

April 8, 1924.

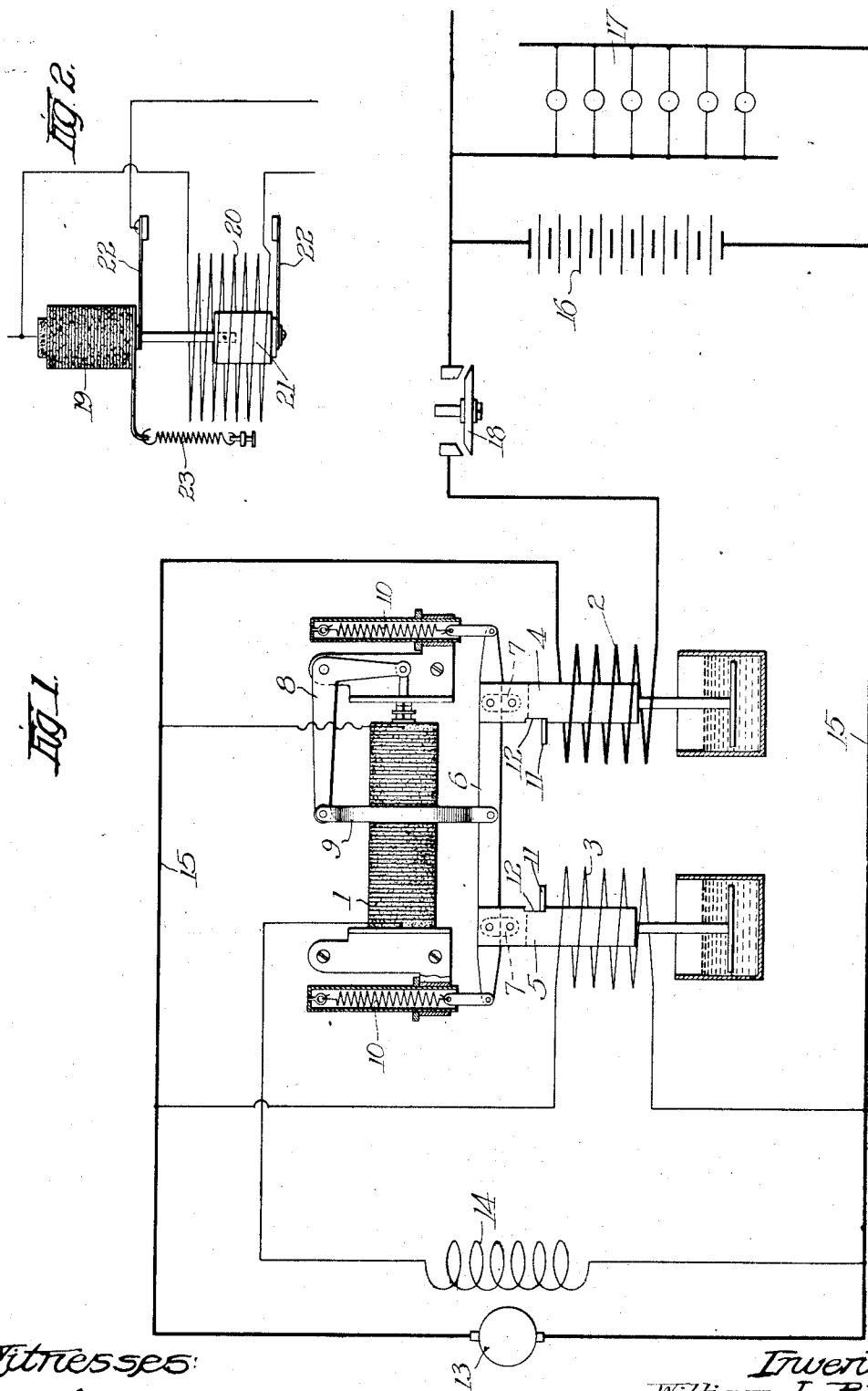
1,489,518

W. L. BLISS

DYNAMO REGULATOR

Filed April 29, 1912

4 Sheets-Sheet 1



Witnesses:

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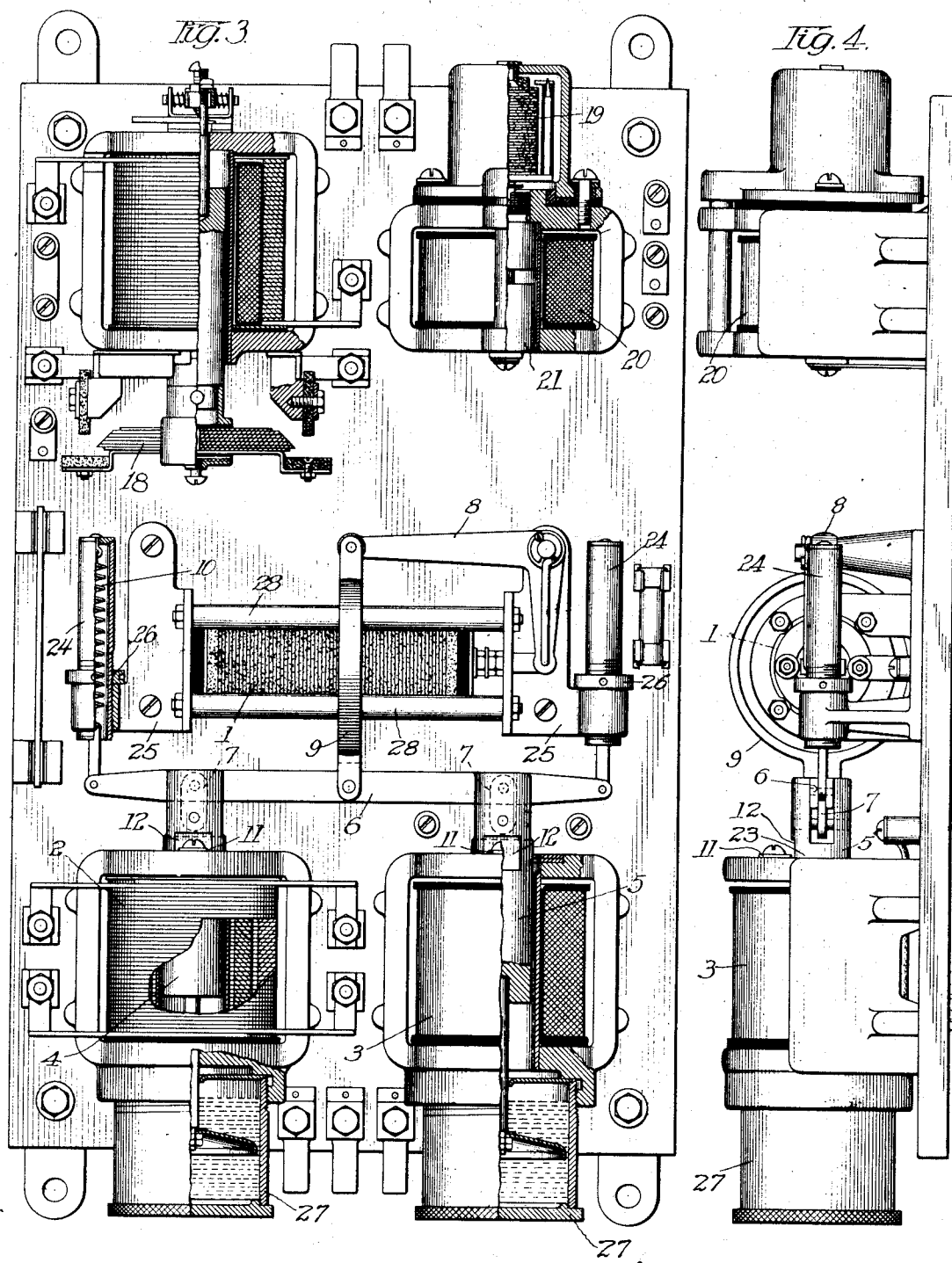
1,489,518

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DYNAMO REGULATOR

Filed April 29, 1912

4 Sheets-Sheet 2



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DYNAMO REGULATOR

Filed April 29, 1912 4 Sheets-Sheet 3

Fig. 5

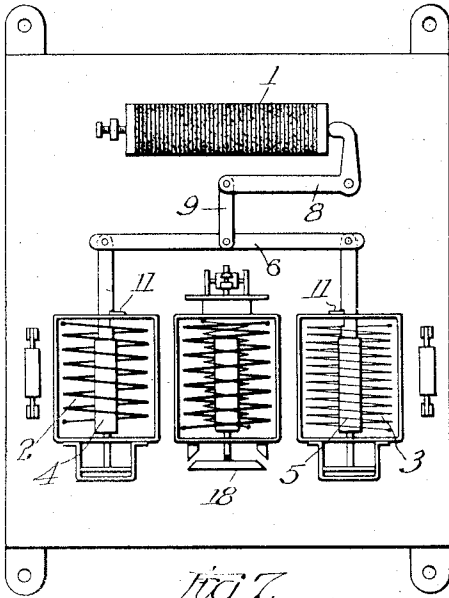


Fig. 6

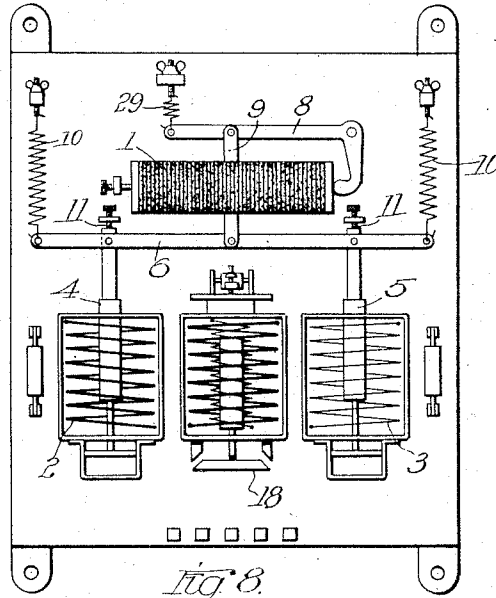


Fig. 7

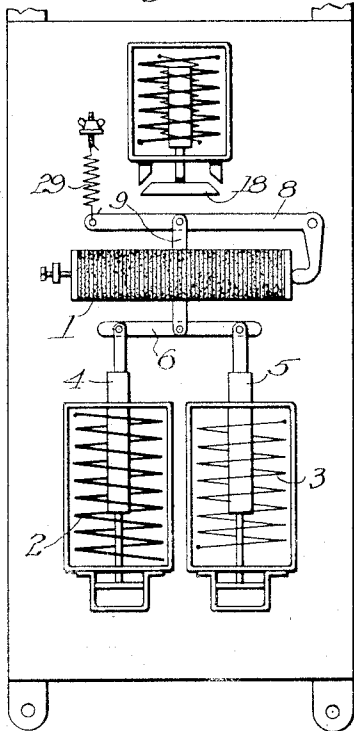
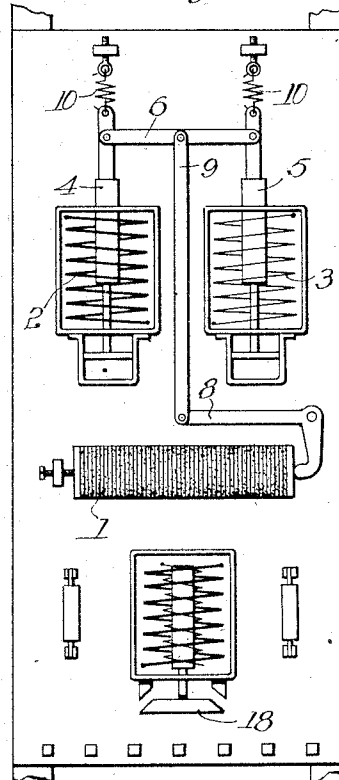


Fig. 8



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April 8 , 1924.

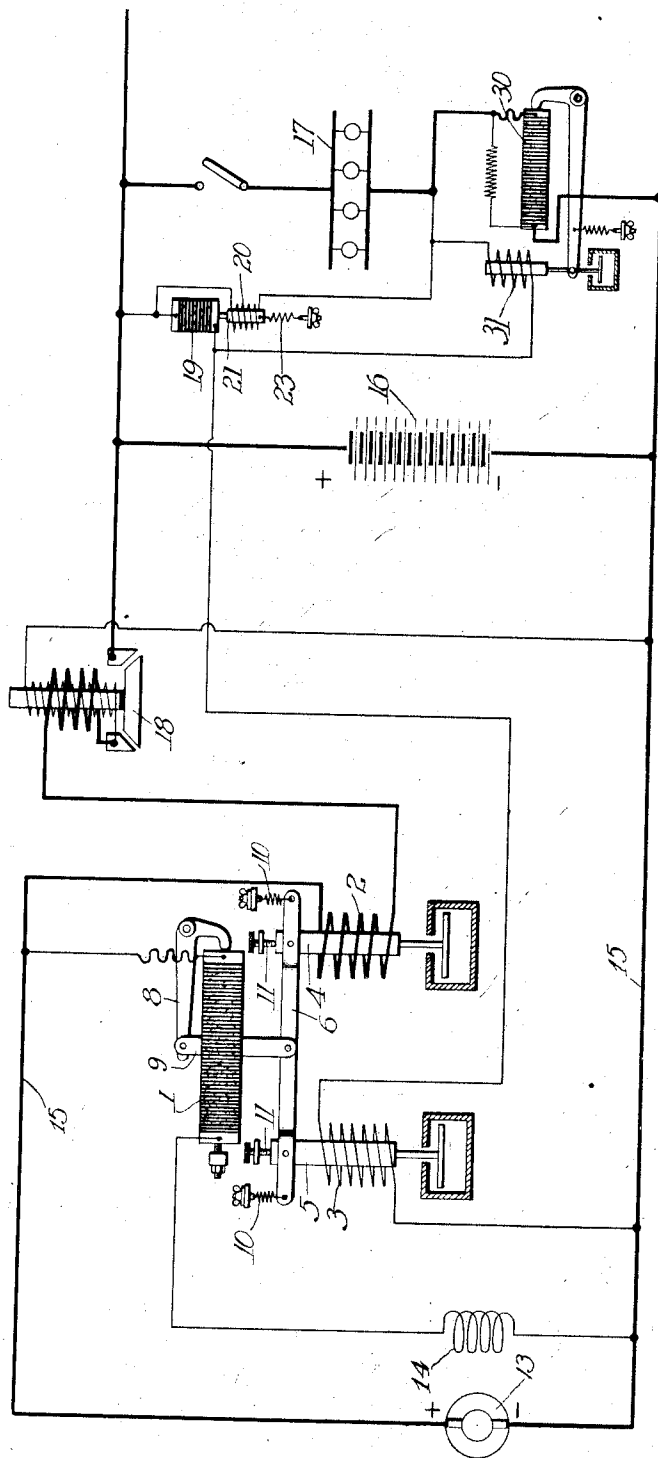
1,489,518

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DYNAMO REGULATOR

Filed April 29, 1912

4 Sheets-Sheet 4



6.627

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UNITED STATES PATENT OFFICE.

WILLIAM L. BLISS, OF NIAGARA FALLS, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO U. S. LIGHT & HEAT CORPORATION, OF NIAGARA FALLS, NEW YORK, A CORPORATION OF NEW YORK.

DYNAMO REGULATOR.

Application filed April 29, 1912. Serial No. 694,016.

To all whom it may concern:

Be it known that I, WILLIAM L. BLISS, a citizen of the United States, residing at Niagara Falls, in the county of Niagara and State of New York, have invented new and useful Improvements in Dynamo Regulators, 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 automatic electric regulators.

My regulator is particularly adapted to be used in car lighting systems. A car lighting system usually has a generator which is driven from a car axle and furnishes current to a storage battery and electric lamps. Inasmuch as the generator is driven at a variable speed, it is necessary to provide a regulator to confine its output within proper limits. Regulators have been employed that have a variable resistance connected in circuit with the generator field, which resistance is varied by means of a series solenoid and a shunt solenoid according to the conditions. The series solenoid varies the resistance to control the current delivered by the generator, while the shunt solenoid varies the resistance to regulate the voltage developed by the generator. During normal conditions the resistance is varied by the series solenoid so as to maintain practically constant current. When the battery becomes nearly fully charged, the generator voltage may rise decidedly, so that the shunt solenoid responds and varies the resistance to regulate the voltage. The charging current is simultaneously decreased or tapered off, thereby preventing overcharging of the battery.

Various mechanical means have been employed to connect the solenoids to the resistance, which latter in many cases consists of a group of carbon discs or electrodes maintained under pressure. Means have been devised to connect the solenoids to the carbon discs, so as to vary the pressure of these discs to vary the resistance. Where attempts have been made to provide a compact structure that may be mounted in a small space, difficulties have arisen in the operation of the carbon discs, due to the

fact that the mechanical connections employed cause translation of the electrodes, when the voltage solenoid takes up the variation of the resistance and the current solenoid relaxes its control. My invention has been devised to overcome these difficulties.

The object of my invention is to provide a regulator such as has been set forth with improved mechanical connections between the solenoids and the resistance, so that either solenoid may vary the resistance without causing a translation of the carbons when the control shifts from one solenoid to the other.

For the purpose of setting forth the advantageous features of my invention, I have illustrated in the accompanying drawings several forms of regulators which I have worked out in practice. In order to explain the operation thereof, I have indicated how these forms may be connected in circuit as part of a car lighting system. It is to be understood, of course, that my improved regulator is not limited in its use to a car lighting system but may be otherwise employed. Furthermore, the invention is not limited to the forms of regulator illustrated, but may be embodied in various other forms.

The views in the drawings are as follows:

Figure 1 is a diagrammatic representation of one form of regulator showing how the same may be connected in circuit.

Figure 2 is a diagrammatic representation of a relay which may be used to increase the sensitiveness of the voltage responsive solenoid of the regulator.

Figure 3 is a front elevation of a complete regulator panel showing one form of regulator in detail and showing various other devices used in connection therewith.

Figure 4 is a side elevation thereof.

Figures 5, 6, 7 and 8 are diagrammatic representations of other forms of regulators.

Figure 9 is a circuit diagram of a car lighting system showing a preferred form of circuit connections for the regulator when used in such a system.

The regulator is provided with a variable resistance 1 controlled by a current responsive or series solenoid 2 and a voltage

responsive or shunt solenoid 3. The variable resistance may assume various forms. It is illustrated as a variable pressure rheostat comprising a series of contacting carbon plates or electrodes. The rheostat is adapted to be connected in the shunt field circuit of the generator and its resistance may be varied by varying the pressure applied thereto. The series solenoid is connected in the external circuit so as to respond to variations in current. It may be connected in the battery circuit, however, if desired. The shunt solenoid is connected across the external circuit so as to respond to variations in voltage thereof, which variations may be due either to variations in the speed of armature rotation of the generator or to the counter-electro-motive force of the storage battery, or both.

The solenoids 2 and 3 are provided with suitable plungers 4 and 5 respectively, which are adapted to be drawn downwardly upon sufficient energization of said solenoids. These plungers are connected to an equalizing bar 6 near the opposite ends thereof, preferably through short links 7, arranged in slots in the plunger and the equalizing bar. A bell crank lever 8 is arranged to bear against one end of the series of carbon plates to vary the pressure thereon, and is connected at its other end by means of a link 9, to the middle of the equalizing bar 6. The link 9 is illustrated as a hoop which encircles or surrounds the series of carbon plates, sufficient clearance being provided to permit the necessary movement of the hoop without interfering with the carbons. The equalizing bar is normally held in uppermost position by means of adjustable springs 10 secured preferably to opposite ends of said bar. A limit stop 11 is provided for each plunger. Each stop projects into a recess 12 in its plunger. Said recess has abrupt upper and lower shoulders which engage the abutment 11, thereby limiting both the upward and downward movement of said plungers, and, consequently, of said equalizing bar. The point of attachment of the equalizing bar to the upper end of either link 7 forms the fulcrum or pivotal point for said bar during the movement of the other end thereof.

Either solenoid when it is energized has a tendency to pull down its corresponding end of the horizontal lever or equalizing bar. During the downward movement of either end, said bar pivots about its point of attachment at the distant end thereof. Any downward motion of either plunger is communicated immediately and directly to the movable end of the variable pressure rheostat or carbon pile and tends to relax the pressure thereon to increase the resistance in the generator field circuit. Any upward motion of either plunger is likewise immedi-

ately and directly communicated to the movable end of the variable pressure rheostat and tends to increase the pressure thereon to decrease the resistance. If one plunger is in the upper position and the other has been drawn down to a lower position and the one in the upper position begins to move downward, its motion and effect are instantly transmitted to the carbon pile irrespective of how long it may take the second plunger to move upward, or irrespective of whether or not said second plunger moves at all. By this construction I obtain independent action of each plunger. No matter in what position either or both plungers happen to be, there is no time lost in one plunger assuming control while the other is relinquishing it, and, of course, there is no movement of the carbon pile as a whole, the pressure being applied to one end only. By this arrangement great refinements in the control of the variable resistance may be attained.

For a further understanding of the operation of the regulator reference may be had to the circuit connections in Figure 1. This figure indicates one way in which the regulator may be connected in circuit. The generator which supplies the current to the circuit is provided with an armature 13 and a shunt field winding 14. The armature may be assumed to be driven at varying speeds. The generator supplies current to the main circuit 15 across which circuit the storage battery 16 is connected so as to be charged by the generator. Translating devices 17 are also shown connected across the main circuit on the side of the storage battery away from the generator. These translating devices are illustrated as electric lamps but may be taken to represent any translating devices. An automatic switch 18 of well known form is provided to close the circuit between the generator and the storage battery, when the generator armature is rotating at a speed sufficiently high to send current to the battery.

The series coil 2 is connected in the main circuit between the generator and the automatic switch, and hence responds to variations in the total current supplied by the generator to the storage battery and the translating devices. The shunt coil 3 is shown connected directly across the main circuit, and responds to variations in voltage. When the generator armature is at rest or is rotating at a low speed, the automatic switch is open and the storage battery supplies current to the translating devices. During such periods the resistance 1 is normally a minimum, the bar 6 being held in uppermost position by the two springs 10 as shown in Figure 1, thereby producing a maximum pressure on the series of carbon plates. After the speed of the armature has increased to a point sufficient to cause the

automatic switch to close, the series coil 2 is energized by current flowing in the main circuit and draws down its plunger, thereby inserting sufficient resistance in the generator field circuit to maintain constant current. The series winding holds the generator current to a constant value notwithstanding the wide variations in speed. During this period the battery is being charged, and the plunger 5 of the shunt solenoid is held in uppermost position by the left-hand spring 10, the equalizing bar 6 pivoting about its fulcrum in the link 7 of said plunger. Accordingly, the action of the current regulating solenoid is entirely independent of the voltage solenoid, which at this time is not energized sufficiently to draw down its plunger in opposition to the pull of the said left-hand spring.

When the battery approaches a fully charged condition, the rise in the counter electro-motive force thereof causes an increase in generator voltage, and accordingly the shunt coil 3 is energized. As a result this coil draws down its plunger, thereby tending to increase the resistance of the variable pressure rheostat 1 and reduce the generator current. Accordingly, the battery charging current is rapidly decreased or tapered off. The decrease in the generator current, of course decreases the energization of the series coil 2 until this winding is energized only by whatever small current is being supplied to the translating devices by the generator. Accordingly, the regulating effect of the voltage responsive winding 3 predominates and the generator voltage is regulated to confine the same within certain limits regardless of wide fluctuations in speed of armature rotation. The parts being properly proportioned, the attainment of a certain pre-determined voltage in the system, due to the condition of the storage battery, results in a rapid decrease in the pressure on the carbon pile and thus the battery charging current is brought rapidly toward zero. As the above action takes place the plunger 4 is released gradually by the series coil 2 and the equalizing lever 6 turns or pivots about its point of attachment to the vertical link 9. The pressure on the carbon pile is held constant while the equalizing lever revolves about its pivotal point, the other end of said bar being drawn downwardly by the descending plunger 5 of the shunt coil 3. The shifting of the control from the series solenoid to the shunt solenoid is effected without disturbances in the system. This feature may be particularly well brought out by opening the battery circuit, especially if no translating devices happen to be in circuit at the time. With the opening of the battery circuit the current in the solenoid 2 instantly falls to zero and the voltage of the solenoid 3 rises to

the operative point, any tendency to go beyond this point being checked in its incipency by the action of the voltage solenoid combined with the fact that the pull on the vertical link is not relaxed by the sudden rising of the current solenoid plunger. Accordingly, no disturbance of the carbon pile takes place during the transition. In other words, the control is given up by one solenoid and assumed by the other instantaneously, or as rapidly as is necessary, without any disturbance taking place. Moreover, by this arrangement, which permits of the independent action of the two solenoids, I am able to so fashion the magnetic circuit that I can produce a very much more rapid tapering of the current flowing to the battery than heretofore.

Under certain circumstances where it is desirable to increase the sensitiveness of the voltage coil 3, a suitable relay or multiplying device may be connected in circuit therewith to amplify the variations in voltage to which said shunt coil is subjected. In Figure 2 I have illustrated somewhat diagrammatically a relay suitable for this purpose, although, of course, other relays may be employed. The relay illustrated is described more fully and claimed in my co-pending application, Serial No. 690,577, filed April 13, 1912, automatic relay for electric regulators. Said relay has a small variable pressure rheostat 19 adapted to be connected in series with the voltage responsive regulating solenoid 3 and a voltage responsive winding 20 for varying the resistance of said rheostat. Said latter winding may be connected across the mains, that is, in parallel with said regulating solenoid. The core 21 of said voltage winding is supported preferably by resilient reeds 22 which also carry the carbon rheostat 19. An adjustable spring 23 pulls down on said reeds and hence relaxes the pressure on the rheostat, thereby maintaining the normal resistance thereof at a maximum value. When the voltage winding is sufficiently energized it draws up its core 21 against the action of the spring 23, thereby increasing the pressure on the rheostat and decreasing its resistance, whereby more current is permitted to flow to the voltage responsive regulating solenoid 3 connected in series therewith. As a result the current flowing in the solenoid 3 is increased due not only to the decrease in the resistance 19, but also to the increased voltage applied to the terminals of said solenoid, whereby a magnifying effect is secured. As a result the sensitiveness of the shunt solenoid may be greatly increased and the character of the regulation correspondingly improved.

Figures 3 and 4 illustrate a complete regulator panel having mounted thereon a regulator of the form shown diagrammatically in Figure 1, associated with an automatic

switch and a relay, adapted to perform the functions of the devices illustrated diagrammatically in Figures 1 and 2 described above. The same reference characters have been applied to the various parts shown in Figures 3 and 4 as have previously been applied to corresponding parts illustrated diagrammatically in Figures 1 and 2. Accordingly, it will not be necessary to describe in detail the devices shown in these figures. In the arrangement illustrated the automatic switch 18 and the carbon relay 19 are mounted adjacent the upper end of the supporting panel. The current solenoid 2 and the shunt solenoid 3 are preferably mounted side by side adjacent the lower end of the panel. The variable pressure rheostat 1 is arranged above said solenoids so that the heat dissipated thereby will not materially affect the latter. The springs 10, which support the equalizing bar 6 and the plungers carried thereby, are adjusted by raising or lowering the tubes or casings 24 which surround them, said tubes having screw-threaded engagement with the extensions on the brackets 25 and being locked in any desired position by the locking ring 26. Accordingly, the pull exerted by each spring on its end of the equalizing bar may be adjusted for a certain critical value of current in the series solenoid and a certain critical value of voltage in the shunt solenoid so that these two solenoids will respond when the desired values have been reached. The adjustment of one solenoid in this manner is entirely independent of and does not interfere with the adjustment of the other solenoid. The tubes or casings which enclose the springs prevent their being tampered with by unauthorized parties after being properly adjusted. Of course, the adjusting springs may be arranged in various other ways in connection with the moving parts of the regulator. The arrangement illustrated, however, has many important advantages.

The slot 12 which determines the vertical movement of the plungers, is preferably milled in the front face of each of said plungers. The relatively fixed stop 11 which projects into said slot, is illustrated simply as a small piece of metal preferably screwed to the upper end of the magnet frame. Of course suitable stops or abutments may be arranged in a great many other ways. Said stops, however, should be arranged preferably in alignment with the plungers. The plunger of each solenoid is provided with a dash pot 27 to prevent sudden motions and to smooth out any irregular action that might be due to the motion of the railway car in which the panel may be mounted. The carbon plates or electrodes are supported by suitable insulating rods 28 carried by the brackets 25. The

point of attachment of the vertical link either with the bell crank lever or with the equalizing bar, may, of course, be shifted and thus change the effectiveness of the solenoids with respect to the carbon pile. I find, however, in practice that all ordinary conditions can be met by attaching the vertical link to the center of the equalizing bar, and, accordingly, the points of attachment of the link to the equalizing bar and bell crank lever are not illustrated as being adjustable, although a construction permitting of such adjustments may, of course, be employed if desired.

In Figures 5, 6, 7 and 8 I have illustrated diagrammatically four regulator panels showing modified arrangements of the main elements of the regulator. The same reference characters have been used in these figures as in preceding figures to indicate corresponding parts.

In Figure 5 the bell crank lever is inverted with respect to the prior arrangements. Accordingly, an upward movement is required in order to relax the pressure on the carbons. With this arrangement I am enabled to dispense with springs, the weight of the plungers and associated parts tending to restore them to normal position. In Figure 6 the automatic switch 18 is arranged preferably between the series solenoid 2 and the shunt solenoid 3, thereby necessitating the employment of a longer equalizing bar 6. Said equalizing bar is supported by the adjustable springs 10, as in the first form described, said springs being assisted by an additional spring 29 secured to one arm of the bell crank lever 8. The additional spring, however, may be dispensed with if desired. In Figure 7 the automatic switch is arranged preferably at the top of the panel and the regulating solenoids are arranged near the bottom of the panel with the variable pressure rheostat arranged between the upper and lower groups. In the arrangement illustrated, the spring 29 supports the entire weight of the equalizing bar and bell crank lever. Additional springs may be used, however, to support opposite ends of the equalizing bar if desired. In the form of device illustrated in Figure 8 the regulating solenoids are arranged preferably near the upper end of the panel and the automatic switch is arranged near the lower end thereof with the variable pressure rheostat occupying an intermediate position. In this figure the vertical link 9 is secured at its upper end to the equalizing bar 6 and passing down between the solenoids is connected at its lower end to the bell crank lever 8. The various parts are normally maintained in uppermost position by the adjustable springs 10. It is understood, of course, that in all four figures suitable stops are provided to limit

the movement of the plungers. It is to be further understood that the various features illustrated in connection with one of said figures may also be used elsewhere wherever applicable. In fact, all of the various forms of regulators shown throughout the drawings are selected for the purpose of illustration only as suggesting only a few of the various forms which the device may assume.

In Figure 9 I have illustrated certain preferred circuit arrangements where the regulator is used in connection with a car lighting system. The system includes a variable speed shunt wound generator, a storage battery and lamps connected across the external circuit supplied by said generator, an automatic switch adapted to close the circuit between the generator and the battery, a regulator for the generator, a regulator for the lamp circuit and a relay or multiplying device for increasing the sensitiveness of both regulators. For the sake of simplicity, the same reference characters have been used in this circuit diagram as have been used elsewhere throughout the preceding figures of the drawings where the parts are substantially the same, or where they perform the same general function. The generator is regulated for modified constant current in the manner previously described, that is to say, the generator supplies substantially constant current to the battery during the normal charging period, but the charging current is rapidly tapered off when the battery approaches a fully charged condition. The lamp regulator prevents an excessive voltage from being impressed on the lamp circuit. This regulator is illustrated as being made up of a variable pressure rheostat 30 interposed in series with the lamps and controlled by a shunt coil 31 connected around the lamps between said lamps and the storage battery. The shunt coil 31 responds to the increased voltage which tends to impress itself upon the lamp circuit and increases the resistance 30 in series with the lamps. In this manner the lamps are protected against an excessive voltage.

The relay for increasing the sensitiveness of the regulation may be of any suitable type. For example, it may be of the type illustrated in Figure 2. Accordingly, I have applied to this relay the same reference characters used in Figure 2 and elsewhere in the preceding figures of the drawing. The relay is connected with its resistance 19 in series both with the voltage coil 31 of the lamp regulator and with the voltage coil 3 of the generator regulator. From the preceding description of the operation of the relay, it will be apparent that the sensitiveness of the voltage regulation, both of the generator regulator and the

lamp regulator, will be greatly increased. The generator regulator illustrated diagrammatically in this figure is intended to represent any one of the various forms of regulators heretofore described, the form illustrated and described in connection with Figures 3 and 4 being the one employed in this instance. In fact, the regulator panel shown in said Figures 3 and 4 is particularly adapted for use in connection with a car lighting system such as just described, as the particular type of relay shown on said panel has been found to give very satisfactory results when connected in series both with the generator regulator and the lamp regulator, the latter not being shown on said panel as it is customary to mount it beneath the car body.

As previously stated, the invention is not limited to the forms of regulators described and illustrated, or to the details thereof, or to the various suggested changes therein, as it is apparent that various other forms and combinations of elements may be devised which fall within the scope of the invention. It is to be further understood that the invention is not limited to use in connection with a car lighting system but may be used in various other systems and circuits. In general, I desire to have it understood that the various words and phrases used throughout the entire specification were used in a descriptive rather than in a limiting sense and accordingly I desire to cover in the appended claims, any suitable equivalent means for accomplishing the desired results wherever said means fall within the scope of said claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:—

1. An electric regulator comprising among its elements two solenoids, each having a magnet frame, a plunger for each solenoid, an equalizing bar connected at opposite ends to said plungers, tension means tending to draw said plungers out of said solenoids, and means for limiting both the outward and inward movement of said plungers, the means for each plunger including a projection on the corresponding magnet frame operating in a slot in said plunger, said slots having abrupt walls at their ends adapted to abut against opposite sides of said projection when the plunger moves in or out.

2. An electric regulator comprising among its elements a substantially horizontal equalizing bar, an adjustable retractile spring secured to each end of said bar, a solenoid and plunger mounted adjacent each end of said bar, each plunger being connected to one end of said bar whereby either end of said bar may be drawn downward against the action of the adja-

cent spring independently of the movement of the other end of said bar and whereby both ends of said bar may be drawn down against the action of said springs, the movement of either of said plungers in any position causing said bar to pivot about its point of connection at the opposite end.

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

WILLIAM L. BLISS.

Witnesses:

C. C. CARPENTER,
C. E. MEAD.