

## SECT. II.—OTHER SELECTED PAPERS.

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(Paper No. 2648.)“The Signalling at the Waterloo Terminus of the London and South-Western Railway.”<sup>1</sup>

By ALFRED WEEKS SZLUMPER, M. Inst. C.E.

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HISTORICAL.

PREVIOUS to the year 1867 all the points in Waterloo Yard were worked by hand-levers, and the signals consisted of one disk-signal fixed near the end of the platforms, for indicating to the man working the stop-signal whether a train could be received, a stop-signal, fixed near Westminster Road bridge, and a distant-signal about 400 yards away, towards Vauxhall. The first two signals were worked by hand-levers, and the distant-signal by a lever fixed near the stop-signal. All trains were stopped just outside the station, the engine was shunted, and the train roped in to the platform road; a lever fixed near Westminster Road bridge actuated a gong near the end of the platforms, the number of beats indicating the train that was about to be roped in. This, practically, was the signalling of Waterloo Yard in its earlier days, when the daily average of passenger-trains had reached about 228. This number has now grown to about 570 on a busy day.

In March 1867 a new signal-box, built by Messrs. Stevens & Sons, was opened, and designated the “A” box; it was fitted with a 47-lever locking-frame, in two rows (parallel to the line of railway), 24 referring to the main-line movements and 23 to the Windsor line. A stirrup-frame, for pulling off 4 main and 4 Windsor line signals, was also provided. All the chief points and signals were connected to this box and properly interlocked. In the year 1874 the box was reconstructed, a new one being built alongside in which a 109-lever frame in one length (at right-angles to the line of railway) was fixed by Messrs. Saxby & Farmer, the old box was removed, and all points and signals

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<sup>1</sup> Reference may also be made to an article entitled “The New Signalling System and Alterations at Waterloo Station,” which appeared in *Engineering* of the 27th May, 24th June, 16th September, and 28th October, 1892.—*Sec. INST. C.E.*

were connected with the new one. In the year 1878 another new signal-box was built encasing the 1874 box, so as to enlarge it, the shell of the old box was removed, and an additional row of 35 levers was added by Messrs. Stevens & Sons, parallel to and interlocking with the 109 levers already existing. In 1880, 20 levers were added, followed by 65 more in 1885, bringing up the total to 209 levers in two parallel rows. This signal-box sufficed to work the traffic until the completion of the extensive widening and improvement works,<sup>1</sup> when it became necessary to remodel all the lines leading into the platform bays. As it was not possible to add more levers to the old box, it was decided to build a new one immediately adjacent to it and to complete this new box, with new signals, &c., before disturbing the old one. This new box has been finished and brought into use, and is designated the new "A" box.

#### NEW "A" BOX.

The signal-box is built on girders spanning the Windsor lines with a gangway 12 feet wide, continued and spanning the main lines to carry some of the rodding, signal-wires, &c. (Plate 1). The box is built in two storeys, the lower floor, 74 feet by 30 feet, containing all the locking-machinery, &c.; and the upper floor is divided in four rooms, viz., a room 60 feet by 30 feet, containing the levers, instruments, &c.; a mess-room, 13 feet 4 inches by 9 feet 6 inches; a battery-room (lined with lead), 15 feet by 9 feet 4 inches; and a telephone-room, 4 feet square—the difference in level between the two floors being 9 feet 5 inches. The upper floor is specially designed to give ready access to any part of the locking-troughs by movable hatches. Practically, the whole of the points, facing-point locks and signals to and from the 18 platform-bays and sidings are worked from this box—the 3 small yard-boxes only working the "in" platform indicating-arms.

#### INTERLOCKING-MECHANISM.

The new box contains an interlocking apparatus of 236 levers, and was made by Messrs. Stevens & Sons, and fitted up in position by that firm. There are 102 signal-levers, working 247 connections; 50 point-levers, working 81 points; 46 facing-point lock-levers, locking 68 points; 7 gear levers, for adjusting the triple working; 16 small setting-levers and 15 spare levers, all

<sup>1</sup> Minutes of Proceedings Inst. C.E., vol. cvii. p. 287.

interlocked for and actually accomplishing the work of 350 levers (Plate 1 and Appendixes). The levers are 8 feet in length, fixed in two parallel rows 12 feet 8 inches apart when in their normal position. The levers are  $4\frac{1}{2}$  inches from centre to centre throughout, excepting two spaces of 2 feet 6 inches, one in each row, to afford the signal-men more ready access to the windows of the box, and at the same time to divide the Windsor from the main-line levers. The levers are worked by the signal-men standing between the rows. The interlocking is accomplished in three wide cast-iron horizontal locking-troughs, running from end to end of the apparatus—one in the centre between the rows of levers, containing 51 channels or grooves in which the interlocking mechanism is placed, and one on each side, between the levers and the windows to the box, containing 80 channels. Two long tappets only are used, attached one on each side of each lever, connected by links imparting a horizontal movement to the tappets, which are provided with the necessary bevel-notches &c., to give motion to the locks and slides running in the grooves of the locking-trough at right-angles to the tappets. All the necessary facing- and trailing-points, and also the facing-point locks have to be set before a passenger-train signal can be lowered; in addition to this, special "rotation-locking" is provided for each route, locking the route after the signal has been replaced to "danger" until a particular facing-point lock-lever has been returned to its normal position (generally the central point lock of the route set); the act of returning this lever removes all the back locks. For instance, take Road 7 to A, passenger out (Plate 1 and Appendix I)—gear-lever 128 would be set to the first position; the signal-man would then pull the following levers, viz., points 61 and 59, facing-point locks 64, 63, and 60, and signal 121; this signal-lever would be the first to be replaced, and, although replaced, all the other levers would still remain back-locked until facing-point lock 60 had been put back to its normal position; when the signal-man would be able to replace the remaining levers in the usual manner. This "rotation locking" is an invention of Mr. O'Donnell, and Fig. 1, Plate 2, explains its working (the ordinary releasing of signal 121 by the points, and the other locks are omitted in the Fig.).

#### SIMPLEX APPARATUS.

72 levers have their interlocking-mechanism so arranged that (conditionally upon the position of a gear-lever) each is capable of working three distinct signal-connections; this is accomplished

by the "Simplex" machines, Figs. 2, Plate 2. This "Simplex" apparatus is gathered into nests, or batteries, and there are seven such, fixed at suitable spots under the locking-frame in the lower floor, viz. :—


No. 1. Battery containing the apparatus for levers 7 to 18, controlled by gear-lever No. 19; these 12 levers working 30 signal-connections relating to the up-Windsor line: No. 2. Battery for levers 188 to 199, controlled by gear-lever No. 200; working 30 signal-connections relating to the down-Windsor through line: No. 3. Battery for levers 202 to 216, controlled by gear-lever No. 217; working 39 signal-connections relating to the down-Windsor local line: No. 4. Battery for levers 83 to 95, controlled by gear-lever No. 96; working 36 signal-connections relating to the up main through line: No. 5. Battery for levers 97 to 106, controlled by gear-lever No. 107; working 28 signal-connections relating to the up main local line: No. 6. Battery for levers 121 to 127, controlled by gear-lever No. 128; working 16 signal-connections relating to the down main line: No. 7. Battery for levers 177 to 179, controlled by gear-lever No. 180; working 6 signal-connections relating to the Windsor line engine-table roads. These batteries are not worked up to their full power; No. 1 being capable of working 6, No. 2, 6, No. 3, 6, No. 4, 3, No. 5, 2, No. 6, 5, and No. 7, 3, additional connections. Fig. 2 shows battery No. 1, which is similar in construction to the others. Each battery is fitted up in two tiers, to economise space, and works in a cast-iron guide. A is a blade actuated by the rod-connection F, leading from the tail of the gear-lever. B B<sup>1</sup> are rods leading to the signal-levers and terminating in selector-blades C C<sup>1</sup>, which engage with blades D D<sup>1</sup> connecting with the signal-wires. The blade A is provided with a series of studs, or projections, on the upper and lower sides, the selector-blades C C<sup>1</sup> travelling across the path of these studs; the movement of A causing the selector to engage with either one of three blades D in the top row, or one of three blades D<sup>1</sup> in the bottom row, by a stud on the selector fitting in a notch in the blades D D<sup>1</sup>. These blades are in fixed bearings, having a movement at right-angles to the blade A. In the first position of A, the selector is engaged with the blades leading to the passenger-train signals; in the second position, A has travelled 2 inches, and the selector now engages with the blades leading to the "out" shunt-signals; and in the third position, A has travelled another 2 inches, when the selector engages with the blades leading to the "in" shunt-signals. Thus in all cases, the first position works the passenger-train con-

nections, the second position, the "out" shunt-connections, and the third position, the "in" shunt-connections. The movements of the gear-levers are properly interlocked, so that it is not possible to set them for a wrong road. Special three-position release-labels and name-plate, and triple electric repeaters, are provided to suit this complex working. By the adoption of this triple working, the locking-apparatus is much reduced in size, and the distance the signal-men have to move about is also less; but the number of pulls is not reduced—the only difference being that the same lever is pulled for 3 distinct signals, instead of a separate lever for each. The 16 small setting-levers are placed between the ordinary levers, and are for interlocking only where alternative routes to the same platform-bay are provided.

#### SIGNALS.

Fixed on the station side of the new box is a 67-arm iron gallery-signal resting on the girders carrying the box (Plate 1). A signal-bridge spanning all the lines west of Westminster Road bridge carries a 21-arm iron gallery-signal, and at the end of each platform there are iron bracket-signals.

The 67-arm signal consists of two top arms, viz., down-Windsor through and down-Windsor local indicating arms, working in connection with the row of Windsor-line signals, informing the engine-driver which of the two down-Windsor lines the lower signal is given for; the upper row has 20 arms referring to the main lines, and the lower row 27 arms referring to the Windsor line passenger-train movements to and from the 18 platform bays and the 6 running lines, A, B, C, D, E, and F. The lowest row has twelve arms referring to shunting movements, these 12 arms being repeated on the opposite side of the signal-box, and partially so on Westminster Road signal-bridge. The 21-arm signal on this signal-bridge has 6 stop-arms, two for each of three up-roads, B, C, and F; the upper row for the main-line bays 1 to 7, and the lower row for the Windsor-line bays 8 to 18. There are also 6 "in" shunting-arms, one for each road, and 9 arms referring to the down traffic, viz., 6 advance-signals (3 for right and 3 for wrong road), and three distant-signals (the latter worked from the "B" signal-box). Each of the bracket-signals at the end of the platform-bays has passenger-train "starting," shunt "out" on right road, and shunt "out" on wrong road; the latter being indicated by

a scissors-shaped semaphore, , with a distinctive light (purple) at night. This scissors-arm is a great improvement upon the old arrangement, as the same arm was then used for a "right away" and shunt to "wrong" road signal, a distinctive letter only being lowered over the arm for the latter; this was found unsatisfactory and liable to be mistaken. There is also an arm for arrival traffic, indicating by three positions whether the bay about to be entered has a train already standing in it or is empty (each bay being large enough to take two trains). The working of these signals is described in the section, "Electric Locking to Platform-bays." All these signals are electrically repeated in the "A" box.

#### TRAFFIC-MOVEMENTS.

Referring to Plate 1, which presents a diagram of Waterloo yard in its normal state, the lines marked A, B, C, and (1) to (7) (at the end of the platform-bays) are considered as main-line territory, and those marked D, E, F, and (8) to (18) as Windsor-line territory, and these lines are so arranged as to admit of the following traffic-movements, namely:—from the down main line marked A to platform-bays (1) to (7) inclusive, also the Necropolis sidings and main-line turntable and sidings; between the up main local line marked B and platform-bays (1) to (10) inclusive, sidings and main-line turntable; between the up main through line marked C and platform-bays (1) to (13) inclusive, siding and main-line turntable; between the down Windsor local line marked D and platform-bays (4) to (18) inclusive, sidings and Windsor-line turntable; between the down Windsor through line marked E and platform-bays (7) to (18) inclusive, sidings and Windsor-line turntable; between the up Windsor line marked F and platform bays (7) to (18) inclusive, sidings and Windsor-line turntable—the three roads, A, D, and E, being the down lines, and the three marked B, C, and F, up lines. All points are fitted with the ordinary point-locks, and, where possible, safety-bars are provided.

#### SYKES ELECTRIC LOCK-AND-BLOCK.

In place of the ordinary block system, the Sykes electric lock-and-block has been adopted throughout, and specially arranged for terminus working. This system differs essentially from the ordinary block, inasmuch as the electrical working of the absolute

block system is combined with the mechanical working of the outdoor signals controlled by the movement of the trains passing over treadles fixed to the rails, rendering it practically impossible for a wrong signal to be given. For the up-trains, the first "A" box block section extends from the "B" signal-box (a distance of 467 yards towards Vauxhall) to the "A" box, and the second section from this box to the platform-bays. For the down-trains, the first section may be considered to extend from the platform-bays to the advance signals on the Westminster Road signal-bridge (the mechanical locking of the platform-bay signals, and the automatic working of these advance-signals, practically constituting this section); the second section extends to the "B" box.

#### ELECTRIC LOCK-AND-BLOCK INSTRUMENT.

The electric lock-and-block instruments in the "A" box, working in connection with the "B" box for all up-trains, are shown in Figs. 3 and 4, Plate 2. A represents four 7-inch permanent magnets (capable of supporting about 7 lbs. each); B, a pair of small electro-magnets fixed to the poles of the permanent magnets; C, an armature connecting with a stop on F; F F<sup>1</sup> F<sup>2</sup> are lock-blades (labels or tablets are fixed on these blades); E E<sup>1</sup>, line springs; G, a small lever connecting with a cross-head on to F and F<sup>2</sup>; and H, a rod leading to and actuating the auxiliary lock in the tappet (Figs. 6 and 7). In its normal state the armature is not attracted to the magnet. The man in charge of "A" box having received from "B" box a bell-signal warning him that a train is approaching, he pulls over the small lever G; this action raises the blades F and F<sup>2</sup>, also the rod H, putting the lock in the tappet (Fig. 7); it also pushes the armature against the magnet, which is now sustained by magnetic attraction, and the instrument is in a condition to be plunged. This is done and contact is made with the springs E E<sup>1</sup>, completing a circuit to the "B" box instrument, and enabling "B" box to release the lever feeding this particular road. At the same time, a click on blade F is pushed aside, when it drops and locks the plunger. A "train on" having been accepted from the "B" box, the switch S is placed over the plunger, breaking the circuit and causing the indicating arm over the "B" box instrument to show "danger." The instrument in "A" box is now locked and remains so until the train passes over a mercurial contact-treadle fixed to the rails near the "in" signal on the signal-bridge; when a circuit is completed with the instrument, causing an opposing current to travel through

the magnets which neutralizes their attractive power, when the armature falls away, releasing the stop on F and allowing the rods F F<sup>2</sup> to drop; these actuate H, pushing it down and removing the lock in the tappet. The instrument now returns to its normal position. This instrument is a "double," or "sending and receiving" instrument.

The instrument used for down-trains working is somewhat similar to the one described, except that there is no plunger or switch, but only the locking portion, and it is a "single," or "receiving," instrument.

#### AUXILIARY LOCKS ON SIGNAL LEVERS.

In connection with the Sykes locking, the signal-levers are fitted with auxiliary locks. The signal-levers actuating signals relating to trains approaching Waterloo are provided with a direct-acting electric lock, Figs. 5, Plate 2. A is an electro-magnet, B is an armature actuating the lock C, D is a tappet fixed to the lever, having a notch at E; F F<sup>1</sup> are insulated springs, and G is an ebonite pin. The lock is normally in the notch in the tappet that locks the lever. When a circuit is made with one of the yard boxes, the magnet A attracts the armature, lifting the lock from the notch, when the signal-lever is released. These electric locks are disconnected for an "in" or "out" shunt movement—the action of setting the gear lever accomplishing this by lowering the tappet D free of the lock C.

The auxiliary locks fitted to the signal-levers that actuate the "advance" signals is a double lock, Fig. 6; A is the lock hung on a mount G; B is a tappet fixed to the lever; C C<sup>1</sup> are notches in the tappet; D is a rod connecting with the lock-and-block instrument; D<sup>1</sup> is a rod tailed into a mechanical locking instrument, (G<sup>1</sup>, Fig. 8); E is a shifting cam. In the operation of pulling over the lever, the cam E engages with the rod D, raising it; this locks the lock-and-block instrument, and also actuates the lock A, which now drops into the rear notch in the tappet. The lever thus becomes locked, and remains so until the train passes over a mercurial contact-treadle (close to the advance signal), completing a circuit with the lock-and-block instrument, releasing the rod D (H, Fig. 3); this drops down, and the lock is raised from the tappet. The lever is now returned home, and the cam E, in the return motion, again raises D, locks the instrument, and causes the lock A to drop into the front notch; the lever is now again locked, and cannot be used until a circuit between the "B Box" and



"A Box" is made; this is effected when the train reaches the former box. When the lever is pulled over,  $D^1$  is pushed upwards, and this locks the group of starting-signals by means of the mechanical locking-instrument.

The lock on the starting-signal levers is very similar to the last described, excepting that there is only the front notch in the tappet, and the rod D is tailed into the mechanical-locking instrument (G, Fig. 8). F is a cross-head connecting a group of starting-signal locks. The lever does not become locked until it has been pulled and returned home, when the lock drops into the notch in the tappet by the action of the cam. This lock is removed after the advance-signal has been used, by means of the mechanical-locking instrument, Figs. 8. The auxiliary lock used on the "shunting" signal-levers is shown in Fig. 7. A is the lock hung on a mount at E; B is a tappet fixed to the lever, having a notch C which is under the lock only when the lever is home; D is a rod connecting with the lock-and-block instrument (H, Fig. 3). The lock is normally off, as shown in the Fig., being held in position by the rod D. When the lock-and-block instrument is in use, the lock A, Fig. 7, is placed in the notch locking the lever; and, when the lever is in use, the lock-and-block instrument is locked, as the rod D cannot be moved; consequently, when any shunting operations on the "up" or wrong road, are in hand, it is not possible for "A" box to accept a train from "B" box on this particular road.

All these auxiliary locks are entirely independent of, and in addition to, the ordinary locking.

#### MECHANICAL LOCKING OF GROUP OF PLATFORM-BAY "OUT" SIGNALS.

The cross-head F, Fig. 6, Plate 2, is connected to D, which passes into a mechanical-locking instrument G, Fig. 8, to which is attached a locking-piece A; another rod  $D^1$ , Fig. 6, connected with the "advance"-signal lever (relating to this particular group of "out" signals) also enters this instrument,  $G^1$ , Fig. 8, terminating in a releaser C; B is a click, D a weight.

When a starting-signal is lowered, A travels upwards, as shown in Fig. 8, "2nd position," and is held in position by the click B; when the "advance"-signal is lowered,  $G^1$  travels towards A, pushing B aside and locking A by the releaser C, Fig. 8; "3rd position," the group of starting-signals are locked until the "advance"-signal is returned to danger, when  $G^1$  is withdrawn, allowing A to drop back to its normal position.

Supposing a "starting"-signal has been lowered, and it is required to return it to "danger" before the train leaves the platform-bay—this is accomplished by inserting a key at F, which actuates E, pushing back the click and allowing A to return; this, of course, would only be used in case of emergency, and before the "advance"-signal has been lowered.

#### AUTOMATIC WORKING OF ADVANCE-SIGNALS.

The down "advance" signals on Westminster Road signal bridge are fitted with "electric reversers," which throw the arms to "danger" immediately a train passes. This automatic working of the "advance" signals is of great advantage, as a down train actually protects its own rear; moreover, many of the trains leaving Waterloo are followed by light engines; these are brought up at the "advance" signals.

#### ELECTRIC REVERSER.

The electric reversers are fixed to the signal-rods, and when the signal is lowered, a pin P, Fig. 9, Plate 2, projecting from the back of the reverser, comes into contact with an insulated spring fitted to the signal-post, through which a circuit is carried to a mercurial contact-treadle, Figs. 14, fixed to the rails near the signal. A A are a pair of electro-magnets; B is an armature actuating the link and cross-bar C; D is a hammer fitted with the stop E which is locked by C; F is a pin connecting with the lock G which holds a link H in position. Directly a train passes by the treadle, a circuit is completed to the reverser, exciting the magnets which then attract the armature B, releasing the stop E and allowing the hammer D to fall and strike the pin F, releasing the lock G. The weight of the reverser now causes it to drop, and in so doing it puts the signal to "danger." As the reverser drops, the rod J pushes H aside, and a cam K engages with a wheel L fixed to the hammer, raising the latter and re-setting it. When the signal-man returns the signal-lever home, J is withdrawn to its normal position and the reverser is re-set. The "advance" and "distant" signals being slotted, the reverser actuates both at the same time.

## DUAL WORKING OF "IN" SIGNALS (SHUNTING).

The "in" shunting-signals on the signal-bridge work simultaneously with the "in" shunting-signals on the "A" box, but the signal on the box can be lowered, keeping the one on the bridge to "danger." The dual working of these signals has this advantage—that, if a light engine has been shunted out towards the signal-bridge, "A" box can lower the "in" signal above the box, keeping the one on the signal-bridge to "danger." The engine now shunts back, and is protected during its shunting movements by the signal on the signal-bridge; whilst another train can be brought up to the signal-bridge from the "B" box, entering the yard directly the shunting movements of the light engine are completed.

## ELECTRIC SELECTOR.

This dual working is accomplished by an electric selector, which is fixed to the signal-rod connecting the two signals, Fig. 10, Plate 8. A is an electro-magnet; B is the armature, connected with and actuating C; DD' is the signal-rod joining the arm on the signal-bridge with the corresponding arm on the "A" box. In its normal state the selector is inactive, and the rod DD' is practically continuous, carrying the selector with it as it moves. Should the signal-man wish to bring the selector into use, he switches on a current, and the electro-magnet A attracts the armature, displacing C from the line of the signal-rod, so that when D travels D' remains inactive. The signal in the rear of the selector (on the "A" box) can now be lowered, that on the signal-bridge remaining at "danger."

## ELECTRIC LOCKING OF PLATFORM-BAYS.

The platform "in" signals are worked from the small yard-boxes, the position of the arms being electrically controlled by contact-treadles fixed to one of the rails. Four such treadles are placed in each platform-bay (Figs. 1, 12 and 13, Plate 8). No. 1 treadle may be termed a "danger-bar," and Nos. 2, 3 and 4, "contact treadles." There is a circuit connecting the "danger"-bar with the levers in the yard-boxes, and, should any vehicle be standing on the bar, it would be depressed and the circuit broken; the electric lock could not under these circumstances be raised from the tappet attached to the lever actuating the "in" signal to this road, and it therefore remains locked. The other

treadles are in circuit with the yard-box and platform "in" signals, passing through an electric controller fixed on the signal-post. Supposing all treadles free, the signal-man, by the action of pulling his trigger, A, Fig. 12, joins circuit with the treadle, causing a current to pass through his magnet and raise the lock from the tappet; the act of pulling the lever over makes contact with a line-circuit to the "A" box (it also lowers the platform "in" signal). The electric lock on the lever in the "A" box can now be released by a current passing through the coil, attracting the armature and lifting the lock—the signalman in this box being then enabled to lower his "in" signal for this particular platform-bay. Should, however, either of the treadles Nos. 2, 3, or 4, be depressed, the circuit with the signal (through the controller) is broken, and, in consequence, the electro-magnet in this controller is inactive, causing a trigger to engage with the signal-rod. A, Fig. 11, is an electro-magnet, B an armature connected to a trigger C fitted with a foot C'. When the circuit is complete, the electro-magnet attracts the armature, and the foot C' remains inside the iron case containing the controller; the signal-rod has then a free movement. Should, however, the circuit be broken, the electro-magnet ceases to attract the armature, and, the trigger C falling away, projects the foot C', engaging with the spur D on the signal-rod E, which can now only travel far enough to lower the signal to "caution."

#### DOUBLE CONTACT—MERCURIAL TREADLES.

The contact-treadles fixed to the rails in the platform-bays are very simple in construction (Fig. 13, Plate 8). The flange of a wheel depresses a bar which breaks contact by raising a spring; but these treadles are only suitable where trains pass over slowly; for situations where trains run at high speeds, mercurial contact-treadles, Fig. 14, are used. The treadles are 6 feet in length, and are bolted to the web of one of the rails of a running-road. AA' are levers 18 inches in length, mounted on pins BB'; C is a pin fixed rigidly to the web of the rail and passing in freely through the treadle-box; DD' is a small iron vessel containing about a thimbleful of mercury at the end D' and solid at D; EE' are platinum points fixed in the vessel, E insulated and attached to a line-wire carried to the signal-box (and also to the electric reversers in the case of the "advance" signals); E' is connected to earth. When a train passes the treadles, the deflection of the rail causes the pin C to press on the levers AA'; these levers then tilt the mercurial

vessel, when the mercury covers the platinum points, completing a circuit. There are two mercurial vessels to each treadle in case one fails to act.

#### CROSSING TRAINS AT "B" BOX.

The "B" signal-box may be considered as the commencement of Waterloo Yard, and as there are at this box compound crossings laid in the running-lines, by which a shunt can be made from and to any line, many crossing-movements from Windsor to main lines, or *vice versâ*, can be more readily carried out at times than at the "A" box; and, to meet this work, by a simple contrivance the movements are electrically controlled from the "A" box. There are fixed in the "B" box two large dial-indicators, and, in the "A" box, switches controlling the movements of these indicators. Supposing "A" box wishes a train to be crossed at "B" box, it informs "B" by bell-instrument and then turns the switch indicating the crossing; this is repeated on the dial-indicator in "B" box. There are six movements to each switch, viz., on the switch referring to up-trains: up-main through to up-main local and *vice versâ*; up-main through to up-Windsor and *vice versâ*; up-main local to up-Windsor and *vice versâ*; and, on the switch referring to the down-trains: down-main to down-Windsor local and *vice versâ*; down-main to down-Windsor through and *vice versâ*; down-Windsor local to down-Windsor through and *vice versâ*. Any single movement of the switch locks the remainder.

#### MOVEMENT OF TRAINS APPROACHING AND LEAVING WATERLOO.

To more clearly illustrate the signalling and electric locking and blocking, the movements of an up Windsor-line train approaching and entering Waterloo Station and those of a down main-line train leaving the station will now be described. In the first instance, all "up" trains are described from Vauxhall by speaking-instrument to the "A" box. An up Windsor-line train having reached the "B" box section, it is signalled to the "A" box; if accepted, "A" box signal-man pulls the small lever in connection with the lock-and-block instrument, Figs. 3 and 4, Plate 8, locking the "out" shunt-signals feeding this road; he then plunges connecting circuit with the "B" box (see diagram of electrical connections, Fig. 12). This current removes the auxiliary locks from the "B"-box lever feeding this road, and he now pulls his lever and lowers his signals. Directly the train

passes by the mercurial contact-treadle fixed to one of the rails just in advance of "B"-box "advance"-signal, the circuit is broken (it will be noticed that this treadle "breaks" instead of "making" contact by reversing the position of the vessels containing the mercury), and the battery-power given to "B" box by "A" box is destroyed; "B" cannot now send another train on this road until "A" gives him another permit. When the train reaches the mercurial contact-treadle fixed to the rail near the "A"-box "in" signal (on the signal-bridge), a circuit to the "A" box through the "in" signal is completed, re-setting the instrument in this box. The "A" box signal-man will have obtained from the yard-box permission to lower his "stop"-signal (this signal works in rotation with the "in" platform-signal), and the train now enters a platform-bay.

For a down main-line train leaving Waterloo, the platform departure-signal is first lowered from "A" box. The signal-man will have signalled the train on to "B" box, and, if accepted, "B" plunges and releases the lock of the advance-signal on Westminster Road signal-bridge. The act of lowering the platform departure-signal locks all platform-signals leading to this road. The signal-man at "A" box now lowers the "advance" signal, and, in doing so, switches his electric-locking instrument on to the mercurial contact-treadle near this "advance" signal; as soon as the train reaches this treadle, the "advance" signal is automatically put to danger, and it cannot be again lowered until the train reaches a treadle near "B" box, which completes a circuit to "B" box and removes the lock from his instrument.

#### ELECTRIC BUZZER.

When passing the treadle near the "advance" signal, two currents of electricity are set up, one throwing the semaphore to danger, the other completing a circuit to the "A" box, which removes the back lock from the "advance"-signal lever, and, by completing a circuit between the mechanical and electric locking-instruments, actuates a "buzzer," which emits a sound somewhat similar to that of a toy trumpet—continuing until the signal-man restores his lever, the signal being already put to "danger" by the action of the treadle. This "buzzer" always sounds when the mechanical and electric locking-instruments are at variance, the sound being produced by a make-and-break contact on a thin disk of metal. The "buzzer" is simply to remind the signal-man that he has not worked his lever. In the first case it sounds directly

"B" box removes the lock out of the "advance" signal, and continues until "A" box pulls the lever and lowers the signal.

#### SHUNTING OUT ON "WRONG" ROAD.

For shunting out on the "up" or "wrong" road, the movements are electrically controlled by "B" box; and, before permission is given to "A" box for such a shunt movement, the signal-man at "B" box puts a lock into his up "stop" signals feeding the particular road on which the shunt-movement is about to be carried out. The limit of shunting out on the wrong road extends to a point near "B" box, where ground disks of scissors-pattern are fitted (Plate 7).

#### NUMBER OF CIRCUITS, ETC.

The total number of circuits entering the new box is about 250; all the wires are carried underground, and all circuits and wires have been run to disconnecting-boards in the battery-room, so as to be more easy of access. The instruments used have been constructed so as to permit as far as possible the use of the Leclanché type of battery. The number of cells in the boxes and about the yard is about 683, the greater number being for repeating-signals and bells.

#### RODDING.

The rodding is of necessity very extensive, and, for want of space, is somewhat complex—double-tier rollers having to be resorted to, and rocking-shafts employed for leading away both in "A" box and on the ground. Annett and Wilmer's point-rods, and Stevens & Sons' travelling-rollers are used. In all cases the signal-wires are carried overhead.

#### TRANSFERRING CONNECTIONS FROM OLD TO NEW BOX.

The work of transferring all the connections from the old to the new box was one of considerable magnitude, bearing in mind the large traffic that had to be dealt with at the same time. When the new box was completed, the locking tested and approved by the Board of Trade inspector, and the new points and crossings laid as far as possible, the work of transferring the connections was undertaken; and on the 1st of May, 1892, all the main-line connections were removed from the old signal-box and connected

to the new one. A fortnight then elapsed, during which period preparations were made for the final move. During this fortnight, the main-line traffic was worked from the new box and the Windsor-line traffic from the old one; the shunting from the main line to the Windsor line and *vice versa* being worked by a temporary ground-frame electrically controlled by both the signal-boxes. On Sunday, the 15th of May, the final move was made—all Windsor-line connections being removed from the old box and connected to the new one; the work of dismantling the former and removing the old signals was now carried on day and night. Meanwhile, the work of laying the new points and crossings proceeded; but a few of these could not be completed until the stanchions supporting the girders which carried the old box were removed. The girders were taken down during the week, and on the following Sunday (the 22nd of May) the stanchions were removed and the remaining points and crossings completed. For the first three days after the final move, it was necessary to discontinue a few local trains, and extra ground-signal-men were stationed in the yard to assist the traffic movements. The completed scheme has now been in use for some months, during which period a heavy traffic has been dealt with (as many as 879 trains, empties, &c., on Saturday, the 16th of July,<sup>1</sup> and on several occasions the number has exceeded 800 per day). This has been done with safety and expedition, the new arrangements working most satisfactorily, being well adapted to deal with the traffic of this, probably the most extensive station in existence.

The communication is accompanied by a series of tracings, from which Plates 7 and 8 have been compiled; also by various photographic and printed documents which may be seen at the Institution.

<sup>1</sup> —	Down Main.	Up Main.	Down Windsor.	Up Windsor.
Trains . . . .	118	128	132	127
Engines . . . .	40	53	30	27
Empties . . . .	21	50	63	22
Special trains . . . .	23	30	8	7
	202	261	233	183
Grand Total = 879.				



## APPENDIXES.

NOTE.—Figures marked (61) are point-levers that are not back-locked by the signal.

The first, second and third positions of the gear lever are indicated thus: 124<sup>I</sup>, 124<sup>II</sup>, 124<sup>III</sup>.

Figures marked thus, 126<sup>II</sup>, are the “A” or “B” position of the setting-levers.

## APPENDIX I.

## “A” BOX INTERLOCKING.—DOWN-MAIN LINE “A.” PULLS.

Road.	Traffic Movement.	Pull Lever.
“A” to Necropolis.	Passenger in . . .	117, 138.
Necropolis to “A”.	Passenger out . . .	117, 139.
“A” to siding . . .	Fly shunt in . . .	118, (115), 127 <sup>III</sup> .
Siding to “A” . . .	Shunt out . . .	118, (115), 138, 110.
“A” to Road 1 . . .	Fly shunt in . . .	118, 127 <sup>III</sup> .
Road 1 to “A” . . .	Passenger out . . .	118, 112, 138, 127 <sup>I</sup> .
Road 1 to “A” . . .	Shunt out . . .	118, 138, 127 <sup>II</sup> .
“A” to Road 2 . . .	Over 118, fly shunt in . . .	(113), 118, 127 <sup>III</sup> .
“A” to Road 2 . . .	Over 109, fly shunt in . . .	131, (109), 125 <sup>III</sup> .
Road 2 to “A” . . .	Over 118, passenger out . . .	118, 113, 112, 132, 138, 126 <sup>III</sup> .
Road 2 to “A” . . .	Over 109, passenger out . . .	131, 109, 60, 132, 126 <sup>AI</sup> .
Road 2 to “A” . . .	Over 118, shunt out . . .	118, 113, 138, 126 <sup>III</sup> .
Road 2 to “A” . . .	Over 109, shunt out . . .	131, 109, 126 <sup>AI</sup> .
“A” to table . . .	Over 118, fly shunt in . . .	(113), (111), 118, 127 <sup>III</sup> .
“A” to table . . .	Over 56, fly shunt in . . .	(56), 125 <sup>III</sup> .
Out of table . . .	Over 111, shunt out . . .	113, 111, 129.
Table to “A” . . .	Over 56, shunt out . . .	56, 142.
“A” to Road 3 . . .	Straight, fly shunt in . . .	125 <sup>III</sup> .
Road 3 to “A” . . .	Passenger out . . .	60, 125 <sup>I</sup> .
Road 3 to “A” . . .	Shunt out . . .	125 <sup>II</sup> .
“A” to Road 4 . . .	Over 62, fly shunt in . . .	(62), 125 <sup>III</sup> .
“A” to Road 4 . . .	Over 61, fly shunt in . . .	(61), (52), 125 <sup>III</sup> .
Road 4 to “A” . . .	Passenger out . . .	62, 58, 60, 124 <sup>I</sup> .
Road 4 to “A” . . .	Shunt out . . .	62, 124 <sup>II</sup> .
“A” to Road 5 . . .	Over 61, fly shunt in . . .	(61), (53), 125 <sup>III</sup> .
“A” to Road 5 . . .	Over 62, fly shunt in . . .	(62), (57), (53), 125 <sup>III</sup> .
Road 5 to “A” . . .	Passenger out . . .	62, 57, 53, 67, 60, 123 <sup>I</sup> .
Road 5 to “A” . . .	Shunt out . . .	62, 57, 53, 123 <sup>II</sup> .
“A” to Road 6 . . .	Over 61, fly shunt in . . .	(61), 125 <sup>III</sup> .
“A” to Road 6 . . .	Over 62, fly shunt in . . .	(62), (57), 125 <sup>III</sup> .
Road 6 to “A” . . .	Passenger out . . .	62, 57, 67, 60, 122 <sup>I</sup> .
Road 6 to “A” . . .	Shunt out . . .	62, 57, 122 <sup>II</sup> .
“A” to Road 7 . . .	Fly shunt in . . .	(61), (59), 125 <sup>III</sup> .
Road 7 to “A” . . .	Passenger out . . .	61, 59, 64, 63, 60, 121 <sup>I</sup> .
Road 7 to “A” . . .	Shunt out . . .	61, 59, 121 <sup>II</sup> .

## APPENDIX II.

"A" BOX INTERLOCKING.—UP-MAIN LOCAL LINE "B." PULLS.

Road.	Traffic Movement.	Pull Lever.
"B" to siding . .	Fly shunt in . . .	(115), 81, 116, 106 <sup>III</sup> .
Siding to "B" . .	Shunt out . . .	115, 81, 116, 135, 136, 82.
"B" to Road 1 . .	Fly shunt in . . .	116, 81, 106 <sup>III</sup> .
"B" to Road 1 . .	Passenger in . . .	116, 81, 114, 80, 78, 112, 106 <sup>I</sup> , 119.
Road 1 to "B" . .	Shunt out . . .	116, 81, 135, 136, 106 <sup>II</sup> .
"B" to Road 2 . .	Over 81, fly shunt in .	116, 81, (113), 106 <sup>III</sup> .
"B" to Road 2 . .	Over 109, fly shunt in	116, 131, (109), 104 <sup>III</sup> .
"B" to Road 2 . .	Over 81, passenger in	113, 81, 116, 130, 80, 78, 112, 105 <sup>III</sup> , 119.
"Road 2 to "B" . .	Over 81, shunt out . .	113, 81, 116, 135, 136, 105 <sup>III</sup> .
"B" to Road 2 . .	Over 109, passenger in	131, 109, 116, 108, 66, 80, 78, 60, 105 <sup>AI</sup> , 119.
Road 2 to "B" . .	Over 109, shunt out . .	131, 109, 116, 135, 136, 105 <sup>AI</sup> .
"B" to table . . .	Over 111, fly shunt in	116, 81, (113), (111), 106 <sup>III</sup> .
"B" to table . . .	Over 56, fly shunt in .	116, (56), 104 <sup>III</sup> .
Table to "B" . . .	Over 56, shunt out . .	116, 56, 135, 136, 141.
"B" to Road 3 . .	Fly shunt in . . .	116, 104 <sup>III</sup> .
"B" to Road 3 . .	Passenger in . . .	116, 108, 66, 80, 78, 60, 104 <sup>I</sup> , 119.
Road 3 to "B" . .	Shunt out . . .	116, 135, 136, 104 <sup>II</sup> .
"B" to Road 4 . .	Fly shunt in . . .	103 <sup>III</sup> .
"B" to Road 4 . .	Over 116, fly shunt in	116, (62), 104 <sup>III</sup> , or 116 (61), (52), 104 <sup>III</sup> .
"B" to Road 4 . .	Straight, passenger in	78, 65, 103 <sup>III</sup> , 119.
"B" to Road 4 . .	Over 55, passenger in	52, 70, 55, 51, 68, 65, 78, 54, 103 <sup>AI</sup> , 119.
Road 4 to "B" . .	Straight, shunt out . .	135, 136, 103 <sup>III</sup> .
Road 4 to "B" . .	Over 55, shunt out . .	52, 70, 55, 135, 136, 103 <sup>AI</sup> .
"B" to Road 5 . .	Over 116, fly shunt in	116, (61), (53), 104 <sup>III</sup> , or 116, (62), (57), (53), 104 <sup>III</sup> .
"B" to Road 5 . .	Fly shunt in . . .	(55), (70), (53), 103 <sup>III</sup> .
"B" to Road 5 . .	Passenger in . . .	53, 55, 70, 51, 68, 65, 78, 54, 102 <sup>I</sup> , 119.
Road 5 to "B" . .	Shunt out . . .	53, 55, 70, 135, 136, 102 <sup>II</sup> .
"B" to Road 6 . .	Fly shunt in . . .	55, 70, 103 <sup>III</sup> .
"B" to Road 6 . .	Over 116, fly shunt in	116, (61), 104 <sup>III</sup> , or 116, (62), (57), 104 <sup>III</sup> .
"B" to Road 6 . .	Passenger in . . .	55, 70, 51, 68, 65, 78, 54, 101 <sup>I</sup> , 119.
Road 6 to "B" . .	Shunt out . . .	55, 70, 135, 136, 101 <sup>II</sup> .
"B" to Road 7 . .	Fly shunt in . . .	(55), 103 <sup>III</sup> .
"B" to Road 7 . .	Over 116, fly shunt in	116, (61), (59), 104 <sup>III</sup> .
"B" to Road 7 . .	Passenger in . . .	55, 68, 65, 78, 54, 100 <sup>I</sup> , 119.
Road 7 to "B" . .	Shunt out . . .	55, 135, 136, 100 <sup>II</sup> .
"B" to Road 8 . .	Passenger in . . .	55, 46, 42, 36, 48, 65, 78, 68, 99 <sup>I</sup> , 119.
"B" to Road 8 . .	Shunt in . . .	55, 46, 42, 36, 99 <sup>III</sup> .
Road 8 to "B" . .	Shunt out . . .	55, 46, 42, 36, 135, 136, 99 <sup>II</sup> .
"B" to Road 9 . .	Passenger in . . .	55, 42, 36, 48, 65, 78, 68, 98 <sup>I</sup> , 119.
"B" to Road 9 . .	Shunt in . . .	55, 42, 36, 98 <sup>III</sup> .
Road 9 to "B" . .	Shunt out . . .	55, 42, 36, 135, 136, 98 <sup>II</sup> .
"B" to Road 10 . .	Passenger in . . .	55, 45, 42, 36, 48, 65, 78, 68, 97 <sup>I</sup> , 119.
"B" to Road 10 . .	Shunt in . . .	55, 45, 42, 36, 97 <sup>III</sup> .
Road 10 to "B" . .	Shunt out . . .	55, 45, 42, 36, 135, 136, 97 <sup>II</sup> .

## APPENDIX III.

"A" BOX INTERLOCKING.—UP-MAIN THROUGH LINE C. PULLS.

Road.	Traffic Movement.	Pull Lever.
"C" to siding . .	Fly shunt in . . .	81, 76, 79, 77, (115), 95 <sup>III</sup> .
Siding to "C" . .	Shunt out . . .	115, 81, 76, 79, 133, 134, 82.
"C" to Road 1 . .	Passenger in . . .	{ 81, 76, 79, 114, 80, 78, 77, 112, 95 <sup>I</sup> , 120.
"C" to Road 1 . .	Fly shunt in . . .	81, 76, 79, 77, 95 <sup>III</sup> .
Road 1 to "C" . .	Shunt out . . .	81, 76, 79, 133, 134, 95 <sup>II</sup> .
"C" to Road 2 . .	Over 81, fly shunt in .	(113), 81, 76, 79, 77, 95 <sup>III</sup> .
"C" to Road 2 . .	Over 109, fly shunt in	131, 109, 116, 76, 79, 77, 93 <sup>III</sup> .
"C" to Road 2 . .	Over 109, passenger in	{ 131, 109, 116, 76, 79, 108, 66, 80, 78, 77, 60, 94 <sup>AI</sup> , 120.
"C" to Road 2 . .	Over 81, passenger in .	{ 113, 81, 76, 79, 130, 80, 77, 78, 112, 94 <sup>II</sup> , 120.
Road 2 to "C" . .	Over 109, shunt out .	{ 131, 109, 116, 76, 79, 133, 134, 94 <sup>III</sup> .
Road 2 to "C" . .	Over 81, shunt out . .	113, 81, 76, 79, 133, 134, 94 <sup>BII</sup> .
"C" to table . . .	Over 81, fly shunt in .	81, 76, 79, 77, (113), (111), 95 <sup>III</sup> .
"C" to table . . .	Over 56, fly shunt in .	116, 76, 79, 77, (56), 93 <sup>III</sup> .
Table to "C" . . .	Over 56, shunt out . .	116, 76, 79, 56, 133, 134, 140.
"C" to Road 3 . .	Fly shunt in . . .	116, 76, 79, 77, 93 <sup>III</sup> .
"C" to Road 3 . .	Passenger in . . .	{ 116, 76, 79, 108, 66, 80, 78, 77, 60, 93 <sup>I</sup> , 120.
Road 3 to "C" . .	Shunt out . . .	116, 76, 79, 133, 134, 93 <sup>II</sup> .
"C" to Road 4 . .	Over 116, fly shunt in	116, 76, 79, 77, (62), 93 <sup>III</sup> .
"C" to Road 4 . .	Over 76, fly shunt in .	76, 77, 92 <sup>BIII</sup> .
"C" to Road 4 . .	Over 70, fly shunt in .	77, (70), (52), 89 <sup>III</sup> .
"C" to Road 4 . .	Over 70, passenger in .	{ 52, 70, 51, 68, 75, 77, 54, 92 <sup>AI</sup> , 120.
"C" to Road 4 . .	Over 76, passenger in .	76, 77, 78, 65, 92 <sup>BI</sup> , 120.
Road 4 to "C" . .	Over 70, shunt out . .	52, 70, 133, 134, 92 <sup>III</sup> .
Road 4 to "C" . .	Over 76, shunt out . .	76, 133, 134, 92 <sup>BII</sup> .
"C" to Road 5 . .	Over 116, fly shunt in	{ 116, 76, 79, 77, (61), (53), 93 <sup>III</sup> , or 116, 76, 79, 77, (62), (57), (53), 93 <sup>III</sup> .
"C" to Road 5 . .	Over 76, fly shunt in .	76, 77, (55), (70), (53), 92 <sup>BII</sup> .
"C" to Road 5 . .	Over 70, fly shunt in .	77, (70), (53), 89 <sup>III</sup> .
"C" to Road 5 . .	Passenger in . . .	{ 53, 70, 51, 68, 75, 77, 54, 91 <sup>I</sup> , 20.

APPENDIX III.—*continued.*“A” BOX INTERLOCKING.—UP-MAIN THROUGH LINE C—*continued.*

Road.	Traffic Movement	Pull Lever.
Road 5 to “C” . .	Shunt out . . . .	53, 70, 133, 134, 91 <sup>III</sup> .
“C” to Road 6 . .	Over 116, fly shunt in	{ 116, 76, 79, 77, (61), 93 <sup>III</sup> , or 116, 76, 79, 77, (62), (57), 93.
“C” to Road 6 . .	Over 76, fly shunt in .	76, 77, (55), (70), 92 <sup>III</sup> .
“C” to Road 6 . .	Over 70, fly shunt in .	77, (70), 89 <sup>III</sup> .
“C” to Road 6 . .	Passenger in . . . .	70, 51, 68, 75, 77, 54, 90 <sup>I</sup> , 120.
Road 6 to “C” . .	Shunt out . . . .	70, 133, 134, 90.
“C” to Road 7 . .	Over 116, fly shunt in	116, 76, 79, 77, (61), (59), 93 <sup>III</sup> .
“C” to Road 7 . .	Over 76, fly shunt in .	76, 77, (55), 92 <sup>III</sup> .
“C” to Road 7 . .	Straight fly shunt in .	77, 89 <sup>III</sup> .
“C” to Road 7 . .	Passenger in . . . .	68, 75, 77, 54, 89 <sup>I</sup> .
Road 7 to “C” . .	Shunt out . . . .	133, 134, 89 <sup>III</sup> .
“C” to Road 8 . .	Passenger in . . . .	42, 46, 48, 75, 77, 68, 88 <sup>I</sup> , 120.
“C” to Road 8 . .	Shunt in . . . .	42, 46, 77, 88 <sup>III</sup> .
Road 8 to “C” . .	Shunt out . . . .	42, 46, 133, 134, 88 <sup>III</sup> .
“C” to Road 9 . .	Passenger in . . . .	42, 48, 75, 77, 68, 87 <sup>I</sup> , 120.
“C” to Road 9 . .	Shunt in . . . .	42, 77, 87 <sup>III</sup> .
Road 9 to “C” . .	Shunt out . . . .	42, 133, 134, 87 <sup>III</sup> .
“C” to Road 10 . .	Over 73, passenger in.	{ 44, 43, 39, 73, 47, 33, 75, 77, 30, 86 <sup>III</sup> , 120.
“C” to Road 10 . .	Over 42, passenger in.	45, 42, 48, 75, 77, 68, 86 <sup>III</sup> , 120.
“C” to Road 10 . .	Over 73, shunt out . .	44, 43, 39, 73, 133, 134, 86 <sup>III</sup> .
“C” to Road 10 . .	Over 42, shunt out . .	45, 42, 133, 134, 86 <sup>III</sup> .
Road 10 to “C” . .	Over 73, shunt in . . .	44, 43, 39, 73, 77, 86 <sup>III</sup> .
Road 10 to “C” . .	Over 42, shunt in . . .	45, 42, 77, 86 <sup>III</sup> .
“C” to Road 11 . .	Passenger in . . . .	{ 43, 39, 73, 47, 33, 75, 77, 30, 85 <sup>I</sup> , 120.
“C” to Road 11 . .	Shunt in . . . .	43, 39, 73, 77, 85 <sup>III</sup> .
Road 11 to “C” . .	Shunt out . . . .	43, 39, 73, 133, 134, 85 <sup>III</sup> .
“C” to Road 12 . .	Passenger in . . . .	{ 39, 73, 167, 33, 75, 77, 30, 84 <sup>I</sup> , 120.
“C” to Road 12 . .	Shunt in . . . .	39, 73, 77, 84 <sup>III</sup> .
Road 12 to “C” . .	Shunt out . . . .	39, 73, 133, 134, 84 <sup>III</sup> .
“C” to Road 13 . .	Passenger in . . . .	{ 166, 39, 73, 167, 33, 75, 77, 30, 83 <sup>I</sup> , 120.
“C” to Road 13 . .	Shunt in . . . .	166, 39, 73, 77, 83 <sup>III</sup> .
Road 13 to “C” . .	Shunt out . . . .	166, 39, 73, 133, 134, 83 <sup>III</sup> .

## APPENDIX IV.

"A" BOX INTERLOCKING.—DOWN-WINDSOR LOCAL LINE "D." PULLS.

Road.	Traffic Movement.	Full Lever.
"D" to Road 4.	Shunt in . . . .	71, 70, 52, 219, 216 <sup>III</sup> .
Road 4 to "D".	Passenger out . . .	{71, 70, 52, 69, 64, 67, 58, 218, 72, 216 <sup>I</sup> .
Road 4 to "D".	Shunt out . . . .	71, 70, 52, 216 <sup>II</sup> .
"D" to Road 5.	Shunt in . . . .	71, 70, 53, 219, 215 <sup>III</sup> .
Road 5 to "D".	Passenger out . . .	{71, 70, 53, 69, 64, 67, 218, 72, 215 <sup>I</sup> .
Road 5 to "D".	Shunt out . . . .	71, 70, 53, 215 <sup>II</sup> .
"D" to Road 6.	Shunt in . . . .	71, 70, 219, 214 <sup>III</sup> .
Road 6 to "D".	Passenger out . . .	71, 70, 69, 64, 67, 218, 72, 214 <sup>I</sup> .
Road 6 to "D".	Shunt out . . . .	71, 70, 214 <sup>II</sup> .
"D" to Road 7.	Shunt in . . . .	50, 41, 219, 213 <sup>III</sup> .
Road 7 to "D".	Passenger out . . .	50, 41, 34, 63, 218, 35, 213 <sup>I</sup> .
Road 7 to "D".	Shunt out . . . .	50, 41, 213 <sup>II</sup> .
"D" to Road 8.	Fly shunt in . . .	(46), 219, 211 <sup>III</sup> .
Road 8 to "D".	Passenger out . . .	46, 34, 48, 218, 35, 212 <sup>I</sup> .
Road 8 to "D".	Shunt out . . . .	46, 212 <sup>II</sup> .
"D" to Road 9.	Fly shunt in . . .	219, 211 <sup>III</sup> .
Road 9 to "D".	Passenger out . . .	34, 48, 218, 35, 211 <sup>I</sup> .
Road 9 to "D".	Shunt out . . . .	211 <sup>II</sup> .
"D" to Road 10.	Over 45, fly shunt in.	219, (45), 211 <sup>III</sup> .
"D" to Road 10.	Over 39, fly shunt in.	39, (43), (44), 219, 207 <sup>III</sup> .
Road 10 to "D".	Passenger out . . .	39, 43, 44, 30, 49, 218, 35, 210 <sup>I</sup> .
Road 10 to "D".	Shunt out . . . .	39, 43, 44, 210 <sup>II</sup> .
"D" to Road 11.	Over 39, fly shunt in.	39, 219, (43), 207 <sup>III</sup> .
"D" to Road 11.	Over 147, fly shunt in.	147, 219, (155), 206 <sup>III</sup> .
Road 11 to "D".	Over 147, passenger out	147, 155, 148, 157, 218, 29, 209 <sup>AI</sup> .
Road 11 to "D".	Over 147, shunt out .	147, 155, 209 <sup>AI</sup> .
Road 11 to "D".	Over 39, passenger out	39, 43, 30, 157, 218, 35, 209 <sup>BI</sup> .
Road 11 to "D".	Over 39, shunt out .	39, 43, 209 <sup>BI</sup> .
"D" to Road 12.	Over 39, fly shunt in.	39, 219, 207 <sup>III</sup> .
"D" to Road 12.	Over 147, fly shunt in.	147, 219, (155), 206 <sup>III</sup> .
"D" to Road 12.	{Over 147, 31, fly shunt in . . . . .}	147, 31, 219, (163), (160), 205 <sup>III</sup> .
Road 12 to "D".	Over 147, passenger out	{147, 160, 148, 161, 162, 218, 29, 208 <sup>AI</sup> .

APPENDIX IV.—*continued.*“A” BOX INTERLOCKING.—DOWN-WINDSOR LOCAL LINE “D”—*continued.*

Road.	Traffic Movement.	Pull Lever.
Road 12 to “D”	Over 147, shunt out	147, 160, 208 <sup>III</sup> .
Road 12 to “D”	Over 39, passenger out	39, 30, 162, 218, 35, 208 <sup>BI</sup> .
Road 12 to “D”	Over 39, shunt out	39, 208 <sup>BI</sup> .
“D” to Road 13	Over 39, fly shunt in	39, 219, (166), 207 <sup>BI</sup> .
“D” to Road 13	Over 147, fly shunt in	147, 219, (154), 206 <sup>III</sup> .
“ ” to Road 13	{Over 147, 31, fly shunt in. . . . .}	147, 31, 219, (163), (154), 205 <sup>III</sup> .
Road 13 to “D”	Over 147, passenger out	{147, 154, 148, 161, 165, 218, 29, 207 <sup>AI</sup> .
Road 13 to “D”	Over 147, shunt out	147, 154, 207 <sup>AI</sup> .
Road 13 to “D”	Over 39, passenger out	39, 166, 30, 165, 218, 35, 207 <sup>BI</sup> .
Road 13 to “D”	Over 39, shunt out	39, 166, 207 <sup>BI</sup> .
“D” to Road 14	Over 147, fly shunt in	147, 219, 206 <sup>III</sup> .
“D” to Road 14	{Over 147, 31, fly shunt in. . . . .}	147, 31, 219, (163), 205 <sup>III</sup> .
Road 14 to “D”	Passenger out	147, 148, 161, 218, 29, 206
Road 14 to “D”	Shunt out	147, 206 <sup>II</sup> .
“D” to Road 15	Fly shunt in	147, 31, 219, 205 <sup>III</sup> .
Road 15 to “D”	Passenger out	147, 31, 148, 146, 218, 29, 205 <sup>I</sup> .
Road 15 to “D”	Shunt out	147, 31, 205 <sup>II</sup> .
“D” to Road 16	Fly shunt in	147, 31, 149, 219, (168), 202 <sup>III</sup> .
Road 16 to “D”	Passenger out	{147, 31, 149, 168, 148, 146, 218, 29, 204 <sup>I</sup> .
Road 16 to “D”	Shunt out	147, 31, 149, 168, 204 <sup>II</sup> .
“D” to Road 17	Fly shunt in	147, 31, 149, 219, (170), 202 <sup>III</sup> .
Road 17 to “D”	Passenger out	{147, 31, 149, 170, 148, 146, 218, 29, 203 <sup>I</sup> .
Road 17 to “D”	Shunt out	147, 31, 149, 170, 203 <sup>II</sup> .
“D” to Road 18	Fly shunt in	147, 31, 149, 219, 202 <sup>III</sup> .
Road 18 to “D”	Passenger out	{147, 31, 149, 148, 146, 218, 29, 202 <sup>I</sup> .
Road 18 to “D”	Shunt out	147, 31, 149, 202 <sup>II</sup> .
“D” to out Table	Fly shunt in	{147, 31, 149, 219, (158), (176), 202 <sup>III</sup> .
“D” to in Table	Fly shunt in	{147, 31, 149, 219, (158), (175), 176, 202 <sup>III</sup> .
Out Table to “D”	Shunt out	31, 147, 149, 158, 176, 179 <sup>I</sup> .
In Table to “D”	Shunt out	{31, 147, 149, 158, 175, 176, 179 <sup>II</sup> .

## APPENDIX V.

## "A" BOX INTERLOCKING.—DOWN-WINDSOR THROUGH LINE "E." PULLS.

Road.	Traffic Movement.	Pull Lever.
"E" to Road 7.	Shunt in . . . .	32, 40, 50, 41, 199 <sup>III</sup> .
Road 7 to "E".	Passenger out . . .	{ 32, 40, 50, 41, 148, 34, 63, 201, 29, 199 <sup>I</sup> .
Road 7 to "E".	Shunt out . . . .	32, 40, 50, 41, 199 <sup>II</sup> .
"E" to Road 8.	Fly shunt in . . . .	32, 40, 46, 197 <sup>III</sup> .
Road 8 to "E".	Passenger out . . .	{ 32, 40, 46, 148, 34, 48, 201, 29, 198 <sup>I</sup> .
Road 8 to "E".	Shunt out . . . .	32, 40, 46, 198 <sup>II</sup> .
"E" to Road 9.	Fly shunt in . . . .	32, 40, 197 <sup>III</sup> .
Road 9 to "E".	Passenger out . . .	{ 32, 40, 148, 34, 48, 201, 29, 197 <sup>I</sup> .
Road 9 to "E".	Shunt out . . . .	32, 40, 197 <sup>II</sup> .
"E" to Road 10.	Fly shunt in . . . .	32, (43), (44), 193 <sup>BIII</sup> .
"E" to Road 10.	Over 40, fly shunt in .	32, 40, (45), 197 <sup>III</sup> .
Road 10 to "E".	Shunt out . . . .	32, (43), 44, 196 <sup>II</sup> .
Road 10 to "E".	Passenger out . . .	{ 32, 43, 44, 148, 49, 30, 201, 29, 196 <sup>I</sup> .
"E" to Road 11.	Over 155, fly shunt in	(155), 192 <sup>III</sup> .
"E" to Road 11.	Over 32, fly shunt in .	32, (43), 193 <sup>BIII</sup> .
Road 11 to "E".	Over 155, passenger out	155, 148, 157, 201, 29, 195 <sup>AI</sup> .
Road 11 to "E".	Over 155, shunt out .	155, 195 <sup>AI</sup> .
Road 11 to "E".	Over 32, passenger out	{ 32, 43, 148, 30, 157, 201, 29, 195 <sup>BI</sup> .
Road 11 to "E".	Over 32, shunt out .	32, 43, 195 <sup>BII</sup> .
"E" to Road 12.	Over 32, fly shunt in .	32, 193 <sup>BIII</sup> .
"E" to Road 12.	Over 160, fly shunt in	(160), 192 <sup>III</sup> .
"E" to Road 12.	{ Over 31 and 160, fly shunt in . . . . }	31, (163), (160), 191 <sup>III</sup> .
Road 12 to "E".	Over 160, passenger out	{ 160, 148, 161, 162, 201, 29, 194 <sup>AI</sup> .
Road 12 to "E".	Over 160, shunt out .	160, 194 <sup>AI</sup> .
Road 12 to "E".	Over 32, passenger out	32, 148, 30, 162, 201, 29, 194 <sup>BI</sup> .
Road 12 to "E".	Over 32, shunt out .	32, 194 <sup>BII</sup> .
"E" to Road 13.	Over 32, fly shunt in .	32, (166), 193 <sup>BIII</sup> .
"E" to Road 13.	Over 154, fly shunt in	(154), 192 <sup>III</sup> .

APPENDIX V.—*continued.*“A” BOX INTERLOCKING—DOWN-WINDSOR THROUGH LINE “E”—*continued.*

Road.	Traffic Movement.	Pull Lever.
“E” to Road 13 .	{ Over 31 and 154, fly shunt in . . . }	31, (163), (154), 191 <sup>III</sup> .
Road 13 to “E” .	Over 154, passenger out	{ 154, 148, 161, 165, 201, 29, 193 <sup>III</sup> .
Road 13 to “E” .	Over 154, shunt out .	154, 193 <sup>III</sup> .
Road 13 to “E” .	Over 32, passenger out	{ 32, 166, 148, 30, 165, 201, 29, 193 <sup>III</sup> .
Road 13 to “E” .	Over 32, shunt out .	32, 166, 193 <sup>III</sup> .
“E” to Road 14 .	Straight, fly shunt in .	192 <sup>III</sup> .
“E” to Road 14 .	Over 31, fly shunt in .	31, (163), 191 <sup>III</sup> .
Road 14 to “E” .	Straight, passenger out	148, 161, 201, 29, 192 <sup>I</sup> .
Road 14 to “E” .	Straight, shunt out .	192 <sup>II</sup> .
“E” to Road 15 .	Fly shunt in . . .	31, 191 <sup>III</sup> .
Road 15 to “E” .	Passenger out . . .	31, 148, 146, 201, 29, 191 <sup>I</sup> .
Road 15 to “E” .	Shunt out . . .	31, 191 <sup>III</sup> .
“E” to Road 16 .	Fly shunt in . . .	31, 149, (168), 188 <sup>III</sup> .
Road 16 to “E” .	Passenger out . . .	{ 31, 149, (168), 148, 146, 201, 29, 190 <sup>I</sup> .
Road 16 to “E” .	Shunt out . . .	31, 149, 168, 190 <sup>II</sup> .
“E” to Road 17 .	Fly shunt in . . .	31, 149, (170), 188 <sup>III</sup> .
Road 17 to “E” .	Passenger out . . .	{ 31, 149, 170, 148, 146, 201, 29, 189 <sup>I</sup> .
Road 17 to “E” .	Shunt out . . .	31, 149, 170, 189 <sup>II</sup> .
“E” to Road 18 .	Fly shunt in . . .	31, 149, 188 <sup>III</sup> .
Road 18 to “E” .	Passenger out . . .	31, 149, 148, 146, 201, 29, 188 <sup>I</sup> .
Road 18 to “E” .	Shunt out . . .	31, 149, 188 <sup>II</sup> .
“E” to Table . .	Fly shunt in . . .	{ 31, 149, (158), (155), (176), 188 <sup>III</sup> .
Out Table Road to “E” . . . . . }	Shunt out . . . . .	31, 149, 158, 176, 178.
In Table Road to “E” . . . . . }	Shunt out . . . . .	31, 149, 158, 175, 176, 178 <sup>II</sup> .



## APPENDIX VI.

"A" BOX INTERLOCKING.—UP-WINDSOR LINE "F." PULLS.

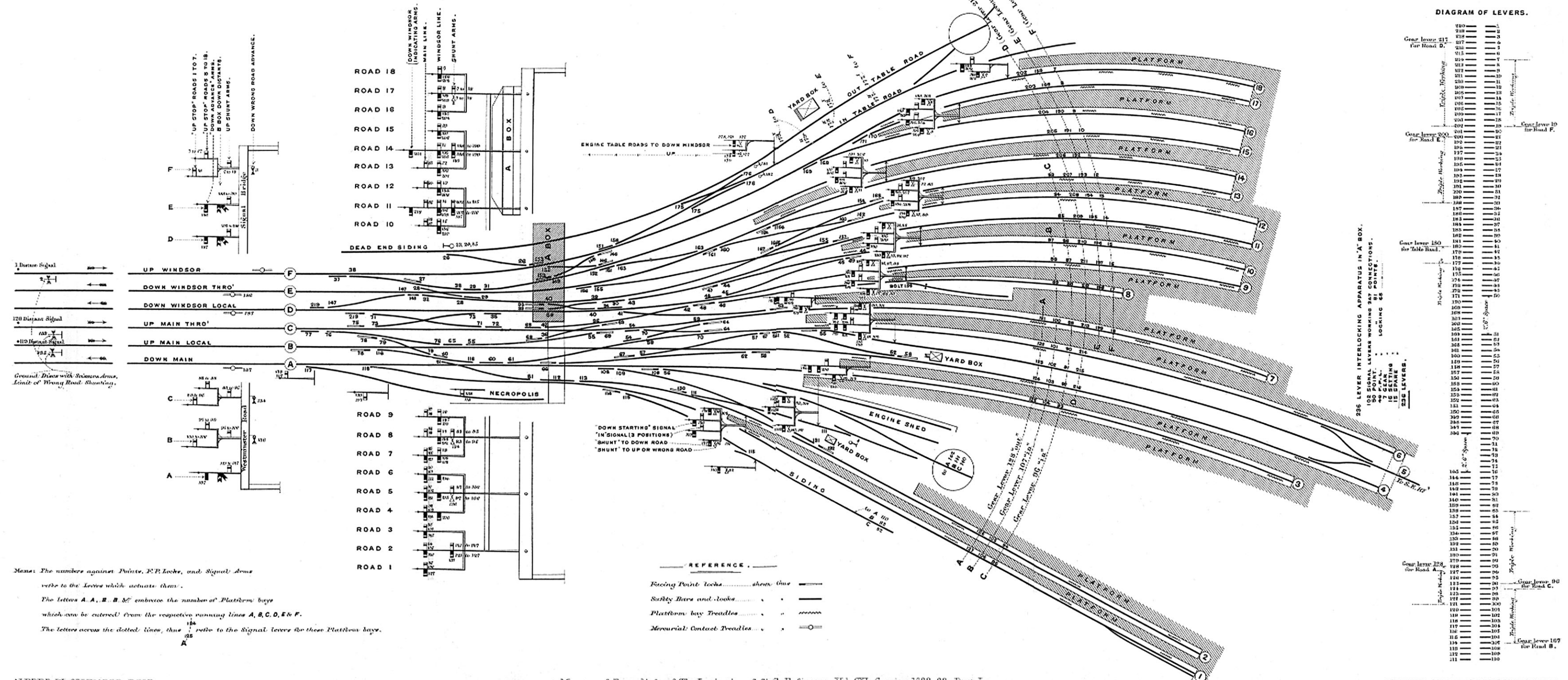
Road.	Traffic Movement.	Pull Lever.
"F" to Road 7 . .	Passenger in . . . .	{ 38, 28, 40, 50, 41, 33, 27, 37, 34, 18 <sup>I</sup> , 1.
"F" to Road 7 . .	Shunt in . . . . .	38, 28, 40, 51, 41, 37, 18 <sup>III</sup> .
Road 7 to "F" . .	Shunt out . . . . .	38, 28, 40, 50, 41, 2, 3, 18 <sup>II</sup> .
"F" to Road 8 . .	Passenger in . . . . .	{ 38, 28, 40, 46, 48, 33, 27, 37, 34, 17 <sup>I</sup> , 1.
"F" to Road 8 . .	Fly shunt in . . . . .	38, 28, 40, 37, (46), 16 <sup>III</sup> .
Road 8 to "F" . .	Shunt out . . . . .	38, 28, 40, 46, 2, 3, 17 <sup>II</sup> .
"F" to Road 9 . .	Fly shunt in . . . . .	38, 28, 40, 37, 16 <sup>III</sup> .
"F" to Road 9 . .	Passenger in . . . . .	{ 38, 28, 40, 48, 33, 27, 37, 34, 16 <sup>I</sup> , 1.
Road 9 to "F" . .	Shunt out . . . . .	38, 28, 40, 2, 3, 16 <sup>II</sup> .
"F" to Road 10 . .	Over 40, fly shunt in .	38, 28, 40, 37, (45), 16 <sup>III</sup> .
"F" to Road 10 . .	Over 44, fly shunt in .	38, 28, 37, (43), (44), 12 <sup>III</sup> .
"F" to Road 10 . .	Passenger in . . . . .	{ 44, 43, 38, 28, 47, 33, 27, 37, 30, 15 <sup>I</sup> , 1.
Road 10 to "F" . .	Shunt out . . . . .	44, 43, 38, 28, 2, 3, 15 <sup>II</sup> .
"F" to Road 11 . .	Over 28, fly shunt in .	38, 28, 37, (43), 12 <sup>III</sup> .
"F" to Road 11 . .	Over 155, fly shunt in	38, 37, (155), 11 <sup>III</sup> .
"F" to Road 11 . .	Over 155, passenger in	38, 155, 29, 27, 37, 156, 14 <sup>AI</sup> , 1.
"F" to Road 11 . .	Over 28, passenger in	{ 38, 28, 43, 47, 33, 27, 37, 37, 30, 14 <sup>BI</sup> , 1.
Road 11 to "F" . .	Over 155, shunt out . .	38, 155, 2, 3, 14 <sup>AI</sup> .
Road 11 to "F" . .	Over 28, shunt out . .	38, 28, 43, 2, 3, 14 <sup>BI</sup> .
"F" to Road 12 . .	Over 28, fly shunt in .	38, 28, 37, 12 <sup>III</sup> .
"F" to Road 12 . .	{ Over 38, 160, fly shunt in . . . . . }	38, 37, (160), 11 <sup>III</sup> .
"F" to Road 12 . .	Over 152, fly shunt in .	{ 152, 37, (163), (164), 10 <sup>II</sup> , or 7 <sup>III</sup> .
"F" to Road 12 . .	Over 152, passenger in	{ 152, 163, 160, 161, 153, 37, 151, 13 <sup>AI</sup> , 1.
"F" to Road 12 . .	Over 28, passenger in	{ 38, 28, 167, 33, 27, 37, 30, 13 <sup>BI</sup> , 1.
Road 12 to "F" . .	Over 152, shunt out . .	152, 163, 160, 2, 3, 13 <sup>AI</sup> .
Road 12 to "F" . .	Over 28, shunt out . .	38, 28, 2, 3, 13 <sup>BI</sup> .

APPENDIX VI.—*continued.*“A” BOX INTERLOCKING.—UP-WINDSOR LINE “F”—*continued.*

Road.	Traffic Movement.	Pull Lever.
“F” to Road 13 .	Over 28, fly shunt in .	38, 28, 37 (166), 12 <sup>BIII</sup> .
“F” to Road 13 .	Over 38, 154, fly shunt in .	38, 37, (154), 11 <sup>BIII</sup> .
“F” to Road 13 .	Over 152, fly shunt in .	152, 37, 163, 154, 10 <sup>III</sup> , or 7 <sup>III</sup> .
“F” to Road 13 .	Over 152, passenger in .	{ 152, 163, 154, 164, 161, 153, 37, 151, 12 <sup>AI</sup> , 1.
“F” to Road 13 .	Over 28, passenger in .	{ 38, 28, 166, 167, 33, 27, 37, 30, 12 <sup>BI</sup> , 1.
Road 13 to “F” .	Over 152, shunt out .	152, 163, 154, 2, 3, 12 <sup>AI</sup> .
Road 13 to “F” .	Over 28, shunt out .	38, 28, 166, 2, 3, 12 <sup>BIII</sup> .
“F” to Road 14 .	Over 38, fly shunt in .	38, 37, 11 <sup>BIII</sup> .
“F” to Road 14 .	Over 152, fly shunt in .	152, 37, (163), 10 <sup>III</sup> , or 7 <sup>III</sup> .
“F” to Road 14 .	Over 152, passenger in .	{ 152, 163, 164, 161, 153, 37, 151, 11 <sup>AI</sup> , 1.
“F” to Road 14 .	Over 38, passenger in .	{ 38, 164, 161, 29, 27, 37, 156, 11 <sup>BI</sup> , 1.
Road 14 to “F” .	Over 38, shunt out .	38, 2, 3, 11 <sup>BII</sup> .
Road 14 to “F” .	Over 152, shunt out .	152, 163, 2, 3, 11 <sup>AI</sup> .
“F” to Road 15 .	Fly shunt in . . .	152, 37, 10 <sup>III</sup> , or 7 <sup>III</sup> .
“F” to Road 15 .	Passenger in . . .	152, 153, 37, 151, 10 <sup>I</sup> , 1.
Road 15 to “F” .	Shunt out . . .	152, 2, 3, 10 <sup>II</sup> .
“F” to Road 16 .	Fly shunt in . . .	37, (168), 7 <sup>III</sup> .
“F” to Road 16 .	Passenger in . . .	168, 169, 153, 37, 151, 9 <sup>I</sup> , 1.
Road 16 to “F” .	Shunt out . . .	168, 2, 3, 9 <sup>II</sup> .
“F” to Road 17 .	Fly shunt in . . .	37 (170), 7 <sup>III</sup> .
“F” to Road 17 .	Passenger in . . .	{ 170, 171, 169, 153, 37, 151, 8 <sup>I</sup> , 1.
“F” to Road 18 .	Fly shunt in . . .	37, 7 <sup>III</sup> .
“F” to Road 18 .	Passenger in . . .	171, 169, 153, 37, 151, 7 <sup>I</sup> , 1.
Road 18 to “F” .	Shunt out . . .	2, 3, 7 <sup>II</sup> .
“F” to Table . .	Fly shunt in . . .	37, (158), (175), (176), 7 <sup>III</sup> .
Out Table Road to F	Shunt out . . .	158, 176, 2, 3, 177 <sup>I</sup> .
In Table Road to F	Shunt out . . .	158, 175, 176, 2, 3, 177 <sup>II</sup> .

# WATERLOO SIGNAL STATION LONDON AND SOUTH WESTERN RAILWAY.

PLATE 7.



# WATERLOO SIGNAL STATION LONDON AND SOUTH WESTERN RAILWAY.

PLATE 8.

