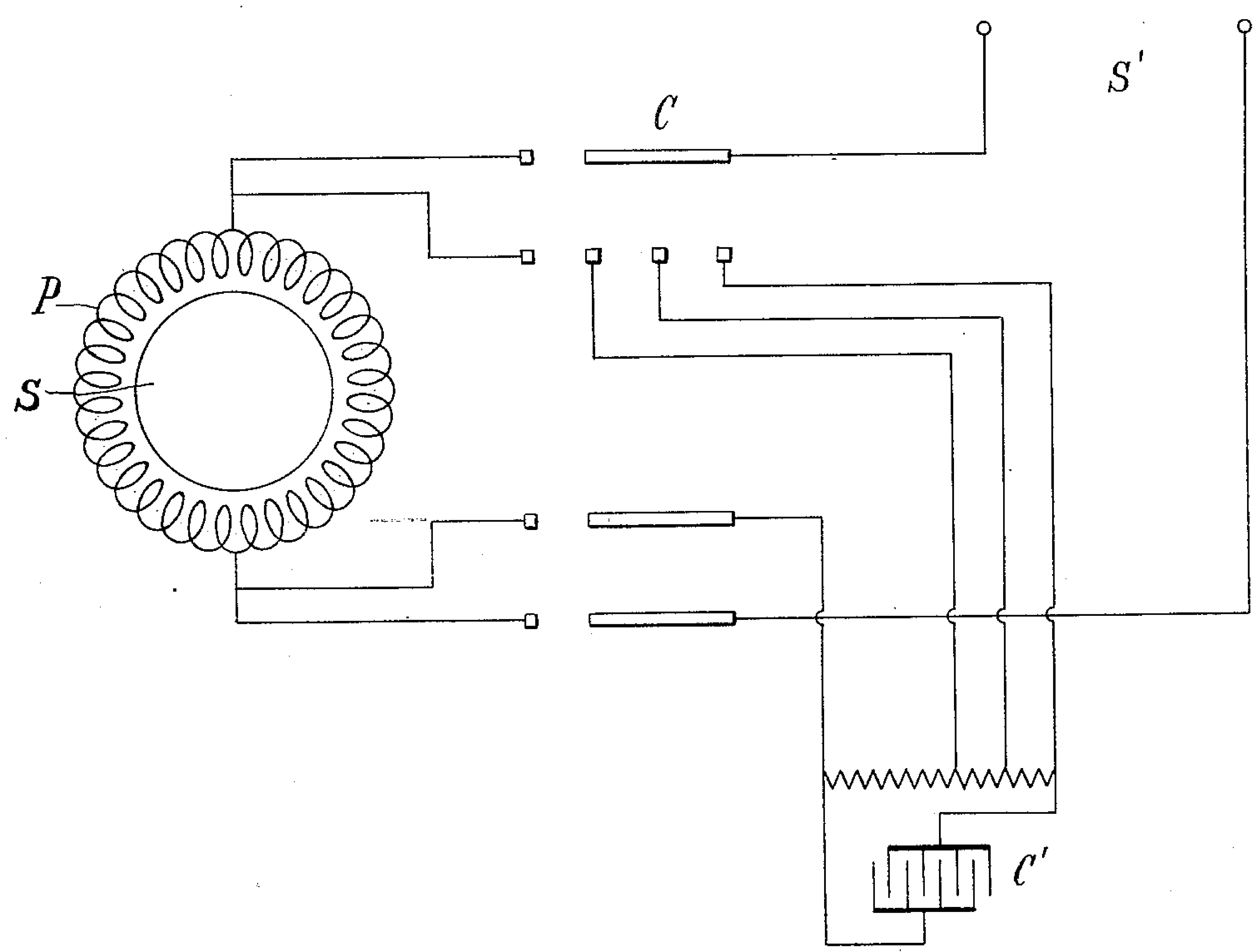
4 SHEETS—SHEET 4.

Fig. 6.



Witnesses
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UNITED STATES PATENT OFFICE.

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ALTERNATING-CURRENT APPARATUS.

No. 854,831. Specification of Letters Patent. Patented May 28, 1907.

Application filed October 31, 1904. Serial No. 230,663.

To all whom it may concern:

Be it known that I, RALPH D. MERSHON, a citizen of the United States, residing at New York, in the county and State of New York, have invented certain new and useful Improvements in Alternating-Current Apparatus, of which the following is a specification, reference being had to the drawings accompanying and forming part of the same.

My invention relates to alternating current motors supplied with single phase current, and has for one of its objects the production of a uniform, or approximately uniform, rotating field.

A further object is to regulate, when desired, the amount of quadrature current taken by the motor and to obtain a better distribution of the copper losses in the motor, thus reducing the copper losses and increasing the capacity of the motor.

It is well known that, if to the primary of a single phase motor there be connected a reactance or a capacity, on an electrical diameter or chord at an angle to that of the impressed electromotive force, a rotating field will be produced and that with a closed secondary the motor will be self-starting.

The effects of reactance and capacity, both at starting and when running, are of course different as to the kind of current taken by them. The former takes the same kind of current as that ordinarily taken by the motor, namely a lagging current, and the reactance will therefore cause the lagging current to the motor to be increased. On the other hand the condenser takes a leading current, and by properly proportioning the same, both when used alone and when a reactance also is used, as described in my copending application Serial No. 226,451, the motor may be made to take from the supply source a current of approximately unity power factor, or even leading if desired.

The best position, in general, for the condenser connections when the motor is running is midway between the leads for the impressed electromotive force; that is, with the condenser connected on an electrical diameter, or common electrical diameters, 90 electrical degrees from the diameter or diameters of the impressed E. M. F. This angular position however, is not the best for starting effect, and my invention therefore makes provision for starting the motor with the condenser, or reactance, as the case may be, connected at an angle less than 90 electrical degrees, and then shifting the connections to a greater angle when increase in speed or other cause make it desirable to do.

In general the best angle for starting effect is 45 electrical degrees, but it may of course be any other angle if desired, or the motor even may be started by auxiliary means with the condenser at 90 degrees. In changing from a smaller to a larger, or what may be called the ultimate angle, the change may be made at a single step, or by a plurality of steps through one or more intermediate positions. For example, starting at 45° when the motor increases in speed to a point which makes the 90° connection better, the connections may be shifted directly the latter; or, as the speed increases the connections may be shifted to an angle less than 90°, and then to the latter, or through any number of intermediate steps. Of course the more steps used the more gradually is the condenser brought to its ultimate position, and its position may by such means be made at all times to approach to that which is best for the operation of the motor at any particular instant.

My invention therefore includes an arrangement whereby the motor may be started with the condenser (or reactance) connected at one angle, and the connections of the latter shifted to a greater angle when changed conditions in the motor, as for example increase of speed, make such change advisable. The motor may have any number or numbers of poles, as for example one in which the number of poles may be varied, for the purpose of varying its speed. In such case the condenser connections may be shifted, as described, for each number of poles.

Instead of changing the connections of the condenser from a smaller angle to a greater for each number of poles they may be maintained, for all the numbers of poles or for two or more numbers of poles, at the same position relative to the leads for the impressed electromotive force. In such case the maintained angle between the condenser connections and the supply leads should, generally speaking, be 90 electrical degrees, which, as before stated, is the best for the conditions when the motor is running. My invention therefore further includes an arrangement whereby, in a motor adapted for change in the number of its poles, the condenser (or reactance) connections may be shifted, **when** necessary, so as to maintain the same at a certain angle, for example, 90 electrical degrees, for the supply leads, for various numbers of poles.

It is desirable that the value of the current taken by the condenser (or other device) should be such as will produce the best results in the motor, and I have accordingly made provision whereby this current value may be suitably regulated. The same may be effected in a variety of ways. For example, the device, whether reactance, or capacity, may be connected to the primary inductively, as through a transformer, and in this case the ratio of the transformer may be varied, thus causing a higher or lower voltage to be impressed upon the device, as the case may be. With a reactance the desired result may be obtained by varying the number of turns. With a capacity it may be effected by increasing or diminishing its value, as by using a greater or less number of condensers, or by switching condensers into series and into multiple; the reactance current also might be varied in a corresponding way.

The precise method by which the current to the device or devices is regulated is immaterial, and is rather a matter of convenience and desirability under particular circumstances. This regulation of the condenser or reactance current, or both, may be utilized with motors having but one number of poles, or more than one number. My invention therefore further includes an arrangement whereby the value of the current taken by the device or devices may be regulated to suit the condition in the motor.

In the accompanying drawings I have shown the invention diagrammatically applied to machines having primary elements consisting of a single ring winding, but the same is of course applicable to machines of the drum type, and also to those of either type having a plurality of windings.

Figure 1 illustrates an arrangement of a two pole motor and a condenser connected with the primary element, provision being made for shifting the connections of the condenser from 45 degrees to 90 degrees from the supply leads. Fig. 2 shows a similar arrangement, but provided with intermediate connections for the condenser, at 67.5 degrees from the supply leads. Fig. 3 shows a two pole motor and a condenser connected to the primary element, with provision for shifting the condenser connections from 45 to 90 degrees, and also for varying the current taken thereby. Fig. 4 shows a motor adapted to run with four and two poles, and a condenser connected therewith, means being provided to keep the condenser connections 90 electrical degrees from the supply leads for both number of poles. Fig. 5 is a system in which the number of poles in the motor may be four or two, the condenser connections being shifted from 45 to 67.5 and then to 90 electrical degrees from the supply leads for each number of poles, and the current taken by the condenser being varied at suitable times. Fig. 6 shows a system in which the condenser is connected with the primary element through the same leads as the external circuit, with means for regulating the current taken by the condenser.

Throughout the various figures P indicates the primary element of the motor, and S its secondary. A single phase source is shown at S′, and a condenser at C′.

Referring now more particularly to Fig. 1, therein is shown a two-pole motor, connected with the source S′ through a controller C. The condenser C′ is also connected through the controller, and by tracing the leads it will be seen that in the first position the condenser is connected at points approximately 45 electrical degrees (which in a two-pole motor are identical with degrees of arc) from the leads for the impressed electromotive force. Shifting the controller to its next position this angle is changed to 90 degrees. Such change may of course be made whenever it becomes necessary for the best operation of the machine.

In Fig. 2 a similar arrangement is shown, with the addition of an intermediate position, as for example 67.5 degrees, between the starting and running positions of the condenser connections, there being in this case three steps of the controller. Two or more intermediate positions may be employed if desired, making the change to the final running position more gradual and therefore conforming more closely to the varying conditions in the motor.

In Fig. 3 is shown an arrangement whereby the position of the condenser connections may be changed, and also the value of the current taken thereby. In the first position of the controller the condenser is connected at 45 degrees, with a certain number of turns of the transformer *t*. In the second step the number of transformer turns connected with the motor is increased, thus modifying the condenser current from what it would have been if the number of transformer turns were not changed. In the third step of the controller the condenser connections are shifted to 90 degrees, with a greater number of turns in the transformer, and at the last step the number of turns is still greater, with the connections remaining at 90 degrees.

Fig. 6 shows a further application of this feature of my invention. In this case the condenser is connected to the supply leads, but the current taken by it is regulated, as by varying the number of turns in its transformer, through the controller C.

As before stated, my invention includes an arrangement whereby the condenser (or reactance, as the case may be) is maintained at a certain position relative to the leads for the impressed E. M. F., for two or more of the various numbers of poles with which the motor is adapted to operate. Such an arrangement is shown in Fig. 4. The motor may have four or two poles, according to the position of the controller, and by tracing the leads it will be seen that in both positions, that is, for both numbers of poles, the condenser is connected at the same points relative to the supply leads, in the present instance 90 electrical degrees therefrom. Of course the position of the condenser connections, whatever it may be, can be maintained for as many numbers of poles as desired. The value of the current taken by the condenser may be regulated, if desired, as described above.

In Fig. 5 several of the features of my invention are combined in a single system. The controller C has twelve positions, the first six giving four poles through motor leads l, l', l^2, l^3; and the last six, two poles, through leads l', l^3. In the first step, the condenser C′ is connected at points 45 electrical degrees from the supply leads, through leads l^4, l^5, l^6, l^7, with a certain voltage impressed on the condenser through the transformer t. The latter is an auto-transformer, but may of course be one of the ordinary type if desired. At the second position of the controller the condenser remains connected at the same points, but the voltage impressed on it is modified from what it would have otherwise been, by connecting more turns of the transformer with the motor primary. In the third step the condenser is connected at 67.5 electrical degrees from the points of supply, through leads l^8, l^9, l^{10}, l^{11}, with still more transformer turns connected with the motor. In the fourth step, the condenser connections are still at 67.5 degrees, but the number of transformer turns is increased. In the fifth step the condenser connections are shifted to 90 electrical degrees, through leads l^{12}, l^{13}, l^{14}, l^{15}, the number of transformer turns being again greater. In the sixth step the 90 degree connection is maintained, with still more transformer turns included. At the seventh step the number of poles is reduced to two, the current being delivered though leads l', l^3. At the same time the condenser is connected to the leads l^{13}, l^{15}, only, which, with two poles are only 45 electrical degrees from the points of supply. The voltage impressed upon the condenser, however, is again modified relative to that in the preceding position of the controller. In the eighth position the number of transformer turns is increased, but the points of connection are unchanged. In the ninth step the condenser connections are shifted to 67.5 degrees from the supply points, to leads l^{16}, l^{17}, and the number of transformer turns is simultaneously increased. In the tenth step the 67.5 degree position is maintained, but the number of turns in the transformer is again increased. At the eleventh step the condenser connections are again changed, this time to the leads l, l^2, which are 90 degrees from the supply leads l', l^3. At the same time a still greater number of transformer turns is included. At the twelfth and last step of the controller a further increase is made in the number of transformer turns, the points of connection remaining at 90 degrees.

The number of changes in the number of poles, in the position of the condenser connections, and in the regulation of the condenser current, are of course merely typical in the above, and the same may be increased or diminished at will without departure from the proper spirit of my invention.

In the above description I have referred only to increasing the number of transformer turns connected with the motor, for the purpose of regulating the condenser (or reactance) current, but it is clear that changes in the other direction are permissible and may at times be desirable, either for one or more steps.

So far, for the purpose of avoiding confusion, and to make the explanation clearer, I have mentioned a motor as the machine to which my invention is applicable. It is evident, however, that the same may be applied to advantage in the case of a generator. The motor itself may at times become a generator, as when driven above synchronism at any number of poles, as might be the case when using the motor for braking purposes.

Throughout the description the reactance and the capacity have been spoken of as if they were equivalents. By this it is understood that so far as the generic claims herein are concerned, one device may be substituted for another. Their effects are the same to the extent that they both take a current which is 90 degrees or approximately 90 degrees away from the E. M. F. impressed upon them. Each may therefore be described as a "quadrature device," and as this effect, of taking a quadrature current, is one of the elements of my invention, it is plain that any device which will produce this effect is, for the purposes of the invention, included therein.

It will also be understood that the use of a plurality of devices, where only one is specifically mentioned, is within the scope of my invention, and that the device or devices may be connected on chords as well as on electrical diameters. Furthermore, it is evident that shifting the leads of the external circuit relative to the connections of the quadrature device, for the purpose of changing the angle between them, is equivalent to shifting the latter connections relative to the former, and is therefore not a departure from the proper scope of the invention.

What I claim is:

1. The combination with an alternating current machine, and a single-phase circuit connected therewith, of a quadrature device connected with the primary element of the machine, and means for shifting the connections of the quadrature device to two or more angular positions relative to the connections of the single-phase circuit, as set forth.

2. The combination with an alternating current machine, and a single-phase circuit connected therewith, of a quadrature device connected with the primary element of the machine, the connections thereof being at an angle to those of the single-phase circuit, means for shifting the connections of the quadrature device, and means for regulating the current taken by the quadrature device, as set forth.

3. The combination with an alternating current machine, and a single-phase circuit connected therewith, of a quadrature device connected with the primary element of the machine, means for shifting the connections of the quadrature device to two or more angular positions relative to the connections of the single-phase circuit, and means for regulating the current taken by the quadrature device, as set forth.

4. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the number of poles in the machine, of a quadrature device connected with the primary element of the machine, and means for shifting the points of connection of the quadrature device for different numbers of poles, as set forth.

5. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the number of poles in the machine, of a quadrature device connected with the primary element of the machine, and means for shifting the points of connection of the quadrature device from one angle to another relative to the connections of the single-phase circuit, for each number of poles, as set forth.

6. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the number of poles in the machine, of a quadrature device connected with the primary element of the machine, and means for shifting the points of connection of the quadrature device from one to two or more angular positions relative to the connections of the single-phase circuit, for each number of poles, as set forth.

7. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the number of poles in the machine, of a quadrature device connected with the primary element of the machine, means for shifting the points of connection of the quadrature device for different numbers of poles, and means for regulating the current taken by the quadrature device, as set forth.

8. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the number of poles in the machine, of a quadrature device connected with the primary element of the machine, means for shifting the points of connection of the quadrature device from one angle to another relative to the connections of the single-phase circuit, for each number of poles, and means for regulating the current taken by the quadrature device, as set forth.

9. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the number of poles in the machine, of a quadrature device connected with the primary element of the machine, means for shifting the points of connection of the quadrature device from one to two or more angular positions relative to the connections of the single-phase circuit, for each number of poles, and means for regulating the current taken by the quadrature device, as set forth.

10. The combination with an alternating current machine, and a single-phase circuit connected therewith, of a condenser connected with the primary element of the machine, the connections thereof being at an angle to those of the single-phase circuit, and means for shifting the connections of the condenser, as set forth.

11. The combination with an alternating current machine, and a single-phase circuit connected therewith, of a condenser connected with the primary element of the machine, and means for shifting the connections of the condenser to two or more angular positions relative to the connections of the single-phase circuit, as set forth.

12. The combination with an alternating current machine, and a single-phase circuit connected therewith, of a condenser connected with the primary element of the machine, the connections thereof being at an angle to those of the single-phase circuit, means for shifting the connections of the condenser, and means for regulating the current taken by the condenser, as set forth.

13. The combination with an alternating-current machine, and a single-phase circuit connected therewith, of a condenser connected with the primary element of the machine, means for shifting the connections of the condenser to two or more angular positions relative to the connections of the single-phase circuit, and means for regulating the current taken by the condenser, as set forth.

14. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the

number of poles in the machine, of a condenser connected with the primary element of the machine, and means for shifting the points of connection of the condenser for different numbers of poles, as set forth.

15. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the number of poles in the machine, of a condenser connected with the primary element of the machine, and means for shifting the points of connections of the condenser from one angle to another relative to the connections of the single-phase circuit, for each number of poles, as set forth.

16. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the number of poles in the machine, of a condenser connected with the primary element of the machine, and means for shifting the points of connection of the condenser from one to two or more angular positions relative to the connections of the single-phase circuit, for each number of poles, as set forth.

17. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the number of poles in the machine, of a condenser connected with the primary element of the machine, means for shifting the points of connection of the condenser for different numbers of poles, and means for regulating the current taken by the condenser, as set forth.

18. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the number of poles in the machine, of a condenser connected with the primary element of the machine, means for shifting the points of connection of the condenser from one angle to another relative to the connections of the single-phase circuit, for each number of poles, and means for regulating the current taken by the condenser, as set forth.

19. The combination with an alternating current machine, a single-phase circuit connected therewith, and means for varying the number of poles in the machine, of a condenser connected with the primary element of the machine, means for shifting the points of connection of the condenser from one to two or more angular positions relative to the connections of the single-phase circuit, for each number of poles, and means for regulating the current taken by the condenser, as set forth.

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