(No Model.) 3 Sheets—Sheet 1.

E. W. RICE, Jr.

REACTIVE COIL.

No. 381,420. Patented Apr. 17, 1888.

Fig. 1.

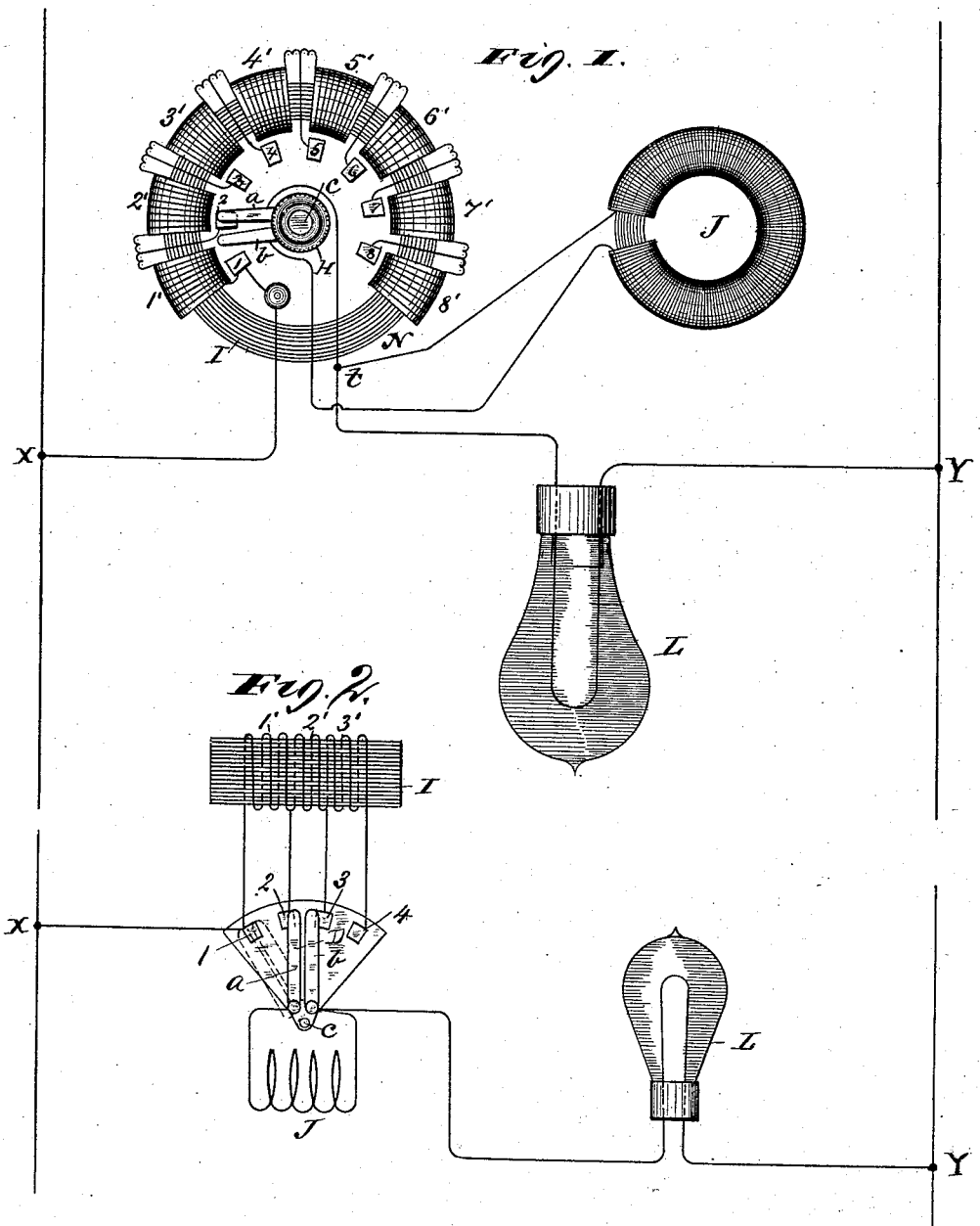

Fig. 2.

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Fig. 3.

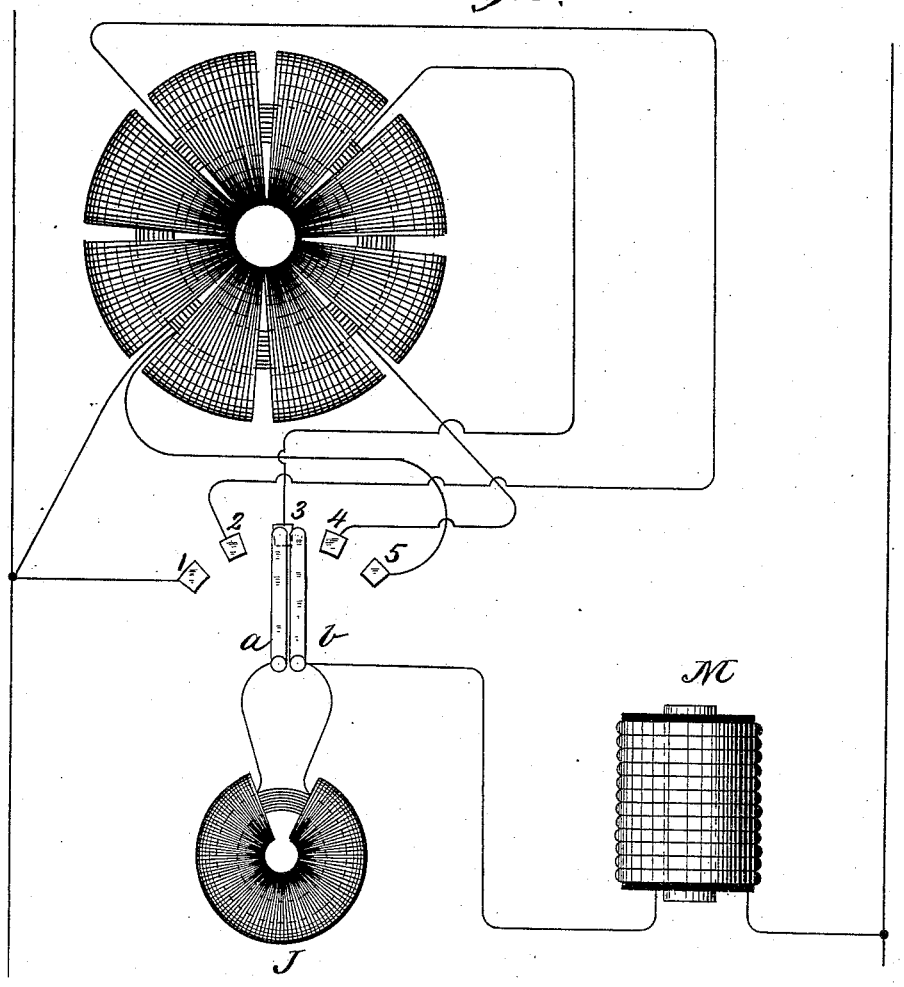

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Fig. 4

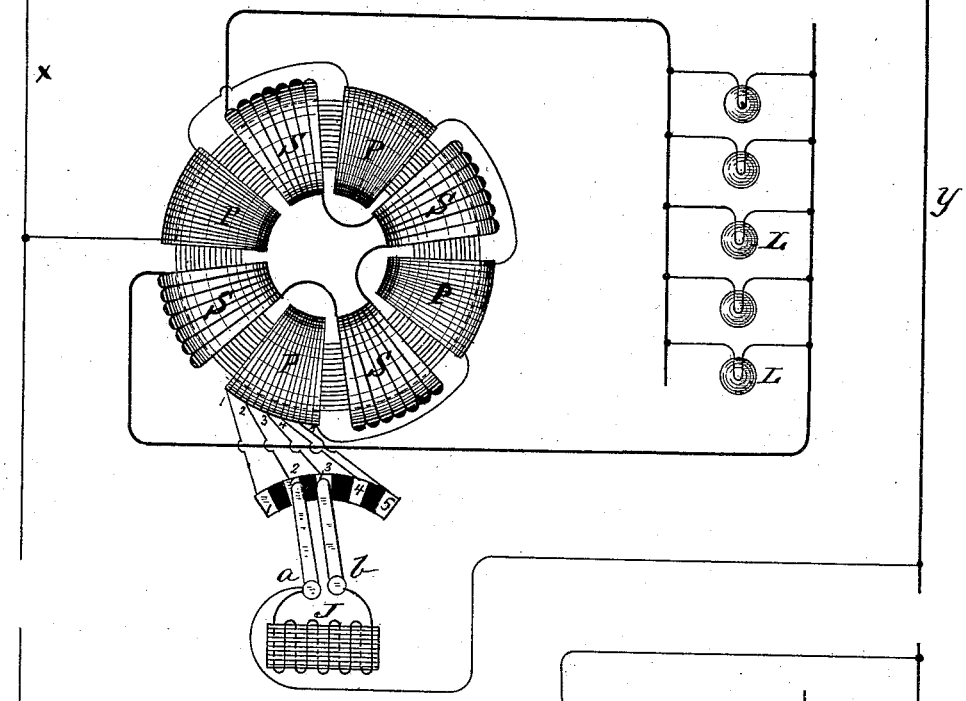
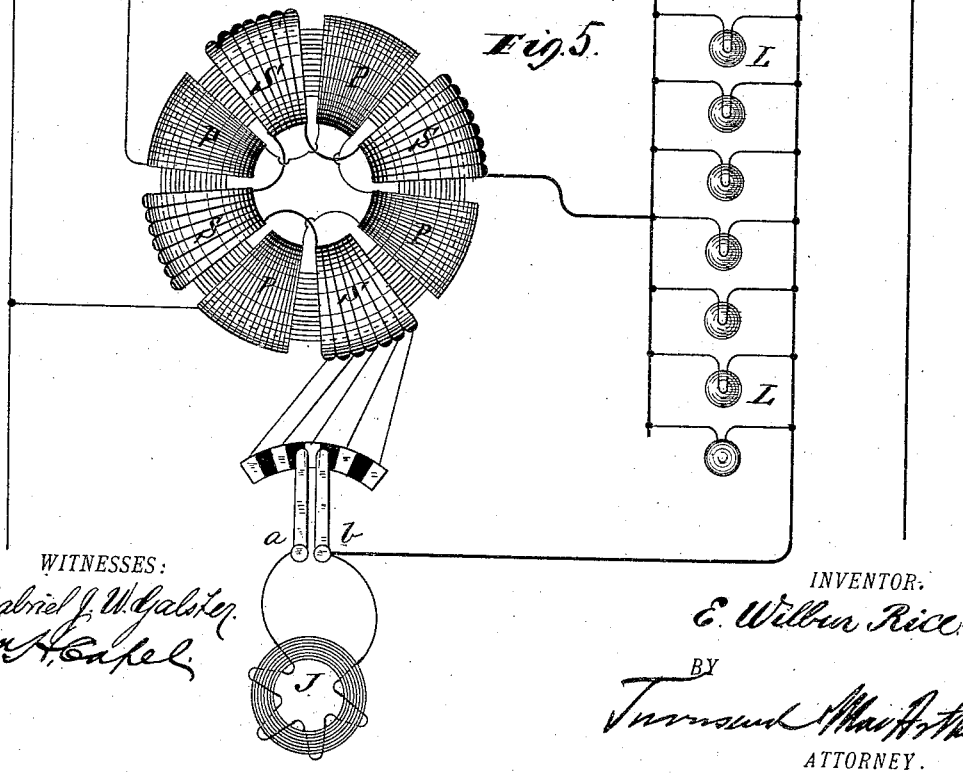


Fig. 5.



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UNITED STATES PATENT OFFICE.

E. WILBUR RICE, JR., OF LYNN, MASSACHUSETTS.

REACTIVE COIL.

SPECIFICATION forming part of Letters Patent No. 381,420, dated April 17, 1888.

Application filed October 28, 1887. Serial No. 253,665. (No model.)

To all whom it may concern:

Be it known that I, E. WILBUR RICE, Jr., a citizen of the United States, and a resident of Lynn, in the county of Essex and State of Massachusetts, have invented a certain new and useful Reactive Coil, of which the following is a specification.

My invention relates to sectional electric coils, such as induction-coils, reactive coils, or other forms of magnet-coil when used with alternating electric currents; and the invention consists, more particularly, in the switch employed for varying the power of such a coil by varying the number of sections of coil in action.

The object of the invention is to provide a means whereby the variation may be produced gradually and smoothly without interruptions of the current in the apparatus.

Hitherto, in varying the power of an induction-coil, a reactive coil, or other form of magnet-coil on an alternating-current circuit by increasing or decreasing the length of the coil in action, one of two difficulties has arisen. Either the circuit was temporarily opened by the switch in its movement from one position to another in changing the number of coils in action, or in those forms in which the interruption of a circuit was avoided a portion of the winding of the coil would, at certain position of the switch, be short-circuited, thereby causing a sudden increase of current in the circuit, owing to the fact that the reactive effect of the coils in action would be killed through the existence of the short-circuit for a coil in the magnetic field of the apparatus.

My invention consists, essentially, in overcoming the difficulties stated by so combining and connecting with the switch an artificial resistance or reactive coil that when the switch apparatus is in an intermediate position, where connection is made with both terminals of the coil, said artificial resistance or reactive coil shall be interposed in the connection from one terminal to the other.

In the improved form of my invention the artificial resistance or reactive coil is thrown progressively into multiple connection with the sections of the coil whose power it is desired to vary.

My invention consists, further, in the combination, with a sectional magnetic coil—such as a reactive coil or an induction-coil—connected with a source of alternating currents, of a two-part switch the contacts for which are connected to the sections of the coil, while the two parts of the switch that make successive connection with said contacts are insulated from one another and are connected through the artificial resistance or reactive coil.

My invention is designed more especially for application to reactive coils and induction-coils, and will be described more particularly with such application.

In the preferred manner of carrying out my invention the terminals of the sectional windings for the reactive or induction coil whose power it is desired to vary are led to a series of suitable contact plates or studs of metal, over which plates or studs a pivoted switch-arm composed of two spring-metal plates or arms insulated from one another is arranged to pass. In a circuit between the metal pieces of this switch-arm is placed a small reactive coil or resistance whose opposition to the flow of electric current is approximately equal to that of the portion of coil between any one of the contact-pieces mentioned. The contact-plates for the sectional windings of the induction-coil are so placed relatively to each other that they cannot be short-circuited by one of the metal pieces of the switch.

When the switch-arm is so placed that the small reactive coil or resistance is open-circuited or short-circuited, the path for the electric current is through that part of the induction-coil circuit terminating in the contact-plate on which the switch-arm is resting, the small induction-coil or resistance being, however, in multiple circuit with a section-winding when the two arms of the switch are resting on adjacent contact-plates.

Assuming that it is desired to change the power of the reactive induction-coil by cutting in or out of action a section-winding, the switch-arm is moved in the proper direction for that purpose, thereby simultaneously throwing the small induction-coil or resistance into multiple connection with that section which it is desired to cut in or out. Thus the electric current, instead of suddenly producing the effects of its presence in a section-winding on

the induction-coil, acts to gradually change the conditions existing by reason of its partial flow through the small induction-coil or resistance, while at the same time the short-circuiting of the section of coil is prevented. The latter path being now removed by a further movement of the switch-arm, the full effects of the active section-windings are obtained.

Reference may now be had to the drawings for a detailed description of my invention.

Figure 1 is a general plan view of an apparatus embodying my invention. Fig. 2 is a simplified diagram of the connections. Fig. 3 shows my invention as adapted to varying the current flowing through any electro-receptive device, such as the field-magnet of a dynamo-electric machine, a motor-magnet, or other device. Fig. 4 illustrates the application of my invention to an induction-coil, and shows also my method of increasing or decreasing the potential at the terminals of the secondary. Fig. 5 illustrates the application of my invention to an induction-coil and illustrates a modified plan of varying the potential.

In Fig. 1, I is a reactive coil consisting of a core of divided iron, such as iron wire or iron sheets N, around which are wound coils 1′ 2′ 3′, &c., of copper wire. From the coils of copper wire, 1′ 2′ 3′, &c., connections are led to the contact blocks or pieces 1 2 3, &c. *a* and *b* are metal strips insulated from each other and adapted to rotate around a common center, *c*, by means of a handle, H, and to pass over the contacts 1 2 3, &c. The contacts 1 2 3, &c., are so spaced that the blade *a* is not wide enough to touch two contacts at once, and yet not so spaced but that the blade *a* can touch one contact, 1, while the other blade, *b*, touches the next adjacent contact, 2, thereby preventing any interruption of the circuit as the switch is moved to operate the number of coils in action.

Referring to Fig. 2, the action of my invention is as follows: Assuming the switch D to be in the position shown in the dotted lines, the current from the line *x*, which leads to one of the poles of an alternating-current dynamo or other source of alternating currents, runs to the contact-piece or segment 1, through switch D, to lamp L, and to *y*, the other terminal of the source of alternating current meeting with practically no resistance outside of that in the lamp itself. The lamp L will therefore burn at full brilliancy. If, now, the switch D be moved until one of its blades, *b*, rests upon and in electrical contact with segment 2, while the blade *a* still remains in contact with the segment 1, the current will find two paths to the lamp L—one through the reactive coil J and the other through section 1 of the reactive coil I. A reaction or counter electro-motive force is thus established in the circuit from *x* to *y*, diminishing the current flowing through it and the lamp L or other electro-receptive device. It will be seen that the reactive effect or counter electro-motive force established in the circuit *x* to *y*, when the switch D is in the position just mentioned, is that produced by the coil J and section 1 of coil I acting in multiple, and is therefore less than were section 1 of coil I acting alone. If the switch D is now moved forward so as to bring its two arms *a b* on contact-piece 2, the whole of the current passing through *x y* will traverse the section 1 of the coil I, which increases the reactive effect or counter electro-motive force in the circuit *x y*, again reducing the current flowing through the electro-receptive device L. Another forward movement of the switch D brings one of its arms, *b*, into contact with plate 3 and the other arm, *a*, into contact with the contact-plate 2, as shown in the drawings. The counter electro-motive force in the circuit *x y* is by this means still further increased, it being now that produced by section 1 of the coil I united with that established in section 2 of coil I and the coil J acting in multiple. On again moving the switch D so as to bring both its arms *a b* on the contact-piece 3 another reduction is made in the current flowing through *x y* by reason of another increase in the counter electro-motive force, both sections 1 and 2 of the coil I now operating to resist the passage of current. In the same manner the current may again be diminished until the entire reactive effect of the coil I is interposed in the circuit *x y*, reducing the current in it to a minimum. As will be seen from this description, the action of the coil J is to prevent any abrupt change in the current flowing through the circuit *x y*, as well as to avoid the short-circuiting of the coil at the time the switch makes connection with both terminals thereof.

Hitherto a switch with a single contact-arm has been used in cutting in or out of action sections of reactive coil; but this produced great fluctuations in the current, because in moving such arm from one segment to another, as from segment 1 to segment 2, Fig. 2, the circuit is entirely interrupted, and when such arm is moved to contact with segment 2, Fig. 2, the current is again suddenly established through *x y*. Such action is not remediable by making the spaces between the contacts 1 2, &c., of such width that the circuit is not interrupted upon a movement of the single contacting arm being made, because in this instance a section 1 2 3 of the coil I will be short-circuited, totally destroying the reactive power of the coil I or its effectiveness as a counter-electro-motive-force generator in the circuit *x y*. In my invention, however, such short-circuiting tendency of a section 1 2 3 of the coil I is opposed and overcome by the use of a reactive coil J or other device combined with the switch, so as to be thrown into the connection between the terminals of the coil and resist the passage of current from one terminal to the other.

Fig. 3 shows a modification of my invention, in which the copper coils of the reactive coil J between the arms *a b* are incased in iron wire or sheet-iron, and also illustrates my invention as applied to adjusting the flow of

current in a circuit containing magnet, M, which may be an electric-motor magnet, the field-magnet of a dynamo, &c., the current through which it is intended to vary in amount.

I do not limit my invention to a reactive coil J interposed between the arms *a b;* but, as already stated, a resistance—such as German-silver wire—may be used in its stead.

Fig. 4 illustrates the application of my invention to an ordinary induction-coil having the usual primary and secondary windings. The primary coils P are in the connection between the alternating-current mains X Y, and the secondary coils S connect to the electric lamps L or other translating devices. The switch and reactive or resistance coil J are combined with the sectional primary, in the manner described.

In induction-coils it is often desirable to have some means of changing the potential between the terminals of the secondary, so as to vary the brilliancy of lamps in theaters, &c., or in houses where it is desired to run lamps at some time during the evening or night at a lower brilliancy than at others; or, again, it may be desired to adjust the potential in an electric distribution system at the point which is connected to the system of mains.

When dimming incandescent lamps or decreasing the potential of the secondary, I find that it is necessary to increase the number of turns in the primary coil or to diminish the number of turns in the secondary coil; or, conversely, if it is desired to increase the potential between the terminals of the secondary coil, I find it necessary to diminish the length of wire on the primary coil or to increase the length of the secondary wire. This is best done by the smooth-acting reactive coil, which acts by producing variations so smoothly that no sudden jump, break, or variation is produced in the incandescent lamps. The great advantage of the application of a smooth-acting coil to making this change is that it would be impossible to make the change by any other method without its putting out the lights dimmed, because, as before explained, if a switch is used which short-circuits a portion of the primary or secondary wire as it moves from one segment to another, this short-circuiting is sufficient to destroy the reaction of the induction-coil and produce a very marked lowering of potential between the terminals of the secondary. If, on the other hand, a switch is employed which is constructed to avoid the difficulty of short-circuiting by being so arranged as to leave one contact before making connection with the succeeding one, there will obviously be an interruption of circuit, resulting in the same difficulty.

Fig. 4 illustrates the method of increasing the potential at the terminals of the secondary by diminishing the number of coils on the primary. The diminution of potential would obviously be produced by the reverse operation of increasing the number of coils.

In Fig. 5 the reactive coil and switch are shown applied to the secondary coil of the induction-coil. In this case the variation of the potential at the terminals would be produced by moving the switch in a direction to increase the length of wire on the secondary for the purpose of increasing the potential and diminishing the number of turns for the purpose of decreasing the potential. It is obvious that in this case the coil J, combined with the switch and the sectional secondary, produces the beneficial effect already described in other applications of the invention.

It is obvious that my invention may be used in connection with any sectional magnetic coil subject to the influence of an alternating-magnet field.

What I claim as my invention is—

1. The combination, with a variable or adjustable sectional electro-magnetic coil placed in an alternating magnetic field, of an electric switch and an artificial resistance or reactive coil as described, in the connection between the terminals of the coil-section when the switch is connected with both coil-terminals at the same time.

2. The combination, with a variable or adjustable sectional magnetic coil in an alternating magnetic field, of a series of switch contacts or plates connected to the coil-sections and a two-part switch having an artificial resistance or reactive coil in the circuit between the two parts, as and for the purpose described.

3. The combination, with an induction-coil having a sectional wound set of coils, of an electric switch for varying the length of wire in a set to vary the potential at the terminals of the secondary, and a reactive coil, J, connected with the switch and included successively in multiple with the coil-sections as the switch is moved for varying the number of coils in circuit.

4. The combination, with an induction-coil having its primary wound in sections, of a switch for diminishing or increasing the length of wire on the primary in order to increase or diminish the potential at the terminals of the secondary, and a reactive coil, J, included successively in multiple with the sections on the primary as the switch moves to diminish or increase the length of primary wire in circuit, as and for the purpose described.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 22d day of October, A. D. 1887.

E. WILBUR RICE, JR.

Witnesses:
ELIHU THOMSON,
J. W. GIBBONEY.