Indicator Diagrams.—The appended diagrams are given to show the setting and condition of the valves. The leading feature, it will be observed, is a large degree of cushioning, caused by the closing of the exhaust valve before the completion of the stroke.

Nos. 1 and 2 are from the starboard and port cylinders; steam pressure in boilers per gauge, 13.25 pounds per square inch; back pressure in condenser per gauge, 1.7 pounds per square inch; double strokes of engine, 15 per minute; draft of vessel, 16 feet 1 inch forward, and 17 feet 1 inch aft. *Throttle wide.*

Nos. 3 and 4 are from the starboard and port cylinders; steam pressure in boilers per gauge, 14½ pounds per square inch; double strokes of engine, 15 per minute; draft of vessel, 16 feet 6 inches forward, and 17 feet 1 inch aft. *Throttle ¾ths open.*

To be Continued.

For the Journal of the Franklin Institute.

Notice of the Earliest Steam Engines used in the United States. By FREDERICK GRAFF, Esq., Superintendent of Philadelphia Water Works.

(With a Plate.)

The following notice of the few steam engines used in this country in the year 1801, with a description of those erected and started in that year at the Centre Square and Schuylkill Water Works, believed to have been the first stationary engines of any considerable size put up in the City of Philadelphia, and probably the first engines of such large dimensions manufactured in this country, may not be uninteresting to the readers of the *Journal*.

The first steam engine of any size appears to have been introduced into America about the year 1763, at the Schuyler copper mine, situated upon the river Passaic, New Jersey. All its principal parts were imported from England, and a Mr. Hornblower (the son it is believed of the well known steam engineer of that time) came to this country, for the purpose of putting up and running the engine.

At the time when the manufacture of the engines for the Water Works was commenced, and as late as the year 1803, we find five engines, in addition to the one mentioned, noticed as being used in this country: two at the Philadelphia Water Works, one just about being started at the Manhattan Water Works, New York, one in Boston, one in Roosevelt's saw mill, New York, and a quite small one used by Oliver Evans to grind plaster of paris in Philadelphia.

The engines for the Philadelphia Water Works were manufactured by Nicholas Roosevelt, at works established by him near the copper mine above referred to, on the river Passaic. Their dimensions were as follows: that at Centre Square had a steam cylinder of thirty-two inches diameter, and six feet stroke, and worked a double acting pump eighteen inches diameter and six feet stroke, raising the water into a tank at the top of the building about fifty-one feet high.

The other engine, situated at the corner of Schuylkill Front and Chestnut streets, had a steam cylinder of forty inches diameter and six feet stroke, and a double acting forcing pump of seventeen and a half inches diameter and six feet stroke, raising the water about fifty-five feet. In both these engines, the lever beams, arms, and shafts of the fly wheels, the bearings upon which the fly wheels are supported, the hot wells, the hot and cold water pumps, the cold water cisterns, and even the steam boilers, were all of wood; in fact, all the engines mentioned above as then in use in America, were supplied with steam generated in wooden boilers.

The following is a description of those used at the Water Works. They were composed of rectangular chests, made of white pine plank, five inches in thickness, were nine feet square at the ends, and fifteen feet long, braced on the outside with oak scantling, and securely bolted together by rods passing through the plank. Inside the chest was a fire box with vertical flues, through which the water passed, the fire acting around them, and passing into an oval flue situated just above the fire box, and carried from the back to the front of the boiler and returned; this fire box was first made of wrought iron with the flues of cast iron, but the unequal contraction and expansion of the two metals caused continual leakage, and eventually wrought iron flues were substituted for those of cast iron. Mr. Latrobe, the engineer who designed the Water Works, claimed great merit for these boilers on account of the non-conducting power of the wood, and for the plan of the vertical flues contained in the fire box. He also gives the following memorandum of the work done by the engines: that at Schuylkill Front street pumping by actual experiment when running sixteen revolutions per minute 1,474,560 ale gallons per twenty-four hours, with a consumption of seventy bushels of Virginia coal; and the Centre Square engine pumping 962,520 ale gallons per twenty-four hours, consuming fifty-five bushels of coal; the pressure of steam ranging from two and a half to four pounds per square inch.

The wooden boilers first put in rotted out in seven years: those at Centre Square being renewed, were used as late as the year 1814. About the end of the year 1803, a new boiler, made totally of cast iron, was erected at the Schuylkill engine house. This boiler had semicircular ends, and was seventeen feet long, eight feet wide at the bottom, and nineteen

feet long, and ten feet wide, at near the top. The flame from the fire passed under the bottom, and around the back, into a flue which passed through the boiler and returned, and then around the outside of the boiler to the stack. This boiler was made of cast iron plates, with flanged joints, bolted upon the inside. The drawings of the wooden and iron boilers (Plate VII.) will explain more fully their construction.

The following extract from a Report made to the Watering Committee in July, 1801, by one of its members, who was sent to Roosevelt's manufactory to examine the progress making with the engines, and which describes the boring of the steam cylinder for the Schuylkill engine, gives a very good idea of the state of mechanical knowledge in this country at that time. The Report states that—

"The large cylinder is cast in two pieces and united by copper, the joint being secured externally by a strong iron band of cast iron, eighteen inches broad, and weighing twelve hundred pounds. Seven thousand five hundred pounds of iron was used to make the cylinder; it is six and a half feet long, and about thirty-eight and a half inches in the bore; about three-quarters of an inch was at first to be cut away. Two men are required; one almost lives in the cylinder, with a hammer in hand, to keep things in order and attend to the steelings; the other attends to the frame on which the cylinder rests, which is moved by suitable machinery; these hands are relieved. The work goes on day and night. One man is also employed to grind the steelings; the work only stands at dinner, and whilst the steelings are being changed, which requires about ten minutes time, and in ten minutes more are dull. I examined some, and found them worn an eighth of an inch in that time. Three steelings, which are about three and a half inches on the edge, are fixed in the head piece at one time; the head piece is a little less than the diameter of the cylinder, and six inches thick, secured on a rod of iron eight inches diameter, which forms the shaft of the water wheel. The workmen state that the boring was commenced on the 9th of April, and has been going on ever since, about three months, and that about six weeks more will be required to finish it."

"Eight or ten hands are employed on the fire box of the boiler; the wrought plates of which it is made are imported from England, are thirty-eight by thirty-two inches; that made in this country is clumsy stuff, of different sizes, the largest being thirty-six inches by eighteen."

This cylinder, after all the labor upon it, proved to be at least three-eighths of an inch larger diameter in the middle of its length, than it was at the ends. What a contrast does this present to the casting and boring done at the present day. I am informed that the cylinders for the Ericsson Caloric engine, eleven feet diameter, and about seven feet long, were bored complete by Messrs. I. P. Morris & Co., of this city, in something less than ten days time.

For the Journal of the Franklin Institute.

James Millholland's Improved Locomotive Boiler; Patented Feb. 17, 1852.
(With a Plate.)

Within the past few years, the attention of locomotive builders has been directed to the accomplishment of some plan for the economical and efficient combustion of anthracite coal in locomotive boilers.

Plate VIII. is an accurate engraving of Mr. Millholland's boiler as constructed for this purpose, and now in use on two passenger engines belonging to the Philada., Reading, and Pottsville Railroad Co. The main features of this boiler are, the use of "dust-plates," contracting the area of grate, and intended to prevent overheating on the sides of the fire box; and an intermediate, or mixing chamber, into which the flame and gases