

## ON INCREASED BREAK POWER FOR STOPPING RAILWAY TRAINS.

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The subject of increased Break Power for stopping quick trains in a shorter distance than is at present practicable has become of great importance, and the attention of railway companies has recently been specially drawn to it by the railway department of the Board of Trade, by whom a number of experiments were tried on breaks of engines and carriages; and a recommendation was made to the railway companies for carrying out a system of continuous breaks to the whole train. The subject was also under the consideration of a committee of the House of Commons last year, before whom evidence was given on the causes of railway accidents: this evidence was in favour of increased break power on the engine, if not too suddenly applied; for it was shown that no break on the carriages could be applied quickly enough to prevent accidents.

The subject of this paper is a plan for obtaining increased break power, by retarding the speed of the engine by means of a throttle valve placed in the exhaust pipe, which can be instantly closed to any required extent so as to obstruct the exit of the steam from the cylinders, the regulator remaining open; at the same time the exhaust steam is admitted to a small cylinder, the piston of which acts through levers upon a break on the engine wheels.

This arrangement is shown in Plate 45. Fig. 1 is a side elevation of a passenger engine, showing the steam break applied to the leading and trailing wheels simultaneously; Fig. 2 is an enlarged view showing the steam break cylinder A and the throttle valve B in the exhaust pipe, and Fig. 3 shows the position of the throttle valve in the expanded portion of the pipe. The spindle of the throttle valve B projects through the side of the smokebox, and is worked

from the foot plate by means of a lever and connecting rod C. The break cylinder A is 8 to 10 inches diameter ; the exhaust steam is admitted into the bottom of the cylinder through a  $1\frac{1}{4}$  inch pipe provided with a cock D, and acting on the underside of the piston lifts the break lever E and presses the break blocks F against the wheels. The cock D in the  $1\frac{1}{4}$  inch pipe is worked from the foot plate by means of a lever H turning loose on the spindle of the throttle valve B ; the throttle valve can thus be closed without at the same time admitting the exhaust steam to the break cylinder, while the latter can also be instantly applied in cases of sudden emergency. When the steam pressure is removed from the cylinder A, the weight of the piston and lever draws the break blocks back clear of the wheels ; the break cylinder being contiguous to the smokebox, and the pipe leading to it short and open to the heat in the exhaust pipe, there is no risk of water accumulating in the cylinder to prevent the descent of the piston when the steam pressure is removed. The break blocks being under the charge of the engineman and fireman will be regularly adjusted by them.

The break cylinder applies the breaks simultaneously to the leading and trailing wheels of the engine, as shown in Fig. 1, and the driving wheels are at the same time retarded by the back pressure of the exhaust steam on the pistons consequent upon the closing of the throttle valve in the exhaust pipe ; the pressure of steam in the break cylinder is the same as the back pressure in the driving cylinders, both being regulated by the extent of closing of the throttle valve. The power of the break cylinder is limited so as not to skid any of the wheels, in order to avoid wearing flat places on the tyres, and to produce the greatest effect in retarding the speed ; a break power of from 14 to 22 tons can thus be obtained by the steam break alone. The break power obtained by the use of the throttle valve alone, retarding the driving wheels of the engine, is equal to that of the tender break, the regulator being open to the driving cylinders all the time. The application of the steam break by the engineman may be followed immediately by that of the tender break by the fireman, and the guard's break in the van next to the tender ; thus giving at once a greater break power than has

usually been applied in retarding trains, and diminishing the liability to accidents from want of sufficient break power.

For the ordinary stoppages the throttle valve can be used to bring the train nearly to a stand, the tender break being applied for the last few yards only ; this will effect a great saving in the permanent way, tender tyres, and break blocks. By partially closing the throttle valve, trains may be controlled to any desired speed in passing down an incline, while a great surplus of break power is reserved in the steam break cylinder and the tender and van breaks, to bring the train to a stand quickly on the incline: in an experiment made with a gross load of 200 to 210 tons, down an average incline of 1 in 80, of 5 miles length, the train was controlled by the throttle valve alone from a speed of 30 miles per hour at starting to 15 miles per hour down the whole incline. In approaching stations, half the time may be saved by the joint use of the tender break and the throttle valve alone in the exhaust pipe, and a still further saving of time effected by also admitting the steam to the break cylinder. By using the steam break for ordinary purposes in place of the tender break there is less risk of heating and flattening the tyres, since the steam break is arranged so as not to skid the wheels.

In this method of obtaining break power from the engine, the speedy reversing of the engine valve gear from forward to backward gear is rendered an easy operation, whereby a further increase of retarding power is obtained ; for the exhaust steam at the back of the driving pistons being compressed in the exhaust port by the closing of the throttle valve, the pressure of steam inside the slide valves becomes equal to or greater than that outside in the steam chest, so that a balance of pressure is established, enabling the valves to be reversed instantly with perfect ease. The partial closing of the throttle valve may be employed to prevent violent slipping of the driving wheels, which will revolve only in proportion to the quantity of steam allowed to escape from the exhaust pipe, and this may be regulated to any extent by the throttle valve, which can be worked with greater ease and nicety than the regulator.

The retarding power of this steam break has been tested by the writer in some experiments made in August on the Scottish Central Railway, the results of which are given in the following Tables I, II, and III. In the two first trials, only the throttle valve in the exhaust pipe was used, without the addition of the steam break cylinder, thus retarding only the driving wheels of the engine by the back pressure of the exhaust: the third trial was made with an engine having the steam break cylinder in addition to the throttle valve.

Table I gives the average results of experiments made with a passenger engine, run over a level portion of the line, with pretty calm weather and rails dry; the engine weighed 18 tons and the tender 12 tons, making 30 tons total load; the break power was applied over the same ground in each case. The third result is an average of four experiments, the others of two each.

Table II shows the results obtained with a goods' engine having four wheels coupled of 5 feet diameter; the engine weighed 26 tons and the tender 14 tons, and there were 18 wagons weighing 140 tons, making 180 tons total load. The break power was applied at the same mile post in each case, and over the same rails; the first  $\frac{1}{4}$  mile from the post was level, and the next  $\frac{1}{4}$  mile beyond was a rising gradient of 1 in 500; the weather was calm and the rails dry. The second result is an average of three experiments.

Table III gives the results of experiments made with a passenger engine having a steam break cylinder in addition to the throttle valve, under the same circumstances and over the same ground as in Table II; the engine weighed 18 tons and the tender 12 tons, and there were 11 empty carriages weighing 55 tons, making 85 tons total load. The carriage breaks were not applied in any case.

It appears therefore from these experiments that the retarding power produced by closing the throttle valve in the exhaust pipe is fully equal to that of the tender break, and the engine steam break also produces an effect fully equal to the tender break: so that by employing both throttle valve and steam break in conjunction with the tender break, the retarding power obtained is more than double that of the ordinary tender break alone.

TABLE I.  
*Passenger engine with Throttle Valve only.*  
*Total load 30 tons.*

Speed in running.	Break Power applied.	Time in stopping.	Distance run in stopping
Miles per hour.		Seconds.	Yards.
26	Tender break only: steam shut off.	50	440
30	Throttle valve only: steam kept on.	52	440
30	Throttle valve and tender break: steam kept on.	21	200
36	Throttle valve and tender break, and engine reversed.	16	200

TABLE II.  
*Goods engine with Throttle Valve only.*  
*Total load 180 tons.*

Speed in running.	Break Power applied.	Time in stopping.	Distance run in stopping.
Miles per hour.		Seconds.	Yards.
30	No breaks applied: steam shut off.	130	1000
29	Throttle valve only: steam kept on.*	70	620
30	Tender break only: steam shut off.	65	610
30	Throttle valve closed and engine reversed.	58	440
30	Throttle valve and tender break, and engine reversed.	50	355

\* Train not brought quite to a dead stand, owing to slight leak at throttle valve.

TABLE III.

*Passenger engine with Throttle Valve and Steam Break.**Total load 85 tons.*

Speed in running.	Break Power applied.	Time in stopping.	Distance run in stopping.
Miles per hour.		Seconds.	Yards.
36	No breaks applied: steam shut off.	156	1432
36	Throttle valve only: steam kept on.*	80	800
36	Tender break only: steam shut off.	66	715
36½	Throttle valve closed and engine reversed.	63	710
36	Throttle valve and tender break, and engine reversed.	50	460
36	Throttle valve and tender break: steam kept on.	55	450
36	Throttle valve and engine steam break: steam kept on.	50	400
36	Throttle valve, engine steam break, and tender break: steam kept on.	30	275
36	Throttle valve, engine steam break, tender break, and engine reversed.	23	220

\* Train not brought quite to a dead stand, owing to slight leak at throttle valve; but speed very slow for the last 220 yards.

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Mr. ALLAN observed that the importance of an increased power for stopping railway trains in cases of emergency, proportionate to the increase that had taken place in the speed and weight of the trains, had long been felt; and he was satisfied that to accomplish this effectually it was essential to arrange for the break power to be applied

by the engine driver, as there was no time for communication with the guard, and the mischief was done before the guard could get his breaks applied. The great object to be attained was the application of a powerful retarding force at the earliest possible moment to check the speed of the train, and the value of the break mainly depended upon its instantaneous action as soon as the danger was perceived; and as the weight of the engine and tender formed a large portion of the total weight of the train, and the steam break was under the immediate control of the engine driver, it afforded the most efficient means of accomplishing this object. By the experiments it was found that closing the throttle valve so as to shut the escape from the engine cylinders, which was done instantaneously, produced a retarding effect as great as that of the tender break; and the addition of the steam break caused the train to be stopped in less than half the distance. The throttle valve also enabled the engine to be reversed easily, by balancing the pressure on the slide valves, removing the ordinary difficulty in reversing large engines.

Mr. R. MORRISON had seen some experiments upon a steep incline of 1 in 40 on the Edinburgh and Glasgow Railway, with a steam break contrived by Mr. Paton which gave a very powerful retarding force; the break was applied to the leading and trailing wheels of a large tank engine having all the wheels coupled, and the pressure was produced by a steam cylinder communicating direct with the boiler. The action of the break was very efficient, but he believed the principal objection to it was found to be the great shock caused by its sudden application, which often deranged the levers of the apparatus and occasioned an objectionable concussion to the train.

Mr. ALLAN said that with the plan of the throttle valve in the exhaust pipe this objection was removed, as the pressure came on gradually by the gradual compression of the exhaust steam; and no objectionable shock was perceived beyond what was of course unavoidable in stopping a quick-moving train within a short distance: a train at a speed of 40 miles per hour was stopped in 150 yards upon a level by means of the steam break and tender break without any objectionable shock being produced. The throttle valve and steam break were found to answer well in going down inclines, where

the tender break was ordinarily used, and were more convenient for application, and had the advantage of saving the wear of the tender wheel tyres which were generally skidded by the breaks; but the pressure on the engine breaks was adjusted by the size of the steam cylinder so as not to be able to skid the wheels.

The CHAIRMAN observed that it was certainly an important subject, and it had become very desirable to have an increased power for stopping trains which would be promptly available for application. He proposed a vote of thanks to Mr. Allan for his paper which was passed.

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The following Paper was then read :—



**Fig. 1. Side Elevation of Locomotive  
with Steam Break.**

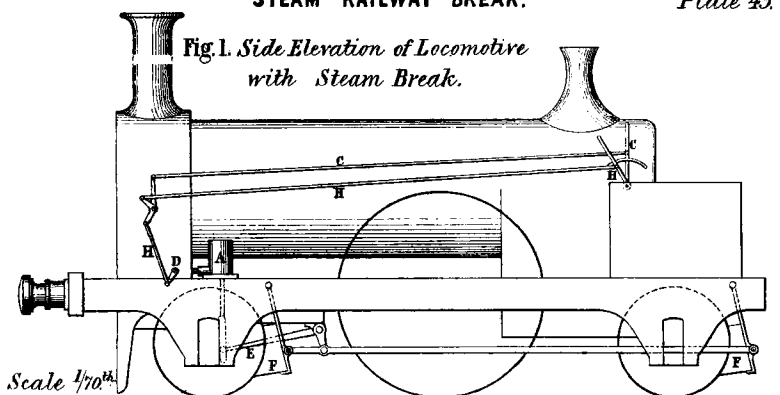
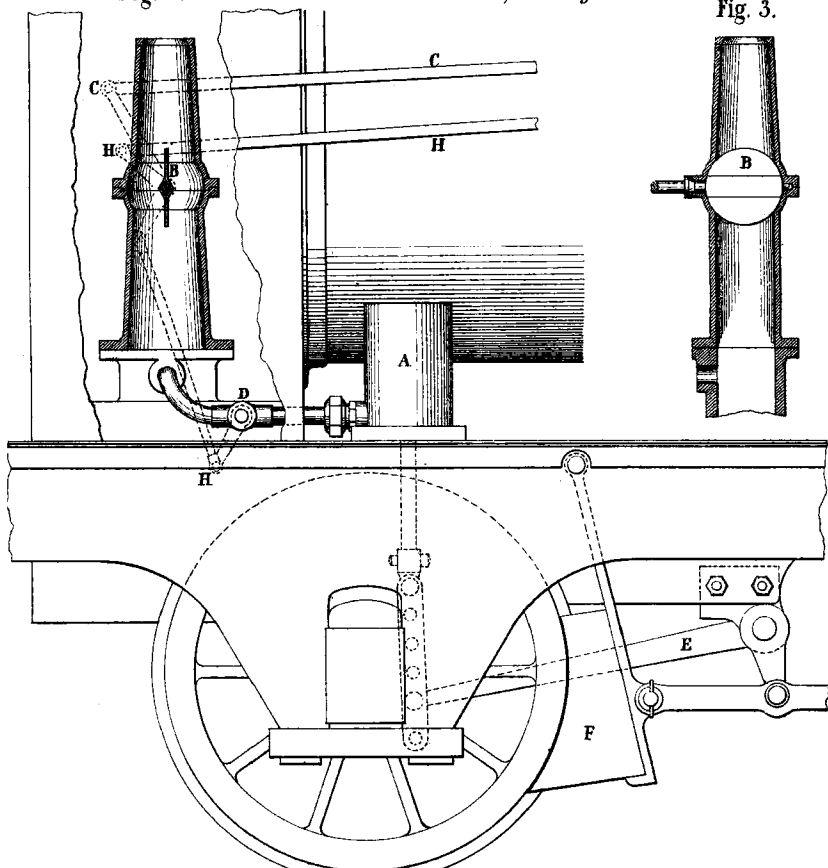


Fig. 2. *Detail of Steam Break, enlarged.*



Scale  $1/20^{\text{th}}$ .