

K. SCHOLZ.
RAILWAY SIGNALING SYSTEM.
APPLICATION FILED APR. 27, 1905.

4 SHEETS—SHEET 2.

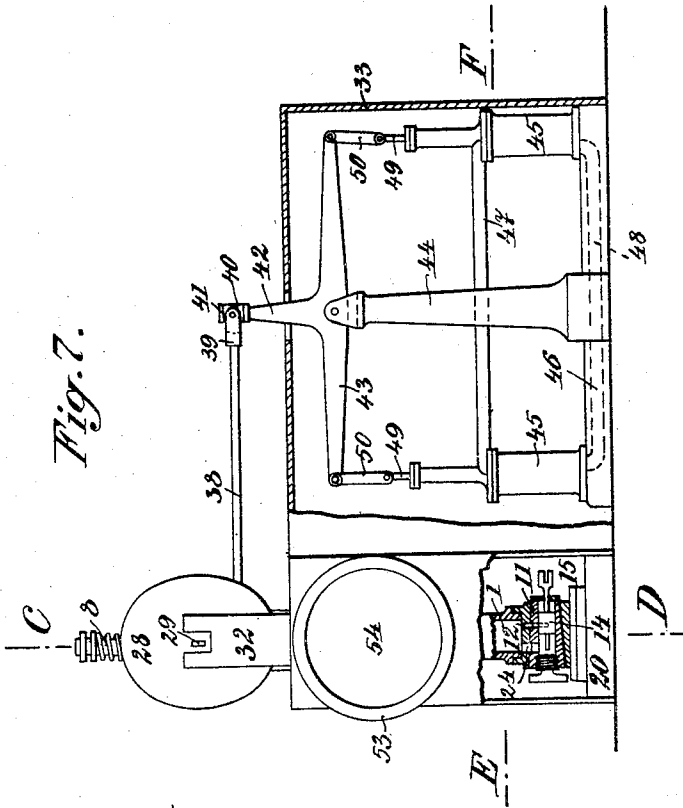


Fig. 7.

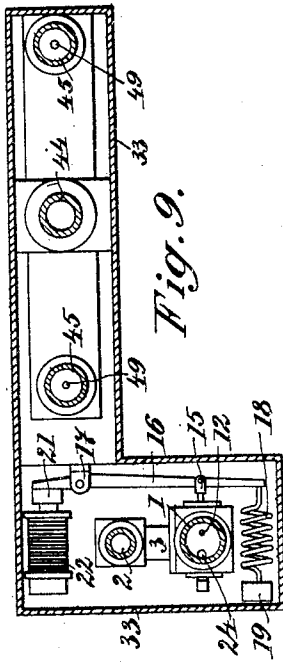


Fig. 9.

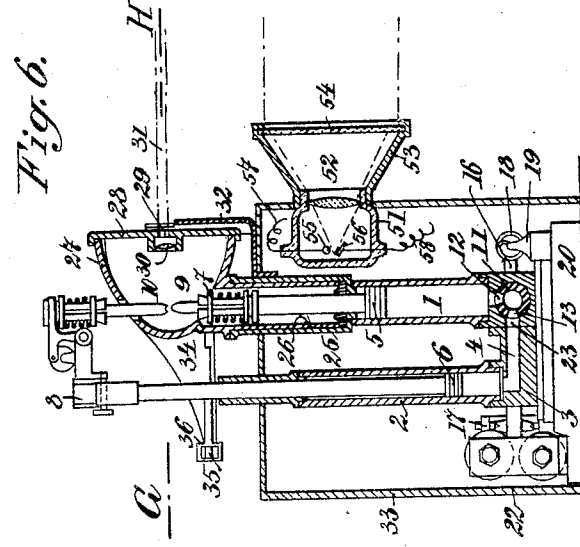
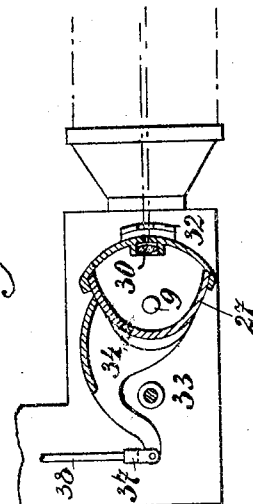


Fig. 6.

Fig. 8.



Witnesses

W. M. Avery

A. C. Davis

Inventor

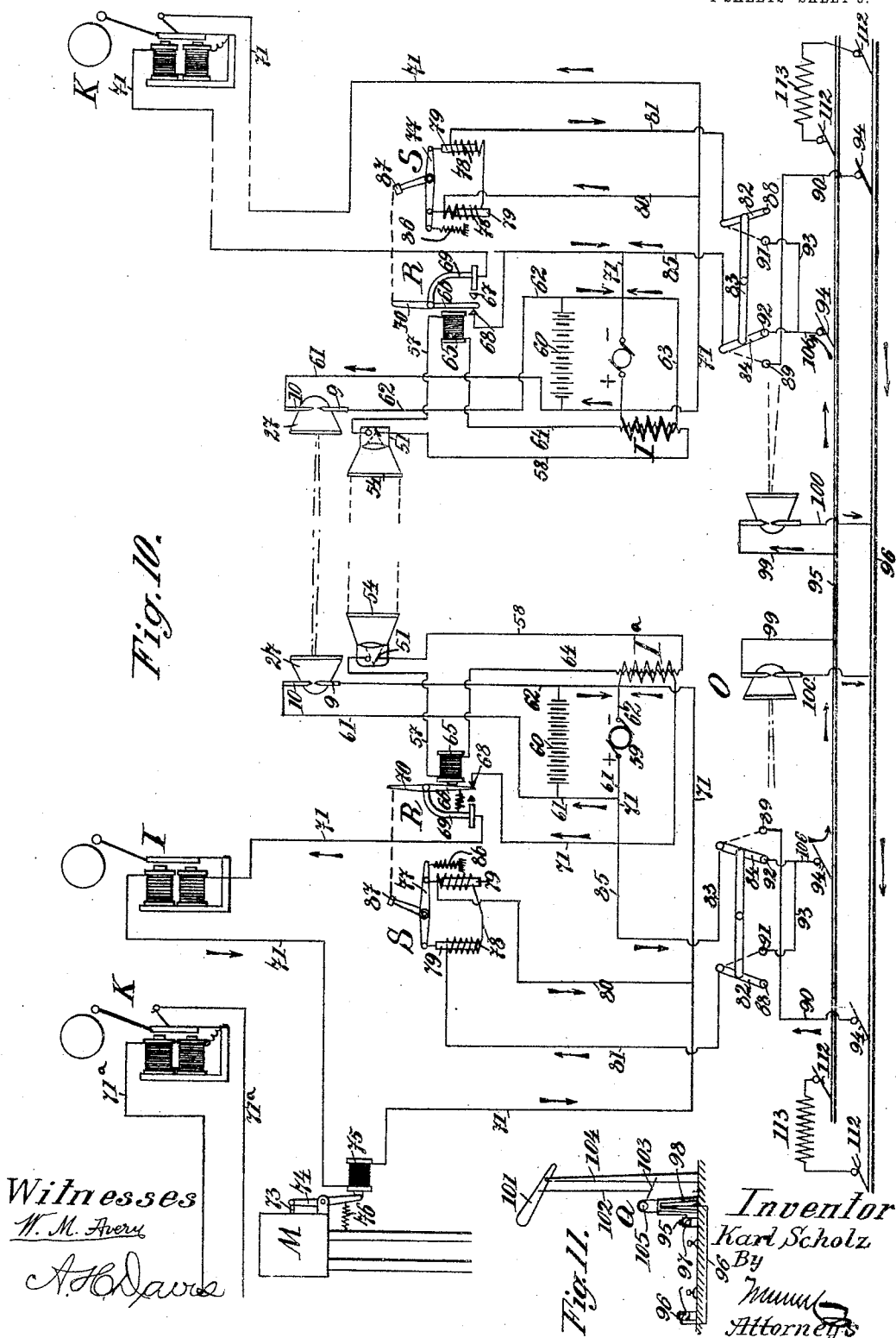
Karl Scholz

By Mumm

Attorneys

K. SCHOLZ.
RAILWAY SIGNALING SYSTEM.
APPLICATION FILED APR. 27, 1905.

4 SHEETS—SHEET 3.



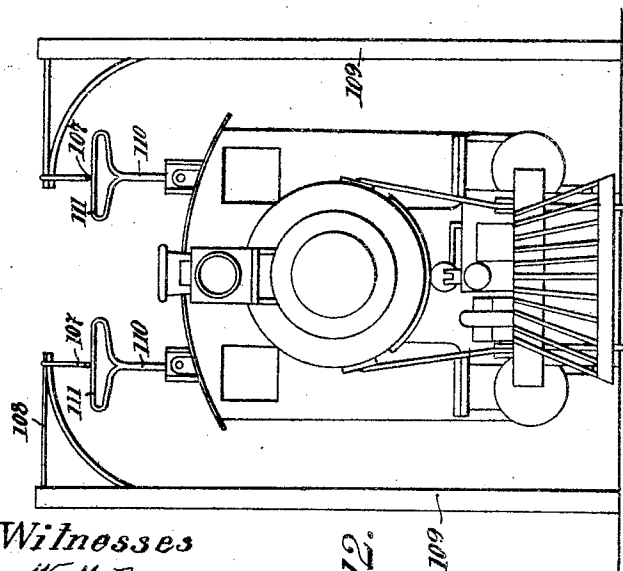
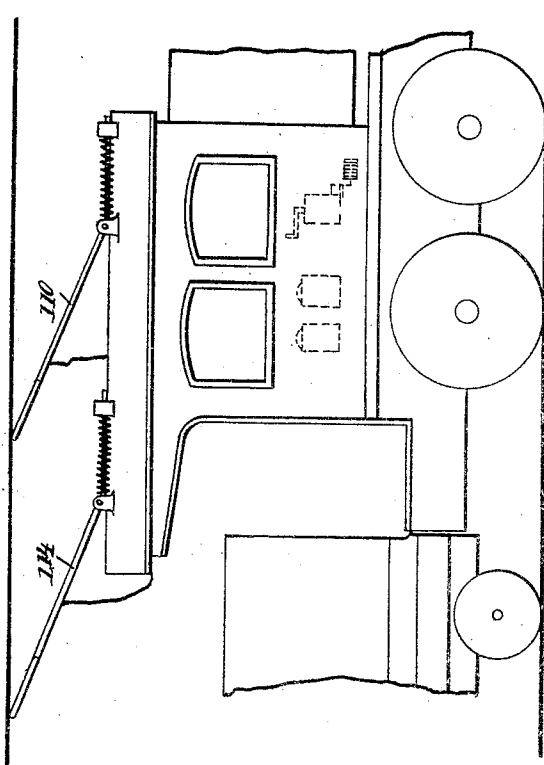
Witnesses
H. M. Avery
A. H. Davis

Inventor
Karl Scholz
By
Munich
Attorneys

K. SCHOLZ.
RAILWAY SIGNALING SYSTEM.
APPLICATION FILED APR. 27, 1905.

4 SHEETS—SHEET 4.

Fig. 13.



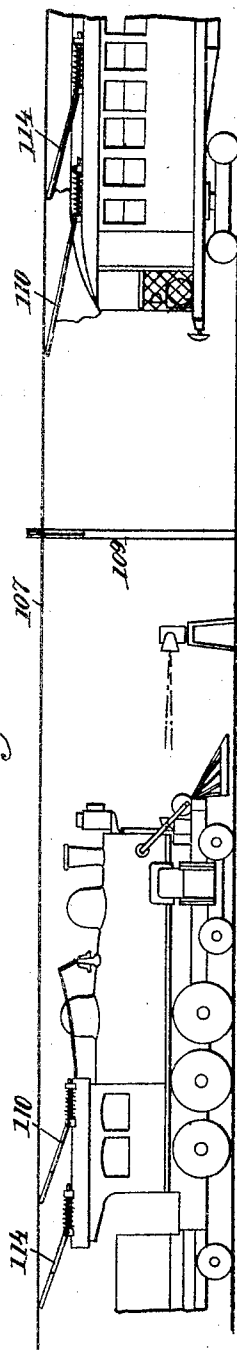
Witnesses

W. M. Frenz

A. C. Davis

Fig. 12.

Fig. 14.



Inventor
Karl Scholz
By *Munn*
Attorneys

UNITED STATES PATENT OFFICE.

KARL SCHOLZ, OF LIEBAUTHAL, AUSTRIA-HUNGARY.

RAILWAY SIGNALING SYSTEM.

No. 801,049.

Specification of Letters Patent.

Patented Oct. 3, 1905.

Application filed April 27, 1905. Serial No. 257,605.

To all whom it may concern:

Be it known that I, KARL SCHOLZ, a subject of the Emperor of Austria-Hungary, residing at Liebauthal, near Eger, Bohemia, in the Empire of Austria-Hungary, have invented a new and useful Railway Signaling System, of which the following is a specification.

As is well known, the rays of light having short wave lengths, more particularly the ultra-violet rays, have the property of reducing the electrical resistance of a spark-gap and causing the discharge of sparks. When, for example, the distance between the ball-like electrodes of a working induction-coil is so much increased that the potential difference ceases to cause the discharge of sparks and when ultra-violet rays of light are directed toward the spark-gap, they will instantly reproduce the discharge of sparks in spite of the increased length of the distance of the two electrodes.

My invention relates to a railway signaling system in which this property of the ultra-violet rays of light is made use of for stopping two trains approaching each other in the same track or for preventing a collision between two trains running in the same direction and in the same track, but at different speeds, by calling on the locomotive driver of the first train to hurry on and to leave behind the second train, no matter whether the trains be on straight tracks or in curves or whether they severally arrive at a station or leave the same, also whether the radius of the curves be large or small.

The objects of my invention are, first, to provide in every train, the front of the locomotive and the rear of the last carriage, each with a sender, a receiver, a dynamo, a battery, a relay, a double solenoid, two coupled switches, the necessary circuits, and a device for automatically pointing the sender during the run through curves; second, to provide the locomotive of each train with an alarm and a device for actuating the air-brake, both parts being controlled by the apparatuses on the locomotive, and with an alarm controlled by the apparatuses on the last carriage; third, to provide in every train, both the locomotive and the last carriage each with two contact-brushes or two trolley-poles; fourth, to provide along every sharp curve either two contact-rails or two overhead lines and two stationary senders, and, fifth, to provide a

sender at every block-signal and to arrange the latter for rendering the former active on being lowered and inactive on being raised. I attain these objects by the railway signaling system illustrated in the accompanying drawings, in which—

Figure 1 is the front view of a locomotive provided with the several apparatuses and a cross-section through two contact-rails on the sides of the track. Fig. 2 is an elevation of this locomotive seen from left to right in Fig. 1, an intermediate part being omitted. Fig. 3 shows in elevation, on a reduced scale, a locomotive on the left, parts of the contact-rails at a curve in the middle, and parts of these contact-rails and part of the last carriage of another train on the right, both trains being assumed to run in the same direction from left to right. Fig. 4 is the plan of a sharp curve with two stationary senders, on an exaggerated scale, for the sake of clearness. Fig. 5 is a vertical cross-section through the line A B in Fig. 4. Fig. 6 is a vertical longitudinal section through a sender and a receiver adapted to be mounted on the front of a locomotive or on the rear of a last carriage, the section being taken on the line C D in Fig. 7. Fig. 7 is a front view of the same in combination with the device for automatically pointing the sender, which device is shown in elevation, parts being shown in section. Fig. 8 is a horizontal section through the line G H in Fig. 6. Fig. 9 is a horizontal section through the line E F in Fig. 7. Fig. 10 is a diagram and shows on the left the several apparatuses and circuits on a locomotive, on the right the several apparatuses and circuits on the last carriage of another train in combination with the alarm on the locomotive of the latter, and below two contact-rails with two stationary senders at a sharp curve. Fig. 11 is a vertical cross-section through a track on the same scale as Fig. 5 and shows a block-signal, a stationary sender, and the connecting parts between them. Fig. 12 is the front view of another locomotive provided with the several apparatuses and two trolley-poles and the elevation of two poles supporting the two overhead conductors. Fig. 13 is the elevation of the rear part of this locomotive, a part of the tender, and parts of the overhead conductors; and Fig. 14 shows in elevation, on a reduced scale, the above locomotive, the overhead con-

ductors, and a part of the last carriage of another train, both trains being assumed to run in the same direction from left to right.

Similar characters of reference refer to similar parts throughout the several views.

Figs. 6 to 9 show a sender and a receiver in combination with a device for automatically pointing the pencil of rays emanating from the sender. The sender is an electric-arc lamp of a class suitable for locomotives and capable of performing its duty in spite of all vibrations and shocks. I have shown a lamp of a well-known construction which comprises two vertical cylinders 1 and 2, a base-plate 3, with a passage 4, two pistons 5 and 6, with the carbon-holders 7 and 8, respectively, and two carbons 9 and 10. An externally conical cylinder 11 is ground into the base-plate 3 at right angles to the passage 4 and is provided with two holes 12 and 13 in the same plane, through which a communication can be established between the two vertical cylinders 1 and 2 by means of the passage 4, the lower hole 13 communicating with the passage 4 through a by-pass 23 in the base-plate. In order to maintain the arc-light in the same point, the area of the large cylinder 1 is made double that of the small cylinder 2, so that the stroke of the small piston 6 is double that of the large piston. This is correct, seeing that the upper positive carbon 10 wastes twice as quick as the lower negative carbon 9, as is well known. I do not further describe the carbon-holders 7 and 8, as their construction is immaterial. A piston 14 is mounted in the small cylinder 11 to reciprocate and is provided with a bent hole at right angles to its axis. The two ends of this bent hole can register with the two holes 12 and 13 of the cylinder 11, and the piston 14 is adapted to close and to uncover these two holes 12 and 13 at the same time. Through a channel 24 the large cylinder 1 is put in constant communication with the space in the cylinder 11 on the left side of the piston 14 in Fig. 7. The piston 14 is pivotally connected by a forked rod 15 with the long arm of a two-armed lever 16, which latter is mounted to turn between two points in a bracket 17. The end of the long arm of the lever 16 is connected with a strong helical spring 18, the other end of which is attached to a stud 19 on a ground-plate 20. The short arm of the lever 16 carries the armature 21 of an electromagnet 22. The latter is inserted in the circuit of the electric lamp. The spaces in the two cylinders 1 and 2 beneath their pistons 5 and 6 in the passage 4 in the cylinder 11 on the left side of the piston 14 in Fig. 7 and in the bent hole in the piston 14 are filled with a heavy liquid, such as oil or glycerin, while the space in the cylinder 11 on the right side of the piston 14 in Fig. 7 is left without any liquid. This arc-lamp operates as follows: At the commencement when fresh carbons 9

and 10 have been put in the piston 6 in the small cylinder 2 occupies its uppermost position and the other piston 5 in the large cylinder 1 its lowermost position, so that a small distance may be left between the points of the two carbons 9 and 10. Normally the helical spring 18 draws the long arm of the lever 16, so as to push the piston 14 from right to left in Fig. 7 and to detach the armature 21 from the electromagnet 22. Thereby a communication is established between the two cylinders 1 and 2 through the holes 12 and 13, the bent hole in the piston 14, the by-pass 23, and the passage 4. Then the greater weight of the positive-carbon holder 8 will force the small piston 6 downward and the large piston 5 upward, so that the two carbons 9 and 10 will touch each other, whereby the circuit is closed. The current circulating in this circuit will energize the electromagnet 22, so that its armature 21 is attracted, and by the lever 16 the piston 14 is moved from left to right in Fig. 7. Thereby the communication between the two cylinders 1 and 2 is interrupted and at the same time a small quantity of the liquid is sucked from the large cylinder 1 through the channel 24, so that the large piston 5 sinks through a small distance, whereby the arc-light is produced between the two carbons 9 and 10. In this position the two carbons are maintained until by burning down the distance between their points is so much increased as to reduce the strength of the current, so that the electromagnet 22 no longer overbalances the tension of the helical spring 18 and the latter pushes inward the piston 14 by the lever 16. Thereby a small quantity of liquid is permitted to pass from the small cylinder 2 to the large cylinder 1, whereby the distance between the two carbons 9 and 10 is again reduced, so that the electromagnet 22 overcomes the tension of the helical spring 18 and draws the piston 14 outwardly to interrupt the communication between the two cylinders 1 and 2.

On the top of the large cylinder 1 a cylindrical bearing 25 is secured, in which the hollow trunnion 26 of a suitable reflector 27 is mounted to turn. This reflector 27 may be of any known construction and is closed on the front by a cylindrically-shaped plate 28, which in the middle is provided with a rectangular slit 29. A biconvex lens 30, of rock-crystal, is secured behind the slit 29 and is adapted to collect the rays of light from the arc-light and to send them out in a horizontal slightly-diverging pencil of rays 31. As is well known, every arc-lamp emits besides the white also ultra-violet rays of light, more particularly when the tension of the current is high. The rock-crystal lens 30 is chosen because it permits the ultra-violet rays to pass through, while a lens of ordinary glass would absorb them. The construction of the reflector 27, with the plate 28 and the lens 30, is

immaterial, the only condition being that a strong horizontal pencil of rays 31 be thereby produced which is capable of lighting at a distance of about three hundred meters a rectangular face of about one meter wide and two or three meters high. A bent and forked screen 32 is fastened on the bearing 25, and all the parts beneath the screen 32 are inclosed in a suitable casing 33, of sheet metal. The reflector 27 is provided with an arm 34, by means of which it can be turned around the axis of the large cylinder 1 and the two carbons 9 and 10. This arm 34 terminates in a pin 35, which is surrounded by a bearing 36 with two pins. The bearing 36 can swing around the horizontal pin 35, and its two pins engage in corresponding holes in the forked end 37 of a horizontal rod 38, so that the latter is permitted to swing around the two pins of the bearing 36. The other forked end 39 of the rod 38 is placed at right angles to the first forked end 37 and permits the rod 38 to swing around the two pins of a bearing 40 similar to 37. This bearing 40 is adapted to swing around a vertical pin 41, which forms a part of the vertical arm 42 of a balance-beam 43. The latter is mounted in a suitable support 44 to turn. It will be seen that both the reflector 27 and the balance-beam 43 are perfectly at liberty to move in two planes at right angles to each other, since this is permitted by the construction of the connecting-rod 38. Two vertical cylinders 45 45 are secured on a suitable base 46 and connected at the top and bottom by two tubes or channels 47 and 48. Two pistons or floats (not shown) of any known construction are arranged within the two cylinders 45 45 and are connected with the two ends of the balance-beam 43 by means of two rods 49 49 and two links 50 50. The casing 33, already referred to, is shown as arranged to equally inclose the device just described with the exception of the upper part of the arm 42. The lower halves of the two cylinders 45 45 and the lower tube or channel 48 are filled with a suitable liquid, such as petroleum or the like.

On the front of the casing 33 in the vertical longitudinal plane of the sender also the receiver is arranged. It consists of a vessel 51, of glass or other material, with the spark-gap, a biconvex lens 52, of rock-crystal, a preferably conical vessel 53, and a quartz plate 54 as a window. The spark-gap is formed by two electrodes 55 and 56, coated with platinum-foil and secured on wires 57 and 58, which are melted in the walls of the vessel 51 or otherwise fastened therein. The two electrodes 55 and 56 are at a distance of about ten to fifteen millimeters from each other, and the one, 55, is ball-like, while the other, 56, is a small circular plate placed at an angle of about forty-five degrees to the horizon. The vessel 51 is filled with rarefied air or gas. In other words, it is a vessel from which the air

or gas has been pumped out to facilitate the discharge of sparks. All horizontal ultra-violet rays of light (indicated by the dotted lines in Figs. 6 and 8) which strike the window 54 are permitted by the quartz to pass through, so that they are collected by the rock-crystal lens 52 and sent out by the latter in a conical pencil of rays, (as indicated by the dotted lines in Fig. 6,) meeting the circular plate 56 in a small oval. These ultra-violet rays of light reduce the electrical resistance of the spark-gap and render possible the discharge of sparks.

On the front of every locomotive L (see Figs. 1 to 3) and on the rear of the last carriage N of every train are disposed a sender, a receiver, and a pointing device in a common casing 33, as described above, the sender and the receiver being preferably placed in the central longitudinal plane of the locomotive or carriage, respectively. Besides these apparatuses also a dynamo 59, a storage battery 60, and a relay R, with a double solenoid S and an induction-coil I^a, (see Fig. 10,) the three latter parts being preferably within a casing 61^a, (see Fig. 1,) are disposed. The dynamo 59 may be of any known construction and is arranged to be driven by the locomotive L or the last carriage N, respectively, during the motion of the train. The storage battery 60, of any known construction, is to be supplied with electrical energy from the dynamo 59 during the run of the train and is to supply current to the circuits during the stoppage of the train. It is in any known manner arranged for automatically switching itself off after it has been sufficiently charged by the dynamo 59. Both the dynamo 59 and the storage battery 60 are connected in multiple by wires 61 and 62 with the sender or arc-lamp, of which only the two carbons 9 and 10 are indicated in Fig. 10. Shunted to the dynamo 59 by means of a wire 63 is the primary coil of the induction-coil I, while the secondary coil of the latter is connected with the two wires 57 and 58 of the receiver (see Figs. 6 and 10) by means of a wire 64. Between the two wires 57 and 64 the coil of the electromagnet 65 of the relay R is inserted. The armature 66 of the electromagnet 65 is normally held off by a spring and pressed against a convenient stop 67. It can come in contact with a contact-piece 68, but without touching the core of the electromagnet, so as to prevent it from hardening. The armature 66 is arranged to swing on a suitable support 69 and is rigidly connected with an arm 70, the purpose of which will be explained later on. The contact-piece 68 and the support 69 of the relay R are shunted to the dynamo 59 by means of a circuit 71.

In the cab of every locomotive L an air-brake-operating device M, Fig. 2, is usually disposed, which according to my invention is also placed under the control of the relay

R. This device M may be of any known construction and should be provided with an additional slide, by means of which the brake system may be operated the same as with the aid of the ordinary slide or valve, which is controlled by the known hand-lever or crank 72. The additional slide is not shown, as its construction is immaterial. It is pivotally connected by a rod 73 (see Fig. 10) with a two-armed lever 74, the lower arm of which carries the armature of an electromagnet 75. This armature is normally detached from the electromagnet 75 by means of a suitable spring 76. Two alarm devices I and K are also disposed in the cab of the locomotive. The one alarm device I and the electromagnet 75 of the air-brake-operating device are inserted in the circuit 71 on the locomotive, while the other alarm device K is inserted in the circuit 71^a on the last carriage N, which latter circuit 71 extends for this purpose from the last carriage over the several carriages to the locomotive of the train. This is clearly shown at Fig. 10, where the left part comprises the system on a locomotive and a part of the circuit 71 of the last carriage, while the right part comprises the system on the last carriage of another train and the circuit 71^a. The alarm devices I and K may be of any known construction; but the one K inserted in the circuit 71^a of the last carriage should be a vibrating bell which constantly sounds. The other alarm device I, inserted in the circuit 71 of the locomotive, should be so arranged that after starting it never breaks the circuit in order to maintain the armature of the electromagnet 75 in its position after it has been once attracted.

S denotes a device comprising a balance-beam 77, two solenoids 78 78, and two cores 79 79, suspended from the beam 77. The two solenoids 78 78 are connected with each other in series and with the circuit 71 by a wire 80 and with the axis of a switch 82 by a wire 81. This switch 82 is by a rod 83 coupled with another switch 84, the axis of which is connected with the other branch of the circuit 71 by a wire 85. The device S is shown in Fig. 10 as detached from the relay R, while in reality they are so combined that, say, the balance-beam 77 may be mounted on the pin of the armature 66 to turn. A spring 86 tends to bring the balance-beam 77 into the one extreme position, while the two solenoids 78 78 on being energized by the current of ordinary strength will overcome the tension of the spring 86 and bring the balance-beam 77 into its middle position shown. On the strength of the current being about doubled the two energized solenoids 78 78 will further turn the balance-beam 77 into its other extreme position. The balance-beam 77 is provided with a slanting arm 87, the scooped end of which is adapted to strike against the arm 70 (as is indicated by the dotted line in Fig. 10)

and to take the same along with it for pressing the armature 66 against the contact-piece 68, and thereby closing the circuit 71. The two switches 82 and 84, with the connecting-rod 83, are disposed in the cab of the locomotive L or in a convenient space in the last carriage N, respectively. Two contacts 88 and 89 of the switches 82 84 are by a line 90 connected with the one contact-brush 94 of any known construction and disposed on the frame of the locomotive (see Figs. 1 to 3) or the last carriage, respectively. Two other contacts 91 and 92 are connected by a line 93 106 with the other contact-brush 94. Each locomotive L is on the rear provided with two safety contact-brushes 112 112, which are connected with each other by a resistance 113 and can be turned off in case the locomotive is moving alone. In a similar manner each last carriage N is provided with two safety contact-brushes 112 112 and a resistance 113 between them, these brushes 112 112 being placed in advance of the proper contact-brushes 94 94. The purpose of the safety contact-brushes 112 112 will be explained later on.

At every sharp curve of the railway-track two contact-rails 95 and 96 are disposed along the rails on two convenient elevated supports 97 97 (see Figs. 3 and 5) and are so arranged that they may come in contact with the contact-brushes 94 94 of any locomotive L or last carriage N. The two contact-rails 95 and 96 should terminate at a certain distance (to be found by trials or otherwise) beyond either end of the curve. At suitable distances from the ends of the two contact-rails 95 and 96 two stationary senders O and P are disposed, which are arc-lamps of any known construction and provided with stationary reflectors. They should be placed at about the same height as the senders of the several locomotives and last carriages, and for this purpose the arc-lamps may be put on convenient supports 98. The one carbon of each of these lamps is connected by a wire 99 with the one contact-rail 95 and the other carbon by a wire 100 with the other contact-rail 96. (See Figs. 5 and 10.) These two lamps O and P should be so arranged that the current may pass through them in the one or the other direction. The reflectors of the stationary senders are of course provided with rock-crystal lenses (similar to 30 in Fig. 6) and are arranged to send the pencils of rays over the straight parts of the track, as is clearly shown at Figs. 3 and 4. They should be so directed that the ultra-violet rays of light may strike the receiver of any locomotive or last carriage at a distance of about three hundred meters. A stationary sender Q, similar to O or P, is disposed near the pole 104 of each block-signal 101. The latter is by a rod 102 connected with a lever 103, which is mounted on a pin at the pole 104 to turn and carries a screen 105. This screen 105 is adapted to close and

to uncover a slit similar to 29 in Fig. 7 in the reflector of the stationary sender. From an examination of Fig. 11 it will be clear that when the block-signal 101 is raised to mark the line as "free" it will have shifted the screen 105 upward to close the slit, and if the former is lowered to mark the line as "blocked" it will have lowered the screen 105 to uncover the slit. Where so preferred, any of these stationary senders Q may be provided with two reflectors on opposite sides and in the direction of the track. Then of course two screens 105 on two single levers 103 or a forked lever will have to be employed for closing and uncovering the slits of the two reflectors. The arc-lamp of the sender Q is also connected, on the one hand, with the contact-rail 95 and, on the other hand, with the other contact-rail 96.

The railway signaling system described so far is operated as follows: The spark-gaps of the receivers on all the locomotives and last carriages are so adjusted that the tension of the current ceases to cause the discharge of sparks. During the run of either train the two dynamos 59 on the locomotive L and the last carriage N, respectively, are driven so that they supply each current to both the storage battery 10 and the arc-lamp of the sender. Then a pencil of ultra-violet rays will be sent forward from the locomotive and another one rearward from the last carriage. When moving on a straight part of the track, the train should outrun another train which moves in the same direction—say from left to right in Fig. 10. The pencil of ultra-violet rays of light emanating from the sender of the locomotive on the left will already at a distance of about three hundred meters strike the quartz plate 54 of the receiver on the last carriage of the other train on the right, and after passing through this window these rays will be collected by the biconvex lens 52, Fig. 6, and directed toward the spark-gap between the two terminals 55 and 56. Thereby the electrical resistance of this gap will be reduced, so that sparks will keep springing over and currents will circulate in the circuit 57 58 64, whereby the electromagnet 65 is energized to attract its armature 66, so that the circuit 71, leading to the locomotive of the other train, is closed and the alarm device K is put into motion. Thus the locomotive-driver will be called on to hurry and to leave behind the first train. At the same time the pencil of ultra-violet rays of light emanating from the sender of the last carriage on the right will have struck the quartz plate 54 of the receiver on the locomotive of the first train on the left and produced a similar effect, the electromagnet 65 being energized to attract its armature 66, and thereby to close the circuit 71. Then the two electromagnets of the alarm device I will be energized to sound the latter, and at the same time the electromagnet 75 is energized to attract its

armature, and thereby to move the parts 74 and 73 for applying the air-brake, when the first train will stop, as usual. Thus both trains will have acted upon each other. When the second train on the right has sufficiently proceeded forward and the sender of its last carriage N ceases to act upon the receiver of the locomotive of the first train on the left, the electromagnet 65 will be without current, so that the circuit 71 is broken. Then the spring 76 will detach the armature of the electromagnet 75 and by the parts 74 and 73 return the respective slide into its initial position, whereby the air-brake is released. The locomotive-driver seeing this will know that he is now permitted to proceed.

When the first train on the left runs on a moderate curve, the locomotive will be slightly inclined in the cross-direction by the two rails placed at different heights. If, for example, in Figs. 1 and 7 the right wheels of the locomotive are a little higher than the left wheels, the track before the locomotive being bent to the left, then the level of the liquid (petroleum or the like) in the two cylinders 45 45 will adjust itself and cause the left piston, with the left rod 49, the left link 50, and the left arm of the balance-beam 43, to rise, but the right piston, with the right rod 49, the right link 50, and the right arm of the beam 43, to go downward a little. Thereby the vertical arm 42 will be turned to the right and also by the rod 38 the arm 34 of the reflector 27 in the same direction, so that the pencil of rays emanating from the slit 29 through the cut in the screen 32 will be turned to the left from the longitudinal central plane of the locomotive, as it should be. All the various parts of the device for automatically pointing the sender are so adjusted that whatever the radius of curvature of the curve may be and on what side of the track it may be, the beam of ultra-violet rays will cut the center line of the track at a distance of about three hundred meters and strike the receiver on the last carriage of the second train on the right, the same as before. Then the effect will of course be the same as before. In case, however, the curve should be so sharp as to cause the pencil of ultra-violet rays to cut at a distance of about three hundred meters—not the center line of the proper track, but that of the neighboring track—of course the railway signaling system would fail to work satisfactorily. To prevent such occurrences, the cut in the screen 32 of each sender (see Fig. 7) is so proportioned as to permit the pencil of ultra-violet rays to pass through from the slit 29 only as long as the radius of curvature of any curve is not too small; otherwise the screen 32 is adapted to interrupt the pencil of rays so that the sender is rendered inoperative. For this reason all the sharp curves are each provided with two contact-rails 95 and 96 on both

sides and with two stationary senders O and P, as described above with reference to Figs. 1 to 5. When the first train on the left in Fig. 10 runs through such a sharp curve, the two contact-brushes 94 94 of the locomotive L will come in contact with the two contact-rails 95 and 96 and send current through the same for the purpose of actuating the two stationary senders O and P, which will then send two beams of rays forward and rearward, as is indicated by the dotted lines in Figs. 4 and 10. For the forward motion in the one direction—say from left to right in Fig. 10—the two switches 82 and 84 on both the locomotive and the last carriage of each train are so adjusted by means of the coupling-rod 83 as to bring them into the positions shown by full lines in Fig. 10. For the forward motion in the opposite direction—say from right to left—the two switches 82 and 84 on both the locomotive and the last carriage of each train will require to be brought into the other positions indicated by the dotted lines. From an examination of Fig. 10 it will be clear that for the motion of the locomotive on the left from left to right the current passes from the positive pole of its dynamo 59 through the line 61 7 85, the switch 84, the contact 92, the line 106, the one contact-brush 94, the contact-rail 95, the two arc-lamps O and P, the other contact-rail 96, the other contact-brush 94 on the left, the line 90, the contact 88, the switch 82, the line 81, the two solenoids 78 78, and the lines 80 71 62 to the negative pole of the dynamo 59. The two solenoids 78 78 are then energized and draw the two cores 79 79, while overcoming the tension of the spring 86. Thereby the balance-beam 77 on the left is brought into its middle positions shown, in which its arm 87 remains without any effect upon the arm 70 of the armature 66. The first stationary sender actuated by the locomotive—that is, O—will be on the side of the locomotive, and therefore exert no influence upon its receiver. The locomotive can continue to run forward with its train, and its own sender remains inactive, since the pencil of rays is interrupted by the respective side of the screen 32 in Fig. 7, as explained above. The other stationary sender—that is, P—sends forward its pencil of rays. When the two contact-brushes 94 94 of the locomotive on the left leave behind the first stationary sender O, of course the current leaving the one contact-brush 94 will be divided, and a part of this current will continue to run through the contact-rail 95 to the other stationary sender P, and thence back through the other contact-rail 96, as described before, while the other part of the current passes from right to left through the contact-rail 95 to the safety contact-brushes 112 112 and the resistance 113 and thence back through the contact-rail 96 to the other contact-brush 94, which collects the two parts of the current.

Thereby the first stationary sender O is rendered inoperative, which, however, does not matter, as the train passes over this part of the track. When the two contact-brushes 94 94 of the last carriage on the left (not shown) come in contact with the two contact-rails 95 and 96, the current from the locomotive will be prevented by the two safety contact-brushes 112 112 and the resistance 113 of the locomotive from passing over to the apparatuses on the last carriage. A current passes from the dynamo 59 of the last carriage (see the right part of Fig. 10, which represents the system on a similar last carriage) through the line 61 71 80, the two solenoids 78 78, the line 81, the switch 82, the contact 88, the line 90, the contact-brush 94, the contact-rail 96, (from left to right,) the one safety contact-brush 112, the resistance 113, the other safety contact-brush 112, the contact-rail, (from right to left,) the contact-brush 94, the line 106, the contact 92, the switch 84, and the line 85 71 62, back to the dynamo 59. As long as the two safety contact-brushes 112 112 of the last carriage are behind the first stationary sender O no effect will be produced. Only after these two safety contact-brushes have passed the stationary sender O will the latter be henceforward actuated to send its pencil of rays of light rearward. It will be seen that the circulation of the current is in all cases maintained in the right direction during the passage of the locomotive along the contact-rails 95 and 96 only in either stationary lamp O or P will the direction of the current change. As stated before, the pencil of rays sent forward by the second stationary lamp P will protect the locomotive from any collision in the manner described. The pencil of rays sent rearward by the first stationary lamp P will equally protect the last carriage N from any collision with the locomotive L of any following train, (see Fig. 3,) as at a distance of about three hundred meters the receiver of this locomotive L will be actuated for stopping the latter in a similar manner as explained above.

In case the two contact-brushes 94 94 of the last carriage N of a train are still in contact with the two contact-rails 95 and 96 and from any cause a following train is allowed to run then the two contact-brushes 94 94 of its locomotive L will come in contact with the two contact-rails 95 and 96, whereupon the following occurrences will take place: From the positive pole of the dynamo 59 of the following train (on the left in Fig. 10) the current passes in the direction of the arrows through the lines 71 85, the switch 84, the contact 92, the line 106, the contact-brush 94, the contact-rail 95, the contact-brush of the last carriage of the first train, (on the right in Fig. 10,) the line 106, the contact 92, the switch 84, the line 85 71, the dynamo 59, the lines 61 71 80, the two solenoids 78 78, the line 81, the switch 82, the contact 88, the line 90, the con-

tact-brush 94, the contact-rail 96, the contact-brush 94 of the locomotive of the following train, (on the left in Fig. 10,) the line 90, the contact 88, the switch 82, the line 81, the two solenoids 78 78, and the lines 80 71 62 back to the negative pole of the dynamo 59. It will be seen that the currents of both dynamos 59 59 circulate in the same circuit, which means that the pressure of the current will be doubled, so that both on the locomotive on the left and on the last carriage on the right the two solenoids 78 78 are more energized and caused to turn the balance-beam 77 so much that its arm 87 strikes against the arm 70 and presses the armature 66 against its contact-piece 68, whereby the circuit 71 is closed. Therefore on the locomotive of the first train on the right the alarm device K will sound to call the attention of the locomotive driver, while on the locomotive of the following train on the left not only the alarm device I will sound, but also the air-brake will be applied to stop the train. Thus in the sharp curves the two contact-rails 95 and 96 are made use of for avoiding any collision between two trains.

In case two trains running in opposite directions on the same track approach each other either the senders of their two locomotives may, with the aid of the ultra-violet rays of light, actuate the opposite receivers for stopping the two trains on straight parts of the track or in moderate curves, or the two contact-rails 95 and 96 along a sharp curve may stop the two trains. The manner in which this is effected is obvious after the above explanations and from an examination of Fig. 10, which in this case only requires to be slightly amended by replacing the circuit 71 on the right by another circuit similar to that 71 on the left and by adding a circuit 71, as in the upper left corner of Fig. 10.

When at a station any block-signal 101 (see Fig. 11) should be lowered to mark the line as "blocked" and a train should approach without its locomotive driver being able to see the block-signal, (or the respective night-lamp,) this would be of no consequence, for on the two contact-brushes 94 94 of its locomotive coming in contact with the two contact-rails 95 and 96 a current will circulate in the latter to actuate the stationary sender Q, which will send a pencil of rays through its slit, uncovered by the screen 105, toward the receiver of the locomotive. Then in the manner described above the air-brake will be applied to stop the train. When the block-signal 101 is again raised to mark the line as "free," the pencil of rays emanating from the stationary sender Q will be interrupted by the screen 105, so that the receiver of the locomotive is no longer acted upon. Then the armature of the electromagnet 75 will be detached by the spring 76, and by the arm 74 and the rod 73 the air-brake-operating device will be operated to release the brake. The

locomotive driver seeing this will know that he can now proceed.

Of course where so preferred the two contact-rails for each block-signal may be replaced by a special circuit, through which current from any source may be passed for actuating the respective stationary sender.

Where so preferred, two overhead conductors 107 107, suspended from convenient supports 108 108 on poles 109 109, as shown in Figs. 12 to 14, may be employed instead of the two contact-rails 95 and 96 along each sharp curve and near each block-signal at the station. Both the locomotive and the last carriage of each train require to be each provided with two trolley-poles 110 110 and two trolleys 111 111, also with two safety trolley-poles 114 114, a resistance, (similar to 113 in Fig. 10,) and two trolleys. In this case the operation of the system will be much the same as before, and the diagram in Fig. 10 requires but slight alterations, the two contact-rails 95 and 96 being replaced by two lines above and connected by trolleys and trolley-poles with the lines 106 and 90.

The senders of the various trains and also the stationary senders at sharp curves and at stations, in case the trains are on those places, remain in permanent action—that is to say, their arc-lamps will burn continuously—no matter whether the several trains move or stop, since during the stoppage of the respective train the current is supplied by the storage batteries in place of the dynamos on the locomotive and the last carriage. On the train restarting the storage batteries are recharged by the dynamos, now in motion, until they automatically switch themselves off when sufficiently charged.

The railway signaling system as described may be varied in many respects without deviating from the spirit of my invention.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a railway signaling system, the combination with a sender adapted to emit a horizontal slightly-diverging pencil of ultra-violet rays of light, of a receiver on a train and comprising a quartz plate as a window and adapted to receive ultra-violet rays of light, a rock-crystal lens adapted to collect these rays and a spark-gap adapted to receive the collected ultra-violet rays of light, a circuit on the train and containing said spark-gap, and means controlled by said circuit for giving signals.

2. In a railway signaling system, the combination with a train, of two senders adapted to emit horizontal slightly-diverging pencils of ultra-violet rays of light forward and rearward from said train, two receivers near said two senders and adapted to receive ultra-violet rays of light from the front and the rear, each receiver comprising a quartz plate as a window, a rock-crystal lens adapted to collect the rays of light and a spark-gap adapted to receive

the collected ultra-violet rays of light, circuits on said train and containing the spark-gaps of said two receivers, and means controlled by said circuits for giving signals.

5 3. In a railway signaling system, the combination with a train, of two senders adapted to emit horizontal slightly-diverging pencils of ultra-violet rays of light forward and rearward from said train, means for automatically pointing
10 said two senders to the center line of the track over a determined distance, two receivers near said two senders and adapted to receive ultra-violet rays of light from the front and the rear, each receiver comprising a quartz
15 plate as a window, a rock-crystal lens adapted to collect the rays of light and a spark-gap adapted to receive the collected ultra-violet rays of light, circuits on said train and containing the spark-gaps of said two receivers,
20 and means controlled by said circuits for giving signals.

4. In a railway signaling system, the combination with a train, of a dynamo on said train and adapted to be driven thereby, a storage
25 battery adapted to switch itself off when sufficiently charged, an arc-lamp with a reflector adapted to emit a horizontal slightly-diverging pencil of ultra-violet rays of light, a circuit connecting in multiple with said dynamo
30 and said storage battery with said arc-lamp, means for automatically pointing said reflector to the center line of the track over a determined distance, an induction-coil having its primary coil shunted to said dynamo, a
35 receiver near said reflector and adapted to receive ultra-violet rays of light in the direction of the track, a rock-crystal lens adapted to collect the rays of light and a spark-gap adapted
40 to receive the collected ultra-violet rays of light, a second circuit connecting the terminals of said spark-gap with the secondary coil of said induction-coil, a relay inserted in said second circuit, a third circuit shunted to said
45 dynamo and controlled by said relay, an alarm device in said third circuit, and an electromagnet in said third circuit and adapted to operate the air-brake system.

5. In a railway signaling system, the combination with a train, of a dynamo on said train and adapted to be driven thereby, a storage
50 battery adapted to switch itself off when sufficiently charged, an arc-lamp with a reflector adapted to emit a horizontal slightly-diverging pencil of ultra-violet rays of light, a circuit connecting in multiple said dynamo and
55 said storage battery with said arc-lamp, means for automatically pointing said reflector to the center line of the track over a determined distance, a screen adapted to interrupt the pencil of ultra-violet rays of light on the turn of said reflector exceeding two determined
60 limits, an induction-coil having its primary coil shunted to said dynamo, a receiver near
65 said reflector and adapted to receive ultra-vio-

let rays of light in the direction of the track, it comprising a quartz plate as a window, a rock-crystal lens adapted to collect the rays
of light and a spark-gap adapted to receive the collected ultra-violet rays of light, a second
70 circuit connecting the terminals of said spark-gap with the secondary coil of said induction-coil, a relay inserted in said second circuit, a third circuit shunted to said dynamo and controlled by said relay, an alarm device in said
75 third circuit, an electromagnet in said third circuit and adapted to operate the air-brake system, two stationary conductors along a part of the track, two stationary arc-lamps with reflectors connected with said two stationary
80 conductors and adapted to emit forward and rearward respectively in the direction of the track each a horizontal slightly-diverging pencil of ultra-violet rays of light, two contact means on said train and adapted
85 to come in contact with said two stationary conductors, a balance-beam normally occupying the one extreme position and adapted to actuate the armature of said relay on being brought into the other extreme position, two
90 solenoids, two cores suspended from said balance-beam and engaging in said two solenoids, and a fourth circuit connecting said two contact means with the two branches of said third circuit and containing said two solenoids.

6. In a railway signaling system, the combination with a train, of a sender adapted to emit a horizontal slightly-diverging pencil of ultra-violet rays of light from said train in the direction
100 of the track, a receiver near said sender and adapted to receive ultra-violet rays of light in the direction of the track, this receiver comprising a quartz plate as a window, a rock-crystal lens adapted to collect the rays of light and a spark-gap adapted to receive
105 the collected ultra-violet rays of light, circuits on said train and containing the spark-gap of said receiver, means controlled by said circuits for giving signals, a block-signal, a stationary sender adapted to emit a horizontal
110 slightly-diverging pencil of ultra-violet rays of light in the direction of the track, a screen connected with said block-signal and adapted to interrupt and to release the pencil of rays from said stationary sender, two stationary
115 conductors along a part of the track and connected with said stationary sender, and two contact means on said train and adapted to come in contact with said two stationary conductors, said two contact means being inserted
120 in said circuits.

7. In a railway signaling system, the combination with a block-signal, of a stationary arc-lamp adapted to emit a horizontal slightly-diverging pencil of ultra-violet rays of light
125 in the direction of the track, a screen connected with said block-signal and adapted to interrupt and to release the pencil of rays, and means for supplying current to said stationary arc-lamp.

8. In a railway signaling system, the combination with a train, of two circuits on said train and comprising means for giving signals, two stationary conductors along a part of the track, a stationary arc-lamp connected with said two stationary conductors and adapted to emit a horizontal slightly-diverging pencil of ultra-violet rays of light, four contact-brushes on the locomotive of said train, two of them on the front and connected with one of said two circuits and the other two of them on the rear and connected with each other by a resistance, four contact-brushes on the last carriage of said train, of which two are on the rear and connected with the other of said two circuits while the other two are before the rear brushes and are connected with each other by a resistance.

9. In a railway signaling system, the combination with a train, of two circuits on said train and comprising means for giving signals, two stationary conductors along a part of the track, two stationary arc-lamps connected with said two stationary conductors and adapted to emit two horizontal slightly-diverging pencils of ultra-violet rays of light forward and rearward respectively in the direction of the track, four contact-brushes on the locomotive of said train, two of them on the front and connected with one of said two circuits and the other two of them on the rear and connected with each other by a resistance, four contact-brushes on the last carriage of said train, of

which two are on the rear and connected with the other of said two circuits while the other two are before the rear brushes and are connected with each other by a resistance. 35

10. The combination with a locomotive arc-lamp, of a vertical cylindrical bearing surrounding the lower carbon-holder of said arc-lamp, a reflector mounted in said vertical cylindrical bearing to turn and adapted to emit a horizontal slightly-diverging pencil of ultra-violet rays of light from said arc-lamp, an arm on said reflector, a forked screen on said vertical cylindrical bearing and adapted to interrupt and to release the pencil of rays, a support, a balance-beam mounted in said support to turn in a vertical plane at right angles to the normal longitudinal plane of said reflector, a vertical arm on said balance-beam, means pivotally connecting said arm with said vertical arm, two vertical cylinders beneath the ends of said balance-beam, two channels connecting said two vertical cylinders at top and bottom, two pistons in said two cylinders, two piston-rods, and two links connecting said two piston-rods with the ends of said balance-beam. 40 45 50 55

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses. 60

KARL SCHOLZ.

Witnesses:

ADOLPH FISCHER,
ARTHUR SCHWEZ.