Controlled Manual Block in Hauenstein Tunnel*

A Swiss Installation Involving the Wheel-Counting Principle Instead of Track Circuit

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THE Hauenstein tunnel in Switzerland is situated on the direct line of the Swiss Federal Railways, between Basle and Olten, and is just over 8 kilometers (5 miles) in length. Steam locomotives at present are operated through it. The two block stations on either side are Olten-Tannwald junction and Tecknau station. The distance between them is too long to form one block section without causing traffic delays and an examination of the conditions showed that the correct point at which to divide the section was in the tunnel, 3,698 meters (12,130 ft.) from the northern end and 4,436 meters (14,550 ft.) from the southern portal. The system of block working in use on this part of the road is the "Siemen's Alternating Current Controlled-Manual," used extensively elsewhere on the Swiss Federal lines.

It was, however, clearly impossible to establish a manual block station in the middle of a steam operated tunnel of such a length, so the administration sought to solve the problem otherwise. It was eventually decided to retain the Siemen's block and to establish additional intermediate signals, electriaclly controlled, in the tunnel, operating them from the Olten-Tannwald signal tower. Mechanical signals were of course out of the question. It was also necessary to know when a train was standing at these signals and to ensure that no train should be admitted to an occupied block.

Unusual Conditions Encountered

Figure 1 shows the general arrangement of signals adopted. The northbound section is divided at signal A, which is worked as an advance signal from Olten-Tannwald, and the southbound section is divided at signal D, which is worked from the same tower as an outer home signal. A second train can thus leave Olten-Tannwald when the first has passed and been protected by A, and similarly a second train can leave Tecknau when the preceding one has passed and been protected by D.

*This article refers to the new Haunstein Base Tunnel, opened in 1916 to ease the gradient to not more than 1 ft. in 100 ft. between Basle and Olten, and should not be confused with the old tunnel opened in 1858 which is only 1 mile 1210 yds.

The home signal at Tecknau, B., and run-through signal C, are also electrical, but the remaining signals are the usual Swiss standard type and worked mechanically. Traffic runs left-handed in Switzerland, but the semaphores, being of German pattern, are right-handed and

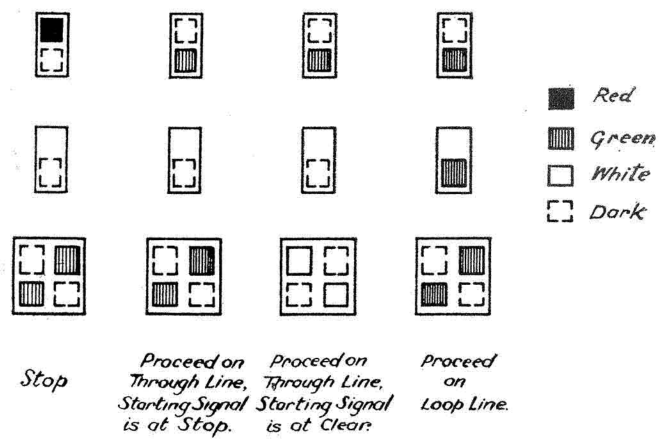

Fig. 2—Indications of Home Signal, Tecknau

point over the track like those used on the Chicago & North-Western. Block and home signals show a red or green light and their repeaters, shown on the diagram, green or white, according to the standard Swiss regulations. Signals B: and C show the indications as given in Fig. 2.

It will be evident that it was necessary to prevent the operator at Olten-Tannwald from clearing his northbound starting signal unless the whole of the previous train had cleared the advance signal A in the tunnel and that signal had been placed at "Danger"—and similarly to prevent his unlocking the southbound block signal at Tecknau until the preceding train had passed entirely clear of his outer home signal D and been protected by it.

The signals are light-signals, shown in Fig. 3, consisting of two incandescent bulbs of 16 to 25 c. p. in alu-

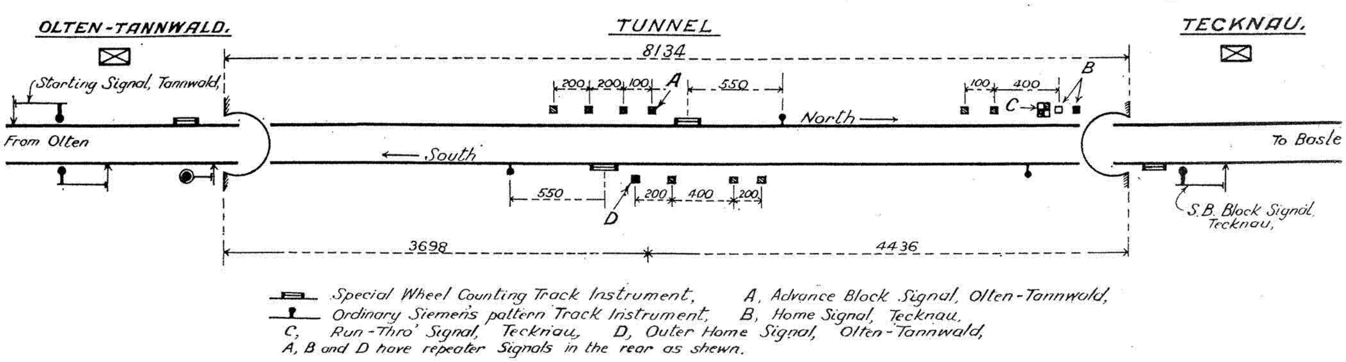

Fig. 1.—Diagram Showing Location of Signals, Track Instruments and Tower

minum water-tight cases, the connections being led in by a cable having a plug connection to a terminal box nearby. The change of circuits is made by switches, either fixed to ordinary levers in the machine at Tecknau or small handles in the special intermediate block instrument at Olten-Tannwald.

The most natural solution of the problem of control would at once appear to be track-circuit and this was duly considered by the railway authorities. It was found, however, that owing to the dampness of the tunnel and the great length of the block it would have been necessary to have six cut-sections to the block in order to get reliable working, and it was thought very undesirable to have to keep watch on bonding, rail joints, relays,

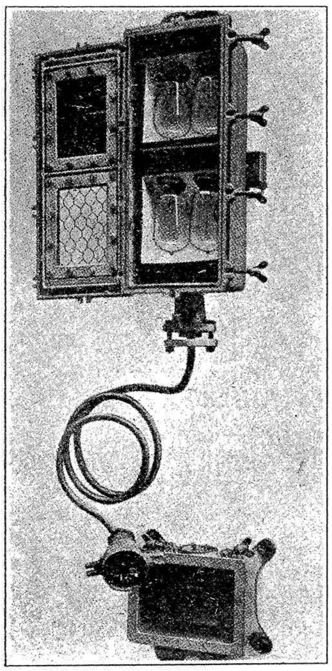

Fig. 3—Tunnel Signal

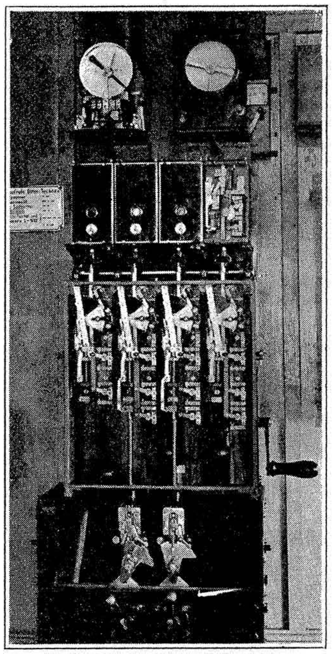

Fig. 4—Intermediate Block Apparatus and Wheel Counters

etc.; in a tunnel so full of smoke and steam. Furthermore, iron ties are used extensively in Switzerland, and this would be impossible with track-circuits.

Wheel Counter Developed

It was accordingly decided to try something else and Rudolph Zaugg, engineer of the telegraph service at Berne, designed a wheel-counting mechanism and experiments with it were conducted near Berne. The principle of the wheel-counter is somewhat similar to that used in car-counting street railway signals, such as the Nachod, United States, etc., well known in America. If every wheel that enters and leaves the block is registered, the two operations being equal, it may be assumed that the block is clear. The late W. R. Sykes in England has a patent for such an apparatus in 1904, and made a set which was tried on the Metropolitan Railway.

When the two mechanisms were in the zero position the block was clear. Mr. Zaugg's apparatus is almost identical with that of W. R. Sykes.

The Zaugg counting apparatus is shown at the top of the photograph in Fig. 4. The two step-by-step movements work a red and a white needle, respectively, and when the block is clear the white needle covers the red one. When a train enters the block each wheel causes the red needle to advance, as shown in the figure, and when the train leaves the block the white needle similarly advances. When the white one again covers the red the block is clear.

In the experiments near Berne track instruments were not used. Instead a very short length of insulated rail, supported by a special chair, was employed, each axle on passing this rail transmitting an impulse to the counting mechanism. These experiments were made with passenger trains and it was thought that no difficulty would be experienced with freight trains. In the tunnel installation, however, this proved to be a mistake. It was found that sometimes with freight trains there would be a discrepancy of one or two wheels between the needles after a train had passed through. Careful investigation disclosed that this was due to flats on the wheels caused by prolonged breaking, these flats making the wheel jump sometimes on the insulated rail, so giving two impulses. The rail was, therefore, given up in favor of the track instrument shown in Fig. 5. This is not worked by the depression of the rail nor by the wheel

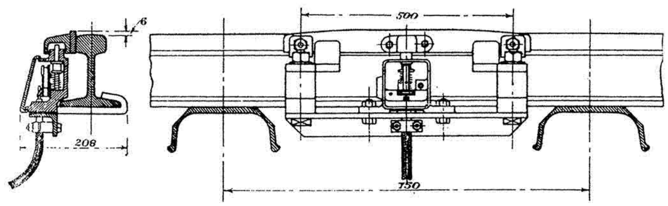

Fig. 5—Wheel Counting Track Instrument

flanges, but by the treads of the wheels, the total depression of the contactor bar being 4 to 6 millimeters. For a speed of 100 kilometers per hour (about 63 miles per hour), up to which the apparatus has been worked, the track instrument has to be capable of giving impulses at about 1-22 sec. apart, when counting the wheels of the bogie-trucks in usual service in Switzerland. In order to respond to this the step-by-step movement has to be accurately constructed. After the substitution of the track-instrument for the short insulated rail no further difficulties were encountered.

Operation of the Siemen's System

In order to understand the application of this apparatus to the Hauenstein installation we must first briefly notice the working of the Siemen's block system. In Fig. 6 may be seen a diagram of a unit or block-field of this system, with its essential parts. It is operated by alternating-current derived from a magneto. These block-fields may be and are used for a great variety of purposes in Swiss and German signaling. Each consists essentially of a spring returned plunger D, acting by collar R on a spring-loaded rod E, which in turn locks the signal lever or other apparatus connected with it, as shown. Normally such a lever is free. When the operator has sent a train forward and requires to clear the rear block he must place his own signal to "Danger," then plunge on rod D by pressing the knob and turn the magneto. This sends current through coils C to the other block station and the oscillation of the armature B allows sector A to fall, the half-axle of which then prevents the return of the trigger G. When this movement is completed the operator releases the plunger, which rises. Rod E can only partly rise on account of trigger G and this in turn permits catch J to go beneath the collar R and lock the plunger. The signal is now locked. When the next block station repeats the same operation the incoming current again oscillates armature B and the sector A then rises under the pressure of the spring pushing up the collar L and pin P. When it is completely up the sector axle frees trigger G, which flies back and so allows rod E to rise, releasing the signal. Mechanical locking is provided which automatically holds the lever after its return to normal until replaced by the electrical field-locking, but this is not illustrated. In order to prevent the premature use of the field track-instrument control is also added. The plunger is coupled by a link to an extension rod in a case above the block apparatus and this is controlled by an electric lock so that unless the track-instrument ahead of the block-signal is actuated the plunger cannot be depressed. In the photographs in Fig. 4 these plunger-locks can be

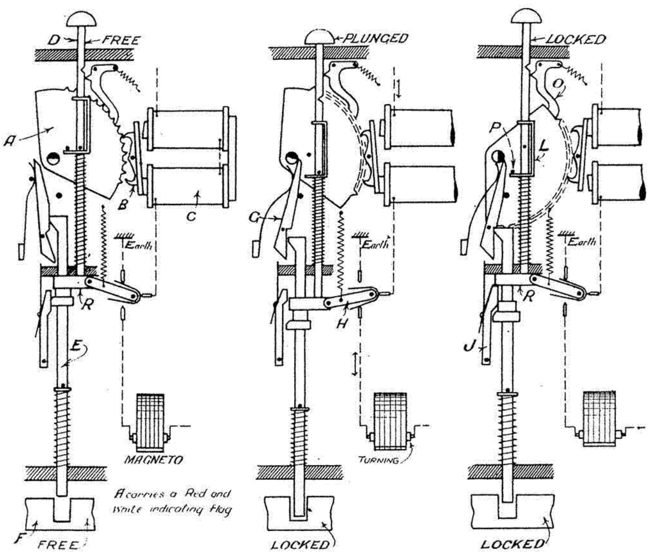

Fig. 6—Diagram of Operating Unit of Siemens Block Apparatus

seen above the main block case. It is clear that the Siemen's block can be used to control the use of two successive signals at one tower, if necessary, as is the case in the Hauenstein tunnel.

Combination of the Wheel-Counter and Siemen's System Ensures Safety

With the wheel-counting system special safeguards must be adopted to prevent false indications through failure. If, for instance, the security depended on the wheel-counter only and the first track-instrument were to altogether fail to act, the train would be unprotected. By combining it with the Siemen's block a very safe system has been constructed.

A set of intermediate Siemen's block, shown with the covers removed in Fig. 4, has been provided to control the two blocks where the wheel-counters are used (see Fig. 1). The small handles in front work the outer home and advance signals in the tunnel and are really switches. The fields are couples in pairs to one plunger, each plunger is locked by *two* plunger-locks, controlled in such

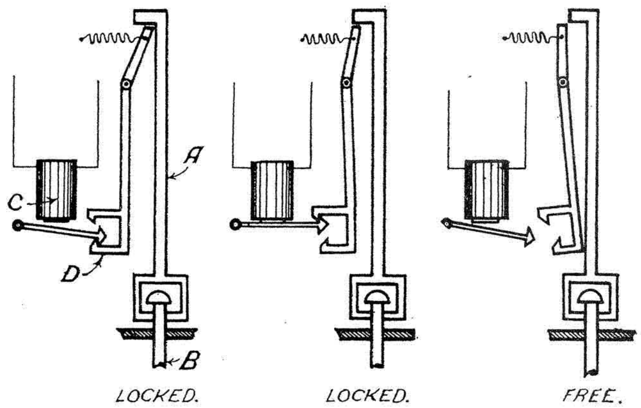

Fig. 7—Double-Action Plunger Lock

a way as to check any failure of the wheel counters. These, as will be seen, are mounted over the plunger-locks. One of these, on each track, is connected as shown in Fig. 7, whereby the armature must rise and then fall again in order to unlock the plunger. The others are direct locks and release when the armature is attracted.

Control Circuits

Reference to Fig. 8, showing the northbound circuits, will enable the working to be understood. Assume the line clear through the, Siemen's apparatus being free throughout, and a northbound train approaching Olten-Tannwald. The operator clears signal A, by the ordinary lever in the machine, closing also contact *b*, and clears the advance signal by switch-handle *c*, closing also contacts *d*. Plunger *g* is at present locked by the two plunger-locks *h* and *k*. When the train passes track-instrument L it works the red needle of the wheel-counter by current from battery P through coils *e*. Directly the red needle moves from beneath the white, contact 1 and 3 is broken and 1 and 2 is made, switching current on to plunger-lock *k*, which, however, only makes half its move, due to the hook mechanism. (If the track-instrument L were broken, therefore, and failed to move the red needle, the plunger lock would still be held.) Signal *a* is replaced when the train has entered the tunnel and is at once held by the Siemen's locking. When the train passes the advance signal it actuates track-instrument N, which causes

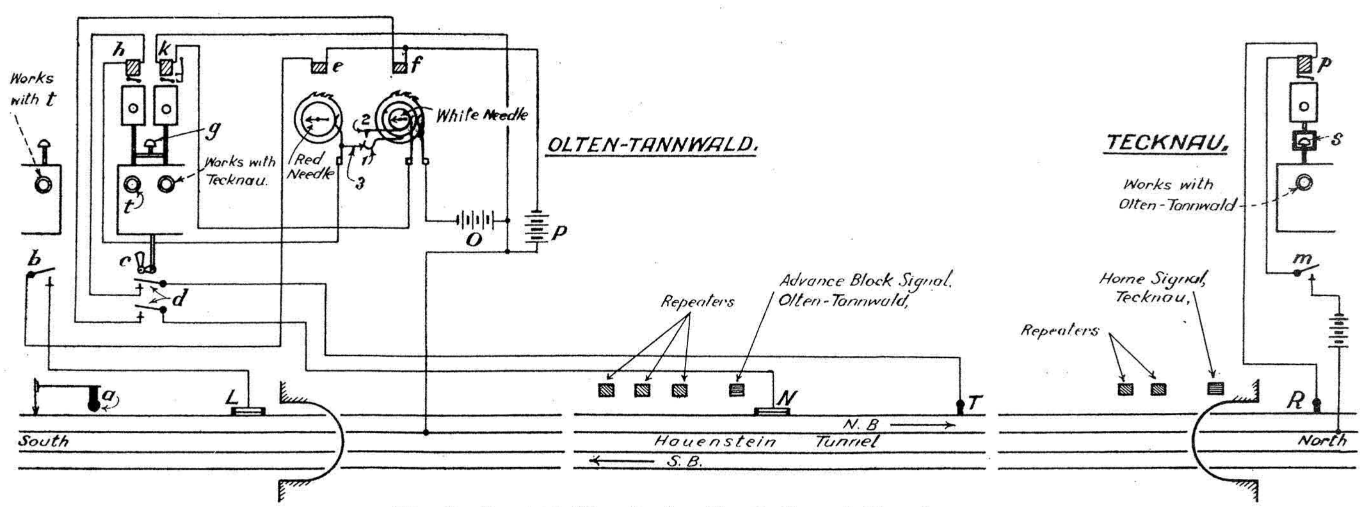

Fig. 8—Control Circuits for North Bound Signals

the white needle to advance with each wheel until it once more covers the red. This opens contacts 1 and 2, cuts current off plunger lock *k* and so releases it. At the same time contacts 1 and 3 being rejoined the circuit is closed to track instrument T (ordinary Siemen's mercurial patterns) 550 meters (1,804 ft.) further on. When this is actuated by the locomotive, lock *h* is released. The signalman can now plunge on the plunger *g*, after replacing switch *c*, thus putting the advance signal to "Danger," and by working his magneto he then electrically locks the advance and unlocks the starting signal *a*. This enables him to send another train on if necessary. The reason for employing the extra lock *h* is an important one. It might happen that the first track instrument broke down before recording all the wheels passing over it. In that case the white needle would pass the red one when the train left the block, but at the moment when the two were over one another, lock K would come off as explained and the Siemen's block could be cleared prematurely. The extra lock prevents this as it is only cleared when the train has gone another 550 meters and the needles are at that moment superposed, which would not be the case if the failure referred to had happened. When the train clears the home signal at Technau, it operates track instrument R and releases lock P. The operator can then after seeing the markers and replacing the signal, plunge on S and by working the magneto, clear the field at Olten-Tannwald controlling the advence signal. The working on the southbound track is similar.

Failure Alarms and Lighting Circuits

In the event of a failure, which leaves the block locked up, the station-masters concerned, after satisfying themselves of the arrival of the train with markers complete are allowed to break the seals of the instrument cases and rest to normal by hand, duly advising the maintainer and inspector. Special switches, locked up, are provided to enable the intermediate working to be cut out and the tunnel converted into a single block, if required. Repeater indicators are provided in the towers for showing if the signals are properly working, and should a lamp go out, that fact is at once indicated by the ringing of an alarm bell.

A very complete telephone system is installed with telephones and alarm signal bells; at each kilometer post (0.62) in the tunnel, also illuminated distance posts are used. The signals are lighted from the alternating current lighting mains, but should this supply fail, accumulators at Olten and Tecknau are at once thrown automatically in circuit. The apparatus was manufactured by the well known firm of telegraph engineers, Hasler A. G. of Berne.

The patent rights for America were acquired by the Bossard Railway Signal Corporation, Troy, N. Y.

Accident at Sulphur Springs, Mo.

Disregard for Signal Indications Results in Death of 37 People

ONE of the worst accidents in the history of the Missouri Pacific occurred at Sulphur Springs, Mo., on the evening of August 5, when passenger train No. 4, northbound from Texas, crashed into the rear of local passenger train No. 32, killing 37 and injuring over 100 people. Train No. 32 had stopped for water when train No. 4, having passed a distant and a home automatic block signal set against it, crashed into it. The engineman of No. 4 jumped off and was killed; and the fireman was severely injured.

The collision occurred on the Missouri division of the Iron Mountain, 23 miles south of St. Louis. This line is double track from St. Louis to Cliff Cave, a distance of 13 miles and is single track from that point south. Trains are operated by train orders and an automatic block signal system which extends from St. Louis to Poplar Bluff, Mo., a distance of 165 miles. The track follows the west bank of the Mississippi River from Cliff Cave through Sulphur Springs to Riverside, 3.5 miles south of Sulphur Springs and is a succession of curves with only short stretches of tangent.

Approaching the point of accident from the south, north-bound distant signal No. D232 is located 1,275 ft. north of mile post 24. The track is tangent to a point 396 ft. north of the signal where it curves to the left with a 2 deg. curve 1,320 ft. long. There is then 198 ft. of tangent when a 2 deg. 48 min. curve starts to the right. The accident occurred at a point 1,360 ft. from the begining of this curve. The water tank is located on the curve 615 ft. north of the point of the accident and Sulphur Springs station is 422 ft. north of tank.

Track Plan From First Signal South of Riverside Through Sulphur Springs

The single track territory where this accident occurred is protected by automatic block signals. Three position upper quadrant home signals are used and two position upper quadrant distant signals, the latter operating from the 45 deg. position to the 90 deg. position. Home automatic block signals Nos. 232 and 233 are located 35 ft. south of the south end of the bridge. The northbound distant signal 232, mentioned above, is 3,289 ft south of its home signal. The control circuits of both the home signal and its distant signal overlap the next home signal in advance, the control of northbound home signal 262 at