Already in his experiments with a locomotive under steam but stationary, Clark had obtained results sufficient to prove the proposition that the vacuum stands in a direct ratio to the blast-pipe pressure. This was investigated with the apparatus with stacks having the greatest variations of diameter and length and with all five of the blast nozzles, and was found to be in exact correspondence in every instance.

If we take the blast-pipe pressure as abscissas and the corresponding vacuums as ordinates, the end points of the latter will form straight lines. In figs. 19 to 23 these diagrams are given for the operation of a stack having a diameter of 13.78 in. The blast-pipe position for all 15 of the readings was the same, or 1 ft. 10 in. Equal abscissas correspond to equal steam pressures. If the latter were twice, four times, or five times as great, the vacuum would increase twofold, fourfold, or fivefold, as the case might be.

The amount of steam issuing forth increases as the diameter of the nozzle is made larger, about in the ratio of the square of the diameter of the nozzle. If we consider that the amount of steam issuing from a nozzle 4 in. in diameter to be equal to 1, it follows that, with the same steam pressure and a

Nozzle diameter	= 4 in.,	the steam delivered	= 1.00
"	"	= 4.4 in.,	"	"	= 1.21
"	"	= 4.8 in.,	"	"	= 1.44
"	"	= 5.2 in.,	"	"	= 1.69
"	"	= 5.6 in.,	"	"	= 1.96

Notwithstanding the fact that with a nozzle diameter of 5.6 in., nearly twice as much steam is delivered as would be through one only 4 in. in diameter, a casual comparison of these five diagrams shows that the vacuum rises in a far smaller ratio.

To make this still clearer, the following figures are brought together :

TABLE I.

Diameter of Stack.	Shape of Stack.	Increase in the vacuum with the nozzle located at 22 in., if the nozzle diameter is opened from 4 in. to 5.6 in.
13.78 in.	Cylindrical...	From 4.08 to 4.6 in. = .52 in. = 12.7 per ct.
	Conical $\frac{1}{12}$....	" 3.96 " 5.14 in. = 1.18 in. = 30.7 "
	Conical $\frac{1}{6}$.....	" 3.4 " 4.84 in. = 1.44 in. = 42.3 "
15.75 in.	Cylindrical...	" 3.58 " 4.42 in. = .84 in. = 23.4 "
	Conical $\frac{1}{12}$....	" 3.08 " 4.36 in. = 1.28 in. = 41.5 "
	Conical $\frac{1}{6}$.....	" 4.88 " 3.78 in. = 1.1 in. = 52.4 "

Hence, if the outflow of steam increases by about 100 per cent., the vacuum (under this ratio) will increase about 52 per cent., the shape of the stack remaining the same.

From these five diagrammatic representations we can readily see, without any further demonstration, how a cylindrical stack having a diameter of 13.78 in. falls off in its action with the same amount of steam as compared with the conical stack. With a nozzle diameter of 4 in. the cylindrical form seems to be the best when taken in connection with the height of the vacuum ; at a diameter of 4.4 in. it nearly coincides with the conical form having an inclination of $\frac{1}{12}$; with a further opening of the blast nozzle it drops down below the last-named form, until at a diameter of 5.2 in. for the nozzle it has fallen even below the stack having an inclination of $\frac{1}{6}$.

In other respects the diagrams show that the action of the cylindrical stacks is very much better than that of the conical if we take stacks having a larger diameter than 13.78 in. It so happens, then, that under the same ratios as shown in figs. 19 to 23, that with stacks having a diameter of 14.76 in., the cylindrical stack first coincides with the conical stack having an inclination of $\frac{1}{12}$ when the nozzle has a diameter of 5.06 in. With a diameter of 15.75 in., as well as with all five diameters of nozzle, the cylindrical form is superior to the conical (the nozzle position being 1 ft. 10 in.) as is shown by figs. 24 to 28.

We next have to show the reason why we believe, from the results obtained from the experimental apparatus, that a cylindrical stack 13.78 in. in diameter and 4 ft. 9.68 in. high is too small to be used with a nozzle 4.33 in. in diameter, just as a stack of 14.76 in. in diameter is too small for a nozzle having a diameter of 5.06 in. or more. And we are inevitably led to the further conclusion that the cylindrical stack, as being also superior at the smallest cross-section, must be preferred to the conical stack if we expect to maintain the same vacuum with the two forms under the same conditions. Likewise the conical stack should be given different inclinations, and the narrow inclination of $\frac{1}{12}$ be increased to $\frac{1}{6}$, as shown latter in Section X.

Finally, we can state, as a well-defined conclusion, that the blast-pipe pressure has no influence upon the form of the stack, a conclusion that Prüssmann has already announced as the re-

Fig. 19.

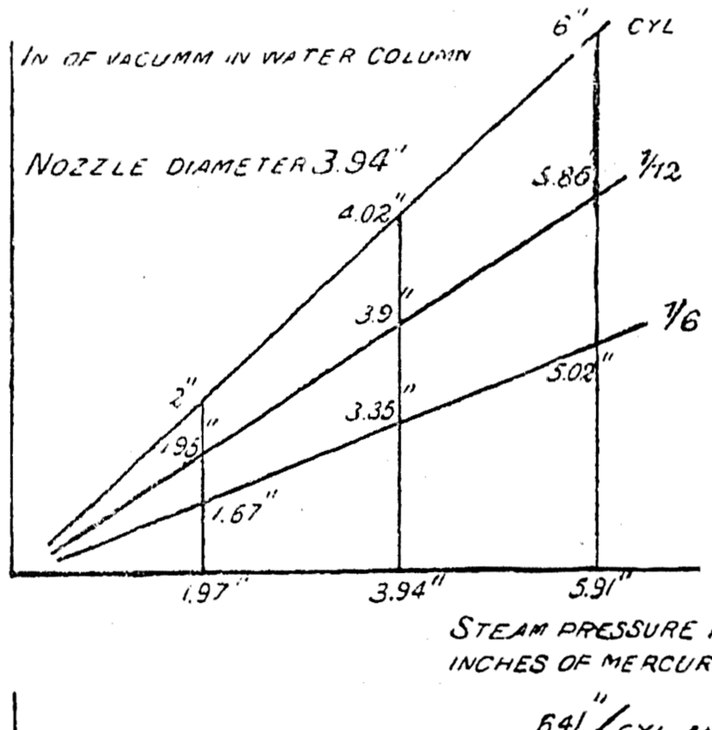

Fig. 20.

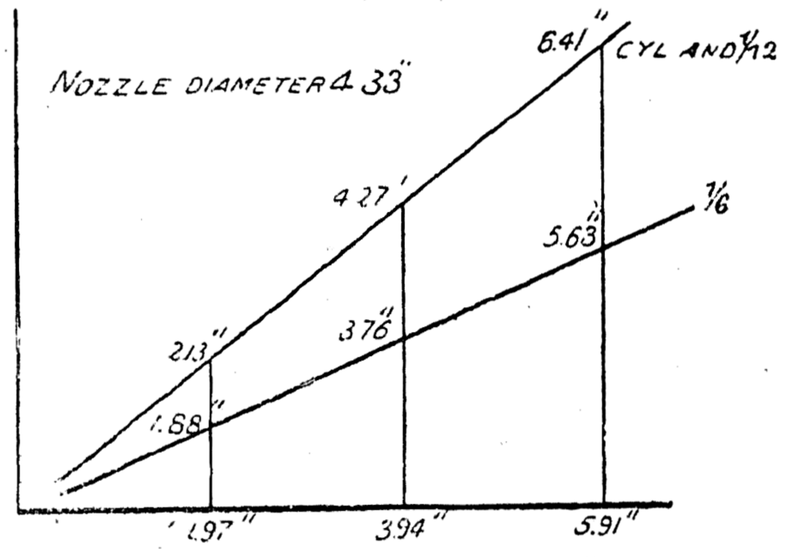

Fig. 21.

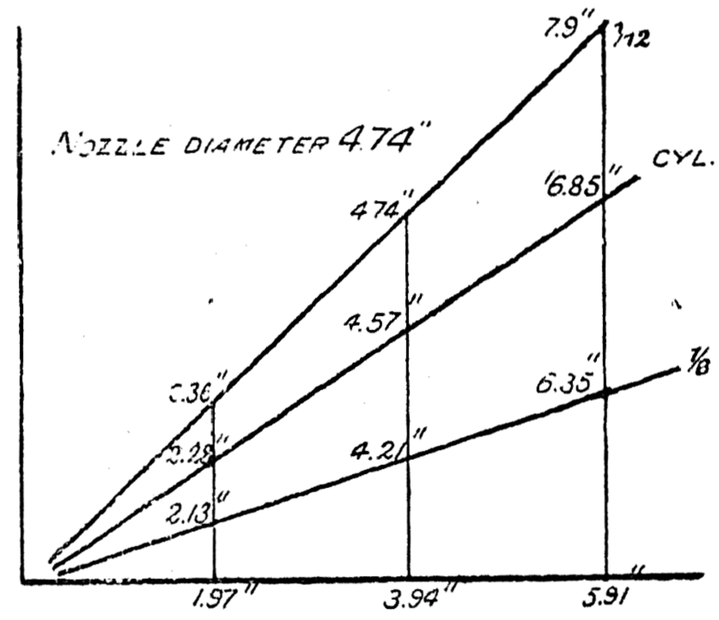

Fig. 22.

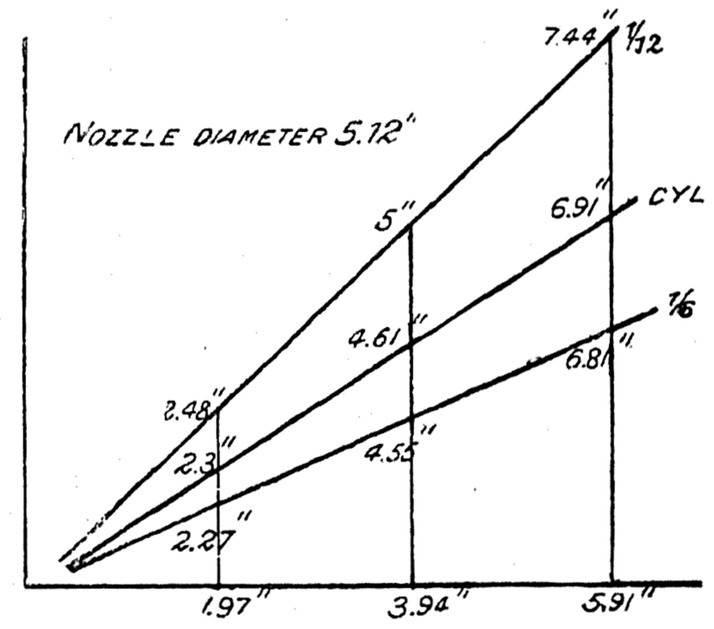

Fig. 23.