CHAPTER XII.

ELECTRO-PNEUMATIC AND ELECTRO-GAS SYSTEMS.

ELECTRO-PNEUMATIC systems, which are used on many busy lines, employ low voltage controlling circuits, the working medium for operating switches and semaphores being compressed air, supplied by a local compression plant and conveyed to the subsidiary apparatus through underground pipes. The circuits generally used on such systems (normal clear for single track) are shown in Fig. 157.

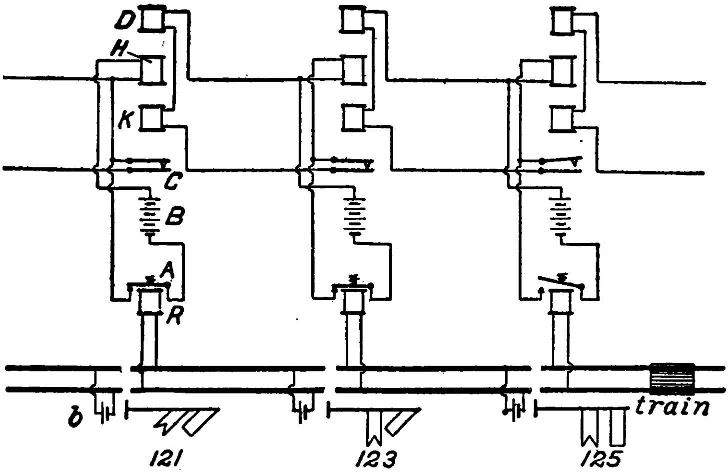

FIG. 157

Three consecutive home and distant signals, 121, 123, and 125, are considered, with single sections, a train being on the block protected by 125. The admission of air to the cylinder operating the home semaphore is controlled by the electro-magnet, *H*, and to the distant cylinder by *D*. A circuit controller, *C*, is operated by the home semaphore's movement, and is closed when the latter is at clear; while *K* is a circuit breaking arrangement in series with the distant magnet, and operated by the returning to the stop position of the home arm, thereby preventing a clear distant arm when the home is at danger, an occurrence which would be confusing to the engineman. Each section is provided with a track battery, *b*, and relay, *R*, as in other systems. *B* is the main battery which operates the home and distant control magnets, the former through a local circuit, the latter over line wires.

The train, by short-circuiting the track relay, open-circuits the main battery, and, by depriving the home magnet of current, moves the home blade to the stop position. The distant also assumes the caution position by the action of the circuit breaker; the distant blade of 123 thus maintaining this position by reason of its opened circuit controller. Sometimes the latter is effected by using the polarized track-circuit principle, line wires not being then used.

Liquid carbon dioxide (CO_2) has numerous advantages as a source of power, which result from its enormous expansion at almost any pressure desired, through the use of proper valves. In exhausting at low pressure, or entering a chamber during expansion, it precipitates no moisture; in fact it may be relied upon to remove any moisture with which it comes in contact, since its point of saturation is high.

The Hall electro-gas signal, which uses this agent as a motive power, is now regarded as a very high development of the automatic semaphore, and possesses inherent features which bid fair to rank it as a standard type. It employs standard posts, case, and fittings, with additional special accessories for the control and reception of the gas and flasks. These flasks are identical with those used for soda fountain purposes, and are about four and one-half feet long and eight and one-half inches in diameter, weighing when charged about 150 pounds, containing 50 pounds of liquid gas. Two such flasks are used at each signal, and are placed in a chute near the base of the latter.

The flasks are provided with a safety valve blowing off at 2400 pounds pressure, and when charged exert a pressure of about 800 pounds per square inch. In direct sunlight, or when near a locomotive boiler, this valve operates, although the flasks will actually stand about one and one-half times this pressure.

Before passing to the operating cylinders, this is reduced to about 40 pounds by a reducing valve.

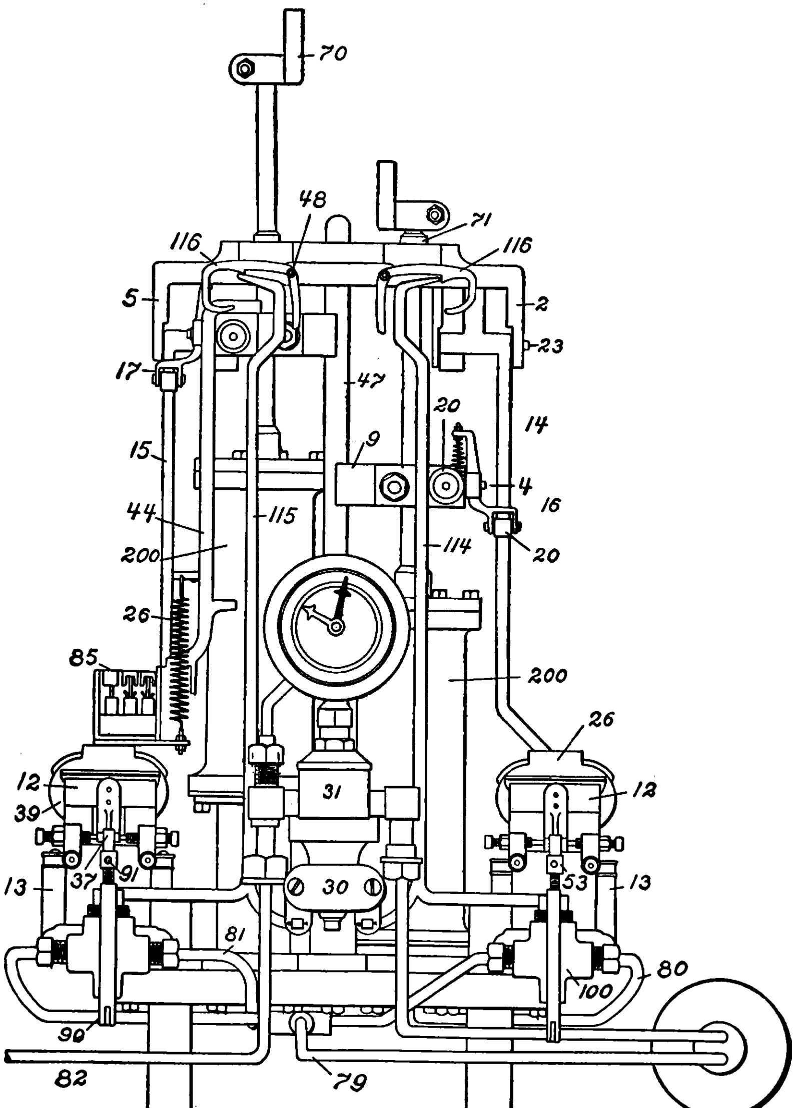

Fig. 158

In Figs. 158, 159, and 160, the mechanism of this signal is revealed. The first is a front elevation, the second a side view, and the third a part section showing important details of construction. The signal is a home and distant, although a three-

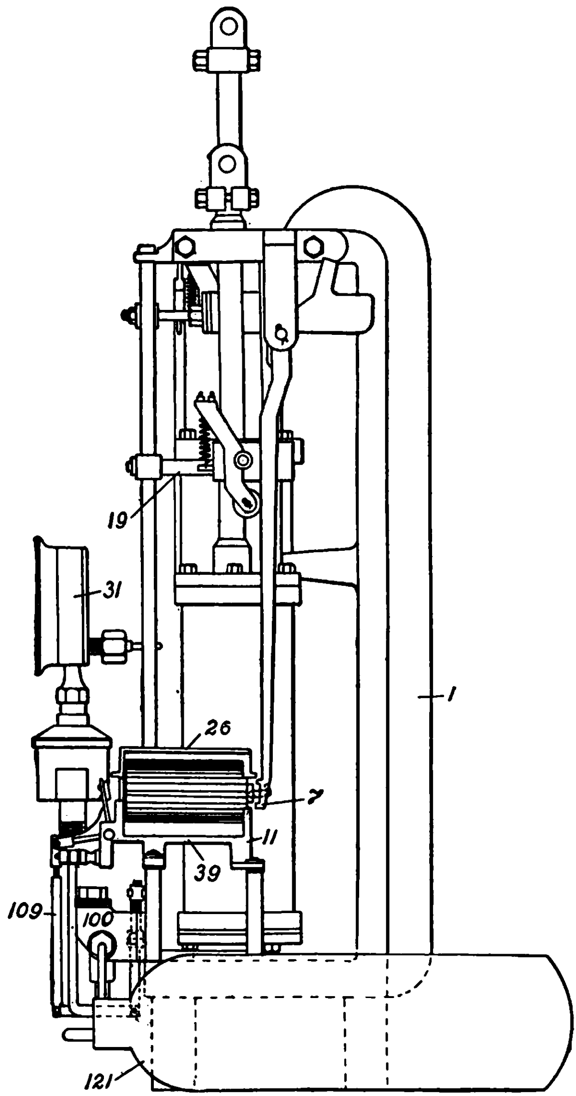

FIG. 159

position structure can be equally well adapted to this motive power. The gas expands and exerts its force through the vertical cylinders, 200, the semaphores being moved by the extended cylinder rods, 70, the cylinders being movable, and the pistons

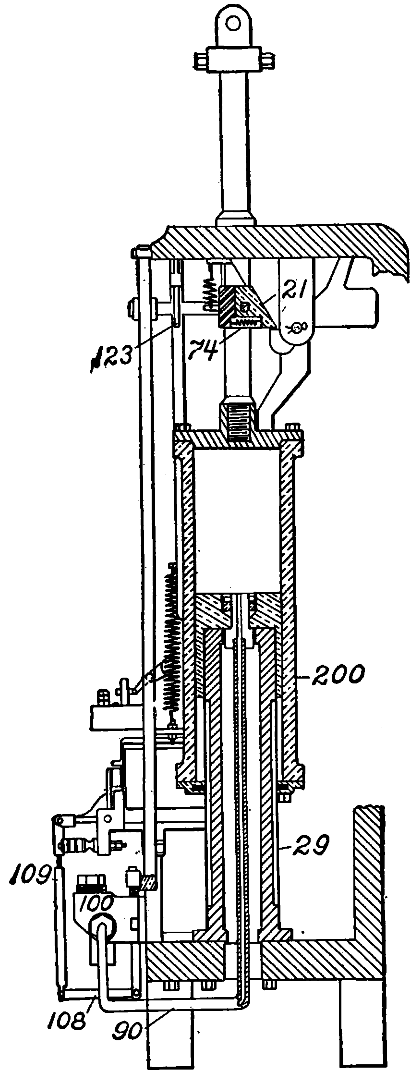

Fig. 160

fixed to the mechanism frame. The home signal-control electromagnet appears on the right side and the distant on the left;

these magnets, through their armatures, governing the admission of gas to the working cylinders, and are interposed as a function between the cylinders and flasks.

The magnets are controlled by track circuits on either line wire or wireless systems, and are energized through a local battery. In connection with Fig. 162 such an arrangement will be described. When a blade has been cleared, it is held in the clear position by latches controlled by the magnets, their release allowing gravity to throw the same to the stop position. The home movement controls the distant as in other types, the means by which this is effected being shown later.

The reducing valve, 31, whose gauge has two pointers, showing the supply and working pressures, is connected to the expansion chamber and valves, 100, the latter being controlled by the magnets, the armatures, 12, raising the link, 109, and lever, 108. The reducing valve is also in connection with the supply flask through the pipe, 82. The semaphores are held at clear by the clutch levers, 14 and 15, which are actuated by their attached armatures, 7, moving before the poles of the magnets. When the signal is at clear, the rocking latch, 21, holds it in this position by engaging with the clutch lever. The roller buffer levers, 17 and 16, keep the clutch lever from striking the magnet poles when the signal returns to the danger position, and maintain the armature at a short distance from the pole tips when in this position, so that danger of freezing fast is eliminated. The magnets, it will be seen, are double functioned, their front armatures operating the gas valve, and rear armature holding the signal at clear.

When the signal has cleared, the cut-off levers, 114 and 115, act, and cut off the gas from the working cylinder, allowing it to exhaust at the same time, they being controlled through the pawls, 116, pivoted at 48. These pawls engage with the roller, 20, at the upper position, the gas thus being shut off by their mutual action, the stroke of the cylinder being varied by changing the point of release and clutch engagement. The clutch casting, 9, is fastened to the cylinder rod, rod 47 guiding it. The position of 9 can be changed, thus changing the stroke. A switch, 85, is operated by the rod, 44, when the stud, 19, is in engagement with it, and rocks about a central shaft which carries the contact blades.

The clearing action is as follows: When the magnets, 39, are energized, their armatures, 7 and 12, are attracted, the gas valve being thereby opened through the links, 37, 108, and 109. The supply valve, 96 (see Fig. 161), is raised, while the exhaust port is simultaneously closed. Gas enters the cylinder through the center of the piston, and raises the former, thus clearing the signal. When the latch, 21, has moved past the projecting finger of the clutch lever, 15, the pawl, 116, is raised by the roller, 20, the cut-off lever, 115, moving downward. The links, 109 and 108, are thereby forced down, thus closing the supply

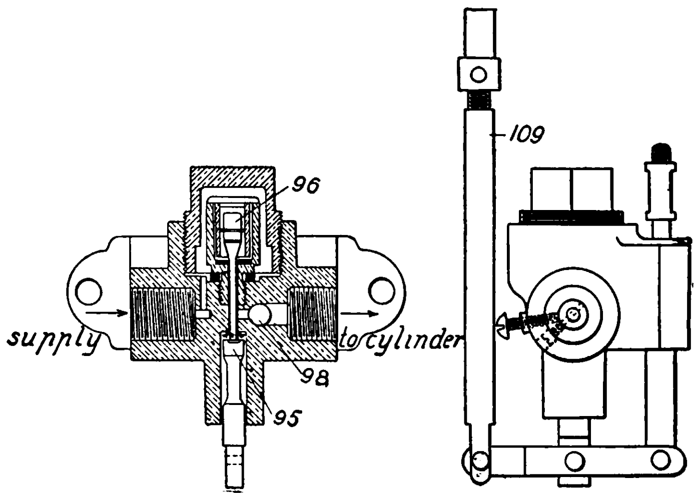

FIG. 161

port, 96, and opening the exhaust port, 95. The latch, 21, through its engaging with 15, thus opposes gravity, which tends to move the mechanism to danger. As long as the armature, 7, is attracted, the signal will remain at clear.

If the track section becomes occupied, armature 7 is released, thereby causing lever 15 to move back. This releases 21, and the semaphore moves to stop. A rapid downward movement is prevented, as the air must be forced out through the partly closed check valve, 98, the entrained air thus damping this motion.

The expansion chamber, 30, is for the purpose of allowing the gas to expand and increase its temperature. As an expanding gas always lowers in temperature, extracting heat from the walls and adjacent parts, should freezing occur its particles are too finely divided to produce any untoward results. Freezing, however, by solidifying a gas having such great expansibility, is a wasteful process.

The piston area is five square inches, and with a 40-pound working pressure, the upward force is equivalent to 200 pounds, which gives sufficient margin for positive action. Should greater pressure be desirable, it can be changed by adjustment of the reducing valve. About 12,500 movements can be made per flask, with this working pressure, or 250 per pound of gas.

The magnets have two windings, which are connected in multiple when the valve is being operated, the high-resistance winding being used to hold the signal at clear. With the polarized track-circuit scheme, when slow releasing clutches are used, the second winding is first disconnected from the battery and immediately closed upon itself by a switch, the induction current thus set up (which opposes any change in flux) preventing the cores from being at once demagnetized and retaining the armature in position.

The slow-releasing clutch-magnets take a current of .0113 ampere at 4 volts, or .045 watt; and retain sufficient flux to hold the semaphore at clear for 2.5 seconds after they are disconnected from the battery, which gives ample time for polarity reversal, and full energization in the opposite direction. The valve requires .1 watt for its operation, and from four to six cells are used in the battery to which the magnets are connected.

In Fig. 162, *A*, *B*, and *C*, are the slot batteries respectively of the normal danger electro-gas single-blade signals, 1, 2, and 3. The cut sections, 5, 6, 7, and 8, have track relays of corresponding number, which produce the required interconnection. The battery, *B*, energizes the working magnets at 2 through the lower armature contacts of relays 7 and 6, and the upper armature contact of 5. Hence, when 7 is short-circuited, 2 will clear by the back contact of 7, providing the sections of 6 and 5 are unoccupied.

The actual circuits embodied in a normal clear, wireless, two-arm, home and distant electro-gas semaphore, for a single-track signal system, are shown in Fig. 163. *R* is a polarized relay, whose neutral armature front contacts are connected to the main battery, *Q*, and both polar and neutral armatures to the home semaphore; *P* is a polarity reverser operating

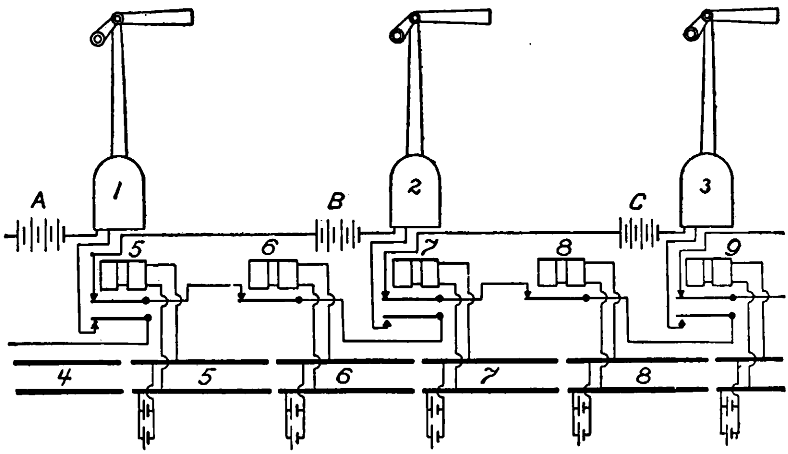

Fig. 162

the preceding distant polar armature; *N*, a compound wound and duplex armature magnet clearing (through its valve operat-

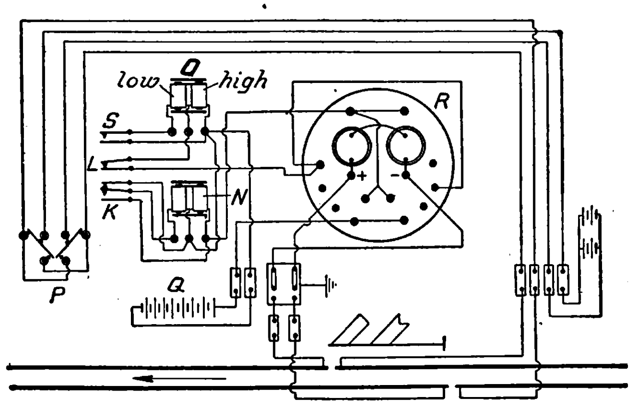

Fig. 163

ing armature) the home blade, and *O* the distant. Each has two windings: one of 280 ohms, and the other of 350 ohms.

These are connected in multiple when the semaphores are to be cleared; the high resistance winding alone being used to hold it at clear. When the home blade is cleared, switch *L* is closed, thus giving current to the distant magnet from *Q*. *K* is a switch arm which is in contact with the upper finger when the home semaphore is at clear, and with the lower when at stop. Its function is to short-circuit the 280-ohm winding, thus leaving in circuit only the high resistance coils. Switch *S* connects the low resistance winding in shunt with the high resistance winding, it being open when the distant blade is clear, thus decreasing the watts used.