"indication" to the cabin to insure that the go-ahead signal for that switch shall not be given prematurely. Besides the usual mechanical interlocking of one lever with another, the electro-pneumatic machine provides numerous additional safe-guards in the way of magnetic locks. With a power machine the work of the signalman is reduced from that of pulling levers, weighted with heavy loads, to the turning of the extremely light handles at the front of the machine. By these handles long horizontal rods are rotated on their axes, and these in their revolution close the electric circuits (thereby actuating the air valves) in proper sequence. The interlocking is effected by longitudinal and transverse rods at the top of the machine. In some machines a diagram of the yard is attached to the machine, and metal strips represent the tracks; and those are movable, so that every operation which takes place on the ground, by the act of the signalman, is repeated before his eyes in the cabin.

At the Grand Central station, in New York city, and at various other large yards, the switches and signals are worked by the low-pressure pneumatic system. With this no electric power is required, the electro-magnet at the operating cylinder being supplanted by a diaphragm valve. The air-valve—one at each signal cylinder and one at each end of each switch cylinder—is opened or closed by the movement of a circular flexible diaphragm, moved up or down a quarter of an inch, by air at a pressure of seven pounds per square inch conveyed in a half-inch pipe from the cabin.

In the operating pipes the pressure is 15 pounds per square inch. When a switch or signal is not in use, its operating pipes are under atmospheric pressure only. The interlocking is similar to that in other types of machine.

Fig. 5 shows the signal cabin containing a low-pressure ("all-air") switch and signal machine recently erected at the Harrison Street station, Chicago. The cabin is supported on the six metal columns, in the way shown, for the purpose of economizing ground room; one of the subordinate tracks of the yard occupying the space beneath the building. The air pipes, extending from the cabin to the ground and there branching to the various switches and signals, are seen in the center of the drawing.

The most recent development in the interlocking signal field is the "all-electric" system of the Taylor Signal Company, of Buffalo. In this system all the switches and signals are moved by small electric motors—a motor for each switch or signal; and the work of the signalman consists of opening or closing electric circuits. The interlocking is mechanical, as in the other types described, and is placed vertically on the front of the machine, as in the well-known Johnson type of mechanical interlocking. Extensive installations of this system have been made at Chicago, and in numerous other Western cities. Electric power is provided from a 60-volt storage battery, and as the current is required only while switches or signals are being moved, the consumption of power is small. A gasoline motor is usually used to run the generator to charge the storage battery. Fig. 7 shows a Taylor motor with the cover off. The connection at the right moves the detecter bar. The motor, through a suitable train of wheels, is made to revolve the large main gear one revolution for a single movement of the rails. The horizontal rod moving the rails receives its motion from a cam fixed to the main gear. When a switch movement is completed, the motor circuit is automatically broken and the motor at that moment is converted into a generator; and by its function as a generator, which lasts but a fraction of a second, it sends a current back to the cabin giving to the signalman the "indication" that the switch movement has been fully accomplished. For a single switch a 1 horse power motor is used, and for a signal a motor of 1-6 horse power. The dwarf signals (used for slow yard movements) are in the Taylor system moved by a pair of solenoids. The solenoids, fixed vertically at the bottom of the signal post, are energized by a current from the cabin and lift a vertical rod which forces the signal downward. In case of failure of any part, the rod is forced downward by a spring, throwing the signal arm up to the stop position.

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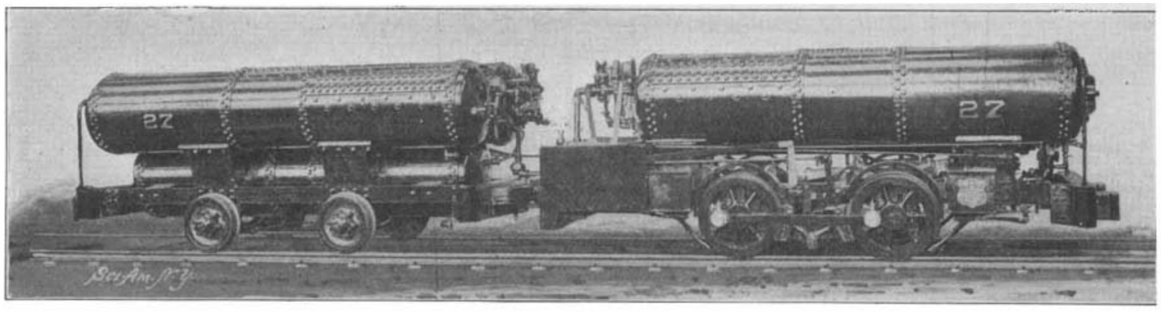
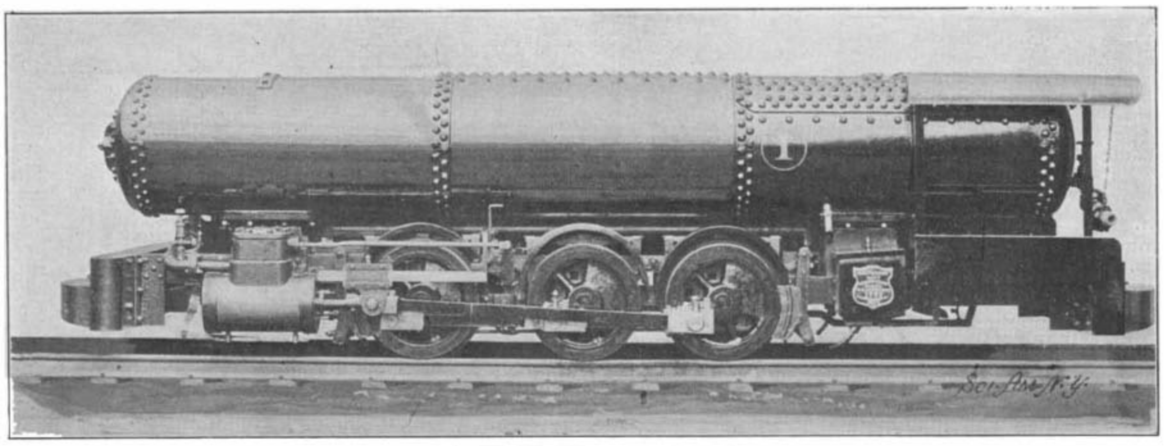
COMPRESSED AIR AS A TRANSPORTATION AGENT.

BY WALDON FAWCETT.

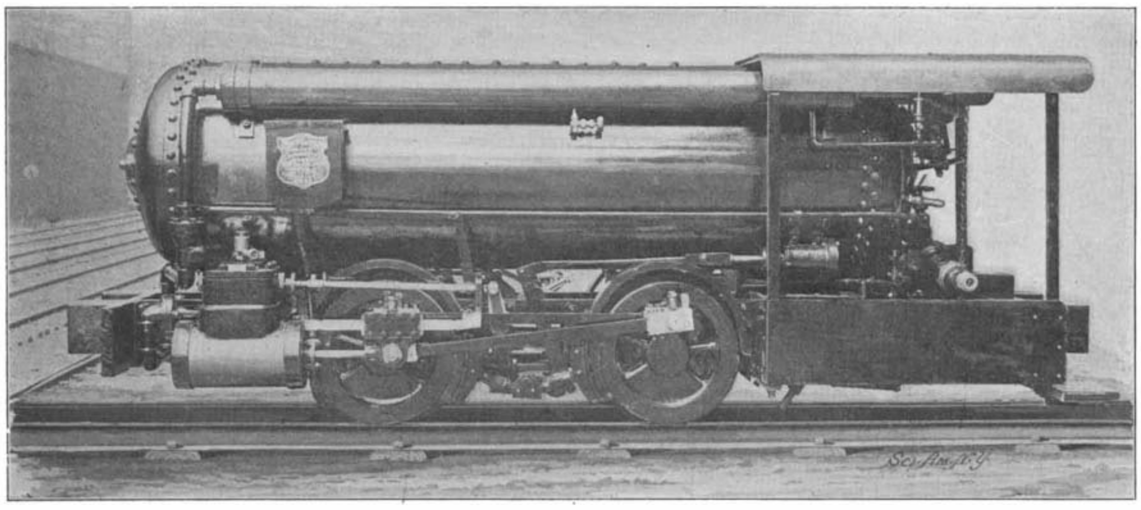
With a more extensive use of compressed air for power purposes has come a corresponding broadening of the scope of its employment as a transportation agent, and indeed it has been conclusively proven that pneumatic traction has decided advantages over all other forms of mechanical haulage for a large variety of operations. Prominent among these are the various phases of underground haulage. For coal mines where there is danger from mine gas its utilization is almost essential, whereas the advantages which commend its employment in non-gaseous mines are almost as potent. A rather unique field has been opened by the introduction of compressed air locomotives in railway tunnels, where the smoke, vapor and gas from steam locomotives are objectionable.



Pneumatic Locomotive.



Locomotive Driven by Compressed Air.



A Compressed Air Locomotive.

COMPRESSED AIR AS A TRANSPORTATION AGENT.

For the ordinary compressed-air haulage plant there are five essential features, namely, the locomotives, constructed to carry stored-up energy in the shape of compressed air, a charging station, a stationary reservoir, usually consisting of one or more storage tanks in which the air is compressed, an air compressor capable of compressing any desired number of cubic feet per minute to any pressure desired, and power for operating the compressor, either steam or water power being applicable for this purpose. The compressed air locomotives now most generally used are made by the H. K. Porter Company, of Pittsburg, Pa.

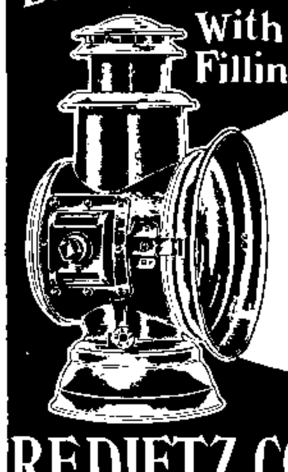
The general machinery of an air locomotive, cylinders, frames, wheels, etc., is usually very similar to that of a steam locomotive, save that the weight is greater, the bearings larger and the details of construction stronger than in a steam machine of the same power. The main points of difference are found in the fact that instead of the usual boiler with its fuel and water accessories for developing power, the air locomotive is equipped with one or more strongly constructed main storage tanks, which are charged with compressed air at high pressure, a combination regulator and automatic stop-valve and an auxiliary low-pressure reservoir in which the air is carried at a uniform working pressure for distribution to the cylinders. The cubic capacity and the pressure of air in the main storage tanks on a motor are determined, of course, by the amount of stored energy required by the length of the run which such a locomotive is to make and the weight of the train which it is called upon to draw. Not infrequently locomotives are built to carry an air pressure of 800 or 1,000 pounds, but relief valves make it impossible to charge the motor tanks to a higher pressure than is required. The initial storage pressure decreases, of course, while the locomotive is working. As illustrating the capabilities of the compressed air motors, it may be mentioned that there are in service in this country a few locomotives which are fitted with seamless steel tubes and carry a pressure of from 1,500 to 2,500 pounds per square inch.

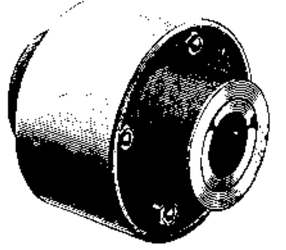
The combination regulator and automatic stop-valve through which the high-pressure air passes from the main storage tank to the low-pressure or auxiliary reservoir is provided with mechanism which can be instantly adjusted for maintaining whatever pressure is found most economical in the operation of the motor. Ordinarily 140 pounds per square inch is satisfactory, but in case of an emergency, such as getting derailed cars on the track, the pressure may be increased by immediate adjustment to 150 or 160 pounds. Not only is the regulation of air between the high-pressure and low-pressure reservoirs automatic, but it is at all times uniform, the air being admitted as rapidly as it is needed and at the required pressure.

For charging the locomotive storage tanks previously referred to, there are provided the charging stations, which are connected with the stationary receiver or reservoir by a pipe. It is customary, when the reservoir or storage system is a pipe line, to have a charging station at each end of the line, so that the motor may take a charge of air at the end of each single trip or each round trip as required. Air locomotives may be charged either direct or by a reservoir. However, direct charging is very wasteful, and consequently the method most generally accepted involves the use of the stationary reservoir.

The reservoir for a compressed-air transportation line usually consists of either a pipe line or one or more storage tanks of construction similar to the locomotive storage tank, although usually designed to carry a somewhat higher pressure. By means of the reservoir system the compressor may be kept in nearly continuous operation at a fairly uniform speed. By an automatic system of governing the compressor, when the work is light, slows down in speed, whereas when the demand for air increases, the speed is quickly brought up to the required capacity.

In a pneumatic street car the storage reservoirs are carried on the car trucks and occupy the space under the seats. The operating, brake and controller stands on the platform are very similar to the corresponding stands on an electric car. In the operation of the car, the air leaving the storage tank on the car passes through a reduction valve, where the pressure is reduced from 2,000 pounds to a working pressure of 150 pounds. It then passes into and through the water in the heater, where it takes up the moisture and heat of which it was robbed after compression and before the air was permitted to enter the station storage tanks. This is the principle that was employed on the cars experimented with on the Metropolitan system, New York. In ordinary service an air car weighing somewhat less than 10 tons will consume 400 cubic feet of free air per car mile, and in some classes of service the consumption is double that.



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