(No Model.) 2 Sheets—Sheet 1.

A. D. STEVENS.

LIGHTING CARS BY ELECTRICITY.

No. 376,116. Patented Jan. 10, 1888.

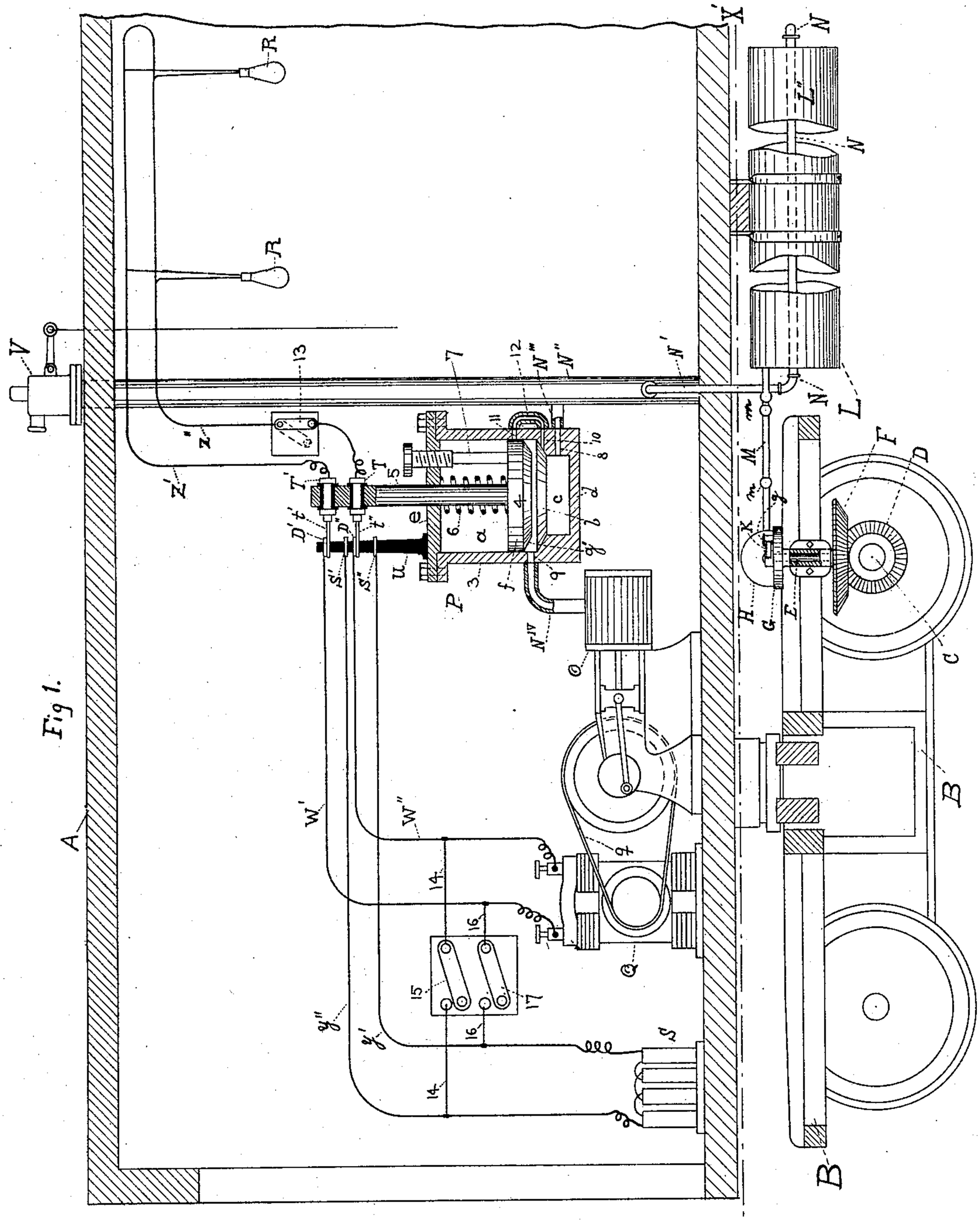

Fig 1.

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(No Model.) 2 Sheets—Sheet 2.

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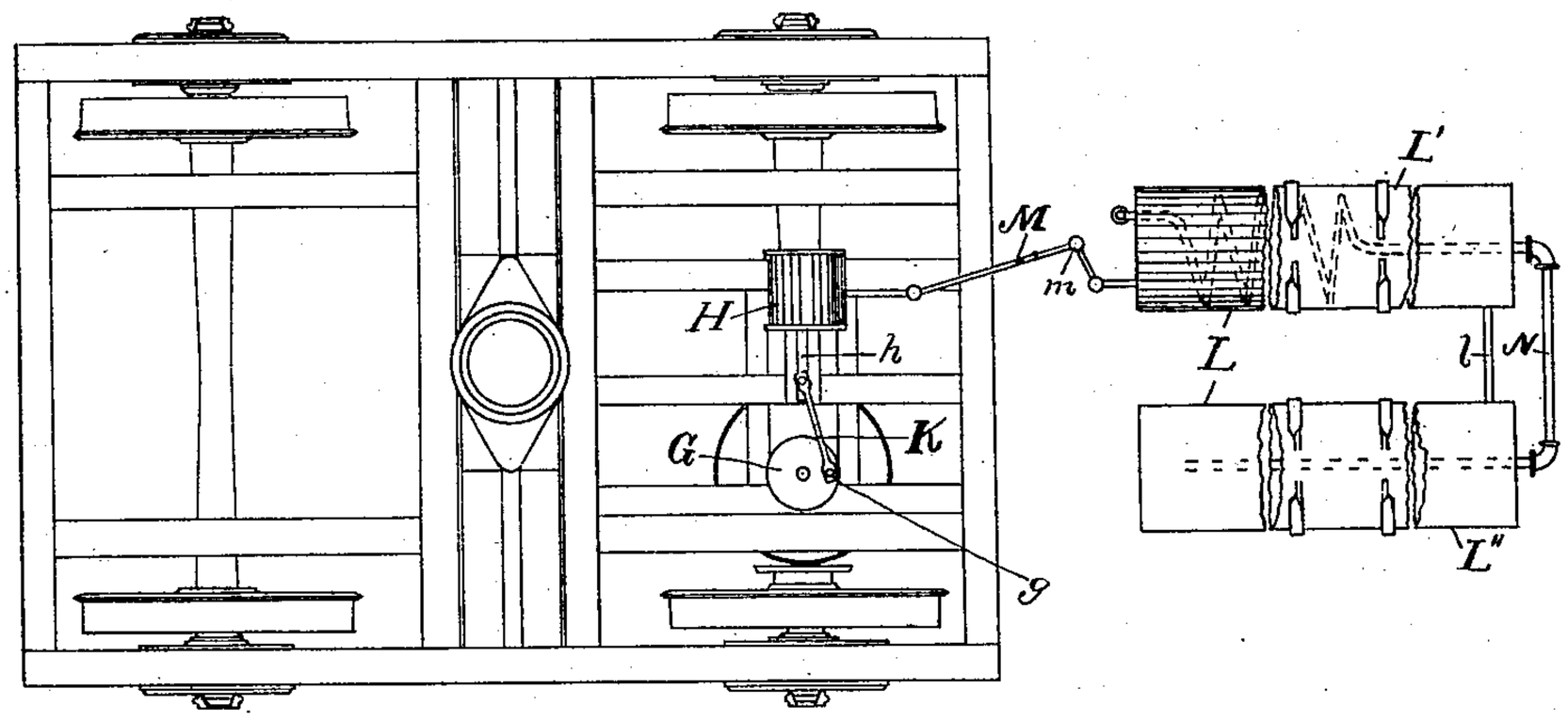
FIG. 2.



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UNITED STATES PATENT OFFICE.

ARTHUR D. STEVENS, OF MINNEAPOLIS, MINNESOTA, ASSIGNOR OF ONE-HALF TO EDGAR B. DILLINGHAM, OF SAME PLACE.

LIGHTING CARS BY ELECTRICITY.

SPECIFICATION forming part of Letters Patent No. 376,116, dated January 10, 1888.

Application filed June 10, 1887. Serial No. 240,943. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR D. STEVENS, a citizen of the United States, and a resident of the city of Minneapolis, county of Hennepin, State of Minnesota, have invented a certain new and useful Means for Electrically Lighting Cars, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to car-lighting; and it has for its object to generate electricity indirectly by power communicated from the axle of the car, and to utilize the same for supporting electric lights within the car in such a manner that a perfectly uniform and steady light will be afforded under all variations of speed or ordinary intermissions of movement.

It consists of the means hereinafter fully described, and particularly pointed out in the claims.

The great difficulty hitherto has been the unsteadiness of the light, on account of the variable speed and irregular motions of the car and the absence of any adequate economical means of sustaining the lights while the train was stopping at the stations. These defects I have overcome by the means hereinafter set forth.

In a general way, my method may be described as consisting in driving a compressor from the axle of the car, transmitting the compressed air to a combined receiver and storage-vessel, charging the same with an excess or store of air during the movement of the car, to be utilized when the train stops, driving the dynamo engine by air from the receiver, supporting incandescent lights by the electricity from the dynamo, charging storage-batteries from the dynamo when the lights are not in use—as during the day—to be utilized when the dynamo temporarily stops at night—as at stations—and in automatically connecting the lights with the storage-batteries the instant the dynamo ceases to act.

In the drawings, like letters referring to like parts throughout, Figure 1 is a longitudinal vertical section of a part of a car, showing my invention in working position, part of the mechanism being shown in side elevation and part in section, and the combined automatic cut-off and electric switch being shown on a relatively large scale; and Fig. 2 is a horizontal section or plan on the line X X′ of Fig. 1.

A is the body of a car.

B is a truck, and C is one of the wheel-axles.

D is a beveled gear-wheel attached to the axle and turning with the same.

E is a vertical shaft held in suitable boxing attached to a part of the truck.

F is a beveled gear-wheel attached to the lower end of the shaft E, and meshing with the wheel D.

G is a crank-disk rigidly attached to the upper extremity of the shaft E.

H is an air compressor, conveniently located with reference to the crank-disk G, preferably on the top of the truck-frame.

K is a connecting-rod connected at one end to the crank-pin on crank-disk G, and at the other end to the piston-rod *h* of the compressor H.

L is a combined air-receiver and air storage vessel, consisting of a pair of strong metallic cylinders, L′ L″, suitably supported under the car, preferably on the opposite sides between the trucks, and provided with the connecting-pipe *l*.

M is an air-conducting pipe suitably connected at one end to the compressor and at the other to the receiver L. This pipe M is made of sections provided with ball-and-socket joints *m*, in order to give a flexible connection from the compressor to the receiver, thereby avoiding the shock, torsion, and strain due to the irregular motion of the car and truck. The pipe M is connected to that part of the receiver which is nearest to the compressor.

N is the outlet-air pipe from the receiver, starting or communicating with the receiver at the part of the same most remote from the air-admission point, passing through the interior of said receiver, and leaving it at a point near the air-inlet, and it is preferably coiled upon itself within the cylinder L, or that part of the same nearest the admission-point. In virtue of the peculiar construction of the receiver and arrangement of the inlet and outlet pipes, the utmost possible air can be stored within the same and be taken out at the highest temperature. The air is taken into the mouth of the outlet-pipe N from that part of the receiver where it is the coolest, and is made to

pass through that part of the air which is the hottest. From the outlet end of the pipe N an extension, N′, leads to a vertical pipe, N″, passing up the side and through the roof of the car, and provided at its upper extremity with a pop or safety valve, V. From N″ an extension, N‴, leads to an automatic cut-off, P, hereinafter described, and a further extension, N^{iv}, leads to an automatic double-cylinder air-engine, O, located at any convenient point on the car-frame, preferably under the car-seats.

Q is a dynamo driven by power communicated from the air-engine through the belt *q* in the customary manner.

R is a series of incandescent electric lamps located within the car.

S is a storage-battery located at any convenient point.

The lamps, dynamo, and storage battery are connected up, as hereinafter described.

The automatic cut-off P may be located at any point on the air-conduit leading from the air-storage vessel L to the air-engine O. All that is necessary is that the air be made to pass through the cut-off on its way to the engine. This automatic cut-off is of peculiar construction, invented by me for the particular end in view. It may be described as follows:

A cylinder, 3, is provided, having interior sections, *a*, *b*, and *c*, of different diameter, of which sections *a*, or the upper section, has a relatively large diameter, *c*, or the lower section has a relatively small diameter, and *b*, or the middle section, has a varying diameter beginning below, of the same width as the section *c;* or looked at from within *a* may be treated as a large cylindrical section, and *b* as a section in shape like the frustum of a cone connecting the other two. Measured on the vertical line, the section *a* is relatively long, and *b* and *c* are relatively short. The cylinder 3 has a bottom, *d*, formed integral with its side walls, and has a removable cap, *e*, provided with a central hole of proper bore to pass a small piston-rod and a screw-threaded hole for holding an adjustable stop.

4 is a piston head or valve provided with a cylindrical section, *f*, fitting the section *a* of the cylinder 3, and a section, *g*, corresponding in shape to the intermediate section, *b*, of said cylinder 3, and adapted to fit the same.

5 is a valve-stem or piston-rod rigidly secured to the piston-head 4, and extending out through and beyond the cap-plate *e*. The joint made by the stem 5 with the cap *e* is not perfectly air-tight. Slight leakage along the valve-stem is allowed.

6 is a coiled spring encircling the piston-rod 5 and bearing against the under side of the cap *e* and the top of the piston-head 4.

7 is an adjustable stop projecting into the cylindrical section *a*, and having a screw-threaded portion working in a screw-threaded hole in the cap *e*. Its function is to limit the upward movement of the piston. It should be noted that the flaring walls of the intermediate section, *b*, serve as a stop, limiting the downward movement of the piston.

8 is an air-inlet duct admitting air from the air-storage vessel (conducted through N′ N″ N‴) to the interior of the small section *c*. The air-outlet duct 9, connecting with N^{iv}, starts (and must start) from some point within the cylinder 3 above the top of the lowermost section, *c*, and below the level of the top of the piston-head 4 when said piston-head is in its lowermost position.

A pair of air-ducts, 10 and 11, relatively small as compared with the ducts 8 and 9, are made through the side walls of the cylinder 3, and are connected by a curved pipe, 12, said duct 10 starting from some point in the section *b*, and said duct 11 entering the cylinder at some point in the section *a* below the level of the piston-head when in its uppermost position and above the level of said piston-head when in its lowermost position.

The operation of this cut-off mechanism is as follows: A tension-spring, 6, is selected having a tension equal to the number of pounds pressure at which it is desirable to cut off the air from the engine, say thirty-five pounds. Suppose the parts to be in the position shown. Air under pressure is entering through the duct 8 and passing on to the engine through the duct 9, the piston 4 being forced to its uppermost limit against the stop 7. If, now, the air-pressure falls a fraction below thirty-five pounds, the piston will start downward, the duct 11 will be opened, allowing part of the air to escape from below the piston around through 10, 12, and 11 to the top of the cylinder, thus tending to equalize the air-pressure above and below the piston-head, and the whole tension of the spring is immediately brought to bear, thus instantaneously forcing the piston to its lowermost limit and closing the outlet-duct 9. An instantaneous cut-off is thus effected. This cut-off would be effected by the spring 6, without the help arising from the ducts 10, 12, 11, but it would not be done so quickly. For the purposes in hand, the cut-off should be instantaneous.

It is equally desirable to effect an instantaneous opening of the duct 9 after the air-pressure has been restored to a point above thirty-five pounds. This is accomplished by the difference in area of the two sections *f* and *g* of the piston-head.

When the piston-head 4 is in its lowermost position, the duct 10 is closed, as well as the duct 9. Any air which may have passed to the upper side of the piston will have escaped by leakage along the valve-stem through the unpacked hole in the cap-plate *e*. Now, when the piston is in its lowermost position, only the area of the section *g* of the piston-head is exposed to the air-pressure. As soon, however, as the piston is started upward, the whole under surface of the larger section, *f*, becomes exposed to the pressure, increasing the number of units of force delivered against the resistance-spring and effecting the in-

stantaneous movement of the piston to its uppermost limit. In this manner the duct 9 is instantaneously opened and the air-engine started.

As hereinbefore stated, this air cut-off operates an electric switch. As shown, this is done as follows: In a part of the valve-stem or piston-rod 5 which is always outside the cylinder 3 are placed a short distance apart a pair of binding-posts, T′ and T″, each of which is insulated from the valve-stem by rubber bushing *j*. These binding-posts T′ T″ are provided with metallic spring-arms or contact-points *t′* and *t″*. A suitable standard, U, made of insulating material, as hard rubber or wood, is rigidly attached to any fixed support conveniently located with reference to the valve-stem 5—as, for example, to the top of the cap-plate *e*. On this hard-rubber standard U are fixed two pairs of metallic contact-points, indicated as D′ and D″ and S′ and S″, respectively. These metallic points are placed on the standard U in the following order, starting from above—viz., D′ S′ D″ S″, with the metallic strip or arm *t′* working between D′ and S′ and the metallic arm *t″* working between D″ and S″. The distance between D′ and S′ and D″ and S″ is considerably less than the travel of the valve-stem 5; hence, when the piston is in its uppermost position, D′ will make metallic contact with *t′* and D″ with *t″*, and when the piston is in its lowermost position S′ and *t′* and S″ and *t″*, respectively, will be in metallic contact. The contacts are lengthened by the spring-points *t′ t″*. From the metallic point D′ a wire, W′, extends to the positive pole of the dynamo Q, and from D″ a wire, W″, extends to the negative pole of the dynamo. From the point S′ a wire, Y″ extends to the negative pole of the storage-battery S, and from S″ a wire, Y′, extends to the positive pole of the storage-battery. From the binding-posts T′ and T″, respectively, extend the wires Z′ and Z″, making up the lamp-circuit, to which the lamps are connected in the customary manner.

From this description it is evident that the lamps are on an electric circuit through the dynamo when the points D′ and *t′* and D″ and *t″* are in metallic contact, and that they are on the storage-battery circuit when the points S′ and *t′* and S″ and *t″* are in metallic contact; but, as we have seen, the former contacts are made when the piston is at its uppermost limit and the latter when at its lowermost limit. The lamps are therefore automatically disconnected from the dynamo and connected with the storage-battery, or reversely, by the air-cut-off device.

It is not essential that the electric switch should assume the particular form shown. Others may be adapted to the purpose; but it is essential that the switch, whatever may be its form, be operated by the air cut-off, and this is the broad feature of my invention in this part of my mechanism.

The storage battery S is charged from the dynamo during the day-time. A hand-switch, 13, on one of the wires Z″ of the lamp circuit serves to open the lamp circuit at that point and disconnect the lamps in all positions of the valve-stem 5. A wire, 14, connects the dynamo-wire W″ with the storage battery wire Y″ through a switch, 15, and a wire, 16, connects the dynamo-wire W′ with the storage-battery wire Y′ through the switch 17. The positive pole of the dynamo is thus connected with the positive pole of the storage-battery and the negative pole of the dynamo with the negative pole of the battery. The dynamo is then run for whatever length of time is required to charge the storage battery or batteries. The switches 15 and 17 are then opened, and the battery is in readiness to re-enforce the dynamo during the night run, as hereinbefore described, when the proper connections are made.

I make the receiver L of a capacity of about ninety cubic feet, and make it strong enough to resist a high pressure. I calculate to carry a pressure in the receiver of about one hundred and eighty pounds and to set the cut-off P to a pressure of about thirty-five pounds. This will give a store of power sufficient when the train stops to continue the working of the engine, with all the lights burning, for a period of at least twenty-six minutes, or for double that length of time with half the lights—a period abundantly long for all ordinary stops. By increasing the size of the receiver or the pressure at which the air is carried this period may be lengthened at will.

Of the storage-batteries I carry a sufficient number to meet all ordinary contingencies—such as waiting for delayed trains, accidents, &c.; but I do not contemplate using them except under such circumstances. They are simply designed as a relay or re-enforcement to come into play when the pressure of the air is no longer sufficient to run the dynamo and maintain the lights.

The operation of my invention is clear from the description already given.

What I claim, and desire to secure by Letters Patent of the United States, is as follows:

1. In a system for electrically lighting cars, in combination, an air-compressor, suitable means for driving said compressor from the car-axle, substantially as described, an air-engine, a combined air-receiver and air-storage vessel intermediate said compressor and said engine, and communicating with each, and an automatic air cut-off intermediate said storage-vessel and said engine for cutting off the supply of air to the engine when the pressure falls below a given amount, as and for the purpose set forth.

2. In the system for electrically lighting cars, as set forth, the combined air-receiver and storage-vessel L, consisting of the cylinders L′ L″ and communicating-pipe *l*, in combination with an air-inlet pipe, M, and an air-outlet pipe, N, starting from a point within the receiver most remote from the air-admis-

sion point and passing through the entire length of both of said cylinders and leaving said receiver at a point near the air-admission point, substantially as described, whereby the utmost possible air may be stored within the receiver, and at the same time the air be taken from the receiver and applied to the engine at a high temperature.

3. An automatic air cut-off for air-engines, consisting of a suitable closed air-cylinder, a valve or piston in said cylinder, a tension-spring within said cylinder and bearing against the top of said valve, an air-inlet duct to said cylinder below the level of said valve when in its lowermost position, and an air-outlet duct through the side of said cylinder at a point covered and closed by the periphery of said valve when in its lowermost position and below the level of said valve when in its uppermost position, substantially as and for the purpose set forth.

4. An automatic air-cut off device consisting of a suitable air-cylinder, a tightly-fitting piston within said cylinder, a tension-spring bearing against the upper side of said piston, an air-inlet below said piston when in its lowest position, an air-outlet below the level of said piston when in its uppermost position and closed by said piston when in its lowest position, and an air-duct leading from the air-inlet side of said piston to a point in said cylinder just below the level of the top of said piston when in its uppermost position, whereby when the air-pressure falls below the spring-tension and the piston starts downward air from below the piston passes above the piston and the cut-off is made instantaneous.

5. An automatic air-cut-off device consisting of an air-cylinder having interior sections of different diameters, a piston having two sections of different diameters corresponding to and fitting two adjacent cylinder-sections, a tension-spring in said cylinder bearing against the top of the larger of said piston-sections, an air-inlet to said cylinder below the lowermost position of said smaller piston-section, and an air-outlet above the lowermost level of said piston and below the uppermost level of the same at a suitable point to be closed by said piston when down and be opened when the piston is up, substantially as described, whereby when the piston starts to rise the area of piston exposed to air-pressure is suddenly increased and the air-outlet is instantaneously opened.

6. An automatic device for instantaneously connecting and disconnecting an air-receiver with an air-engine, consisting of a suitable air-cylinder having three interior sections of different diameters—*i. e.*, a relatively large section, a relatively small section, and a middle conical or flaring section connecting said large and small section, a piston in said cylinder having two integrally-formed sections of proper diameters to fit said large and said middle cylindrical sections and provided with an unpacked piston-rod passing out through the head of said cylinder, a tension spring encircling said piston-rod and bearing against said piston, an air-inlet duct to the small cylindrical section for admitting air from the receiver, an air-outlet duct intermediate the highest and lowest level of the smaller piston-section for passing air to the engine, and an air-duct from the small cylinder-section to a point in the large cylinder-section just below the highest level of the top of the large piston-section, substantially as described.

7. In combination, an air-receiver, an air-engine, a dynamo coupled to said engine, an air-conduit from said receiver to said engine, an automatic air-cut-off device on said air-conduit, a set of storage-batteries, a series of electric lamps, a pair of electric conductors through said lamps, independent pairs of electric conductors through said dynamo and said storage-batteries, respectively, and an electric switch connected to and operated by said cut-off device and adapted to automatically switch said lamps into circuit with said dynamo and out of circuit with said storage-batteries, or reversely, substantially as and for the purpose set forth.

8. In combination, an air-receiver, an air-engine, a dynamo coupled to said engine, an air-conduit from said receiver to said engine, an air-cut-off device on said conduit, consisting, essentially, of a fixed cylinder with inlet and outlet ports, and a spring-pressed piston adapted to close said outlet-port when the air-pressure falls below a given point, and provided with a piston-rod, 5, projecting outside of said cylinder, binding-posts T′ T″, fixed in and insulated from said piston-rod, and provided with the metallic contact-points *t′ t″*, a fixed standard, U, of insulating material, suitably supported near the piston-rod 5, pairs of metallic contact-points, D′ and D″ and S′ and S″, fixed on said standards, said D′ and S′ being on opposite sides of *t′*, and D″ and S″ on the opposite sides of *t″*, a series of incandescent lamps, R, wires Z′ and Z″ from T′ and T″, respectively, to said lamps, a storage-battery, wires Y′ Y″ from S″ and S′, respectively, to said storage-battery, and wires W′ W″ from D′ and D″, respectively, to said dynamo, substantially as described.

9. In combination, an air-receiver, an air-engine, an air-conduit from said receiver to said engine, and an automatic device on said air-conduit adapted to cut off the air from said engine when the air-pressure falls below a given point, substantially as set forth.

10. In combination with a car-body and its supporting-truck, an air-compressor located on said truck, an air-receiver supported on said car-body, and an air-conduit connecting said compressor and receiver composed of a series of sections connected by ball-and-socket joints, as and for the purpose set forth.

ARTHUR D. STEVENS.

In presence of—
GEO. M. BENNETT,
J. F. WILLIAMSON.