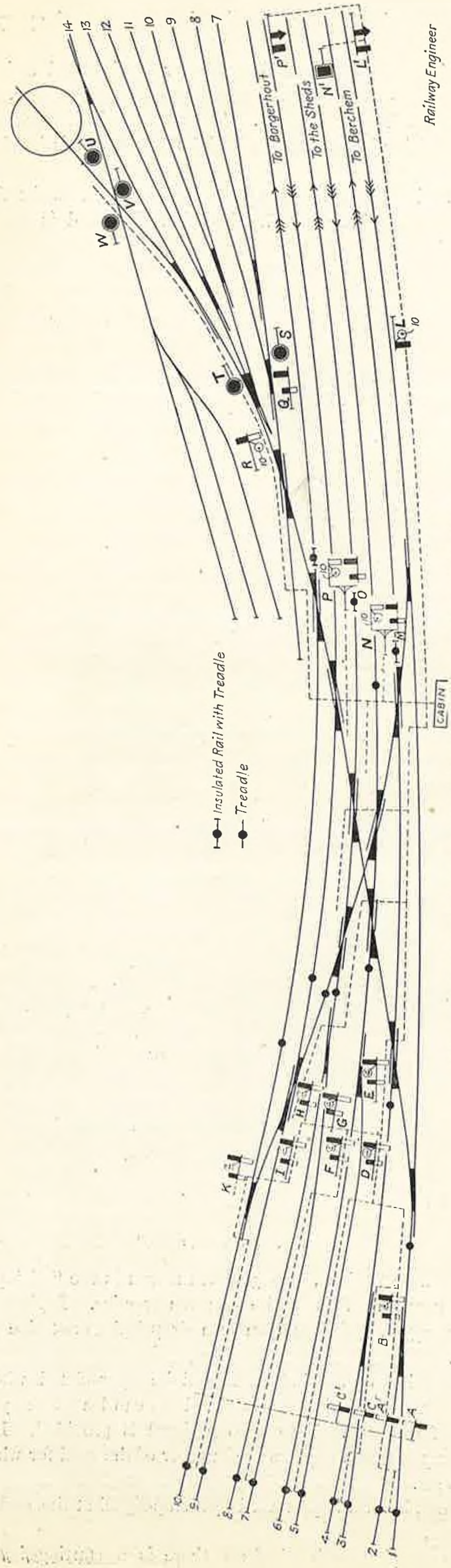

Fig. 1.—Diagram of Arrangement of Signals at Antwerp Central Station.

The Siemens-Halske Power Signalling Plant at Antwerp Central Station; Belgian State Railways.

BEFORE deciding upon a system of power signalling for Antwerp Central Station the Administration of the Belgian State Railways thoroughly investigated the matter, and finally decided that the Siemens-Halske "all electric" system was the one which best suited their requirements. This system is well known on the Continent, where several large installations of it have been laid down, including quite recently one at the *Gare du Nord*, Brussels, comprising four cabins containing 150, 70, 40 and 40 levers respectively.

The writer is indebted to Monsieur L. Weissenbruch, engineer of the Belgian State Railways, for the photographs and drawings from which the illustrations have been prepared.

Fig. 1 shows a general diagram of the station, from which it will be seen that there are 10 roads under the station roof leading to six running roads, which are connected by two through roads with double slips.

The plant consists of 35 levers for points and 17 for signals, besides 33 double route levers and 15 spare levers. To have accomplished the same work mechanically would have required 180 levers.

The plant is divided into what are technically known as "fields," of which there are three kinds, viz., "switch fields," "route fields," and "signal fields."

"Switch fields" operate the points, and their levers are painted blue. The switch lever is normally to the right, and is held in position by a notch in its frame, there being a corresponding notch for the "over" position, which is through an angle of about 80° from normal to the left. Below the lever is a small frame with two windows, one above the other. Behind the upper window a blue disc appears; if any vehicle be on the switches a white disc if the line be "clear." These indications are obtained by means of the insulated lengths of track, referred to below. The lower window has also two indicators—white and black. White indicates that the switches are closed, and correspond with the position of the lever, whilst the appearance of the black disc, accompanied by the ringing of a bell, indicates that the switch motor is moving, or that the switches are run through and burst.

The "route-fields" play a very important part. They save many levers, guarantee that the road is properly set before the signal is lowered, and also "hold" the road. The lever of a "route-field" is painted green, and stands normally in a mid-position. It is turned to the left for one route and to the right for another route. The releasing numbers—*i.e.*, those of the point-levers that have to be "over" to make the route—are marked on a plate above the lever, together with the route the lever in that position gives.

Under the "route-lever" is a frame with one window, behind which appears either a white or a green disc. The normal is the white one, which changes to the green one when the lever is moved, and the latter is at once locked and remains so until the train has passed over an electrical contact at the end of the route. By this means the road is "held."

The "signal-field" is for working signals and its lever is painted red. It is normally inclined to the right, and is pulled to the left to lower a signal.

A "signal-field" has two windows. Behind the upper one are given three indications. A red disc which is normally shown disappears when the route-lever corresponding to the signal is pulled over, leaving the red horizontal bar, which was in front of it and which shows up against the white ground behind it, when the first disc is withdrawn and indicates that the signal is at danger. The red bar is withdrawn leaving the white ground only visible when the signal is "off."

The lower window has the same indications, and is for the same purposes as the lower window of the "switch-field." It shows black when the signal motor is operating and white when the signal corresponds with the lever.

road is set and allow for one signal arm to serve the purpose of two or more.

Fig. 2 illustrates signal E, fig. 1, for leaving and arriving at No. 5 road. The upper left-hand arm is for departure, and its lower arm is for shunting out. The upper right-hand arm is for a train arriving in the station and its lower arm is for shunting in.

Fig. 3 illustrates the same post with the departure signal "off" and the route indicator showing that the road is set for G (sidings).

Fig. 2.—Signal "On."

Fig. 3.—Signal "Off."

The points and signals are actuated by a 110-volt current known as the coupling or working current, but this is only switched on when a movement is necessary. At other times a 25-volt current is available, and this is known as the "controlling current."

A signal lever can work any one of a given number of arms by the use of an electrical selection associated with the "route-fields," and by this means a large number of signal levers have been saved.

A reduction has also been made in the number of signals by the use of route indicators. Like Annett's route indicators on the L. and South-Western R. they show for what direction the

It will be noticed, fig. 3, that the arm in the "off" position points upward. This is the German practice. It gives a more distinct signal, and should an arm drop it does not give a clear signal.

The utility of the indicators will be appreciated when it is stated that each of the three arrival lines can lead to any of the ten platform-roads. Yet only one signal is provided. It has a screen upon which appears the number of the road for which the line is set.

Each platform is protected by a stop-signal at the end of the platform.

For leaving each platform there is a starting-signal with screens showing for which the road is set—either of the three main-lines or the sidings.

Lower shunting arms are provided on most of the signals to govern shunting operations.

All facing-points—and practically all the points at Antwerp are facing-points—are provided with "Jüdel" facing-point lock. No locking bars are provided as the lever working the points is controlled by a section of insulated rail adjacent to the points. An advantage of this is that any length of rail can be protected, whereas the permanent way will often prevent ordinary mechanical locking bars being fixed.

One of the well-known advantages of power-signalling and interlocking plants is the absolute guarantee given that the lever has done its work, and that the switches are fully over (and bolted if facing points), or that the signal is at danger. This is obtained by a check lock, which holds the lever in its travel, and its full movement cannot be obtained until the return indication has come, intimating thereby that the purpose of the movement is attained, and that the points are over or the signal gone to danger. This, however, as we have previously pointed out, compels a signalman to "stand by" and wait for the return indication, and when six or eight levers are required to be pulled over to "set up" a road that this is done more quickly mechanically than by power.

In the Siemens-Halske system this objection is removed, as the levers are pulled fully "over" and put fully "back" at one stroke, and the switches are detected by other means, which is the use of the "route-fields." These are locks in the interlocking which are affected by the return current from the points and cause conflicting point and signal levers to be locked and consequent ones to be freed. The signalman is therefore able to pull all his levers over with all possible rapidity, but he may have to pause before pulling the signal lever for the current to return from the various switches to release the "route-fields."

When a vehicle is on the track circuit a magnet in the locking frame attracts a lever, one end of which falls against a pawl on the point lever and when the lever is attracted by the insulated rail magnet the pawl is held and the points cannot be moved from the position they are in.

It has not hitherto been considered necessary in other power plants to give an "off" indication for signals, but only the "on" or danger position. In the Antwerp installation both positions are recorded. The "off" indication is useful for preventing a second signal to be released, being lowered unless the first is fully "off."

The points-operating mechanism is illustrated by figs. 4 to 7. Fig. 4 is a general view of the apparatus with the cover removed; fig. 5 a view of the motor lifted out of the box. Fig. 6 is a sectional drawing of the mechanism, and fig. 7 a diagram showing the electrical connections.

The box is supported on two wrought iron brackets projecting from the ends of adjacent sleepers and the bottom (outside) of the box is not lower in the ground than half the depth of the sleepers.

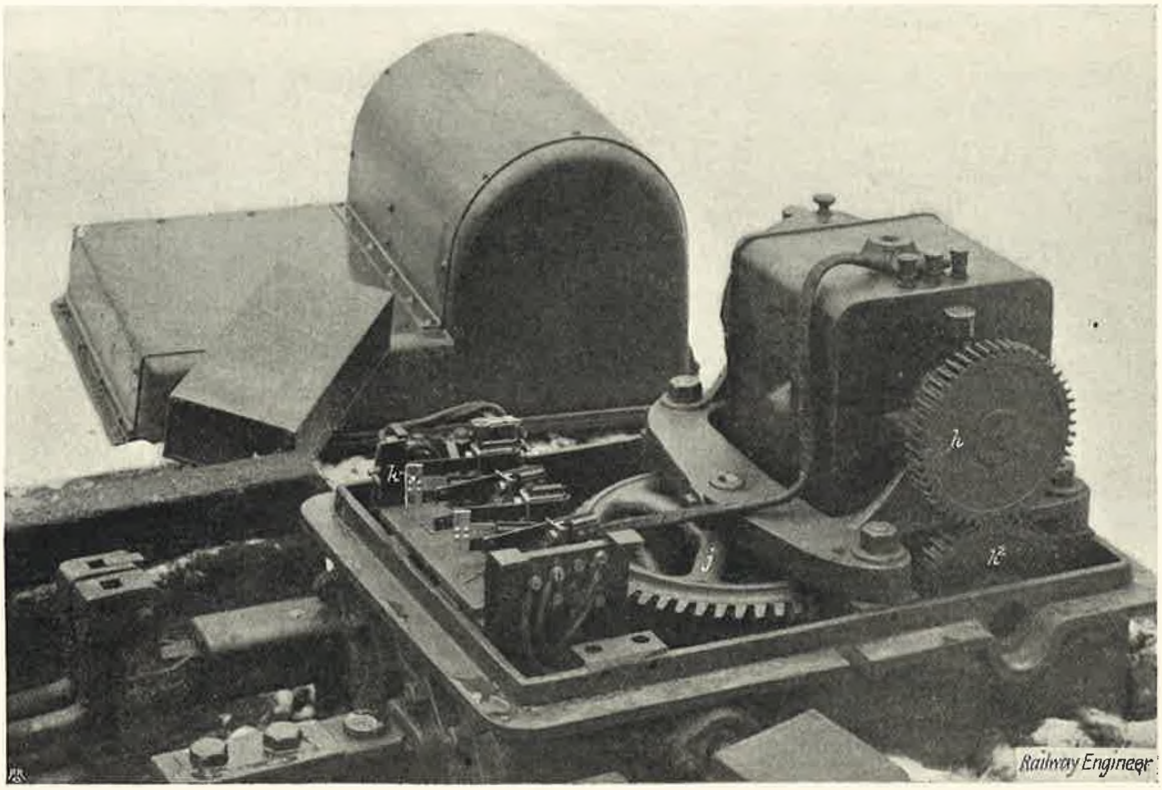

Fig. 4.—View of Apparatus for Operating Switch; Cover removed.

The points are coupled to the rack *a* which is operated by a pinion *b* cast on to the underside of a circular plate b^2, on the upper side of which there is a projection *c c* by means of which the pinion is driven. The motor by means of the spur wheels $h\ h^2$ drives the spindle *i* carrying a worm *j* which drives the worm-wheel *g*. The rim (inside) of the worm-wheel is fitted with a friction clutch consisting of a steel band *f* having its ends pressed apart by two bars $e\ e^2$ separated by a stretcher bar *d* and connected by an adjustable spring d^2. When the worm-wheel is rotated it carries the bars against the projection *c c* of the pinion plate b^2 above mentioned. The object of this friction clutch is to allow the points to be "run through" without damaging the mechanism. On Continental railways, particularly in Germany, it is considered essential to provide for this contingency.

The edge of the plate b^2 is stepped to form cams, which, as b^2

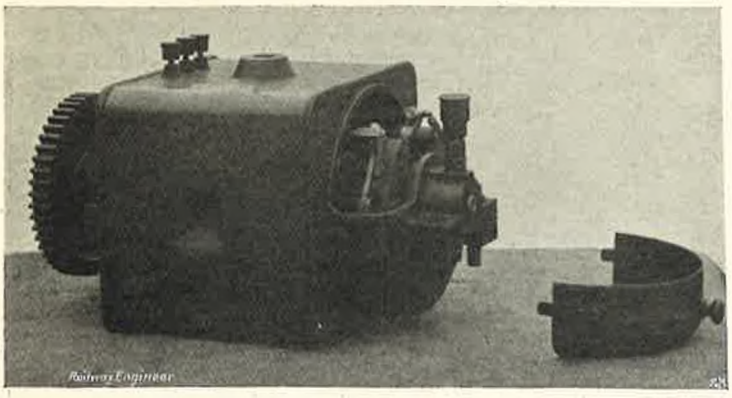

Fig. 5.—View of Motor taken out from Switch Apparatus.

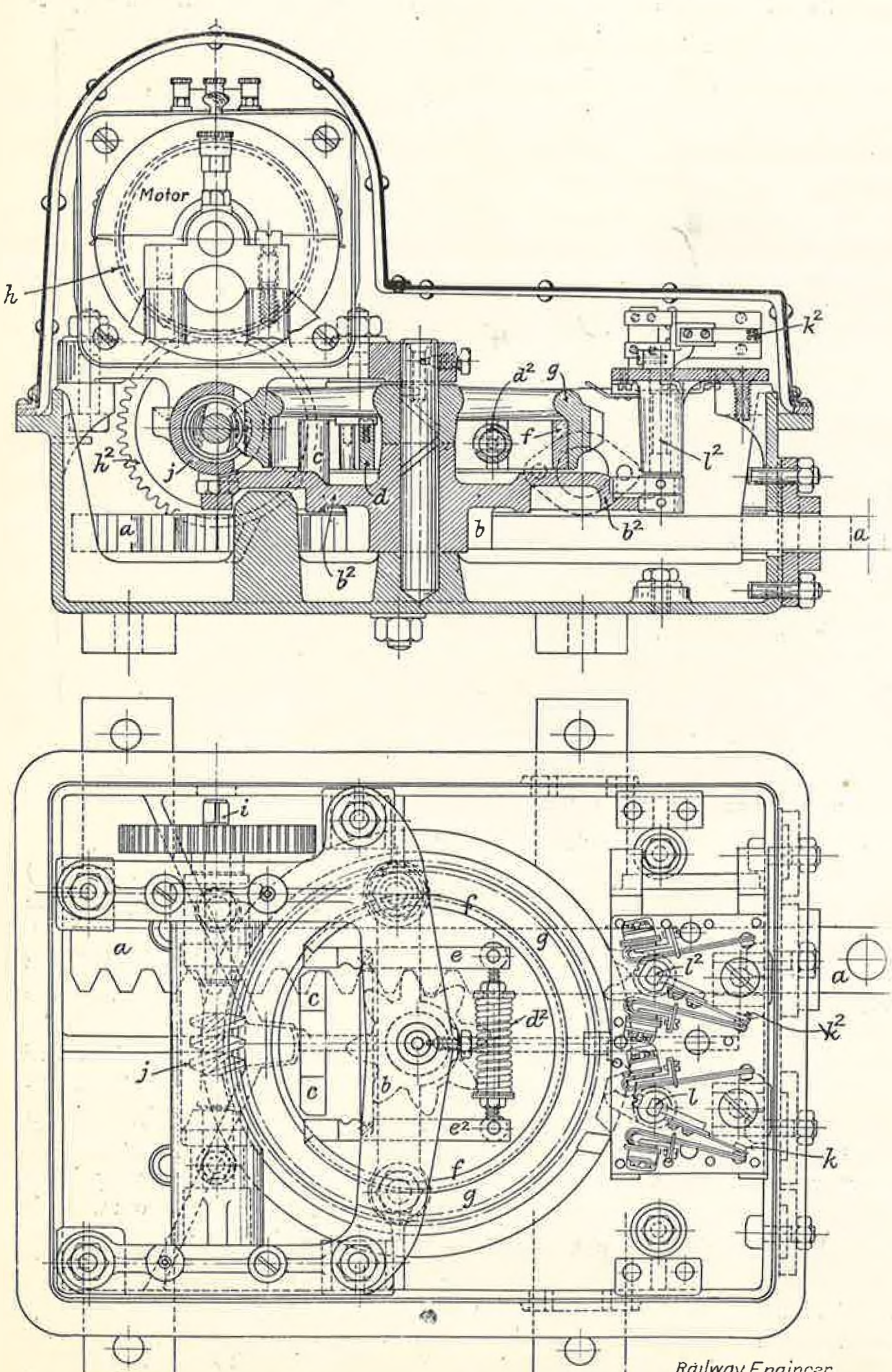

Fig. 6.—Apparatus for Operating a Switch.

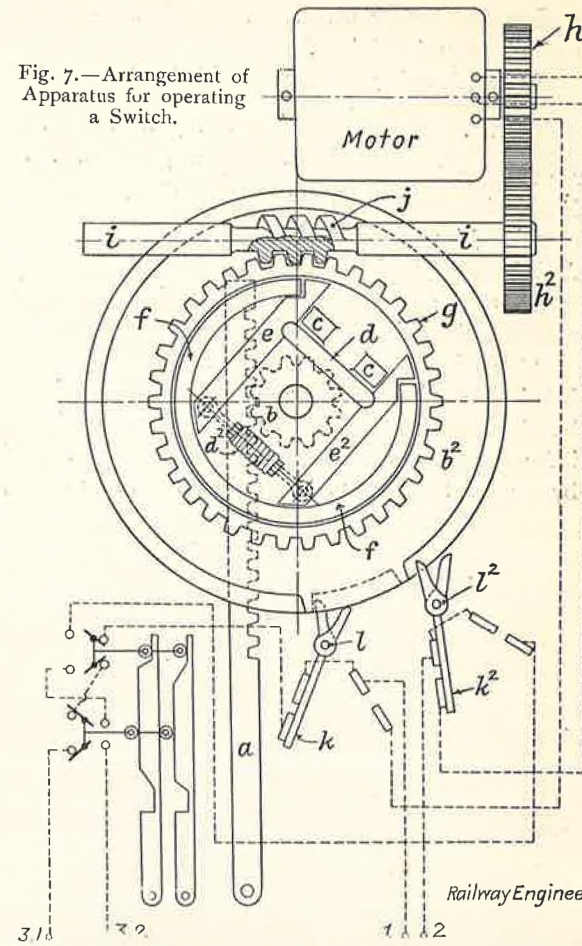

Fig. 7.—Arrangement of Apparatus for operating a Switch.

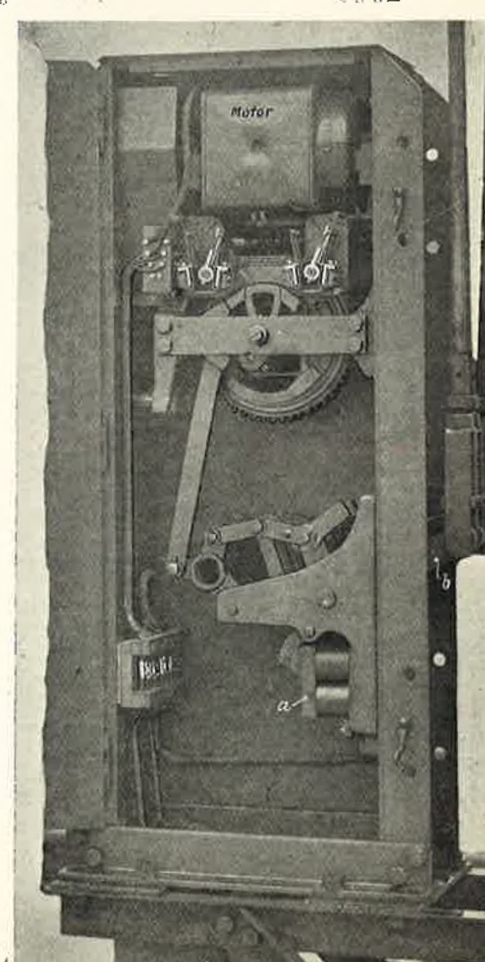

Fig. 8.—View of Apparatus for Operating a Signal.

is rotated, more tappets attached to vertical spindles $l\ l^2$, which at their upper ends carry switches $k\ k^2$. The former k brings into operation an "economiser commutator" in the locking frame. When the point lever is moved to the left the interlocking is actuated, and a switch—the "economiser commutator"—is moved from contact with one set of springs into contact with another, fig. 7, and this switches off the 25 volt controlling current, and switches on the 110 volt to operate the motor.

The initial movement of the point motor being given the circular plate b^2 travels a certain distance and than moves the switch k, fig. 7. This causes to be sent to the locking frame a current which de-energises an electro-magnet, and its armature falling a tumbler is raised that switches the "economiser commutator" back to the 25 volt current, which provides sufficient power to complete the revolutions of the points motor.

The switch k^2, fig. 7, governs the direction in which the motor shall run, according to the position of the points.

And an indication of this would be given in the lower window under the signal lever in the locking frame, and the lever would have to be restored to normal before the signal could be again pulled off even if the magnet at the signal were again energised.

On the right in figs. 2-3 the signal cabin is discernable. It is 48ft. 3in. long by 12ft. 9½in. wide on the floor of the signal cabin, and the apparatus is fixed at the back so as to give the signalmen free access to the windows.

The cabin has an ornamental exterior to correspond with the architecture of the station. No wood has been used in the main structure with the object of reducing the risk of fire. A central hot water apparatus has been provided, the furnace being placed in a separate apartment on the ground floor so as to keep dust, &c., away from the frame, &c. The furnace only requires recharging every 13 hours, and consumes 3 *kilogs.* (6.6lbs.) of fuel on an average per hour during ordinary winter temperatures.

The power is obtained from three batteries of Tudor accumu-

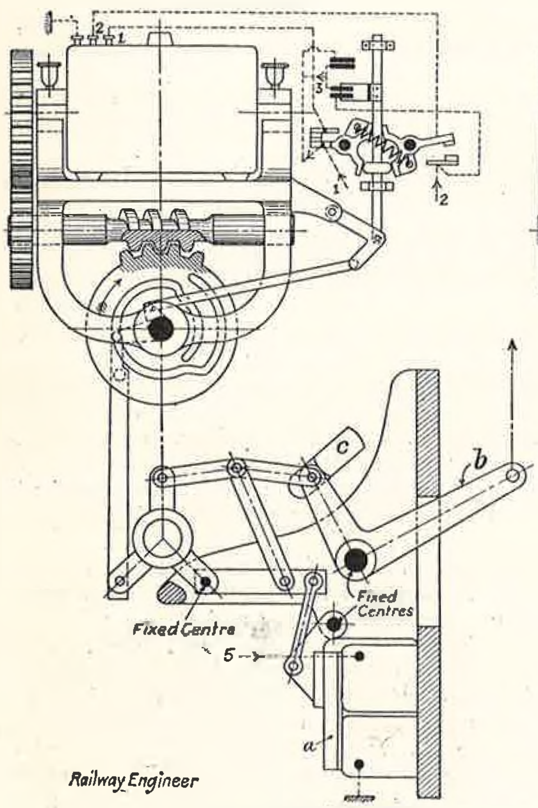

Fig. 9. Arrangement of apparatus for operating signal. Coupler current closed, signal at danger.

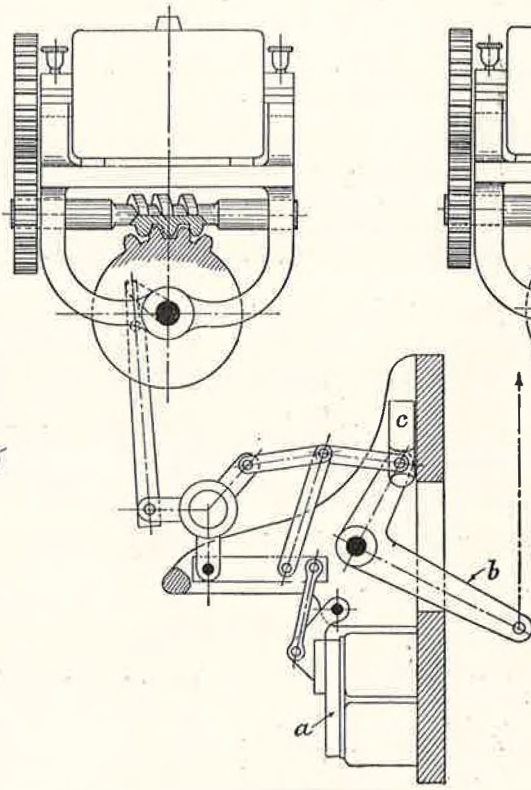

Fig. 10 Arrangement of apparatus for operating signal. Coupler current closed, signal at safety.

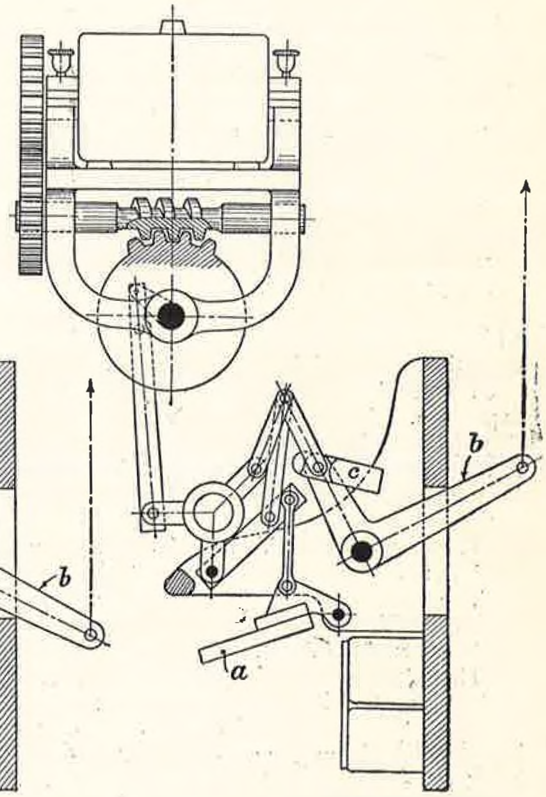

Fig. 11. Arrangement of apparatus for operating signal. Coupler current interrupted.

Detectors coupled to each rail of the points are provided, through which the controlling current returns.

Fig. 8 illustrates the signal mechanism.

The motor is practically the same as that for a switch.

Each signal, or each route indicator, if there be more than one arm, is provided with an electric clutch. If there be more than one that clutch is energised that is applicable to the state of the road.

Fig. 9 shows the clutch *a* attracted by the electro-magnet, and consequently when the motor is worked the position of the mechanism is as seen in fig. 10, and the upright rod which is coupled to the lever *b* is pulled down. If the road be not properly set the controlling current would not enter the magnet; or, if after the signal was "off" the current were interrupted (as for instance, the points being run through and burst), the magnet would be de-energised and the clutch would fly away, and consequently the signal would go to danger as shown by fig. 11.

lators which are calculated to be able to do the work, without recharging, for three days. The first of these batteries is the 110 volt for working, and has a capacity of 60 ampere hours; the second is of 25 volts for controlling and has a capacity of 120 ampere hours, and the third is a battery of 3 cells for track circuit. The first two batteries consist of 60 cells each, and are recharged every day by means of a continuous current dynamo, of 5 h.p. at full load, supplying a current of 27 to 20 amperes at a voltage of 110 to 165 volts and making 1,750 revolutions per minute.

The total cost of the installation, including the cabin, was 258,000frs. (£10,320) made up as follows:—Locking frame in cabin, 80 fields, 35 point-levers, 17 signal-levers, 33 double-route levers and 15 spares, 35,244·5frs.; 35 point-motor mechanisms, 44,995·0frs.; 19 semaphores, 67,677·5frs.; 21 electric contacts, 4,836·0frs.; 28 insulated and armoured cables, distributors and terminals, 38,681·5frs.; batteries, &c., 15,540·5frs.; insulated rails, and making good, 10,040·5frs.; labour, 14,000·ofrs.; building cabin, 27,000frs.

Fuller details of the various items are given in the description of the Antwerp Installation, written by M. L. Weissenbruch for the Bulletin of the International Railway Congress. M. Weissenbruch estimates that the signalling at Antwerp might have been done mechanically with two s gnal boxes at a cost of 107,550frs. (£4,302).

The wages of 9 signalmen (£421 per annum) are saved, but the wages of an electrician, cost of electricity (£18), interest sinking fund on extra capital outlay have to be put against this saving and reduce the saving to £59 per annum.

Natal Government Railways, 1904.

THE annual report of the general manager, Sir David Hunter, is a lengthy, instructive and fully illustrated document, of which the following is a very condensed abstract:—

The total revenue amounted to £1,933,934, as against £2,561,552 in 1903, a decrease of 24·50 per cent. The working expenditure amounted to £1,531,210, or 79·18 % of the revenue, against £1,791,108 or 69·92 % in 1903 (a decrease of 14·51 %), and included £129,702 expended upon additions and improvements. The net profit, after deducting interest on capital, was £17,514.

There was a decrease of 117,212 in the number of passengers and a drop in revenue therefrom of £30,248. The falling-off in the local traffic was 145,8 6 passengers and £40,421 in revenue, but the through traffic increased by 28,674 passengers and £10,173 9s. in receipts.

The goods traffic decreased by 280,104 tons and £593,082, which attests the general shrinkage in the trade and industrial conditions of Natal and the Transvaal.

The coal traffic during the year has shown continuous expansion. The total volume of public coal traffic amounted to 669,896 tons, being an increase of 163,443 tons, but the increase in the revenue was only £9,733. This is due to reduced rates for the conveyance of coal, and the rebates upon all coal shipped at the port.

The receipts from Transvaal traffic amounted to 54 % of the total in 1903; the proportion was 56 %.

The length of the railways open was 775¾ miles, excluding the section Van Reenen to Harrismith (23½ miles) worked by the Natal Railway Aministration for the Central South African R.

The following table exhibits the yearly results of the working of the railways at intervals of ten years:—

Year	1884.	1894.	1904.
Capital open lines	£2,345,946	£6,078,489	£11,170,487
Cost per mile open*... ..	21,874	15,234	15,004
Average miles open for traffic	107¼	399	744½
Earnings	£143,272	£465,872	£1,933,934
Working expenses	137,279	294,063	1,531,210
Balance	6,193	171,809	402,724
Interest charges	124,284	253,378	385,210
Net profit or loss	118,092	81,570	17,514
Working exs to earnings ...	95·67%	63·12%	79·18%
Per average mile open—			
Earnings	£1,336	£1,168	£2,598
Working expenses... ...	1,268	737	2,057
Return	68	431	541
Per train mile—			
Earnings	74·59d.	81·42d.	108·14d.
Working expenses	71·36d.	58·96d.	85·62d.
Return	3·23d.	34·46d.	22·52d.
Passenger journeys	464,496	649,136	2,717,595
Goods tonnage	215,706	336,553	1,771,978
Coal tonnage (included in above)	Nil.	104,963	669,896
Train miles	460,977	1,196,824	4,292,028

* Includes equipment and excludes cost of permanent way and works of Natal-Zululand and Zululand Railways.

The permanent way material was originally 40lbs. to the yard iron rails; to-day the standard is 78lbs. steel rails, shortly to be increased to 80lbs. to harmonise with the rails recommended by the British Standards Committee.

The first engines weighed 29 tons, and had a paying load capacity over the ruling gradient of 30 tons; the latter has now been increased by the latest design of engine to 125 tons.

The original wagons had a capacity of 6 tons; the latest standard has a carrying capacity of 35 tons, or nearly six times the original load.

The eight-coupled tender engines designed by the locomotive superintendent (Mr. D. A. Hendrie) commenced to arrive in October, and at the end of the year 14 were running. The 6-wheeled tender engine (Hendrie engine A), which is a modification of the 8-coupled engine, is intended to work the passenger train service between Ladysmith and Newcastle, and will be capable of taking forward to the terminus the heaviest train brought by the 8-coupled engines to Ladysmith. Two experimental engines of this type are in service. To turn these tender-engines 65ft. turntables, worked by electric power, are being laid down.

The Leeds Forge Co. have supplied 190 wagons to the designs of the locomotive superintendent during the year, and placed in traffic. This type of wagon has a tare of 14 tons 1 cwt. and carries 35 tons. The 10 American wagons referred to in the last annual report have not yet arrived

During the past 10 years practically the whole stock has been re-axled, and broken axles are now practically unknown. The maximum carrying capacity of the 20 ton stock was, as the result, increased by 10 per cent., which is a great economical advantage.

During the year eighteen 8-wheeled carriages were constructed in the carriage shops, and thirteen sleeping and dining corridor carriages were put in hand.

The work is well under way. The vehicles are being well and substantially built, and by constructing them locally, a step rendered economically practicable by the remodelling with modern machinery of the saw mill, and extended carriage shop accommodation, it has been possible to spend in the Colony the wages involved in the construction of the vehicles, which will see longer service than can be obtained from the imported stock, the latter, which have to be shipped in sections, losing to a certain extent in stability. With the experience so far gained it seems that all future additions to the passenger stock might well be constructed in the Colony, but this involves a steady and persistent policy, and the granting of funds to carry it into effect.

The vehicles will be 61ft. long—the size of the new standard passenger stock—and will enable a larger number of passengers per train to be conveyed than has hitherto been possible.

Considerable progress was made with the new erecting, boiler and machine shops at Durban, and new accommodation should by now be available. The new carriage and wagon repairing shops were completed and occupied in March, 1904. The machinery in the saw mill is now all electrically driven, thus further concentrating the development of power in one building.

The new power house at Durban was brought into operation in July, 1904, and at the end of the year was working most satisfactorily and economically. It has been demonstrated that a low class of coal can be burned in the furnaces of this station, and this will tend to increased economy, which, combined with the centralisation so conveniently obtained by the employment of electricity, is estimated to effect an annual saving in the coal bill alone of £3,500. The plant and building have been arranged so as to permit of easy expansion when a demand for additional power arises, at a minimum expenditure in both capital and working costs, and the new power station will demonstrate the value of a central power plant.

The growing employment of electricity suggested the utilisation of the power station at Durban to secure greater efficiency and economy in the working of the shop and other machinery, and after the whole question had been very fully discussed in the Colony the matter was finally referred to the consulting engineer (Mr. H. G. Humby, M.Inst.C.E.) for the purpose of collecting all available information on the subject, and recommending the best course of action. He reported upon the utility of electric current for the driving of the machinery, and plans were prepared by him upon which plant for a modern power station was ordered. The plant obtained, and now working in a highly satisfactory manner, is capable of furnishing a maximum of 900 horse-power. There are five boilers, mechanically stoked, and with the object of reducing the consumption of coal to a minimum Green's economiser for heating the feed-water and condensing plant and super-