There are at present more than 35,000 miles of automatic block signals in use on American railroads, and the mileage is rapidly increasing. Their installation in many instances is an economy, because aside from the greater safety secured they increase the traffic-carrying capacity of the line to such an extent that the construction of an additional track, entailing a much larger expense, may frequently be indefinitely postponed.

Interlocking.—This has been defined as "An arrangement of switch, lock and signal appliances so interconnected that their movements must succeed each other in a predetermined order." The term includes the cabin, the machine, switches and signals and all the connections and appurtenances.

Patents for manually operated interlocking devices were first granted in England in the year 1856, and in 1873 the system had been so generally adopted in England that the London & Northwestern Railway alone employed 13,000 interlocking levers. The first experimental interlocking installation was made in the United States at Spuyter Duyvil Junction, New York City, in 1874. The first important installation on a commercial basis was made by the Manhattan elevated lines in New York City in 1877-78.

Interlocking resulted from the desire on the part of English railways to save labor by concentrating in a single frame the levers operating a number of widely separated switches and signals. After this it was a short and simple step to so lock these levers one with the other that a clear signal could not be given unless the route was properly set up, and so that signals for conflicting movements could not be given. As the cost of labor is higher in the United States than in England there was a demand in this country for an interlocking that would permit of the operation of switches and signals over greater distances and with fewer operators. This resulted in the development of a hydro-pneumatic interlocking, which was first installed in 1884 at Bound Brook, N.J., at the crossing of the Philadelphia & Reading and Lehigh Valley Railroads. From 1884 to 1891 eighteen of these plants, having 482 levers, were installed on six railways. As the system developed many serious defects were found, and its inventors devised the electro-pneumatic system in 1891, which is still in general use, particularly in large installations.

The first interlocking in the St. Louis territory was installed in 1883-84 to control switches and signals at both ends of the tunnel, and at about the same time the crossings, switches and signals at the east end of the east approach to the Eads bridge were also interlocked. The levers of these machines were made to operate special valves which controlled the hydraulic pressure used to operate the switches and signals. Pipes were laid from the ports of the valves to the switch and signal-operating mechanism in which the pressure was maintained by a system of pumps and accumulators or hydraulic rams.

It is here noted that this was one of the first interlocking plants using other than manual power installed in this or any other country. This type of machine, although it developed many defects, was continued in service with some modifications until 1899, when the present electro-pneumatic plant was installed at the tunnel entrances.

Interlocking development has easily kept pace with that in other fields.

The principal types of machines now in use in this country are the mechanical, the electro-pneumatic, the pneumatic and the all-electric.

Mechanical.—A mechanical interlocking plant consists of a frame of levers in a tower, which are connected by means of pipe and wire-runs to switches and signals which are moved by manual power applied to the levers in the tower. Where the distances are not too great, the switch layout comparatively simple and traffic light, this type of plant is both cheap and efficient. With the present tendency toward the control of trains by the block system, most modern mechanical plants are equipped with a number of electric safeguards, such as power distant signals, track circuits, electric route locking, etc. These trimmings in some instances have cost more than the mechanical interlocking itself.

Electro-Pneumatic.—Electro-pneumatic interlocking was first placed on the market in 1891 by the Union Switch and Signal Company. It was found to be particularly advantageous for use in large, complicated installations. The original St. Louis Union Station interlocker, built in 1891-92, was one of the first large installations of this system. This was followed a year or two later by the South Boston station interlocker, and since that time the system has been installed in some of the largest plants in the country, including the St. Louis Union Station as remodeled in 1903-1904.

Electro-pneumatic interlocking is described as follows: Compressed air at a pressure of about 85 lbs. is stored in a reservoir at or near the signal tower and is conveyed in pipe laid underground to cylinders, one at each switch and signal, in which the pressure by means of a piston, moves the switch or signal. The admission of air to a cylinder is controlled by an electric magnet fixed at its side, and the circuit of this magnet is controlled by a miniature lever in the cabin, the wires being run from the switch or signal to the cabin. These little levers are suitably interlocked the same as the large levers in a manual machine. The movement of a lever to work a switch does not, however, actuate the interlocking which releases the lever to be moved next; for the lever movement does not insure that the switch has actually been moved, it only closes the circuit. The next lever is held locked until by an electric current, the circuit of which is closed by the switch rails themselves, after their movement is completed, the "indication" of such completion is sent back to the cabin permitting the unlocking of the next lever.

Electro-pneumatic, in common with other forms of power interlocking, has many advantages over mechanical or manual, particularly in large complicated installations in which the installation of manual interlocking is practically impossible on account of the size of machine required and the great number of pipe-runs. The same amount of interlocking can be accomplished by power with fewer levers and each lever occupies about one-third as much space in the machine. A manually operated machine to operate the Union Station layout, if it were possible to properly lock it, would be at least two hundred feet long; and the pipe-runs would be so numerous and bulky that it would be difficult, if not impossible, to find space for them and the tracks too.

Pneumatic.—Another form of machine is the pneumatic or low-pressure air which has been used to a limited extent within the past 12 or 14 years. This machine acts more slowly than the electro-pneumatic or all-electric. In this system the pressure in the cylinders, moving switches and signals is 15 lbs., and in the small pipes leading to the diaphragm valves it is only 7 lbs. per square inch. The signalman's work consists in opening and closing these valves. The interlocking is the same as in other machines.