telegraphing for both is done on a single Morse circuit. In the United Kingdom the practice is to have separate apparatus and separate wires for each track.

In the simple block system it is clearly possible for a signal­man, through carelessness, forgetfulness, or other cause, and in disregard of the indications of his telegraph instruments, so to lower his signals as to admit a second train into the block section before the first has left it, and that without the driver of either train being aware of the fact. To eliminate as far as possible the chance of such an occurrence, which is directly opposed to the essence of the block system and may obviously lead to a collision, the locking of the mechanical signals with the electrical block instruments was introduced in England by W. R. Sykes about 1876, the apparatus being so arranged that a signalman at one end of a section is physically unable to lower his signals to let a train enter that section until they have been released electrically from the cabin at the other end. The starting signal at a block section A cannot be lowered until the signalman at the next station B, by means of an electric circuit, unlocks the lever in connexion with it. In so doing he breaks the unlocking circuit at bis own station, and this break is restored only on the arrival of the train for which the unlocking was performed, the wheels of the train acting through a lever or by a short rail circuit. Valuable improvements have been made in this machine by Patenall, Coleman and others, and these are in use in America, where the system is known as the con­trolled manual.” The passage of a train is also made to set a signal at “ stop ” automatically, by disconnecting the rod between the signal and its lever. The connexion cannot be restored by the signalman; it must be done by an electro-magnet brought into action by the train as it passes the next block station.

The block system is used on single as well as on double lines. In the United Kingdom and in Australia the means for pre­venting collisions between trains running towards each other on single-track railways is the “ staff system.” The staff, suitably inscribed, is delivered to the engine-driver at station A, and constitutes his authority to occupy the main track between that station and station B. On reaching B he surrenders the staff, and receives another one which gives him the right to the road between B and C. If there are two or more trains to be moved, all except the last one receive tickets, which belong to that particular staff. The staff system requires no telegraph; but to obviate the incon­venience of sometimes finding the staff at the wrong end of the road, electric staff apparatus has been devised. Staffs (or tablets) in any desired number are kept at each of the two stations, and are locked in a\* cabinet automatically controlled, through electro-magnets, by apparatus in the cabinet at the other station; and a staff (or tablet) being taken out at one station, a second one cannot be taken out at either station until this first one is re­turned to the magazine at one station or the other. Thus there is a complete block system. By simple “ catching apparatus ” on the engine, staffs or tablets may be delivered to trains moving at a good speed.

The signals so far described depend for their operation, either wholly or partially, on human agency, but there are others, commonly known as “ automatic,” which are worked by the trains themselves, without human intervention. Such signals, as a rule, are so arranged that normally they are constrained to stand at “ safety,” instead of in the "danger” position, which, like ordinary signals, they assume if left to themselves; but as a train enters a block section the constraint on the signals that guard it is removed and they return to the danger position, which they retain till the train has passed through. To effect this result an electrical track circuit or rail circuit is employed, in conjunction with some form of power to put the signalling devices to safety. Live-wire circuits were formerly employed, but are now generally abandoned. The current from a battery *b* (fig. 9) passes along the rails of one side of the track to the signal *s* and returns along the other rails through a relay. If the current through this relay is stopped in any way, whether by failure of the battery or by a short circuit caused by the presence of a train or vehicle with metal wheels connected by metal axles on any part of the block section, its electro-magnet is de-energized, and its armature drops, removing the constraint which kept the signals at safety and allowing them to move to danger. When the train has passed through the block section the current is restored and the signals are forced back to show safety. The current used for the track circuit must be of low tension, because of the imperfect insulation, and as a rule the ballast must not be allowed to touch the rails and must be free from iron or other conducting substance. At each rail joint a wire is used to secure electrical continuity, and at the ends of each block section there are insulating joints in the track. Block sections more than about 1 m. long are commonly divided into two or more circuits, connected together by relays; but usually they are made under 1 m. in length and often on intra-urban railways very much less, so that many more trains can be passed over the line in a given time than is possible with ordinary block signalling. At points the track circuit is run through a circuit breaker, so that the “ opening ” of the points sets the signal for the section. The circuit is also led through the rails of the siding so far as they foul the main track. An indicator at each switch gives visual or audible warning of an approaching train.

The signals themselves have been devised to work by clock­work, by electricity—obtained, not from the track circuit, but from a power station, or from non-freezing batteries at each post, or from accumulators charged by dynamos situated, say, every 10 m. along the line—and by pneumatic power, either com­pressed atmospheric air laid on from a main or carbonic acid gas stored in a tank at the foot of the posts, each tank furnishing power for several thousand move­ments of the signal arm. A clock­work signal is shown in fig. 10. When an electro-magnet in the rail circuit drops its armature, the mechanism is released and causes the disk to turn and indicate stop. On the restoration of the current the disk makes another quarter turn and then shows only its edge to the approaching train, indicating “ all clear.”

The enclosed disk signal, commonly called a “banjo” (fig. 11), is a circular box about 4 ft. in diameter, with a glass-covered opening, behind which a red disk is shown to indicate stop. The disk, very light, made of cloth stretched over a wire, or of aluminium, is supported on a spindle, which is delicately balanced on a pivot so that the closing of an electro-magnet lifts the disk