AN INTRODUCTION TO RAILWAY SIGNALLING IN NEW ZEALAND

By T. A. McGavin

FROM the earliest days of railway working in New Zealand, signals of various kinds have been used to regulate, control, or protect the movement of trains. Signals may be given by hand, by flag, by lamp, or by fixed semaphore arms or lights, but in this article we shall be concerned primarily with those that are known as fixed signals. These can be defined as signals which, although capable of displaying different indications at different times, are always in the same location and always display an indication of one kind or another.

W. A. Pierre, in his book *Canterbury Provincial Railways* (N.Z. Railway and Locomotive Society, 1964), shows how early signalling practice was introduced by Holmes and Co. from Victoria, and was defined in the Canterbury Rules and Regulations of 1866. Whether made by flags or lamps, red was the signal for "danger", green that for "caution", and white the signal for "clear". Signal posts were furnished with semaphore arms, enginedrivers being required to heed the arm to the left of the post. The white-painted arm* displayed at a 90-degree angle to the post indicated "danger"; lowered to 45 degrees (that is, in the lower left-hand quadrant) it indicated "caution". The "clear" indication was given by disappearance of the arm into a slot in the post.

This system may be traced back to contemporary British practice, wherein positive signal indications were displayed only where there was a need or desire to require the enginedriver to slow down or stop his train The absence of any positive signal to indicate that the track ahead was clear was a fault in the system that was to be demonstrated in a disastrous manner at Abbot's Ripton on the Great Northern Railway on 21 January 1876. Signals had become frozen in the "clear" position, and three trains became involved in a collision when the signals could not be placed at "danger". The ultimate outcome was adoption of the so-called "somersault" type of semaphore signal, invented by

* It appears that red-painted arms were standard from the 1870s, and possibly earlier.

From the W. W. Stewart Collection

An excellent example of an early semaphore home signal on New Zealand Railways. Our notes say this one was at Mercer on the old Auckland Section. Note the line-up of staff at a respectful distance in the yard.

Edward French in April 1877, whereby the arm was pivoted and counter-balanced in such a way that it would automatically return to the "danger" position should the wire break. This "fail safe" principle is one that has become firmly entrenched in railway signalling practice.

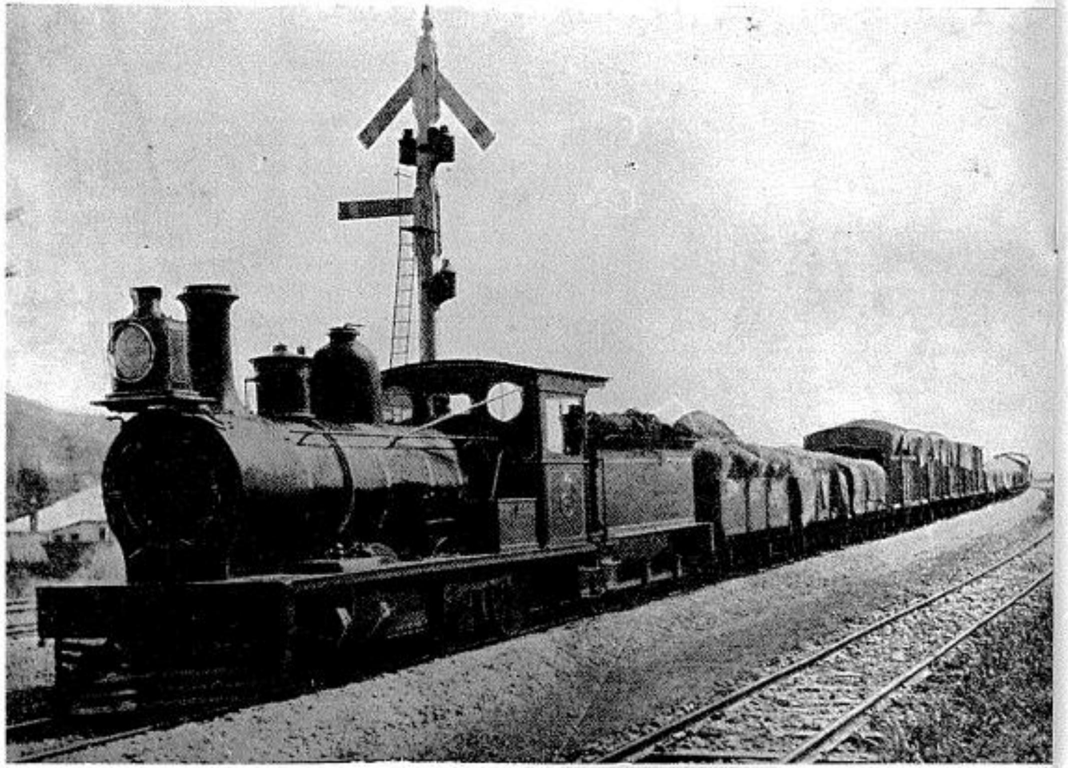
The first fixed signals used in New Zealand appear to have been those installed to protect stations. These are described as "home" signals. Later additional signals with notched or "fish-tail" arms were added to give enginedrivers of approaching trains an early warning of the position of the "home" signal. These early-warning signals are known as "distant" signals. Starting signals to give drivers authority or clearance to enter sections of line between stations also came later, and even then only at major terminals or junctions.

By the close of the 19th century, the provision of semaphore home signals was becoming standard practice at the larger stations. The arms as seen to the left of the post by the driver of an approaching train were now painted red with a white band near the left-hand end; the back of the arm was white with a black band. It had also become standard practice to display just two indications: Danger—Stop, and Clear — Proceed, the latter being shown by the 45-degree position. Red and green coloured spectacles moved in front of oil or gas lamps in conjunction with the semaphore arms to give corresponding indications at night, and a white back light was displayed to the signalman when the arm was in the "stop" position. Back lights were introduced on the NZR in July 1901.

Distant signals, where provided, were distinguished only by the fish-tail arm. It was not until 1930 that yellow was adopted instead of red for their arms and spectacles. This made it possible to establish quite unequivocally that a red signal light meant "Stop", and that it must not be passed until all the appropriate rules and procedures had been observed.

Before 1900, relatively little effort had been made to interlock signals with the points to minimise the possibility of clear signals being displayed when the points were incorrectly set (though there was some interlocking at Christchurch before 1880). Similarly, block telegraph working was only used to a limited extent. Trials with various forms of "block" working, whereby procedures were instituted in conjunction with telegraph messages between stations to admit only one train at a time to the line between those stations, had been conducted during the 1870s and 1880s, culminating in the adoption of the Winter Block System over some busy or difficult sections in the late 1880s.

But the rapid growth of traffic and train services, and a series of accidents that this engendered, particularly the Rakaia Collision of 11 March, 1899, stimulated the Government to make substantially increased allocations for railway improvements. In 1898 a section of the Maintenance Branch had been established under A. H. Johnson to construct and supervise interlocking, block signalling, and other signalling appli-



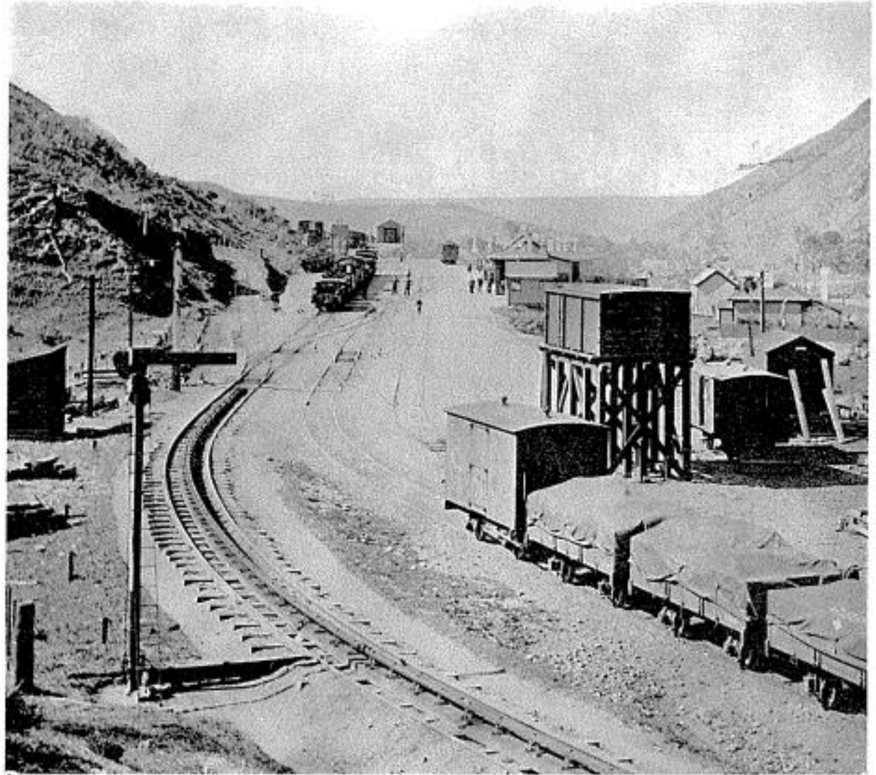
Block from *Canterbury Provincial Railways*, from an illustration in the *Weekly Press*

This Christchurch-Lyttelton goods train entering Heathcote in 1897 is passing an interesting group of old slotted-post semaphore signals located between the up and down lines: down starting signals to the left of the post, and up home to the right.

ances, and by 1900 funds were made available for the installation of mechanical interlocking between points and signals at busy stations and junctions, for extension of the use of fixed signals at stations, for adoption of Tyer's electric train-tablet system for the safe working of trains over single-track main lines, and for fitting Westinghouse continuous air brakes on locomotives and rolling stock. The signalling work came under the jurisdiction of H. J. Wynne, Mr. Johnson having retired in December 1899.

The first complete mechanical interlocking installation in New Zealand was brought into use at Wellington in 1901, and the first sections of line equipped for tablet working (by April 1902) were those from Hawera to Turakina, from Te Aro (Wellington) to Featherston, and Waitati-Dunedin-Mosgiel, a total of 104 miles. By 1913, the retiring general manager, T. Ronayne, was able to report that the tablet system was by then in use at 299 stations controlling 1,389 route miles (2,222 km) of line, and there were 75 interlocking installations. Further extensions brought the route miles under tablet working up to 1,746 miles (2,810 km) by 1926, at which time the number of interlockings was 107.

For the relatively small mileage of double-line railways in New Zealand, for



Photograph courtesy N.Z. Railways Publicity

THE WINTER BLOCK SYSTEM

THIS fascinating view of Cross Creek station yard at the foot of the famous Rimutaka Incline about 1900 shows in the foreground the starting signal that was associated with the Winter Block System of train working. Devised by G. K. Winter, Telegraph Officer of the Madras Railway, India, this system was selected by the NZR management in the 1880s as the most suitable for prevailing conditions, and by 1889 was in use between Auckland-Remuera, Upper Hutt-Cross Creek, Lyttelton-Heathcote, Kaiapoi-Eyreton Junction, Oamaru-Waiareka Junction, and Waitati-Dunedin-Mosgiel.

The system required the exchange of bell signals by telegraph between the signalmen at each end of each single-line section, and the simultaneous operation of their block telegraph instruments to show either "cleared line" or "train on line" as might be appropriate. At some stations, as at Cross Creek, semaphore starting signals of Winter and Craik's design were interlocked with the block telegraph instruments so that the starting signal at one station could not be lowered to indicate "clear-proceed" except with the concurrence of the signalman at the other end of the section.

LEFT: This up starting signal at Aramoho Junction illustrates the standard form of balanced-arm semaphore as introduced and developed since about 1900. The disc below the main arm is used for authorising shunting movements.

RIGHT: The array of up home signals at Frankton Junction shows how separate semaphores were used to indicate which route was to be followed by the approaching train. The nearer group applied to trains from the main trunk. They could be signalled into either the west main, the west loop, the east main, or the east loop.

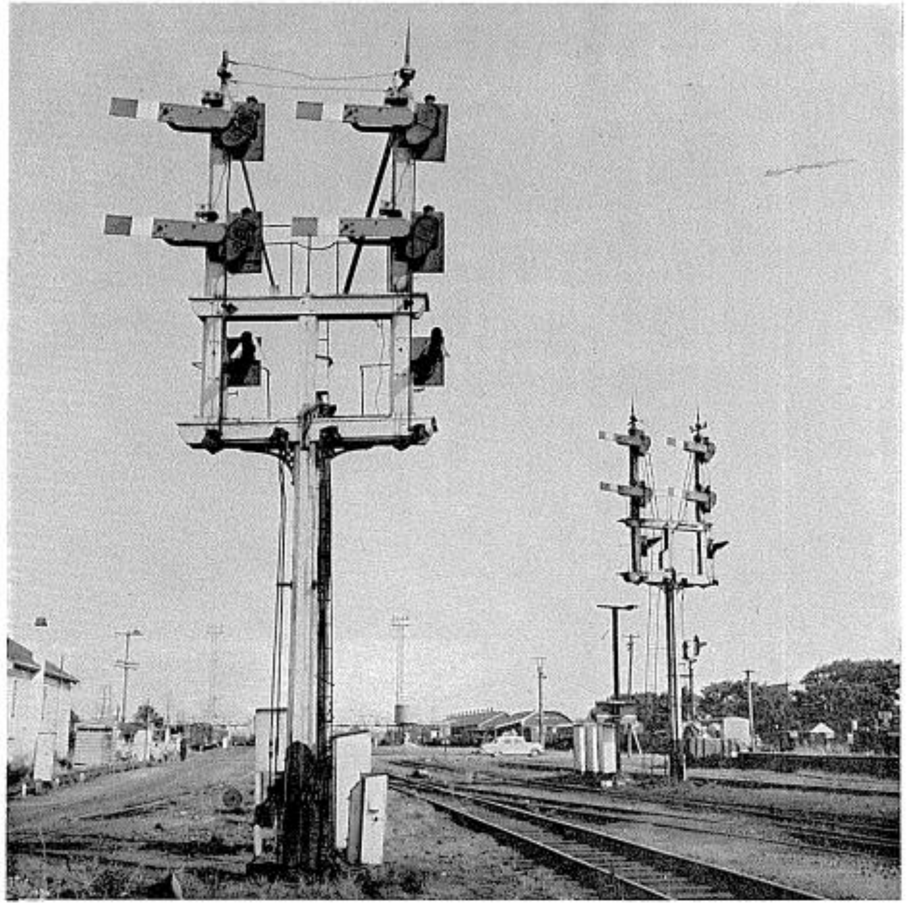
Photographs: N.Z. Railways Publicity

short distances from Auckland, Wellington, Christchurch, and Dunedin, Sykes' electric lock-and-block system of working was adopted in 1908 and fully installed by 1914. Here the principle was that only one train at a time could be permitted to occupy a "block" section between two signal boxes. The system was similar to that used extensively on the main-line railways in Britain.

After the introduction of mechanical interlocking from 1900 onwards with massive lever frames and great lengths of wires and point rodding, the next development was the application of power to ease the work of the signalmen. The electro-pneumatic system installed at Dunedin in 1907 was the first example of a power interlocking in New Zealand, but it was the late 1920s before many more were seen, and the 1930s and 1940s before power interlockings began to spread to the smaller country stations.

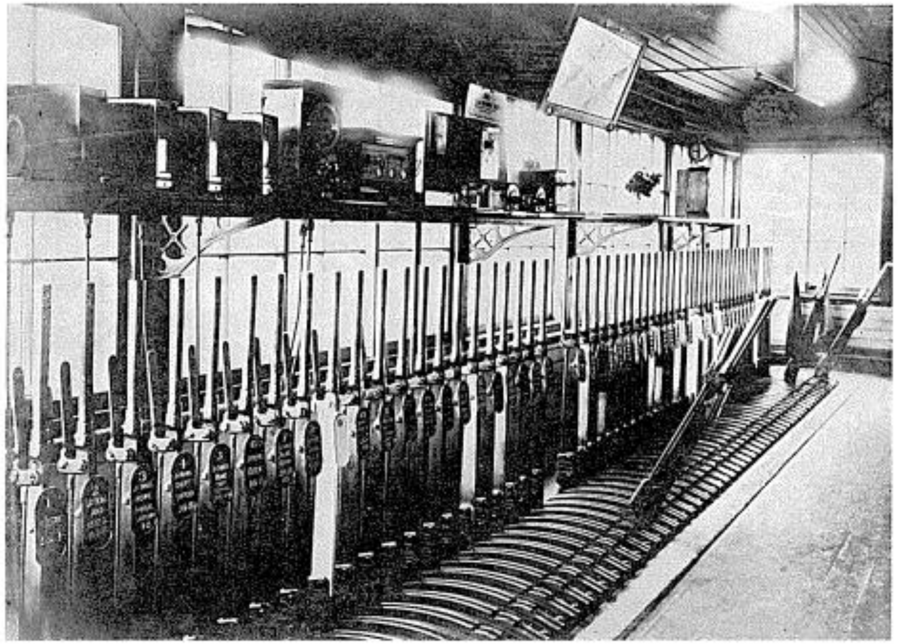
The earlier interlocked stations with wire-worked semaphore signals and rod-operated points had one signal box, or sometimes more, each of which had a straight row of large levers. With this kind of interlocking, the signalman provides manually all the power needed to move signals and points, hence the area that can be controlled from one such box is limited by the effort required to overcome friction. The restraints between the levers to prevent dangerous combinations of settings are mechanical.

When mechanisms were first developed for moving signals or points by electric or pneumatic power, the signal levers were reduced in size but were still arranged in straight rows to permit their being mechanically interlocked with each other. By a process of evolution, mechanical interlocking was replaced by electrical locking, and finally the concept of accomplishing safety by preventing a lever from being moved was abandoned, and the systems were so electrically arranged that, if unsafe lever or switch operations were made, they would have no effect.



Increase in the number of interlocked stations, and extensions of tablet working during the first 25 years of the 20th century were associated with the greatly increased use of the tall semaphore signals that have been such a characteristic feature of the New Zealand railway scene for so many years. At smaller stations, mainly on tablet-worked sections, the locking of the levers controlling the signals and the locking of the main-line points were so arranged that the signals could be cleared only when the points were locked for the main line. At such stations trains entering the loop have to be hand-signalled from the points. The locks are known as Woods locks, and the Woods points key is only available for unlocking the corresponding signal lever when the points are properly set and locked for the main line.

Many main-line points, particularly those at interlocked stations, were provided with lock bars which, when depressed by the wheel flanges of a passing train, would prevent the points being reversed while the train was passing over them. This form of locking was superseded by electrical locking when track circuits were introduced, and as the years went by various combinations of mechanical and power signalling practice were adopted.



LEFT: Two stages in the development of interlocking. The upper view shows the lever frame in the Christchurch East Box in 1910, and the lower shows the array of miniature levers in Wellington "A" Box for the power interlocking installed in 1937. This photograph was taken in 1962. Note the sectionalised track diagram (not to scale) on which twin red indication lights are illuminated to show which sections of track are occupied.

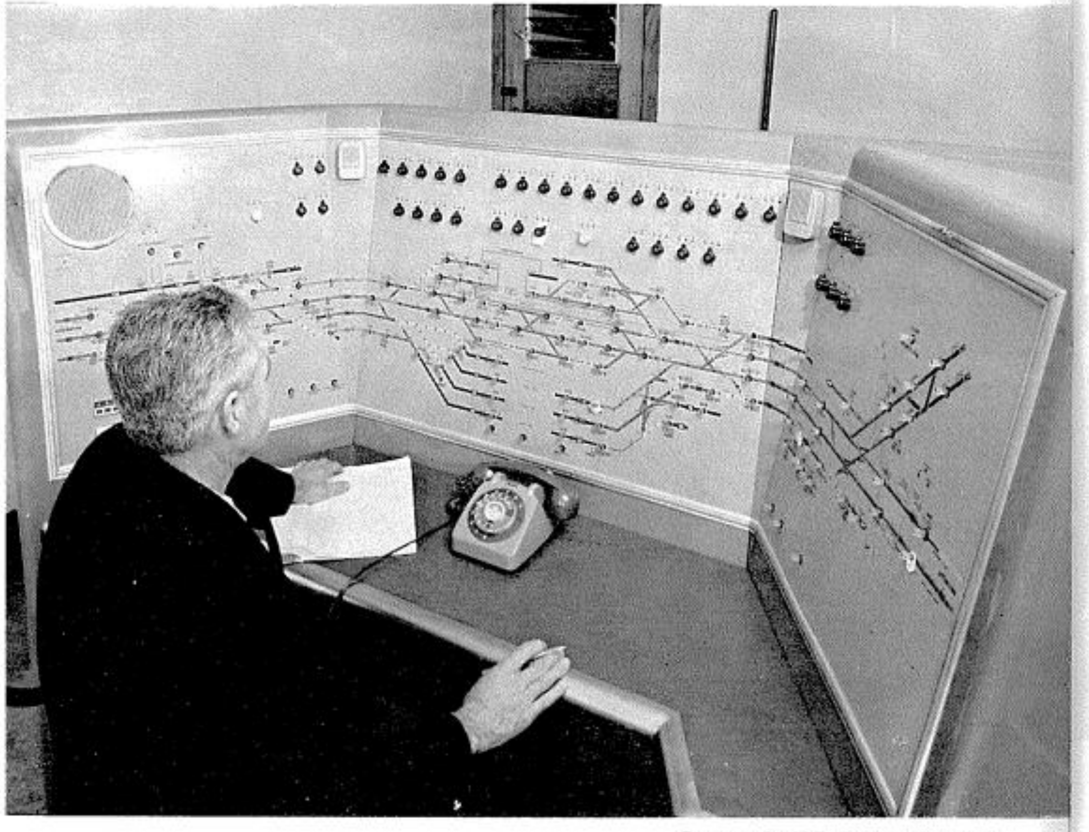
RIGHT: Ohakune North Box in 1956, a typical signal cabin of the mechanical signalling era. Note the rod between the rails in the foreground. This was a facing-points lock which had to be opened before the points could be reversed.

Photographs: N.Z. Railways Publicity

The advent of electricity and development of track circuits made it possible to introduce an effective form of automatic signalling, in which certain signals are normally held at clear, and in which the system is so designed that, should it be necessary or anything go wrong, they go immediately to danger, and are locked in that indication.

The basis of automatic signalling is the track circuit and the associated relay. The rails of each section of line are electrically connected from end to end by bond wires at the joints, but the two rails are insulated from each other and from other sections so that electric currents cannot pass until they are connected in some way, as for exemple by the steel wheels and axles of a vehicle. The usual practice, however, is to maintain a constant electrical circuit between the two rails so that, when it is broken by the passage of a vehicle or in any other way, an associated track relay is operated to change indication lights on a control panel, or to work an electrical lock (on points, for example), or to change the indication of a signal, or to combine all three actions. It is not the function or purpose of this article to describe or discuss all the technicalities involved, hence it must be appreciated that such descriptions as are given to illustrate principles are of a general nature, and can be subject to modification for varying circumstances and different periods of time.

Automatic signalling on New Zealand Railways first appeared between Wellington and Lower Hutt (double line) in 1922, and a few months later on the single line between Lower Hutt and Upper Hutt. Distinctive three-position semaphore signals were used on this line, with the arms working in the upper left-hand quadrant as seen from an approaching train. The arm in the vertical position or a green light denoted "clear"; at 45 degrees from vertical, or a



Photograph: N.Z. Railways Publicity

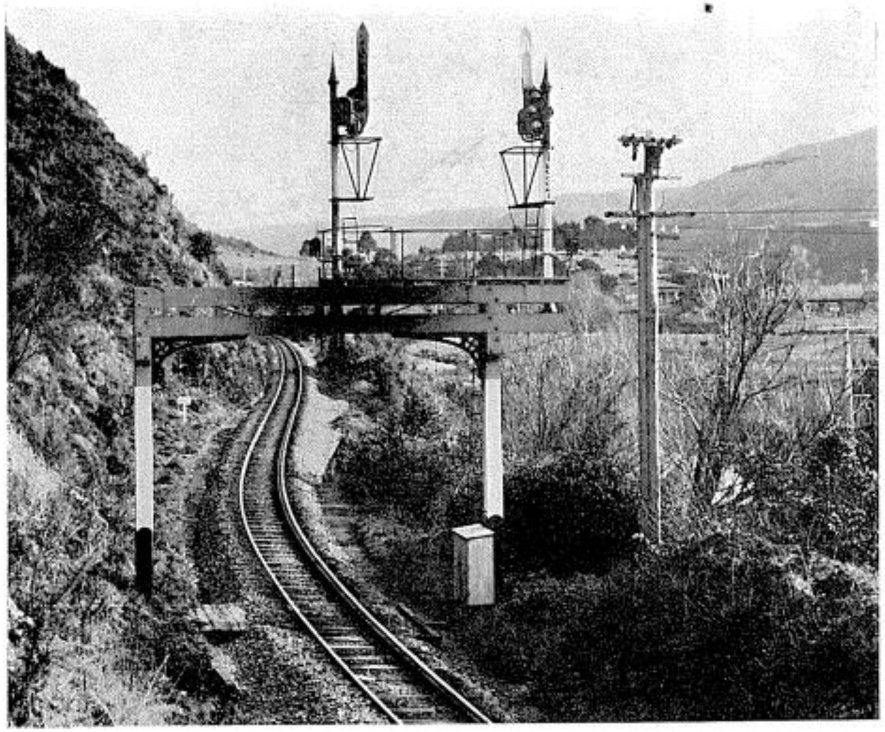
This compact control panel was brought into use at Christchurch in November 1963. It introduced to New Zealand the route-setting principle, whereby the signalman merely depresses two buttons on the diagram, one at the beginning and one at the end of the intended train movement, and the equipment does the rest.

yellow light, it meant "caution—the next signal is at stop"; and the arm in the horizontal position, or a red light, was the imperative "stop" indication.

Signal arms with a square end were "stop and stay" signals; these had a red marker light directly below the main signal light to distinguish them at night. These signals could not be passed in the "stop" position without special authority.

Signals with a pointed end to the arm, and with the marker light "staggered" to the right of the post, were "stop and proceed" signals. They functioned as distant, intermediate or arrival signals, but in the "stop" position, they could, after a short interval, be passed at low speed, the driver being prepared to stop his train short of any obstruction, whether it be another train or vehicle, points wrongly set, or a broken or misplaced rail.

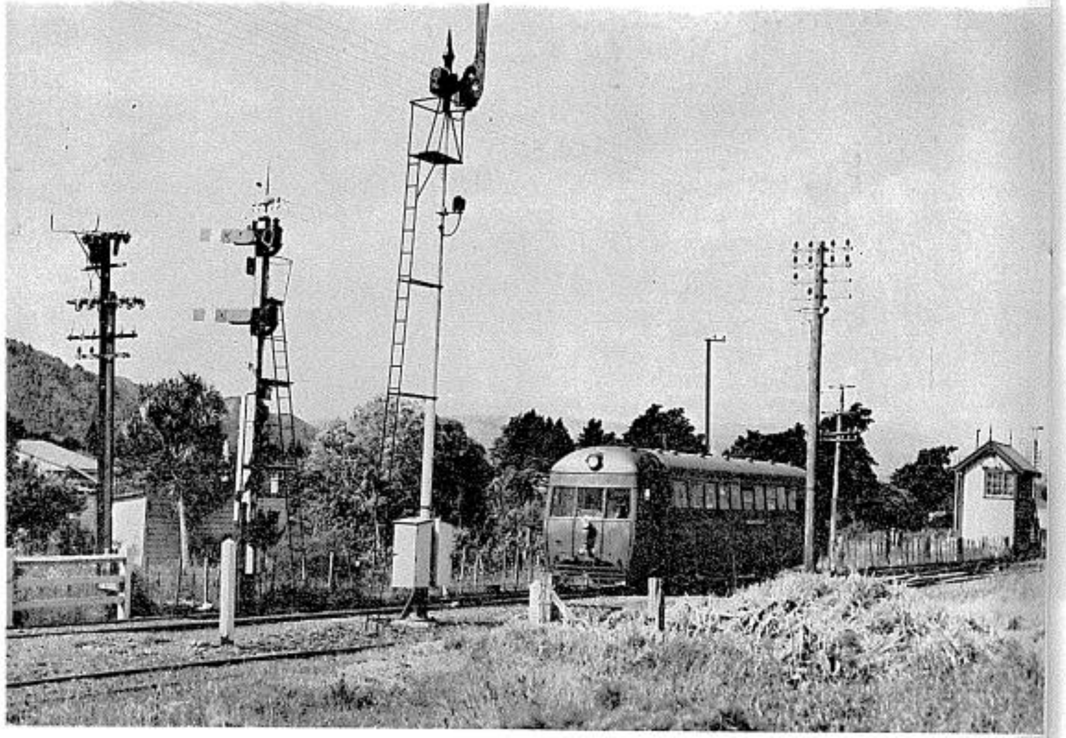
Departure signals controlling the entrance to single-line sections of railway between crossing loops, also home and starting signals at interlocked stations, were normally held in the stop position. Otherwise, automatic three-position signals normally displayed a "proceed" indication, either caution or clear according to the state of the signal next in advance.



ABOVE: Upper-quadrant style semaphore signals as installed between Lower Hutt and Upper Hutt in 1923. These were intermediate signals south of Silverstream on the former single-line section between Silverstream and Haywards. In the vertical position, the arms indicated that the next signal was at caution or clear. Note the "staggered" marker light to the right of the right-hand post, to show that this was a "stop-and-proceed" signal.

BELOW: Side view of a three-position colour-light signal at Ngauranga, as installed in 1965. The telephone in the shelter is for communication with the signalman, who in this instance is some three miles away.

Photographs: N.Z. Railways Publicity



The installation of automatic signalling between Lower Hutt and Upper Hutt, 12 miles (19 km) with five intermediate crossing stations, introduced New Zealand railwaymen to the unattended crossing loop. Here the points were worked by the train crews in accordance with procedures laid down in the rules, and the crossing of trains at these stations was a fairly time-consuming business. Trains passing through, however, would automatically claim the departure signal as they approached, and the signal would clear if the section ahead was unoccupied or had not already been "claimed" by a train approaching the station at the other end.

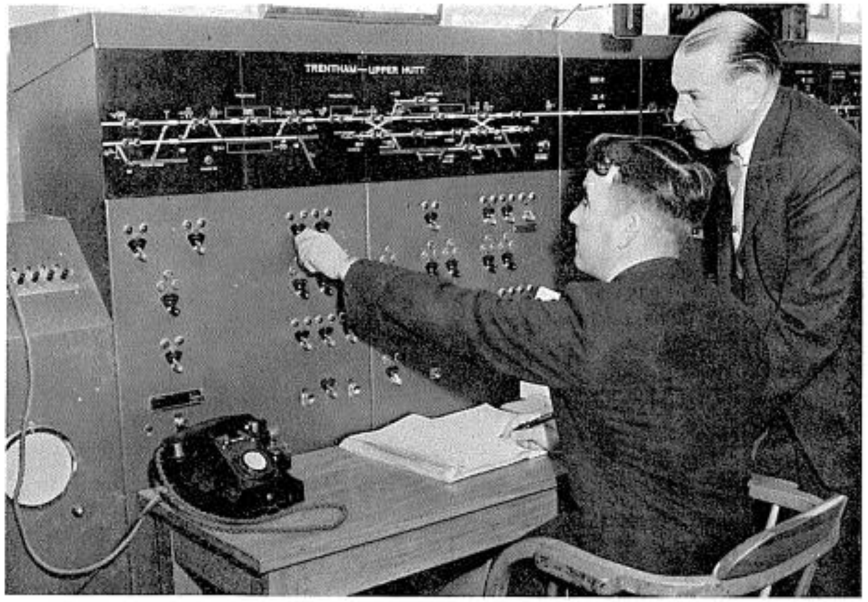
Nevertheless, automatic signalling was gradually extended on some main lines from 1924 onwards, but now with three-position colour-light signals, which confined their indications to lights that could be

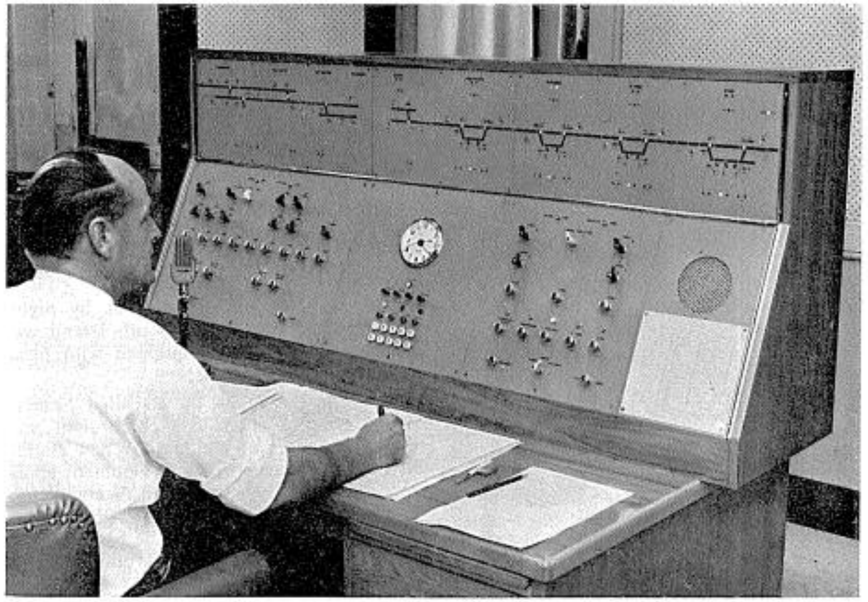
ABOVE: A Masterton-Wellington railcar, "Rm" 7, leaving Upper Hutt for Wellington in 1950. It is about to pass the down departure signal marking the entrance to the automatic signalling area. The up home signals at the left are of the two-position lower-quadrant semaphore type.

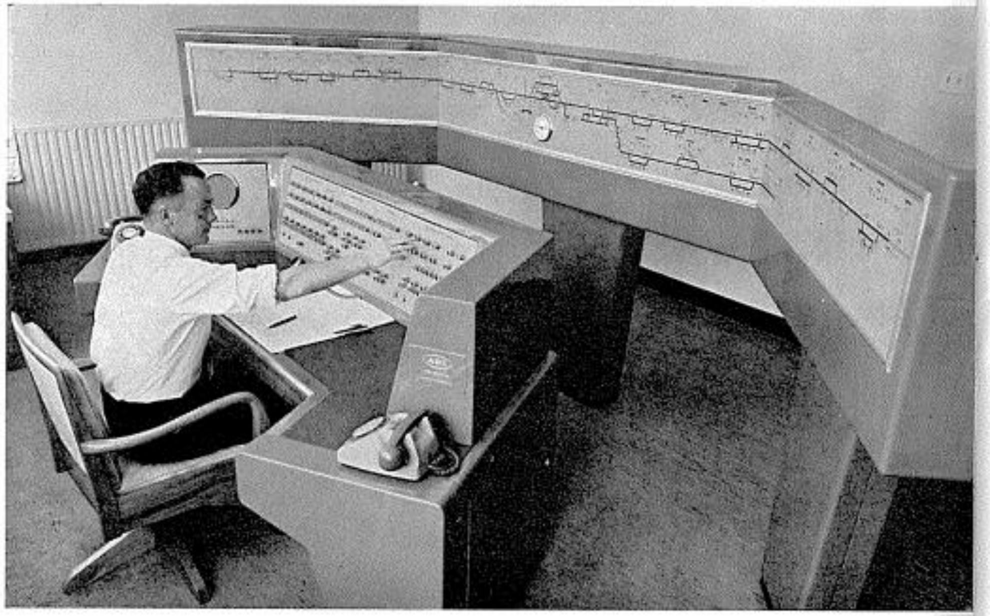
RIGHT, UPPER: This Centralised Traffic Control panel was installed at Upper Hutt in 1955 to cover the 17 miles from Trentham to Featherston via the new tunnel.

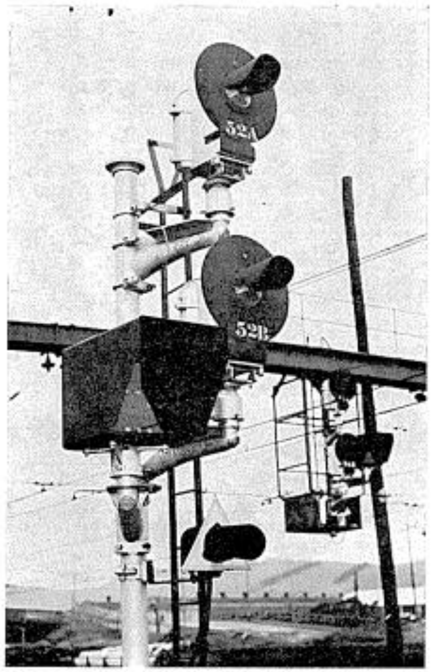
RIGHT, LOWER: A later style of C.T.C. panel was photographed at Wellington in 1965. This covers the line from Pukerua Bay, at the left of the diagram, to Otaki on the right, but excludes Paekakariki, which has its own local interlocking.

Photographs: N.Z. Railways Publicity









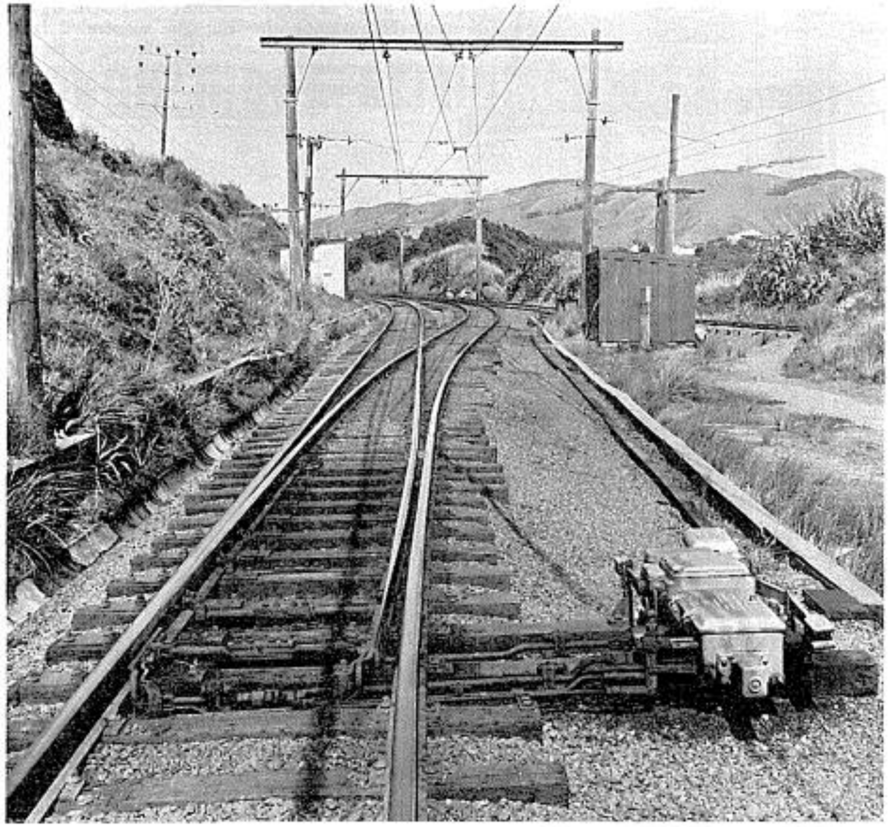
ABOVE: At Palmerston North, the push-button switches for the Otaki-Marton and Palmerston North-Woodville C.T.C. installations are desk-mounted, but the illuminated track diagram is erected separately.

LEFT: Searchlight-type, or single-lens, colour-light signals at Christchurch, with a route indicator.

Photograph: N.Z. Railways Publicity

clearly seen by day as well as by night. The Midland line in the South Island was among the first to be equipped with these new colour-light signals.

Later, in the 1930s, the so-called "searchlight" type of single-lens colour-light was adopted, as seen at Wellington's new station in 1937. Another special development about this time was the installation of completely automatic crossing loops at Wadestown, Ngaio, and Khandallah on the 6½-mile (10.5 km) single line between Wellington and Johnsonville. Here the trains themselves worked not only the signals but also the points. The system, introduced by G. W.



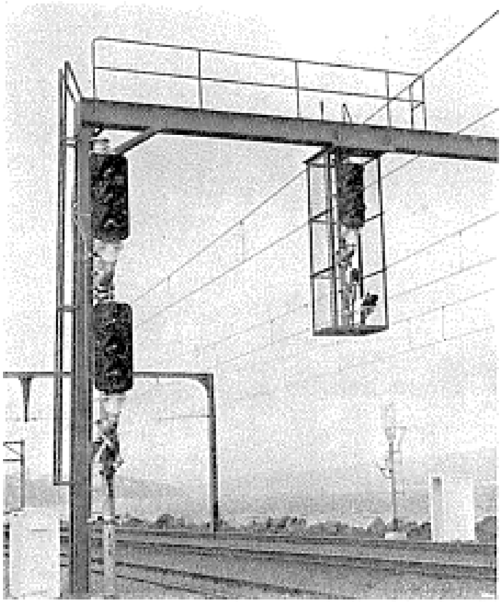
Photograph: N.Z. Railways Publicity

These motor-operated points at South Junction, near Pukerua Bay, are controlled from the C.T.C. panel at Wellington, 20 miles away. This is where the double line from Wellington becomes single for the descent to sea level near Paekakariki.

Wyles, understandably attracted worldwide attention.

By 1937, automatic signalling had superseded lock-and-block working on all double-line sections of railway in New Zealand, and was also in use on 191 route miles (306 km) of single line. Tablet working, however, continued to reign supreme on most main lines for another 20 years or more. This period was one of consolidation, with little reduction in the mileage worked under tablet, but several newly completed main lines, such as Napier-Gisborne, 132 miles (209 km), and Picton-Waipara, 178 miles (275 km), received automatic signalling. There was, however, a continuous if gradual programme for the installation of motor points at the busier tablet stations, and the replacement of semaphore distant signals in difficult locations by two-position (yellow or green) colour-lights.

Another major development in this period was the first use of Centralised Traffic Control. This came at first in 1938 between Taumarunui and Okahukura, 7 miles, and



An array of three-position colour-light signals at Ngauranga, showing one suspended from an overhead structure. The placing of signals is of importance, so that good visibility and identification may be assured.

Photograph: N.Z. Railways Publicity

in 1939 between Te Kuiti and Puketutu, 9 miles. In the latter instance, a new crossing loop was being brought into use at Waiteti, and the new arrangements made it unnecessary to provide for staff to be housed in an isolated locality.

Centralised Traffic Control was an adaptation of three-position automatic signalling to provide for the remote control of main-line points and signals from central locations, one operator (usually but not necessarily the Train Control Operator) often having from 10 to 15 stations under his control. The first major installation of this kind covered the 16 miles (26 km) from Tawa Flat to Paekakariki, with control from Wellington, and was commissioned early in 1940. Further major installations, however, did not appear until the mid-1950s, when a comprehensive programme was adopted. Replacement of tablet working by automatic signalling and C.T.C. on the North Island main trunk line was completed on 5 December, 1966, by which time a total of 520 route miles (837 km) throughout the country was under C.T.C., and another 987 route miles (1,578 km) were equipped with ordinary automatic signalling. The route miles of tablet working by this time were reduced to 1,103 (1,771 km).

The decade of the 1970s undoubtedly will see further contraction in the use of mechanical two-position signalling, and in labour-intensive tablet working. Work is already in hand on preparations to install automatic signalling and C.T.C. between Rolleston and Oamaru, 136 miles (210 km), in the South Island. This will give up-to-date signalling methods all the way from Christchurch to Dunedin, and in fact will confine tablet working on South Island main lines to the Addington-Waipara and Mosgiel-Invercargill areas.

The 1970s, no doubt, will also see the installation of more power interlockings with compact control panels, and with modern route-setting devices for the larger stations and yards as seen at Christchurch in 1963 for the first time in New Zealand. It is clear that New Zealand Railways are now well launched into the "push-button" age.

It has of course been impossible in this relatively short article to cover all aspects of railway signalling practice in New Zealand, but I hope the account has been reasonably intelligible to readers with little previous knowledge of the subject. Some matters, such as train staff and ticket working, shunting signals, and indicators of various kinds, have had to be virtually ignored, and others touched upon only lightly.

I am grateful to Mr J. A. Dangerfield for reading a draft of this article and for his many helpful comments, and I acknowledge in particular the following sources of some of the information:

STEVENSON, Ian D., *Railway Signalling in New Zealand*, a Paper published in "New Zealand Engineering", Vol. 9 (1954), No. 12, pp. 390-398.

TAYLOR, Maxwell, *Railway Signalling*, a Sampson Low Railway Handbook, 1949.