SIGNALLING ON THE BELGIAN NATIONAL RAILWAYS

An account of the principal features of the three-position signal system used in Belgium

THE Belgian railway system, by reason of its important geographical position and consequent close connection with the railways of several countries, developed rapidly into a complicated network of lines carrying a heavy traffic, which in turn early necessitated the adoption of efficient signalling equipment. The first installations were modelled largely on British practice, much of the apparatus being supplied by Saxby and Farmer, with rod

Fig. 1—*Approach warning boards in front of a distant signal*

operated points and lower quadrant signals worked by single wires. Both semaphores and discs were used, distant or, as it would be more correct to call them, outer signals, being square shaped discs at which trains were required to stop. On the Grand Central Belge Railway, a private line taken over by the State on January 1, 1897, the double-wire system was adopted, but the State lines did not make much use of it for points until about 1904, though they had already done so for signals to a certain extent in connection with the introduction of the Siemens & Halske lock-and-block apparatus.

The Hodgson lock-and-block system and the Flamache-Schubart system were at first used in some of the Saxby cabins. When double-wire working was adopted generally about 1907, the levers in those cabins were arranged to operate the new type of transmissions. Gradually, however, the drum pattern of lever, derived from German practice, was adopted for all new work. The principal steps in these developments were made under the direction of the late Monsieur L. P. A. Weissenbruch, who became Signal Superintendent in 1901 and was General Secretary of the International Railway Congress Association from 1897 until his death in 1921. On his advice, in connection with the introduction of faster services on the principal main line sections, a new system of signal aspects was introduced in 1907 on the Brussels-Antwerp and Brussels-Mons lines. Its chief features were the adoption of yellow painted distant signals with yellow lights for "caution," in place of the old outer signals; bracket home signals at junctions with bracket distants to correspond, and arms moving in the upper quadrant.

This system became the standard, being extended to cover all the main routes, totalling 1,600 km. (1,000 miles), and it remained so until after the war, when the reconstruction of a great deal of the signalling became necessary. This was partly owing to damage, and partly because the German administration had substituted signals of its own type on many sections. To reduce the expense and accelerate the work it was determined to adopt the three-position principle, derived from American practice, enabling fewer signals to be used, especially at junctions. A new code of aspects was worked out, under Monsieur Weissenbruch's direction, and the necessary mechanisms were designed in collaboration with signal manufacturers.

On November 11, 1919, the three-position signalling was inaugurated between Brussels and Antwerp, and it is now in operation on 775 km. of double track (485 miles). The two-position system is therefore still in use to a large extent, and to prevent confusion between the old and new signals the former have had circular discs affixed to their arms as a distinguishing sign. Two interesting features of the old signalling require to be noticed. One is the use of approach warning boards, illustrated in Fig. 1, before all distant signals. These are still employed and are installed in front of all signals capable of displaying a "caution" indication. The other is the installation of luminous fog repeater signals, Fig. 2, on the Brussels-Antwerp line, brought into use on June 15, 1908. Each distant signal was preceded by three, and each stop signal by two such repeaters spaced 150 m. (164 yd.) apart. Their working was a great success, but they were removed during the war and never replaced. Cab signalling apparatus of the "crocodile" ramp pattern has, however, been installed in recent years, acting on the Flaman, Teloc or Hasler speed recorders on the engines, similar to the apparatus used on the French lines. The signalling on the Nord-Belge lines is, of course, of French pattern.

Principles of the Three-Position System

The principal characteristic of the Belgian three-position signalling is the use of both stop and distant type arms, each of which can be worked to three positions, and be used singly or in combination (Fig. 3). The stop pattern of arm is shaped and painted like the British type, but the distant arm is arrow headed, not fishtailed, the reason being that for some years the fishtail form was used in Belgium for quite another purpose. The yellow painting of distant signals has long been customary. The rules on which the use of these signals is based will be readily understood with the aid of a few typical examples.

Fig. 2—*A fog repeater installed on Brussels-Antwerp line in* 1908

The simplest example is that of a single stop signal used, say, at an intermediate block post, as shown in Fig. 4, working to the " stop " and " proceed " positions (the positions which the arms can take up are shown in the diagrams by dotted lines). In that case a distant signal is installed, also working from 0 deg. to 90 deg. at a distance on level track of 800 m. (875 yd.) from the stop signal or 1,000 m. on lines where speed is more than 100 m.p.h. When two stop signals follow one another at from 800 m. to 1,000 m. (875 to 1,094 yd.) there is no separate distant signal for the second one. Instead of that the first one is worked to three positions and can be cleared no further than 45 deg. when the first one is at " stop." Fig. 5 shows this arrangement. The two signals may be worked from the same or different cabins. The various indications are arranged solely on the basis of distance, gradient and speed and, in interpreting them, the driver is not concerned with which signal cabin works the signals.

When the distance between two stop signals is less than 800 m. (875 yd.) and the " caution " (45 deg.) position of the first gives insufficient warning for the second, the distant signal assumes the 45 deg. position, as shown in Fig. 6, until the second stop signal is cleared. In this position, as shown in the diagram of signal aspects, Fig. 3, and called " attention," a green and a yellow light appear side by side (equivalent to double yellow in Great Britain).

When a stop signal is required at the point A, as in Fig. 7*a*, and there is less than 800 m. (875 yd.) between B and C, a distant arm is provided beneath it so that four indications may be given by the signal. When the top arm at A is at 45 deg. it indicates that B is " on," when at 90 deg. that B is " off," the distant arm beneath then showing whether reduced speed at B is required or not. The positions of the signals in the two last cases are given in Figs. 7*b* and 7*c*. If there is 800 m. (875 yd.) or more between B and C then, of course, a plain three-position stop signal at A suffices. These illustrations are sufficient to enable the use of the signals for all ordinary cases of straight running to be understood.

STOP SIGNALS			DISTANT SIGNALS		
ASPECT		MEANING	ASPECT		MEANING
DAY	NIGHT		DAY	NIGHT	
	RED LIGHT	STOP		YELLOW LIGHT	CAUTION: PREPARE TO STOP AT NEXT SIGNAL
	YELLOW LIGHT	CAUTION: PREPARE TO STOP AT NEXT SIGNAL		GREEN LIGHT BESIDE YELLOW LIGHT	ATTENTION REDUCED SPEED AT NEXT SIGNAL
	GREEN LIGHT	PROCEED		GREEN LIGHT	PROCEED

COMBINED SIGNALS							
ASPECT	MEANING	ASPECT	MEANING	ASPECT	MEANING	ASPECT	MEANING
	STOP		CAUTION		ATTENTION		PROCEED

The lights exhibited in combined signals correspond exactly with those shown for the equivalent meanings in the single arm signals.

When colour light signals are used the "Caution" indication is conveyed by *TWO* yellow lights placed vertically to assist in eliminating any confusion between red and yellow in foggy weather.

Fig. 3—Three-position signal indications used on the Belgian National Railways

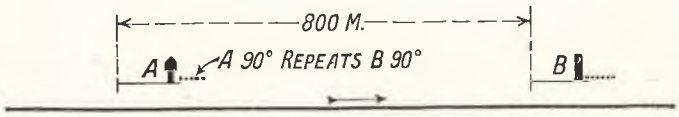


Fig. 4

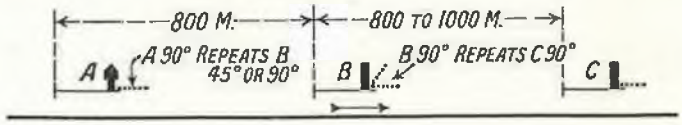


Fig. 5

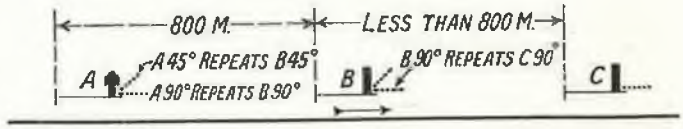


Fig. 6

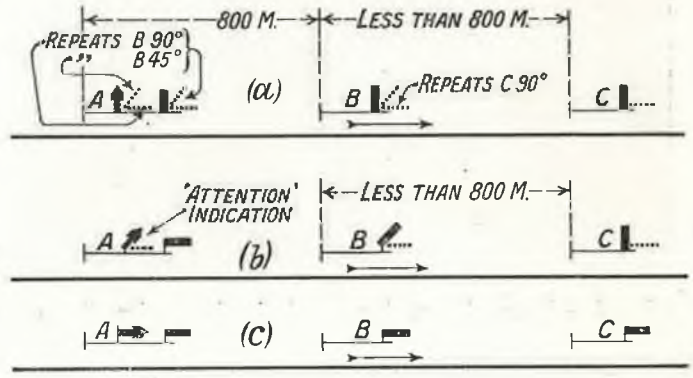


Fig. 7(a), 7(b) and 7(c)

Figs. 4–7—Applications of signals

Junction Signalling

The stop signals at junctions are still arranged on the bracket, or geographical, system, introduced when the upper quadrant two-position signalling was adopted, but there are no bracket distant signals in the three-position system. Instead, the junction distant signal has a single arm and is worked on the speed principle as shown in Figs. 8*a, b, c*. When a junction home signal is cleared for a route having a radius less than 500 m. (547 yd.), the distant signal assumes the " attention " position, warning the driver that reduced speed is necessary over the junction. When the stop signals are " on " the horizontal distant arm gives notice of the fact. This method of working has been found of great use in keeping traffic moving in foggy weather. A combined signal can be used at A in the figure when a stop indication is required there in addition to the three others, on the principles already explained; but if there is no restricted speed route at the junction, such stop signal is a plain three-position signal, as seen in Figs. 9*a, b*.

Where there is a group of lines in running into which the speed must not exceed 40 km.p.h. (25 m.p.h.), route indicators are used in conjunction with a single-armed signal. In that case the distant signal gives only the "caution" and "attention" indications.

Operation of Signals

Except where electric power signalling is in use, as mentioned below, the signals are operated mechanically by the double-wire system, and the various controls for producing the 45 deg. and 90 deg. positions of the semaphores are obtained, in the majority of cases, by the use of special slotting mechanism. In the example given in Fig. 8*a*, however, this is not necessary for the three-position distant signal, which is accordingly worked as shown in Fig. 10 by means of two levers in the signal cabin, the transmissions from which act on a cross-bar at the

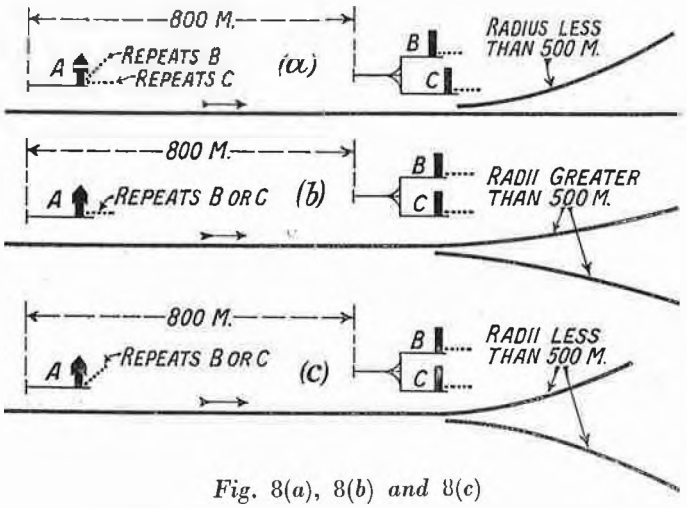


Fig. 8(*a*), 8(*b*) *and* 8(*c*)

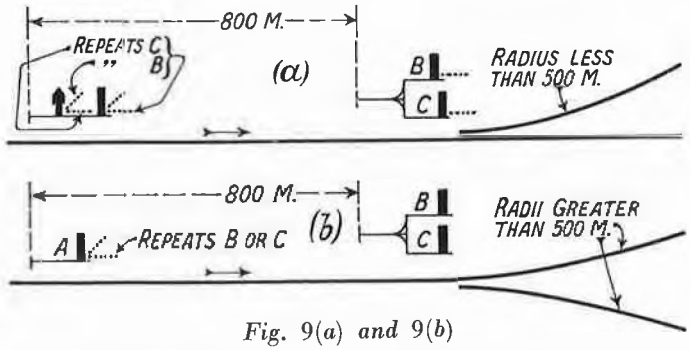


Fig. 9(*a*) *and* 9(*b*)

Figs.* 8 *and* 9—*Applications of signals

signal and impart the full stroke or half stroke to the arm. These levers are, of course, suitably interlocked with those working signals B and C.

The simplest example of the use of slotting is that shown in Fig. 5, where we may assume signals B and C to be worked from different signal cabins. When the lever working B is reversed, that signal must move only to the 45 deg. position, but when C is pulled off it must move automatically to 90 deg. when the C signalman pulls his distant lever. Should the lever working B be returned to normal, the arm must, whatever position it is in, move right back to "stop." Similarly, should signal C be returned to "stop" first, then the arm of B must move back, but only to 45 deg., without signalman B having to do anything.

There are several forms of slot apparatus in use, for fixing either in the runs of the wires or on the signal posts.

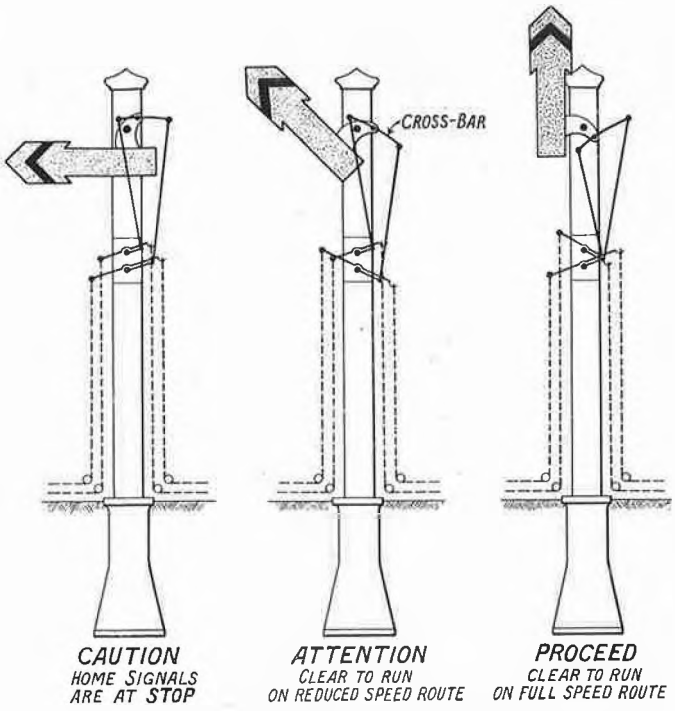
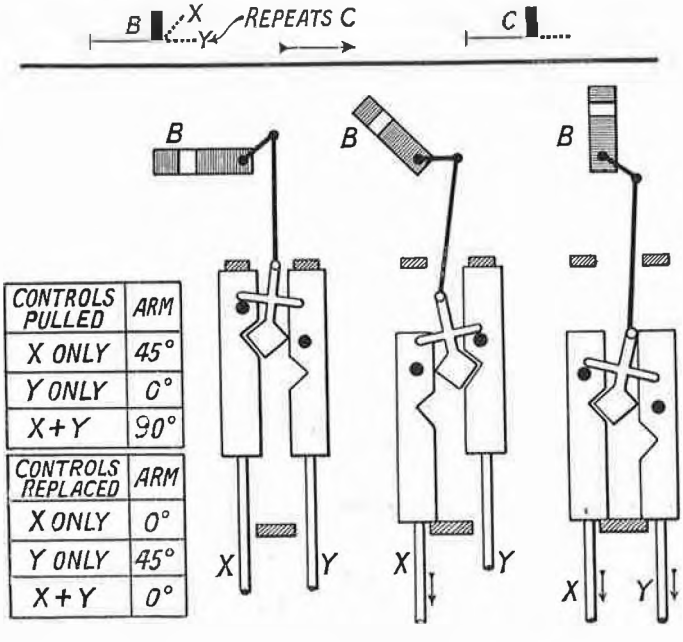


Fig. 10—*Operation of three-position junction distant signal*

The principles of one form, the César rotary apparatus, are illustrated in Fig. 11, and a view of one of the centrally balanced type arms with the slot mounted on the arm spindle is given in Fig. 12. The slide bars in Fig. 11 are in reality discs, and the swinger is a cross-bar attached to the arm spindle with rollers at each end, engaging with notches in the discs. By arranging slots to act in combination, supplemented at times by electric signal reversers, the various indications required can be produced according to circumstances.

As the double-wire system ensures that the necessary movement is always transmitted efficiently to the signal mechanism, there is no great difficulty in obtaining accurate signal aspects at all times. The transmissions are



CONTROLS PULLED	ARM
X ONLY	45°
Y ONLY	0°
X+Y	90°

CONTROLS REPLACED	ARM
X ONLY	0°
Y ONLY	45°
X+Y	0°

Fig. 11—*Principle of operation of César rotary signal slot*

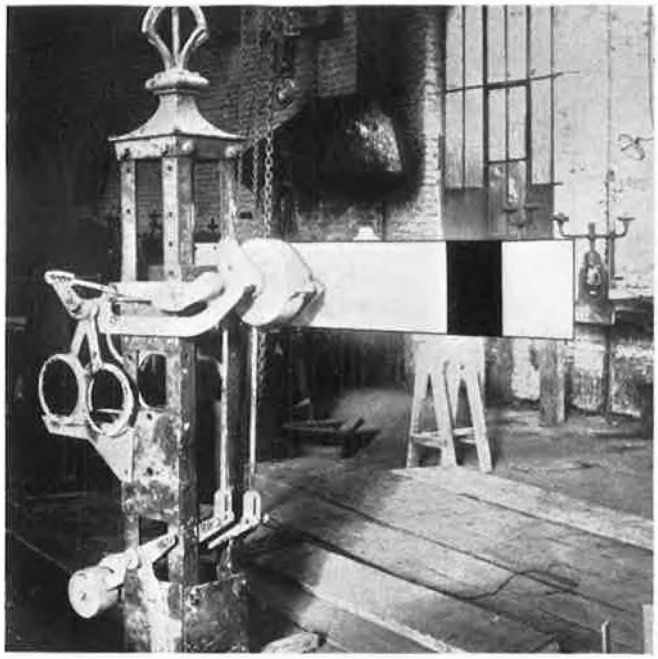


Fig. 12—*Centrally-balanced three-position semaphore with rotary slot mechanism mounted on arm spindle (César's system)*

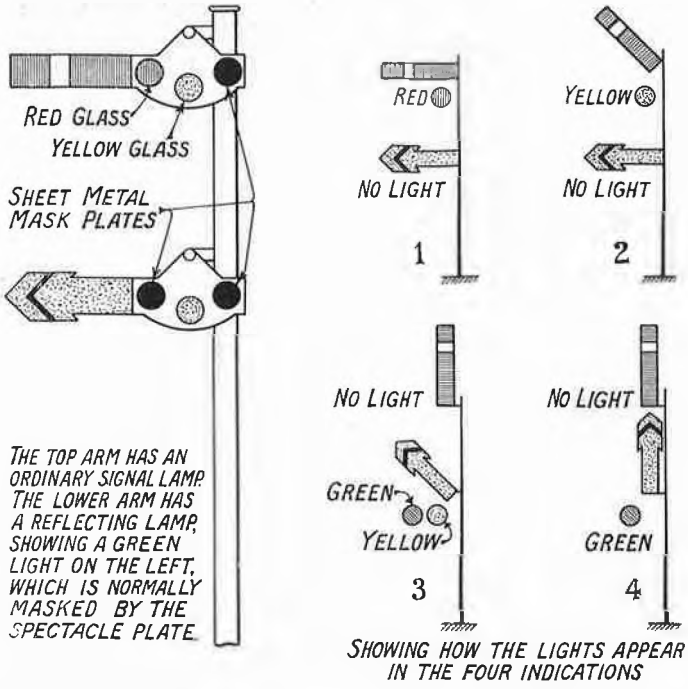


Fig. 13—*Latest pattern of two-armed signal showing how the night signals are produced*

formed of solid steel wire, 4 mm. ($\frac{5}{32}$ in.) dia. for signals and 5 mm. ($\frac{1}{6}\frac{3}{4}$ in.) dia. for points. A small, light but strong chain is used at wheels and lever drums, and not wire rope. The tension is regulated about twice yearly and compensators are used, as a rule, only on long transmissions.

Night Indications

The colours of these are given in Fig. 3. The various changes are produced by spectacles, the working of which is of some interest in the case of combined stop and distant signals. In the earlier pattern of two-armed signal there was a reflecting lantern provided for the top arm, which can be seen on the signal on the right of Fig. 14; the lower arm was without a lantern. This lantern produced a direct white light, in front of which moved the spectacle of the top arm, carrying red and yellow glasses, and a reflected green light, before which moved a sheet metal mask, or blinder, driven from the lower arm. In the 1931 type of signal, seen in Fig. 15, there is a lantern for

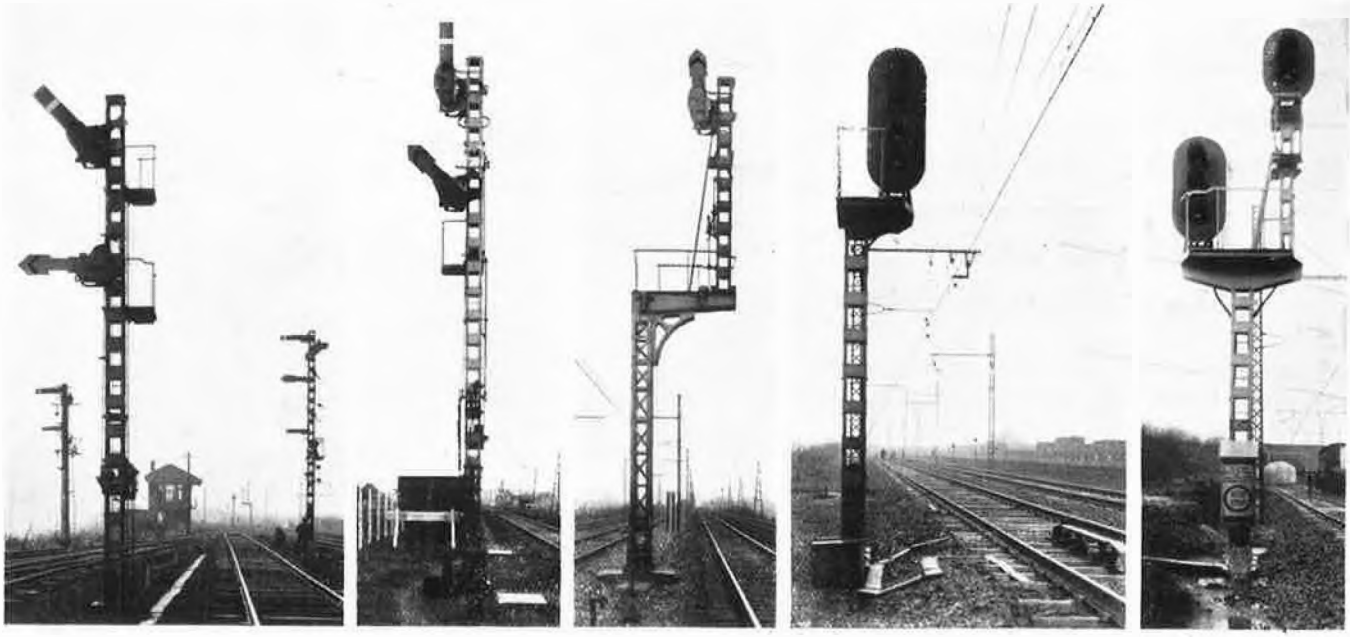


Fig. 14 *Fig.* 15 *Fig.* 16 *Fig.* 17 *Fig.* 18

Fig. 14—*Three-position semaphore signals, showing "caution" indication; earlier form of two-armed signal on the right, with centrally-balanced arms.* *Fig.* 15—*Two-armed signal in the "Attention" position, ordering reduced speed at the following signal. The lights are as shown in the diagram Fig.* 13; *the lanterns are not in place in this picture.* *Fig.* 16—*Three-position distant signal in the "proceed" position.* *Fig.* 17—*Colour light signal on Brussels-Antwerp line, with cab-signalling ramp.* *Fig.* 18—*Bracket-type colour-light signal, showing telephone box for communicating with signal cabin*

each arm, the lower being of the reflecting type. The top arm shows a red or yellow light for 0 deg. and 45 deg., the lower arm then showing no light. When the top arm goes to 90 deg. its light is obscured and the lower arm then shows green and yellow (45 deg.) or green (90 deg.), as shown on the diagram, Fig. 13.

Block System and Power Signalling

There are no automatic block signals on the Belgian National lines. The most important sections, totalling 1,021 km. (638 miles) are worked by means of the Siemens and Halske lock-and-block system with rail-contact control, the line being normally blocked. The remainder is worked by telephone.

Colour-light signals have been introduced on the electric lines between Brussels and Antwerp and between Namur and Charleroi, over a distance of 81 km. (50 m.), but they are worked from cabins in the same manner as the other signals. In some cases, as seen in Fig. 19, a small power frame controls the light signals, forming an electro-mechanical arrangement.

Power signalling has been widely adopted, exclusively of the all-electric type. The first installation, on the Siemens and Halske system, was put into service at Antwerp Central in 1904, and many other cabins of the same type, but incorporating improvements from time to time, were constructed at the principal stations in the years preceding the war. In 1905 the large cabin at Brussels Nord, then among the biggest in Europe, was opened, and it continued to work until early in the present year, when it was replaced by one constructed by the Ateliers de Constructions Electriques, of Charleroi, which has supplied many electrical frames of recent years. The new cabin is illustrated in Fig. 20 and controls the whole of the extensive terminus lines with their approach routes. The train service is a heavy one and there is a great deal of shunting.

Fig. 20—Interior of new electric power signal cabin at Brussels Nord, A.C.E.C. system

Belgium early adopted shunting signals instead of point indicators, following English principles, and in Fig. 14 shunt arms are seen. They show a violet light for "stop." A yellow light (45 deg.) means that shunting is authorised up to a limiting signal or an obstruction, a green light (90 deg.) authorises an unlimited shunt, or allows a train to take siding at intermediate stations.

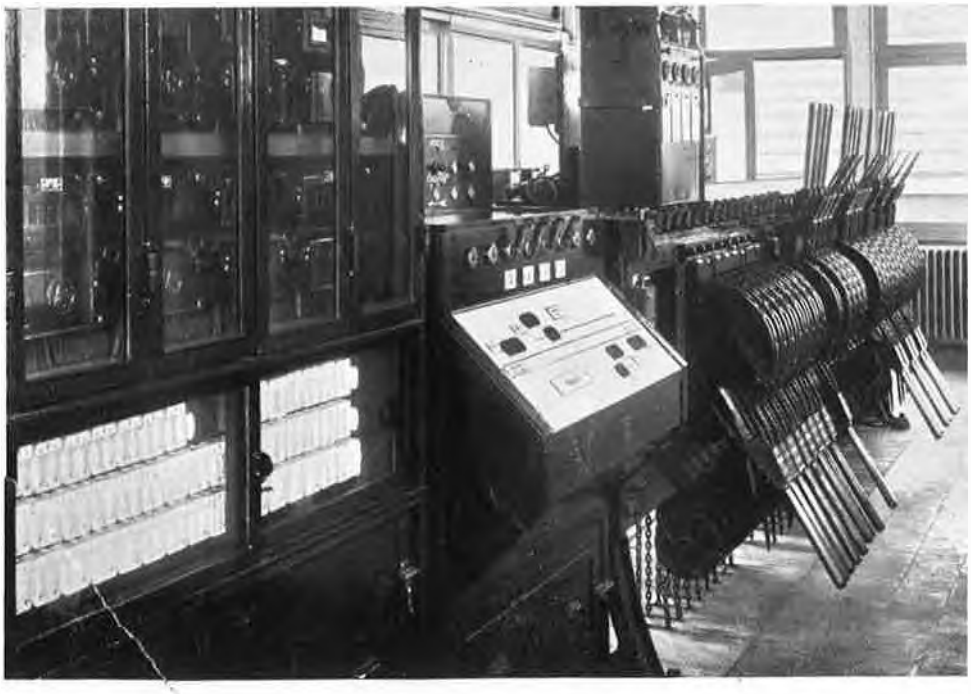


Fig. 19—Interior of signal cabin showing double-wire mechanical frame, electric subsidiary frame controlling light signals, and lock and block apparatus

Train Despatching

Before the war the management of the Belgian railways had come to the conclusion that some form of train despatching, or traffic control, was necessary to overcome certain difficulties in train working which occurred from time to time. Just before war broke out it had been decided to adopt the methods then in use on the Prussian State Railways, and the necessary apparatus was actually on order. After the war, as a result of the experience obtained in France with American selective telephone equipment, the Belgian administration reviewed the question once more and decided to instal the same apparatus on the heavily worked section between Brussels and Namur, where it was brought

Fig. 21—Interior of train despatcher's office at Brussels Nord

into use on October 1, 1921. The results exceeded all expectations, and the savings realised by smoother train working and better use of rolling stock and trainmen's time led to the extension of despatching on all the main routes, so that today a total length of 2,207 km. (1,380 miles) is equipped. The numerous junctions, loops and spur lines, which abound in Belgium, make the working of the traffic a matter of no little difficulty at all times, and the despatching system has had every opportunity of proving its value. According to Monsieur De Caesstecker, then Chief Despatcher at Brussels Nord, writing only three years after the system was introduced, an annual saving of over fr. 27,500 per km. had been obtained and there were probably other savings that could not be directly ascertained.

It will be evident from the foregoing that the Belgian railways rank among the most progressive in the world in the adoption of sound signalling and operating methods. They have for years spared no effort to provide every reasonable safeguard to protect the large traffic carried on their system, and the results form an excellent tribute to the late Monsieur Weissenbruch, his capable successors and their assistants.

NEW STEAM RAILCAR LOCOMOTIVES, AUSTRIAN FEDERAL RAILWAYS

A luggage compartment is built on to the frames of these new 2-4-2 type light traffic engines

FOR some years past light passenger trains on the Austrian Federal Railways, consisting of from two to five four-wheeled coaches, have been worked by 2-6-2 non-superheated compound locomotives. These, however, have proved too large and heavy for the class of service, causing uneconomical operating results, and the endeavour has therefore been made to replace them by other units possessing sufficient tractive effort and speed to meet all the requirements of quick suburban service with light passenger trains of the character above referred to, having due regard to economical working. It was, moreover, desired that the new unit should be able to haul light fast trains over long distances, and it was finally decided to build a railcar type of locomotive consisting of a 2-4-2 steam engine having a built-in luggage compartment on the same framing. This new type of eight-wheeled vehicle was constructed by the Austrian Federal Railways in collaboration with the Wiener Lokomotiv-Fabriks A.G., Wien-Floridsdorf.

The new type, which is illustrated herewith, has a maximum speed of 62·1 m.p.h. and is designed for running at high speed on lines with light permanent way. The weight in working order is 42 tons, distributed with a load of 13 tons on each of the two driving axles and 8 tons each on the leading and trailing axles. When running on lines of light construction the axle load of the driv-