

Oct. 8, 1929.

H. DIEHL

1,731,127

SIGNAL CONTROL SYSTEM

Filed Dec. 30, 1926

2 Sheets-Sheet 1

Fig. 1.

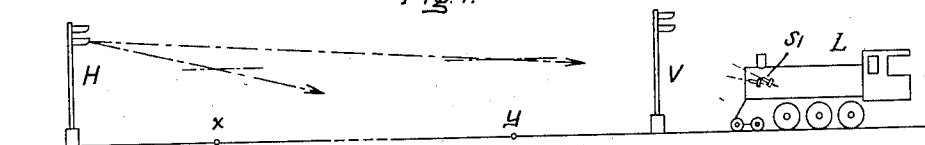


Fig. 2.

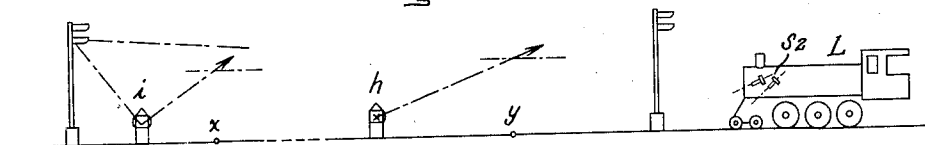


Fig. 3.

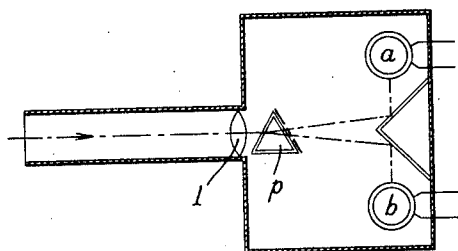


Fig. 4.

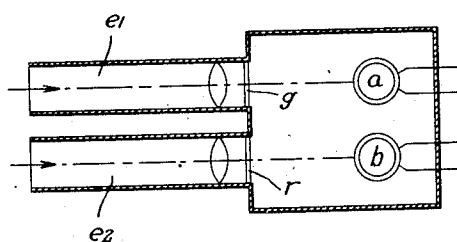
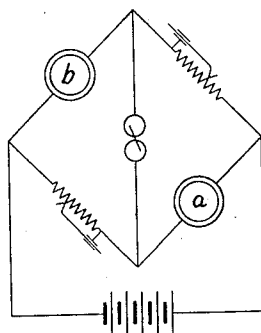


Fig. 5.



Inventor:
Heinrich Diehl,
by *Wendell S. Lunt*
His Attorney.

Oct. 8, 1929.

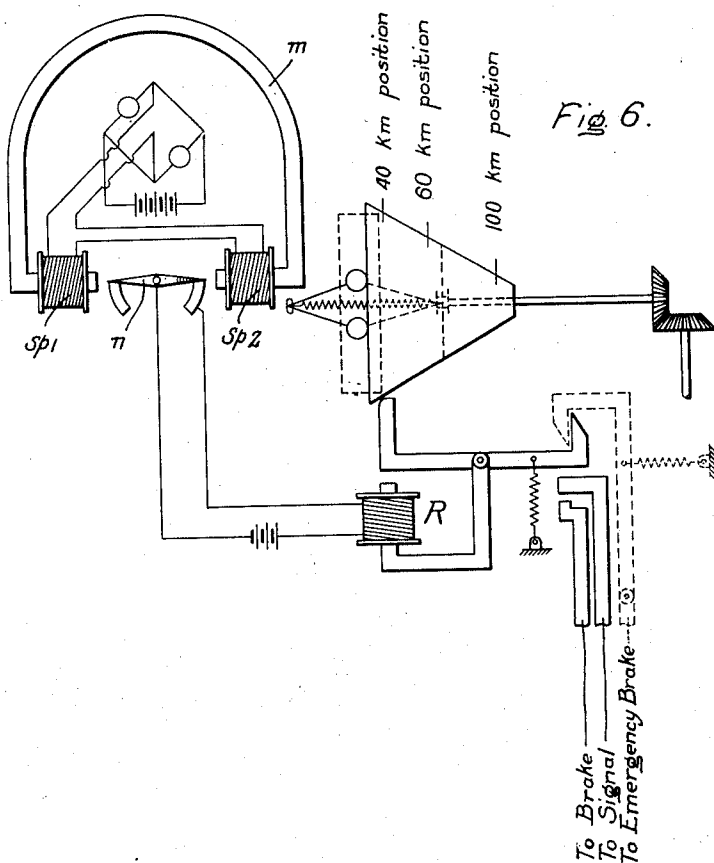
H. DIEHL

1,731,127

SIGNAL CONTROL SYSTEM

Filed Dec. 30, 1926

2 Sheets-Sheet 2



Inventor:
Heinrich Diehl,
by *Myron S. Lind*
His Attorney.

UNITED STATES PATENT OFFICE

HEINRICH DIEHL, OF BERLIN-LICHTERFELDE, GERMANY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

SIGNAL-CONTROL SYSTEM

Application filed December 30, 1926, Serial No. 158,098, and in Germany February 18, 1926.

My invention relates to the control of a power driven structure which travels in a constrained path along a permanent way, whereby the structure may be automatically stopped or otherwise controlled as desired. Power driven moving structures, such as railway trains, electric elevators, hoists and the like may be controlled independently of the operator under predetermined conditions in accordance with the invention. The invention will be disclosed in connection with the control of a railway train in order to explain the principles thereof, but it is to be understood that the invention is not necessarily so limited, but has a broader application.

The various signal transmission and train control apparatus which electrically or mechanically control a train running past a signal have besides various other faults the joint drawback that they require parts secured to the railway track. Apart from the question of cost of such apparatus, the exact positive functioning of these parts with the signal presupposes a reliable positive coupling which in certain cases is already liable to be a source of errors. The functioning is faulty and sometimes fails altogether when these parts secured to the rail track are damaged during the line work (for instance a cable may be cut).

This invention relates to a control apparatus which does not require any parts arranged on the track; on the contrary its constituent parts are mounted on the train in an easily controlled manner, and their working is initiated by a signal light radiated against them. This apparatus presupposes of course the existence of daylight signals.

As is well known, the action required of such control apparatus comprises really two functions: first of all, the apparatus must in all circumstances give an indication to the engine driver when the train is passing a distant signal set to "caution". If the speed of the train exceeds 60 kilometers per hour, a partial braking must be automatically effected at the same time, and the speed of the train reduced to 60 km. an hour. This must take place however only 100 meters past the distant signal, as for example, at y, which is

100 meters from the signal V. This function is the first control. The second control is exercised directly at the home signal, or a few meters in front of the home signal, in the event of the home signal being set at "danger". In such a case the control produces a positive quick action braking in such a manner that the train is brought to a standstill at the latest 200 meters past the home signal, in front of the so-called "danger point". Obviously, the control device does not become operative when the signals show "clear".

The present invention consists substantially in arranging on the power operated moving structure, such as the train, preferably on the engine, one or more light-electric cells in which changes of state are produced by irradiation by the signal light. This temporary change of the cells sensitive to light, produced by the irradiation, can produce in one or more circuits electric changes, by means of which the desired control of the train or other movable structure can be obtained.

The first control point is situated 600 meters in front of the home signal, whilst the second one is situated directly under the home signal or a few meters in front of it. The light-electric receivers mounted on the engine or other movable structure must therefore receive radiation in these two positions. Corresponding experiments have shown that the change in the light-electric receivers, required for producing releasing action, is effective also at a distance of several kilometers even when the rays of the signal, visible to the human eye, are perfectly imperceptible owing to thick fog or smoke. The accompanying drawings show by way of example several methods of carrying the present invention into effect.

In the accompanying drawings, Fig. 1 indicates diagrammatically a control for the rolling stock of a railway, in accordance with the invention, the controlling means being indicated as located on the locomotive so as to be responsive to rays from light sources positioned along the track; Fig. 2 represents diagrammatically a modification of the arrangement of Fig. 1, whereby the controlling means located on the engine will be suitably gov-

erned while the locomotive is on a curve in the track; Figs. 3 and 4 show details of the control whereby there is optically obtained a selective operation of the control in response to differently colored light rays; Fig. 5 shows a Wheatstone bridge arrangement including the light responsive cells whereby the desired selective operation is obtained; and Fig. 6 shows diagrammatically a particular arrangement in accordance with the invention in cooperation with means responsive to the speed of the locomotive whereby a control of the brake and signal mechanism of the locomotive is had.

Those constructions of this apparatus are considered which do not require any changes in the signal devices at present employed. In the existing signal installations danger is indicated by a red light, clear signal by green and caution by orange colored light. In my examples, however, the home signal itself acts at the two control points so that it is necessary merely to obtain different sensations for the red and green light.

The simplest method of carrying the invention into effect is to cause the home signal H to radiate two beams of light (see Figure 1) namely at two different angles, one to be effective 600 meters in front of the signal, and the other to be effective nearer the signal. On the engine L are accordingly mounted two parts S1 (for instance selenium cells, photo-cells or the like) which are sensitive to light and more particularly to red light. The cells are arranged each in a light-tight box into which the light can penetrate only through a long narrow tube or intercepting member. The tubes of the two light-receiving members are arranged also at different angles, so as to be effective at various preselected positions along the permanent way for causing the rays of light of the home signal to cause activation of the various cells to be varied according to the position of the moving structure. Consequently only the first beam of light of the home signal can pass through one tube, and only the second beam through the other tube. Consequently one receiver can receive red light only at the first control point, and the other only at the second control point. When this color-sensitive cell is irradiated by the corresponding red light, there will be produced in it the greatest electric change, so that a relay connected to it may be operated to produce in a secondary circuit the desired control of the train by means of mechanical, electric or pneumatic devices. A green ray of light will not produce any change of the cells sensitive to red. White or colored rays other than red will act, but not sufficiently to operate the relay.

If owing to the curvature of the track the home signal cannot act at the first control point *x*, the first control point could be con-

trolled by the distant signal V which would project a ray of light behind it. Or as shown in Figure 2, this control point could be an auxiliary source of light *h* which would positively alter the colors of its light in accordance with the home signal. In some cases in place of this auxiliary source of light could also be used a two color reflecting mirror which is irradiated by a source of white light provided on the engine, and reflects a correspondingly colored light to the engine. The mirror would therefore be arranged to change its red or green reflection surface positively with the signal.

In the same way the signal light could be projected towards the engine not only directly from the top, but also by means of a reflecting mirror from the bottom, as indicated by the mirror arrangement *i* in Figure 2.

If cells sensitive to color are to be avoided, the construction shown in Figures 3 and 4 could be used, in which for the selection of the different colored rays of light is not required color sensitiveness of the cell, but merely simple sensitiveness to light. The distinction between colors is made here optically.

In the protective box sensitive to light at the end of the receiving tube is mounted the lens 1 which projects the signal light beam through the prism *p*. As is well known, a prism has different refraction for rays of light of different colors, according as the ray of light in question has longer or shorter waves. In Figure 3 are shown the different angles of refraction of the red and green light. The rear surface of the prism is covered with an opaque layer, and left uncovered only at the places where the red and green rays get in or come out so as to form two slots as indicated diagrammatically on the back of the prism *p*. An angle mirror, the object of which is to increase the very small differences in the angle of refraction, is arranged to the rear of the prism *p* so that the apex of the angle mirror is disposed between the two slots. According as the rays of light received are red or green, they will be reflected towards the cell *b* arranged at the bottom or towards the cell *a* arranged at the top. The cells *a* and *b* are switched into a balanced circuit (for instance a Wheatstone bridge) in such a manner that owing to the opposite resistances, with a source of current connected across one diagonal of the bridge no current will flow in the circuit connecting the other diagonal of the bridge when the cells are not activated or are similarly activated (Figure 5).

When daylight or strange light acts on the receivers, this position of rest will not be changed, as the two cells receive a corresponding action mutually balancing. When however the receiver tube comes within the

geometrical shadow of the signal lamp, either red or green rays of light will get in, that is to say only the cell *a* or only the cell *b* will be irradiated; consequently the state of equilibrium at the terminals of the Wheatstone bridge will be disturbed, and the relay connected in the circuit connecting the other diagonal of the bridge will act in a direction depending on whether the cell responsive to the red or the green light is illuminated.

This selective operation in response to the color of the signal light could also be obtained by means of color filters as shown in Figure 4. Here the cells *a* and *b* have separate receiver tubes *e*¹ and *e*², the tube *e*¹ being provided with filter *g*, which filters out the green light, and the *b* tube *e*² with the filter *r* which filters out the red light. Also in this case the cells are connected in a balanced circuit such as the Wheatstone bridge indicated in Fig. 5.

For recording the electric changes produced in the cell circuits, there can be used any relay which is non-sensitive to mechanical vibrations. By way of example, two such relays are provided. A suitably built magnetic needle relay is sketched in Figure 6, in which in the field of force of the permanent magnet *m* is mounted a magnetic needle *n* of small mass which is completely free from vibration on account of the relatively very strong directional force of the magnetic field. On the pole shoes of the permanent magnet are arranged coils *sp*¹ and *sp*² which are in connection with a Wheatstone bridge. When a current passes through the coils due to the heretofore referred to selective activation of the cells, the electromagnetic field changes the permanent field, and the magnetic needle is deflected. These deflections of the needle can be utilized for closing or opening various circuits. In the drawing is shown an auxiliary relay *R* which is deenergized when the coil *sp*² is excited, and acts on the brake or signal devices in connection with a centrifugal pendulum controlled by the speed of the engine. Parts of the brake mechanism and the signal mechanism only are indicated since the particular cooperating means between the light responsive and the brake mechanism and signal mechanism is not of the essence of this invention.

What I claim as new and desire to secure by Letters Patent of the United States, is—
 Controlling means for a power driven structure arranged to travel in a constrained path along a permanent way, comprising means for producing directed beams of light, a plurality of cells carried by the structure and responsive to said beams of light for controlling movements of said structure, intercepting members effective at various preselected positions along the permanent way for causing the various cells to be illuminated according to the position of the moving struc-

ture, and color selective members carried by the structure for effecting a diversity of modes of response of said cells at the various responsive positions to thereby control movements of the structure.

In witness whereof, I have hereunto set my hand this 7th day of December, 1926.
 HEINRICH DIEHL.

70

75

80

85

90

95

100

105

110

115

120

125

130