up; the two effects may be considered as neutralizing each other, and be disregarded.

Distance from Navy Yard Shears to Chester,	15 miles.
Add for current of $2\frac{1}{4}$ miles per hour, acting for one hour and fifty minutes,	4.6 "
Distance back to Navy Yard Shears,	15 miles.
Deduct for current of latter part of flood tide, .75 mile per hour during 43 minutes time,	.54 "
	14.46 "
Actual distance through the water,	= 34.06 "
Time occupied in running to Chester from Navy Yard Shears,	1 hour 50 min.
" " " from " to " " "	1 " 21 "
	3 " 11 "

By dividing is found the average speed of the vessel through the water = 10.7 miles per hour, or 941.6 feet per minute.

The pitch of the propeller at centre of pressure is, 14.71 feet, and it completes two revolutions for one of the engine. By averaging the turns made by the engine, we get for the theoretical progression of the propeller per minute,

$$\begin{array}{rcl} \text{Progression of vessel,} & 41\frac{1}{2} \times 2 \times 14.71 = & 1209.9 \text{ feet.} \\ & & \underline{941.6 \text{ "}} \\ \text{Slip,} & & 268.3 \text{ "} \end{array}$$

or over 22 per cent.

It is expected, that the per centage of slip will be reduced when the vessel is brought to trim more by the head, which will make the angle of the entrance finer. The model of the hull is good; and from the known reputation of the builders, Messrs. J. K. Hammit & Son, has had justice done it in the construction. Not being designed for great speed, the route being short, but a comparatively small amount of engine power was placed in her; so the result of the trial was very satisfactory to contractor as well as builders. She will sail for her destination, to be placed upon her intended route, about the last of October.

For the Journal of the Franklin Institute.

Notes on the Cloud Combination of Steam and Air. By WM. H. SHOCK,
Chf. Eng., U. S. Navy.

By invitation, I lately visited an establishment in New York, where they have a small engine for driving three of "Hoe's Patent Printing Presses," and in which they use the *Cloud Combination of Steam and Air*.

I here submit the facts, collected during my visit, (with two reports made by Horatio Allen, Esq., of New York, annexed,) hoping they will prove an incentive to a further examination of the principles of this phenomena in steam engineering.

The engine used for driving the above presses, is of that class known

as the square engine, 10 inches stroke and about 5 inches diameter. (I had no correct method of arriving at the exact diameter.)

The piston rod is continued above the cross head with reduced diameter, and up through the engine frame, upon which sets the air pump, 10 inch stroke and 2 inches in diameter, forming an arrangement of piston not unlike that of the Worthington pump.

A separate eccentric is used for working the *steam* expansion valve, also, one for working the *air* valve.

The steam chest is the same in all respects, as those usually found on engines with the short slide valve, with the addition, however, of a face on one side of the chest, to admit the air, or, in other words, an air chest on the side, and opening into the steam chest.

The air is compressed, (as shown by gauge,) to exert a pressure, varying from 15 to 20 lbs. per square inch, and is admitted into the cylinder for $1\frac{1}{2}$ inch of the stroke of the piston, and then steam of a pressure of 80 lbs. per square inch for the following two inches, when all communication to the cylinder is closed, the engine making from 65 to 70 revolutions per minute, driving all the *presses*, but as soon as the *air communication* to the cylinder was closed and the operation of the engine depended upon *steam alone*, its speed was immediately reduced, and finally stopped, and it was found that with all the *steam* they could get, it was impossible to drive *one press*.

I am further informed, that the cooler the compressed air enters the chest, the more satisfactory are the results to be obtained, and to that end, it is proposed to immerse the air pump and pipes as far as practicable in a cold bath.

The coal consumed during the working hours (10,) varies from 170 to 200 pounds (anthracite.)

As before stated, Mr. H. Allen conducted a series of experiments, and made reports, of which I have been kindly supplied with copies.

The following appears in the report, dated July, 1854.

"A steam engine, 8-inch diameter of cylinder, and 12-inch stroke, with suitable boiler, was fitted up, and also provided with the means of working an air-pump, and the valves required for introducing air into the cylinder. The revolutions of the engine were controlled by the friction of a pulley. As the same pulley, weight, and appurtenances were used in all cases, and great care was taken to keep a full and uniform supply of water to the surface of the pulley, a great uniformity of resistance was obtained.

"After working the engine as a steam engine at various degrees of expansion, it has been found that, with a pressure of 70 pounds in the boiler, the best results have been obtained by letting on the steam for 2 inches of the stroke.

"With the valves so adjusted, the result of the trials with steam alone, gave 170 revolutions for one pound of coal.

"Having made the trials with steam alone, the same engine was prepared for cloud combination by adding the air-pump and valves.

"In this arrangement, the air was let on for $1\frac{1}{2}$ -inch stroke at its commencement, and then steam (boiler pressure 70 pounds,) for the following 2 inches. The performance of the cloud combination, as shown by several trials, exceeded 250 revolutions for one pound of coal.

"In making these trials of the cloud combination, it has been found that when steam of about 60 pounds pressure is combined with air of from 15 to 20 pounds pressure only, there results a pressure from the combination exceeding that of the steam, at least 10 to 15 pounds.

"This important fact was clearly brought out by the pressure gauges attached to the

steam chest, which indicate the pressure of steam, both before the combination and after the combination. An increase of pressure of 15 to 16 pounds is invariably indicated.

"Another manifestation of this increase of pressure, is found in the operation of the check-valve in the steam pipe, through which the steam is introduced. This valve opens with the current of steam. When the engine is used as a steam engine, this valve closes gently by its own weight as soon as the cut-off stops the current of steam, but when the *cloud combination* is being used, this valve closes very soon after the steam is let on, and before the cut-off closes, with a degree of violence that shows there has resulted from the combination of steam and air, an expansive effect much exceeding that of the steam used.

"As the result of the trials referred to, I have to state that the increase of pressure arising from combination of steam and air, is proved beyond a doubt, and that the increased useful effect resulting from this increased pressure, as shown by these trials, is over 50 per cent."

In August, 1854, a larger boiler was substituted for the one used in the above experiments, and the following tabulated report made:—

"I have repeated the trials of cloud combination with same engine, but a larger boiler. The following is a statement of results:

First.—Steam alone.

Steam in boiler.	Steam in chest.	Coal to raise steam.	Coal while running.	Revolutions.
110 lbs.	100 lbs.	156 lbs.	156 lbs.	16,759

"Stopped three times for ten minutes. Time of trial, four and a half hours. Running time, four hours.

" $16,759 \div 156 = 107$ revolutions for 1 lb. coal.

Second.—Cloud.

Boiler.	Chest.	Air.	Coal to raise steam.	Coal while running.	Revolutions.
110 lbs.	100 to 110	18 lbs.	156 lbs.	104 lbs.	19,749

"Running time, four hours.

" $19,749 \div 104 = 190$ revolutions for 1 lb. coal.

"Cut off for steam, at $1\frac{1}{2}$ inch of stroke, expanding $7\frac{1}{2}$ times.

"Cut off for air $1\frac{1}{2}$ inch, and for steam $1\frac{1}{2}$ inch, expanding 4 to 6 times.

"It will be seen, that the performance with steam alone is under as favorable circumstances as can be provided in a high pressure engine. The expansive principle is fully carried out, and nothing is wanting to make the performance by steam alone, a fair standard with which to compare the cloud engine; and this performance has been largely exceeded by the—

"*Cloud Engine.*—I have previously reported the result of former trials, in all which the performance of the cloud engine has much surpassed that of steam alone.

"It therefore appears to me, that but one conclusion can be drawn from these trials, and that is, that by the cloud combination, a very large saving will be effected.

"The means to be used are simple, and involve no difficult mechanical combination.

"What the proportion of saving is to be, remains to be determined by more extensive use, but I am constrained by the facts which have been developed by these trials, to state my belief that the cloud combination will take the place of the high pressure engine, and prove itself one of the most extraordinary and valuable inventions of the age."

That the results observed by Mr. Allen in his experiments with the cloud combination, are most extraordinary, is beyond a doubt, and deserving of further experiments upon a larger scale.