

6. The position of the train pipe cocks is clearly shown, and any defective brake in a train that may be temporarily cut out is so indicated that every one can see it.
7. It could be coupled up and used with the present Westinghouse system (under one form of valve shown).

The following figures or diagrams are exhibited, it being understood that some of the details such as air ports and valves are drawn larger and simpler than they would be in actual construction in order to facilitate reference to them, the plans are intended to explain the principle rather than to form working drawings:—Plate III., General arrangement of air compressing pump: A Large reservoir, B Driver's valve, F Train pipes H and J; and the brake arrangements for one vehicle. Plate IV., A plan of brake cylinder, reservoir, differential valve, train pipes and cocks to the full size. Fig. 1 and 2, Plate V.; are separate sections of the differential valve. Figs. 1 and 2, Plate VI., are diagrams of a train showing the method of coupling up the train pipes, and the indicators on the side of the carriages showing the positions of the cocks. Figs. 1 and 2, Plate VII., are sections of the Differential Valve with the additions of a small retention valve, *this enables it to be worked with one pipe like the Westinghouse Brake and be coupled up with that system.* Figs. 1 and 2, Plate VIII., are sections of the Differential Valve showing how it can be worked electrically should it ever be necessary with very long trains on level country. Fig. 3, Plate VII., is a diagram showing how flexible diaphragms may be used instead of pistons in the Differential Valve. Figs. 1 to 6, Plate IX., are plans of train pipe couplings showing that the double hose can be connected with one ordinary coupling, if so desired, instead of having two separate couplings crossed. Figs. 1 to 4, Plate X, represent a quick Action Valve.

The fundamental feature of this brake is the Controlling Valve, which is made with two pistons, as in figures 1, Plate V., Fig. 1, Plate VII., and Fig. 1, Plate VIII., or with diaphragms as in Fig. 3, Plate VII. These pistons or diaphragms are connected to one another so as to move together. Confining our attention for the future to the piston form (without referring to diaphragms) in order to avoid repetition, it will be noted that they occupy two separate cylinders, and thus constitute four separate chambers, two in each of the two cylinders respectively. The two pistons being connected, it is evident that their motion depends not upon the pressure against the sides of one of them, but upon the relation of the pressures on all four sides of both of them, that is to say, the sum of the pressures to the right hand must be equal to the sum of the pressures to the left to produce equilibrium, and that the sum of the pressures to the right or left respectively must vary to cause the pistons to move; for instance, in Figures 1, Plate V., Fig. 1, Plate VII., or Fig. 1, Plate VIII., if the left hand piston Q has 30 lbs. in J' forcing it to the right and 60 lbs. in J'' forcing it to the left a pressure of 30 lbs. on the left of piston R in L' will produce equilibrium if there is no pressure in L'' to the right of R.

In diagram Plates 1 and 2, M is the brake reservoir supplied from the main reservoir by train pipe H through train pipe cock and retention valve K, the brake reservoir is thus kept continuously supplied at a somewhat lower pressure than main reservoir B, according to the strength of spring or valve in K (see also B in Fig. 1, Plate VII.) N is the brake cylinder separated from M by division O, and having its main piston P, requiring no further explanation as it need not differ from ordinary forms of brake cylinders and pistons; in fact, the Westinghouse gear may be used for this feature. J is another train pipe from main reservoir B Plate I., but connected to the brakes through a driver's valve, which has provision for admitting the compressed air from B into the pipe and for exhausting the pipe

to the atmosphere. It will be noted that pressure gauges G' and G'' are shown one on each of the two train pipes.

Coming back to the differential valve it will be seen that there are openings in the right hand cylinder cover, YY, Figs. Fig. 1, Plate V., Fig. 1, Plate VII. and Fig. 1, Plate VIII., and that thus the right hand side of the right hand piston is really open to the atmosphere, and is never subject to pressure above the atmosphere. It therefore stands to reason that the pressure on the left hand side of the right piston must be equal to the difference of the two sides of the left piston to produce equilibrium; in other words, the pressure in J'' is equal to the sum of the pressure in J' and L' when the pistons are balanced. A reference to the diagram shows that L' is open to the brake cylinder, J'' connects to the small reservoir, and J' to the controlling train pipe. The constant pressure in the brake cylinder will therefore be that which is the difference between the reservoir and the train pipe pressures. Let us assume a main reservoir and train pipe pressure of 60 lbs., then the small reservoir M will be something less (owing to the spring of retention valve before mentioned), say 58 lbs., and the pistons of the differential valve will be moved hard up to the right with their attached slides, and by the slide P'' and passages N and O the brake cylinder will be open to the atmosphere, and the brakes will be *off*. To apply the brakes the driver lets say 5 lbs. of the air pressure out of the train pipe, which will then be say 55 lbs., and as there is 58 lbs. in the M the pistons will have 3 lbs. pressure to move them to the left, open slide P', and admit air to the brake cylinder until there is 3 lbs. pressure, when this 3 lbs. is admitted it will produce an equilibrium on the pistons, a slight pressure more will move them and close the valves. If 20 lbs. reduction is made in the train pipe, then 20 lbs. pressure will pass to the brakes before the equilibrium is established. Of course the sudden passing of air from M to N reduces the pressure below the initial 58 lbs. for a short period, but M being still in direct communication with the main

reservoir, and not cut off as in other brakes, the supply will be maintained while the brakes are on, and any leakage in N will be made up. Having got 20 lbs. pressure in our brake cylinder and equilibrium in the differential valve, we assume the train to have come to a flatter grade and we wish to reduce the brake pressure from 20 lbs. to 10 lbs., all that is necessary is to open the driver's valve to the main reservoir and admit 10 lbs. more pressure into it, the pistons will then be forced to move to the right and open the brake cylinders to the atmosphere, allowing 10 lbs. of pressure to exhaust, through passage O, when the equilibrium of the pistons being again established the valves close. As there might be a tendency to the valves to "dither" (a purely technical word) every time an equilibrium was reached, the springs shown in Plate II. are provided to act on pistons and keep the valves central. As the pressure in the brake cylinder is entirely dependent on the variation in the relative pressures of the two train pipes, the two pressure gauges upon them enable the driver to at all times know what is going on in the brake cylinders.

With regard to automatic stops from a "break away," or testing the brakes by the guard, this brake is on the same footing as other well-known brakes, for the opening of the train pipe puts the brake full on.

It is hardly necessary to take up much time by a reference to the train pipe cocks, it will be seen they are connected to a handle on each side of the carriage with an indicator as in Plate VI., where it is apparent that the brakes are connected to the train pipes on the tender, the second carriage, and the brake van, but that the first carriage is cut out altogether (probably has a dry leather that leaks the brake off). The cock on the brake van has the  $\rightarrow$  on its side, the plug closing the rear pipes. This arrangement with the cocks at centre of the carriages would leave more air to escape at every uncoupling of a carriage than occurs at present, of no importance except for the sharp "clish" of the exhaust. There are, however,

many forms of self-closing couplings which obviate this, and a small additional air way in the cock plug, as in Figure 1, Plate VII. would allow the contents of that length of pipe to leak off before uncoupling. Figures 1 to 6, Plate IX., show a special coupling for the double train pipe, which needs no explanation.

There is no doubt that exception will be taken to the extra work or complication of the double train pipe used in this brake, but it must be seen the brake can be graduated *both on and off* with one pipe only, as there is the precedent of the Westinghouse Company for the assumption that another pipe is an insignificant addition to the equipment. We are justified in sacrificing a sprat to catch a mackerel; and it is for the members to discuss whether the mackerel of simplicity, security, and certainty aimed at in this brake, is worth the sprat of an extra train pipe.

A few words more. The electric valve explains itself, and would only be required for emergent stoppages on very long trains. An electric current from a battery on the engine causes the electro magnets M on Fig. 2, Plate VIII., to attract the armature K L when the driver makes contact, and an instantaneous and simultaneous application of the brakes from one end of the train to the other is produced.

The valve shown in Figures 1 to 4, Plate X., was devised as a supplement to the brake to enable a quicker application to be effected and to economise air, so that instead of all the air in the governing train pipe passing to the atmosphere at the driver's valve and being wasted it might partly be exhausted into the brake cylinders themselves. This is proposed to be done in the following way, the valve being generally like that shown in Plates III., IV., and V., but with some supplementary parts.

In Figures 1 to 4, Plate X., A is the attachment of the governing train pipe.  
B, the connection to small reservoir.  
C, the connection to brake cylinder.  
D, the exhaust to atmosphere.

E and F, the differentiating pistons.

G and H, the controlling slide valves.

J is an additional piston working in its own cylinder and having a small aperture at K regulated by a screw.

L and M are two valves whereby a communication can be established directly between the governing train pipe and the brake cylinder.

The opening K is so adjusted that in any ordinary and gradual change of pressure in A the whole operation of the brake is the same as with the valve shown in Plates I., II. and III.; but, in the case of a very sudden reduction in A, caused by the wide opening of the driver's valve, a different cycle of operations will take place with this valve.

Assuming that there is 60 lbs. pressure in the train pipe, and that it has passed through K along J, then an instantaneous reduction of say 10 lbs. in A, caused by the sudden opening of the driver's valve, will cause J instantly to descend, by the expansion of the air above it, before it has time to pass back through K. This sudden descent of J forces open valve L and then the 50 lbs. in A has a free vent into the brake cylinder, reducing the train pipe pressure still further, and of course hastening the application of the brake on the next carriage. Should the train pipe be entirely exhausted, the brake cylinder pressure cannot return, on account of valve M and then the pistons are controlled by the train pipe pressure directly as in the simple valve, because passage N is not affected by piston J. The reservoir above J fills up through K again as the pressure in A is increased and the brakes are gradually released.

With this valve it is possible that a much smaller train pipe would suffice.

In conclusion, the author would particularly point out that the diagrams of these valves must not be looked at in the same light as the details of well-known brakes, upon such many years of thought and care of the best minds have been concentrated and tens of thousands of pounds have been expended;

they must be looked at more as being made simply to explain the principles involved. He would ask the members to give an opinion freely on the following points:—(1) Do they think there is sufficient in this brake to warrant the author in asking the railway authorities to look into it? (2) Do they think any harm would have been done if the courtesy of asking him for a personal explanation had been extended? (3) Is it desirable for us to make our own brakes in the colony? (4) Is this proposal worth the time and trouble we have bestowed upon it at our meetings?