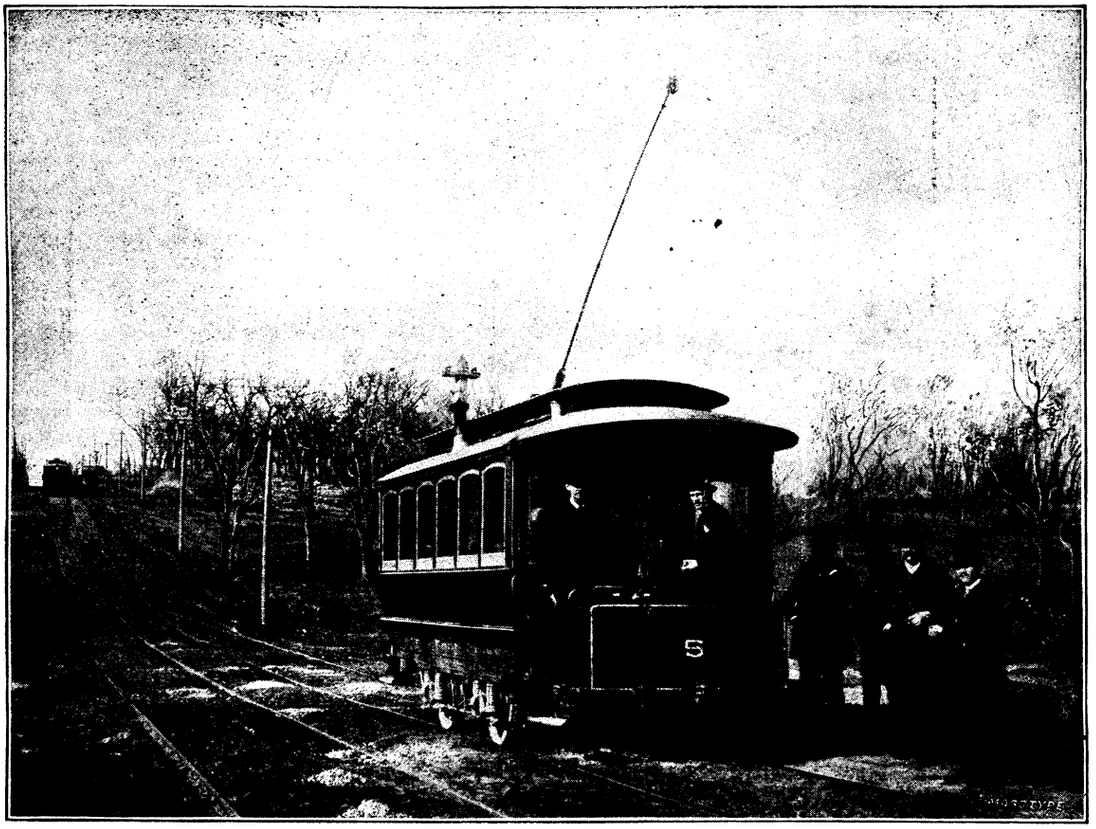
substitute for the chamois-leather now used for these and for analogous purposes. Being, moreover, of a woven texture, and absorbent, it is more healthy for use in garments than chamois-leather, and does not require to be perforated. Unlike leather, also, which gets stiff after washing, this improved material so produced is capable of being repeatedly washed without stiffening, and is found to retain its softness perpetually."

THE ELECTRIC RAILWAY IN ST. JOSEPH, MO.

ONE of the successful electric street-railways in the country is that in operation upon the Wyatt Park Company's line at St. Joseph, Mo., a view of which we give in this issue. This line at St. Joseph was the first one in the country to practically demonstrate the successful operation of an electric railway in a snow-storm. In the early part of this winter a blizzard from the Western prairies struck St. Joseph with all its force, and covered the streets in that city to the depth of from six inches to one foot, in many places drifting badly. The telephone, telegraph, and electric-light wires were borne down by the snow in all parts of the city. In spite of this general blockade, the electric railway ran uninterruptedly, and the cars ploughed their way through the heavy drifts on the line without trouble or stoppage, and without any aid from snow-ploughs.

The grades on the Wyatt Park Railway are in some points on the road as high as nine per cent; and the cars reach a speed of fifteen to eighteen miles an hour in the outside and suburban districts, reducing to a lower rate of speed when operating within the city.

St. Joseph, Mo., already has two street-railways operating by electricity on the Sprague system, and a great many manufacturing industries are kept in operation by the same power by means of stationary electric motors operated from the regular railway circuit. It is said that the two other street-railways in St. Joseph will soon be in operation upon the electric system, so that the horse shall be supplanted entirely for car service in that city.



SPRAGUE ELECTRIC RAILWAY AT ST. JOSEPH, MO.

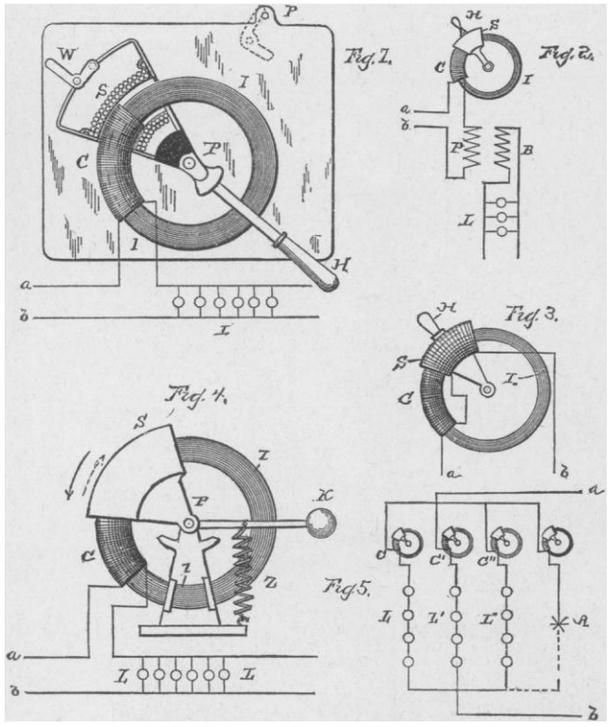
A NEW FORM OF SELF INDUCTION AND REGULATING COIL.

IN the operation of electric lighting and other apparatus in which an alternating current is employed, it is frequently desirable to vary the current or electro-motive force through considerable range. With direct or continuous currents, a variable rheostat is usually employed for such purpose, and, where saving of energy is not an object, might be used also with alternating currents. But with such currents it is possible, by employing self-induction or inductive resistance in place of pure resistance, to secure such variations without much loss of energy, because the action of self-induction is really only a storing-up and giving-back of energy consequent on a displacement of phase of induced alternating impulses from the phase of impressed or supplied impulses. This is what is meant by "lagging of phase," and it is an effect of self-induction or inductive resistance. Any wire capable of producing magnetism is a self-inductive resistance to such currents. A coil wound on an iron-wire core or bundle is a good example; and, if the wire bundle be a ring core or closed magnetic circuit, its effects per unit of length of wire will be enormously intensified.

Hitherto the usual plan of constructing a variable inductive resistance has been to provide a hollow coil with a movable iron-wire core in its axis, so that the centres of coil and core could be made coincident for maximum effect. This arrangement for a given effectiveness is cumbrous and unnecessarily large, inasmuch as it employs only an open magnetic circuit, and not a closed one; and, even though the core be entirely removed from the coil, the self-induction is not neutralized, because of the numerous turns of wire in the coil itself. Besides, the true resistance of the wire as such is considerable.

With a view of obviating these defects, and securing the other advantages of compactness and ease of manipulation, the apparatus to be described was devised.

It has already been applied to a number of cases of practical work, where it takes the place, for alternating-current work, of variable resistances, while it saves the energy of the circuit. It is also made self-adjusting, and can maintain a constant average of alternating current over a variable resistance, such as a series of incandescent or arc lamps connected across the terminals of a system or machine of alternating character.



It is based on the principle of the demagnetizing effect of a closed coil or circuit parallel to the coil or circuit in which the inductive resistance is to be varied; the relation of position of the two coils on a magnetizable core forming a closed magnetic circuit, or nearly so, being made variable.

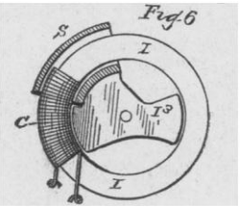
In Fig. 1, *II* is an iron core, preferably of ring or endless form, made of wire or laminæ, suitably piled and insulated to avoid Foucault currents; *C* is a coil of insulated wire wound on the core, as shown; *S* is a closed band or coil around the ring, and arranged to be moved over the coil *C* by a handle, *H*, and pivoted at *P* when preferred, though it could simply be slipped along in some cases. Let, now, an alternating current of fairly constant potential be feeding the lamps *L*, *L*, from *a* to *b*, with the coil *C* in circuit. If the closed coil or band, *S*, be brought down over the coil *C*, very little re-action or self-induction will exist in the coil *C*; and, if its resistance be low, the lights *L*, *L*, will be given their full brilliancy. If the coils *S* and *C* be now separated more and more by moving one away from the other around the ring, the self-induction of coil *C* progressively rises, and becomes greatest when coil *S* is farthest removed from it. The lights are now dimmed as far as possible, any gradation being obtained by setting the coil *S* in a position with respect to coil *C* corresponding to the desired effect. The action is smooth and very effective. If a switch, *W*, be placed in circuit with the coil *S* so as to be opened when it strikes a pin, *p*, suitably placed, and after the coils *C* and *S* have been widely separated, the effect of coil *C* is further enhanced in dimming the lights or in exerting a self-induction which checks the current in any device with which the apparatus may be put in circuit.

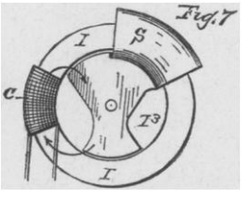
In Fig. 2 the devices are shown placed in series, with a primary coil, *P*, of a transformer, whose secondary, *B*, feeds the lights *L*, or other devices, with current. A very smooth and powerful resisting effect may thus be obtained with moderate sizes of apparatus.

If the directions of windings are made opposite, the two coils *C* and *S*, as in Fig. 3, may be connected in series or multiple arc, and the current led from *a* to *b* through them. They should in such cases be wound to have equal ampère turns capacity in magnetizing the core *I*. When the coils are superposed, they will neutralize one another's self-induction; but, as they are separated, the self-inductive kick or re-action will gradually increase. The variation of induction or re-action is obtained without contacts and switches, and in a smooth and gradual manner.

In the preceding figures the devices shown have been arranged to be operated manually. The same devices, however, if the parts are relatively free to move, give out, from alternating currents, a mechanical power or pressure which may repel the coils apart. To obtain a movement of coil *S*, or pressure tending to move it, coil *C* has only to be put into an alternating-current circuit. Further, this repulsive power may be utilized to make the self-induction self-adjusting, whereby there may be obtained a constant current on the circuit of a set of lamps, or the like, even though variations of voltage of current fed to them may occur. Thus, as in Fig. 4, the source, *a b*, of current may be one which varies in potential, the coil *C* being put in series with a group of lamps, *L*, *L*. In this case the copper band or closed circuit *S* is pivoted freely at *P*, and counterpoised to a certain extent by a lever and weight, *K*, or other device, whose effect may be varied if need be. Sometimes a spring, *Z*, may be used in addition (or even alone, if of proper retractile effect), and suitable stops may be provided to limit the range of movement. Suppose that the coil *S* is set, and so balanced that, with a given current in coil *C*, it is repelled so as to about half cover the coil *C* (or less, if the counter-forces *K*, *Z*, are properly adjusted), and that an increase of current, due to increased potential, takes place in the circuit *A*. Coil *C* will more strongly repel circuit or band *S*, and it will move partly up and away, with the result of increased self-induction in coil *C*; which self-induction, if the parts are suitably adjusted, will approximately restore the current strength to what it was before the change. A fall of potential corrects itself by working in the reverse direction.

The apparatus in this self-regulating or automatic form is to be used in such circuits as are represented in Fig. 5, where wires *a*, *b*, of constant or even somewhat variable potential difference, feed in multiple several separate series of lights, *L*, *L'*, *L''*, such as incandescent or arc lights with alternating currents. Each series, circuit, or branch requires a constant current; and to insure this, even though a light be cut out in any series, the automatic self-inductors of Fig. 4 are placed in each branch or series at *C*, *C'*, *C* , where each acts, as described in connection with Fig. 4, to preserve the current strength. Of course, the group *L* (Fig. 4), or series *L*, *L'*, *L''*, may be replaced by a single light or translating device, such as an arc-lamp, without affecting the result. This has been indicated at *A* (Fig. 5), always assuming the potentials to be not so excessive or so feeble as to exhaust the capacity for regulation to be found in the device.





In Figs. 6 and 7 the part *I''* is of iron, as shown, and carries

coil or band *S*. When the coils or circuits *S* and *C* are separated, as in Fig. 7, a closed iron path for the core *I*, as indicated by the arrows, is afforded the iron *I''*, operating after the manner of an armature, and comes into play to increase the effective self-induction of the coil *C*.

ELIHU THOMSON.

WEST INDIAN HURRICANES.

THE Bay of North America is that portion of the North Atlantic west of the 50th meridian, between Newfoundland and Venezuela, including the Caribbean Sea and Gulf of Mexico. In accordance with the policy followed hitherto by the United States Hydrographic Office, of calling attention to matters of special importance to navigators, on "The Monthly Atlantic Pilot Chart," a telegraphic chart, which we here reproduce, has been prepared to illustrate the admirable facilities that are available for the establishment of a more complete system of telegraphic weather forecasts, for the benefit of the commerce of various nations frequenting this great bay, as well as of the inhabitants of its shores and islands. The general movement of storms over this area is westward in the tropics, then northward into the temperate zone, and eastward in the higher latitudes. West Indian hurricanes follow this path with marked regularity; so much so, that a hurricane reported off Antigua or St. Thomas is almost sure to either sweep across the Greater Antilles into the Gulf of Mexico and strike our Gulf coast with furious intensity, or else (according to the time of the year) cross the Bahamas and follow the Gulf Stream toward Hatteras and the Grand Banks. With the telegraphic facilities that already exist, it is therefore possible to give from twenty-four hours to ten days' warning of the approach of one of these terrific tropical cyclones, — warning that might often result in the saving of more property ashore and at sea in a single storm (not to speak of the lives endangered) than would suffice to pay for the cost of a well-equipped weather service for several years. Moreover, it is well known that the movement of an area of low barometer is controlled to a very large extent by areas of high barometer adjacent to it, especially in advance (even though a thousand miles away), and many noticeable instances might be referred to: the hurricane in the Gulf in August, 1886, for example; the March blizzard of last year; and the severe cyclone off the coast last November. The wider the field of observation, therefore, the better the forecast; and the completion of the cable to Bermuda will be invaluable in