Chesapeake & Delaware Canal Pump House
Chesapeake City
Cecil County
Maryland

HAER No. MD-39

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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Department of the Interior
Washington, D.C. 20240

HISTORIC AMERICAN ENGINEERING RECORD

# Chesapeake & Delaware Canal Pump House

HAER No. MD-39

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| Location: | South side of Chesapeake & Delaware Canal, Chesapeake City, Cecil County, Maryland<br><br>USGS 7.5 Minute Series - Elkton, Maryland<br>UTM Coordinates: 18.430625.4375400 |
| Dates of Construction: | 1851-1854 |
| Engineers/Builders: | Samuel V. Merrick, John H. Towne |
| Present Owner: | Commander<br>U.S. Army Corps of Engineers<br>Philadelphia District<br>Custom House<br>2nd & Chestnut Streets<br>Philadelphia, Pennsylvania 19106 |
| Present Use: | Maintained as a museum, open to the public, by the Philadelphia District, U.S. Army Corps of Engineers. |
| Significance: | The two high-pressure, single cylinder beam engines, built by Merrick & Sons of Philadelphia, are the earliest American built stationary steam engines on their original foundations in the United States. The arrangement of the steam engines driving a 39 foot diameter lift wheel that supplied water to the summit level of the Chesapeake & Delaware Canal also is unique. The physical plant, consisting of the steam engines, lift-wheel and the buildings that housed them, is essentially complete (except for the boilers that supplied steam to the engines), and represents an innovative 19th century engineering design. |
| Transmitted by: | Eric DeLony, Principal Architect, HAER, 1984. |

In Chesapeake City, Maryland stands a unique structure representing 19th-century American civil, mechanical and hydraulic engineering. Robert Vogel, Curator of the Smithsonian Institution's Division of Mechanical and Civil Engineering, stated in a 1974 letter to Robert Howard of the Hagley Museum:

> "...the two Merrick engines are quite clearly the earliest American stationary steam engines extant on their original foundations, and the building and machinery as a whole quite likely constitute the earliest standing pumping station in the Nation with its principal elements essentially intact."

For nearly seventy years these engines, powering a 39 foot diameter by 10 foot wide scoop wheel, lifted water from Back Creek into the Chesapeake and Delaware Canal. The principle used was simple. The powerful engines (300 horsepower combined) turned a wooden scoop wheel which dipped its buckets into a reservoir at a lower level and dumped its contents into the canal at an upper level. This system of lifting water was also used with great success in draining the English Fenlands. The basic principle also was used by the Chinese and Egyptians. However, at the time of its introduction in 1851 at Chesapeake City, it was, and would remain, the only device of its kind in the United States.

For over twenty years, from the opening of the Chesapeake and Delaware Canal in 1829 to the installation of the scoop wheel and engines in 1851-4, the problem of replacing water lost from the canal summit due to locking, leaks and evaporation, was not successfully solved. In 1848 the directors of the canal company decided to sponsor a contest to attract the best design for a steam operated pump to correct this problem. Fifty plans were submitted and after much consideration the choice was narrowed to two.

One plan called for a lift pump similar to one already in use at the United States Navy Dry Dock in Brooklyn. The other was an unusual proposal submitted by Samuel V. Merrick and John H. Towne of Philadelphia for a scoop wheel powered by a steam engine. Further evaluation and study eliminated the pump as being too expensive to construct and maintain. Therefore, in 1851 the firm of Merrick & Sons of Philadelphia was awarded the contract to supply the scoop wheel and steam engine for a price of $22,000.

Merrick's engine, a high-pressure, single-cylinder beam engine with a 36 inch bore and 7 foot stroke, was installed along with a wooden scoop wheel, 39 feet in diameter and 10 feet in width, containing twelve buckets. In July 1853, the official test was conducted and the results showed that the wheel delivered 227,160 cubic feet of water per hour with the wheel working at two revolutions in 55 seconds and the engine turning at 21 revolutions per minute. The results exceeded the contract's requirements. Before long it was found that one engine was not sufficient to supply water for all conditions. In 1854 Merrick installed another engine, with improved valve gear, to correct the problem. In 1856 the scoop wheel was replaced with a sturdier model at a cost of $6,000.

With the opening of a lock-free, sea-level canal in 1927 the Pump House ceased operation. Since that time the wheel and engines have continued to be a focus of interest for historians, industrial archeologists and engineers studying America's early industrial and engineering heritage. In 1965 the Pump House was designated a National Historic Landmark by the Secretary of the Interior and in 1975, it was designated a National Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers (ASME). For nearly fifty years the Pump House has survived scrap drives, modernization and the ravages of the elements because of the vision of the Army Corps of Engineers. The Corps currently maintains a museum of the Chesapeake and Delaware Canal at the site and the scoop wheel and Merrick engines are open for viewing by the public.

# AN ENGINEER'S MISCELLANY

*By*

GREVILLE BATHE
*Co-author of*
OLIVER EVANS
*A Chronicle of*
*Early American Engineering*



*From the Press of* PATTERSON & WHITE COMPANY
In Philadelphia, *at Sixth and Cherry Streets*
1938

# IX

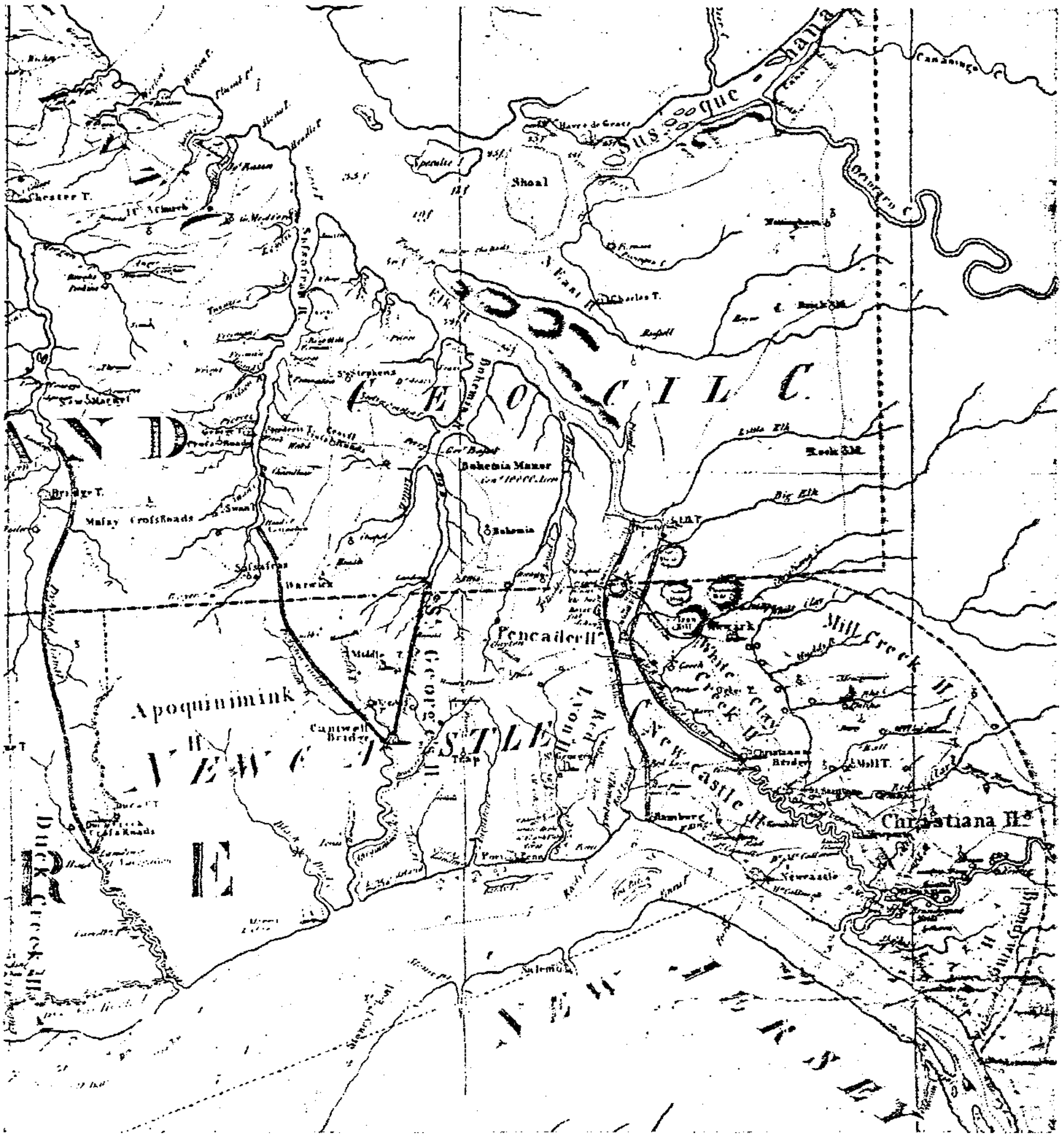
# The Lift Wheel Pumping Plant of the Chesapeake and Delaware Canal

## HISTORICAL SYNOPSIS

THE Chesapeake and Delaware Canal connects the lower part of the Delaware River with the upper end of Chesapeake Bay, using here a part of the Elk River which goes northeast as far as Welsh's Point. At this point the channel turns almost due east into a tributary of the Elk called Back Creek. After travelling some three miles, the western end of the canal is reached at Chesapeake City. There was a deep lock of 14 feet lift here until 1926 when it was removed to make way for the new dredging operations. Just inside the western entrance on the south bank stands the old stone engine house containing a pair of beam engines which in the past drove the lift wheel.

The first proposed route of the canal had been tentatively surveyed as early as 1764–1769 by a committee delegated by the American Philosophical Society at the request of sundry merchants of Philadelphia. The committee suggested in 1769 "that the same might be done in several places, but particularly between the heads of the Bohemia River and a branch of the Apoquinimink called Drawyer's Creek about 3¾ miles," but nothing more was done in the matter until an effort was made to revive the project in 1784, and although a corporation was formed in this year to take care of the construction, it accomplished nothing and fell into bankruptcy sometime before 1799.[1]

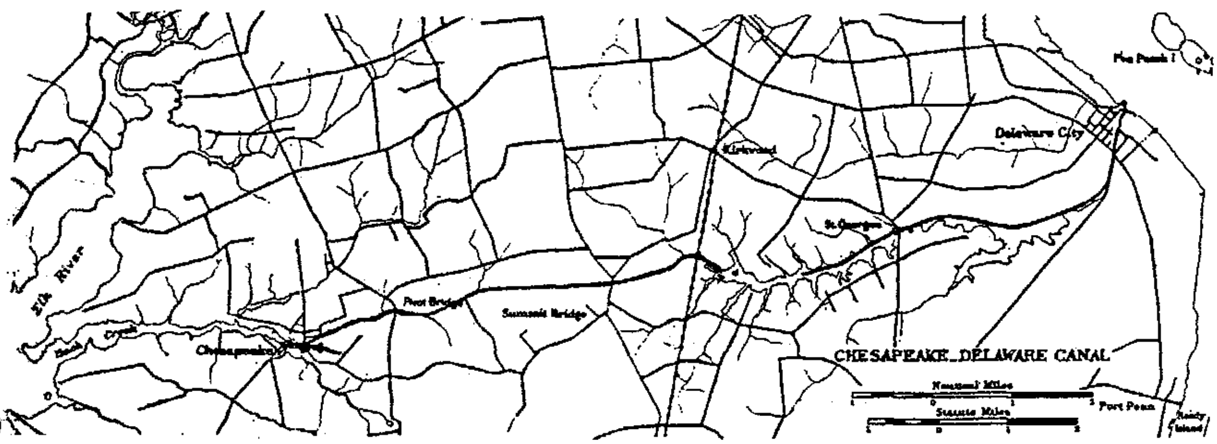
[1] Up to 1799, there had been five major surveys made (Plate I). They were as follows: Using a part of Duck Creek on the Delaware River, then west into the Chester River. The second proposed route was by using the Apoquinimink Creek to Cantwell Bridge, then southwest into the head waters of the Sassafras River. The third suggestion was the shortest as far as the actual digging was concerned; this was by using the Apoquinimink as before but going west into the big branch of the Bohemia River. The fourth survey and considered the best at the time, was from Hamburg, afterwards renamed Delaware City, then into the upper end of the Elk River and coming out at Frenchtown. The fifth survey was the one advocated by Benjamin Henry Latrobe. In a




Early surveys for the Chesapeake and Delaware Canal
as shown on a map by Francis Shallus, 1799

# Pumping Plant of the Chesapeake and Delaware Canal

The problem of getting the three states most vitally interested, Pennsylvania, Delaware and Maryland, into an agreement was the greatest difficulty the canal project had to face, but by 1802 things had been adjusted and the states chartered a corporation and shortly after, $400,000 was subscribed, but before very long the stockholders realized that $100,000 had already been expended merely in surveying and buying up water rights, so they refused to meet further assessments and appealed to the three states to help them out. They received nothing, however, but kindly good wishes; as a result further work on the canal abruptly came to an end.



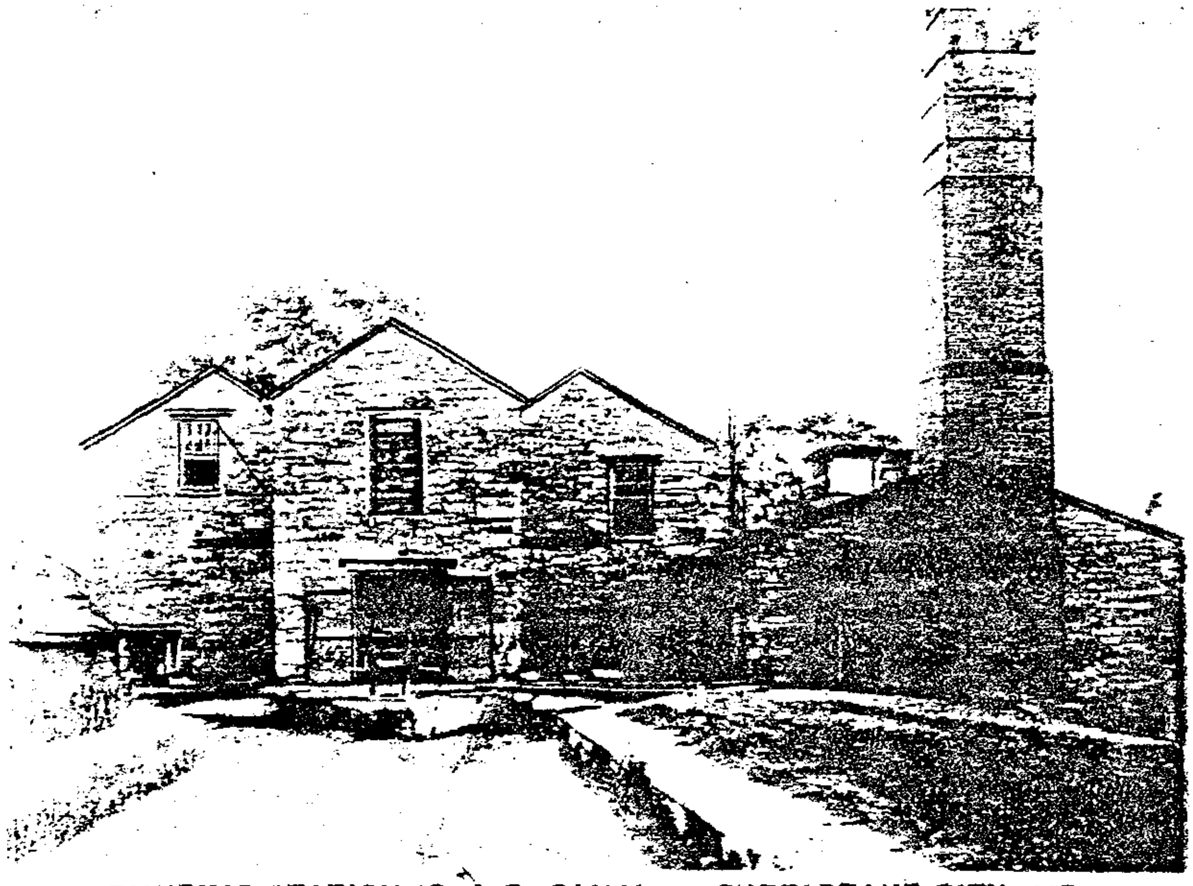

Route of the Chesapeake and Delaware Canal up to 1926
Arrow indicates the Pumping Plant

Not until 1822, was another movement started to complete the work with a new board of directors and a fresh survey. The estimate this time was more than double what it had been before. Again the states were approached and the following sums were this time granted: Pennsylvania $100,000, Maryland $50,000 and Delaware $25,000. The Federal Government added a further comfortable sum of $300,000 so that on the strength of these amounts, and a growing enthusiasm in the public mind for canal transportation, a further sum of $525,000 was raised by popular subscription and the completion of the project seemed assured, and on this basis digging was commenced on April 15th, 1824.

The biggest work on the canal was in the deep cut four miles from Chesapeake City going east. By 1828, nearly seven miles on the Delaware River end had been completed and was in use. Towards the end of 1829, water was permitted to enter the deep cut and by 1830, the canal was finished, being thirteen and five-eighths miles long, with three locks. One of these was at Delaware City and the second

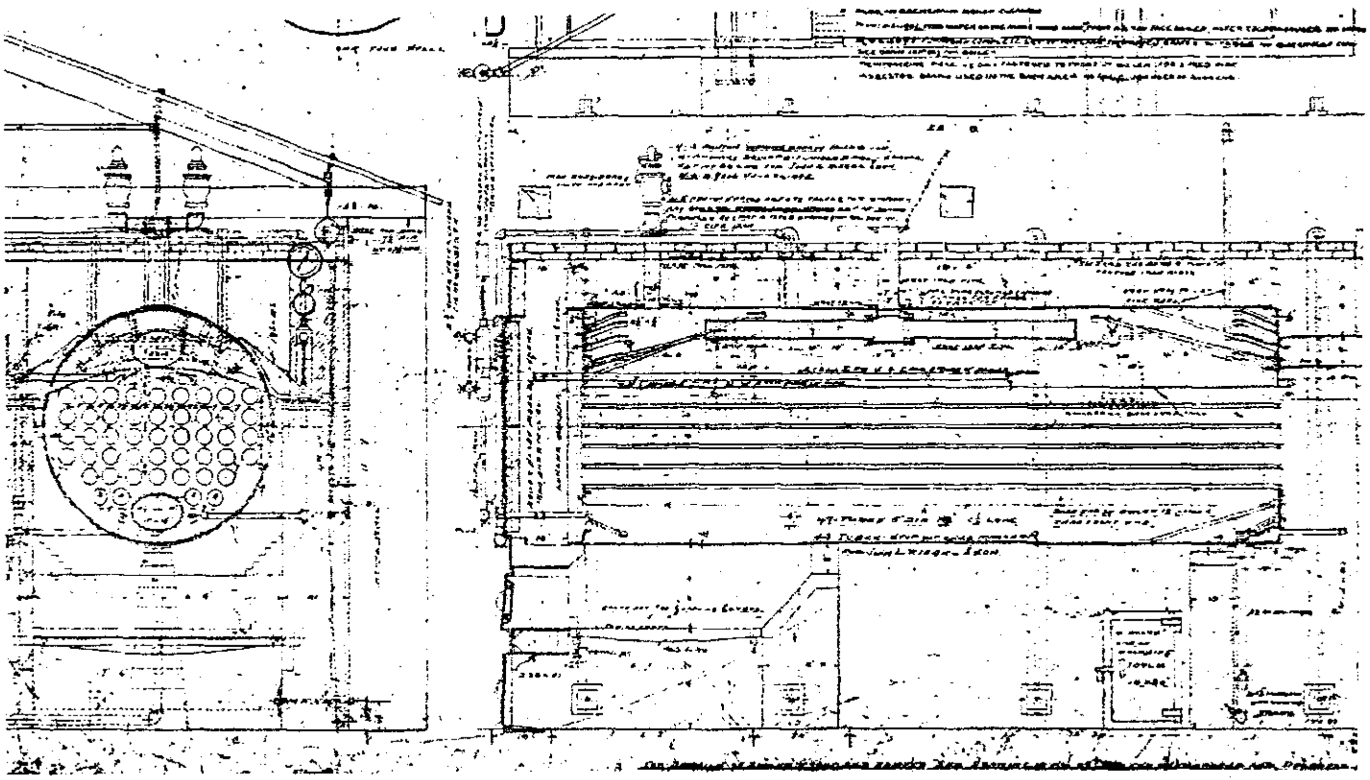
letter to Albert Gallatin, Secretary of the Treasury, dated April 1st, 1808, Latrobe suggests using the Christiana River up to the bridge and then cutting through into the big branch of the Elk River, using the Red Clay and White Clay Creeks as feeders for the canal. Not until 1822, was the present route of the Canal considered and adopted.

PLATE II



PUMPING STATION, C. & D. CANAL. CHESAPEAKE CITY. MD.

Early photograph of about 1880



Boilers made for the Chesapeake and Delaware Canal in 1894,
by Pusey and Jones Corporation, Wilmington, Delaware

*Drawing reproduced by courtesy of this firm* at St. George's and the third at Chesapeake City, as before mentioned. Between the two latter locks including the deep cut was the highest lift. Here it was found necessary later on to install a steam pump to assist in replacing the water lost by opening and closing the locks.

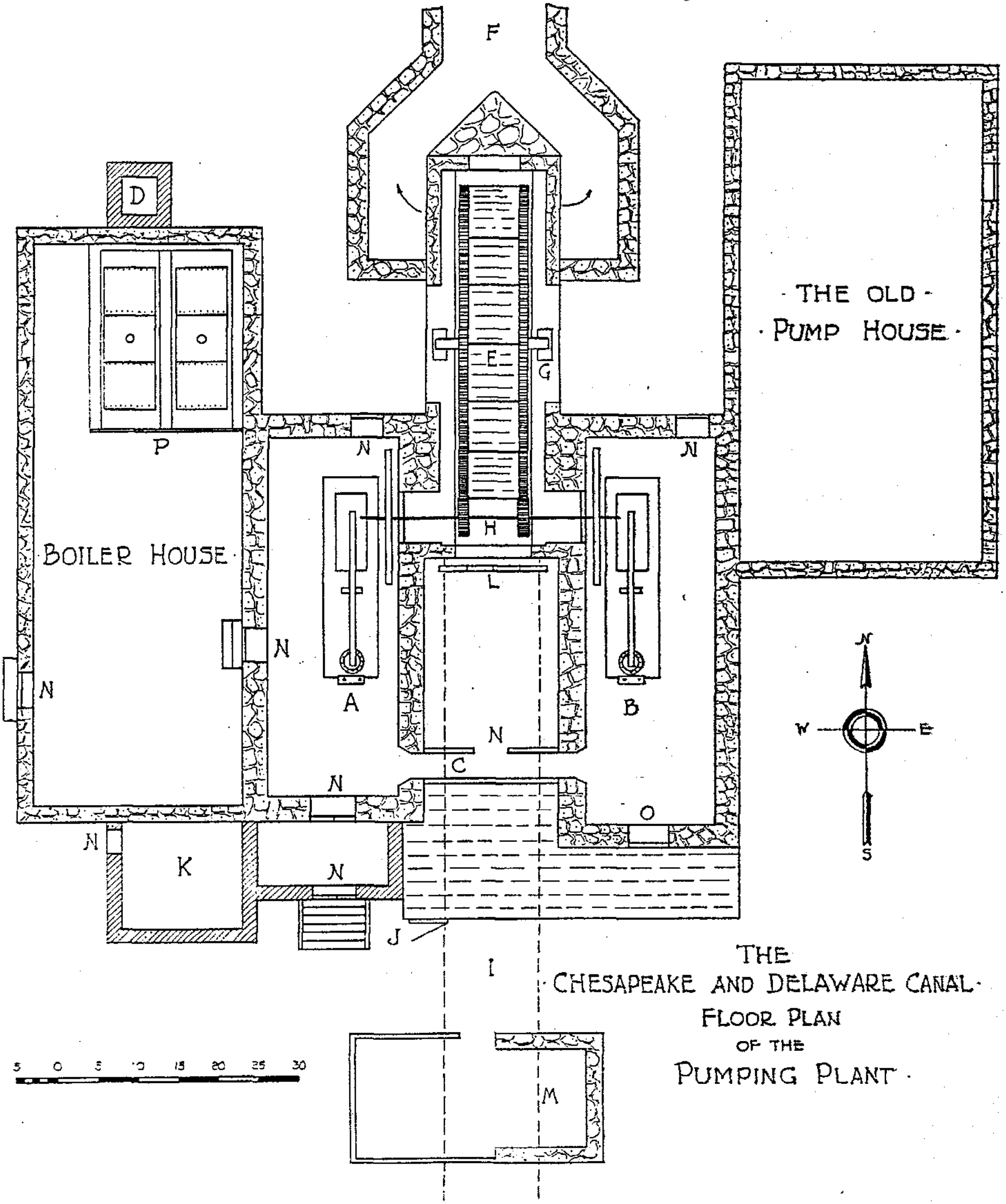
The actual cost of the canal was two and one-quarter millions of dollars and was said to have been the most expensive canal project of its day. On each side of the canal was the usual tow path and horse and mule tows could still be seen on the paths up to about 1902. As early as 1871, it was proposed to make the canal a national waterway, and the stockholders were more than willing to sell out to the government. Finally in 1919, the Federal Government purchased the canal from the holding company at considerably more than it had originally cost to build. The government very shortly proceeded to dredge it out to form a sea level canal with ninety feet width on the bottom and designed to carry a draft of 12 feet at low water. The three old stone locks were removed during the winter of 1926, after the final dredging of the canal was completed. As the pumping plant was then of no further use it was shut down,[2] though the buildings were restored and the machinery was allowed to remain. However, the boilers were removed and the boiler house is at present used as a garage by the Army Engineer Department which now controls the canal.

## BUILDINGS AND MACHINERY

The engines, as they now remain in the original stone buildings (Fig. 1), were not the first used to supply the locks with water; there was a previous engine which dated from 1837. This original engine as described by Mr. Toward Loraine,[3] the retired chief engineer of the canal, was, as far as he can remember, a large horizontal pumping engine, the cylinder and pump of which were in line on the same rod but with a fly-wheel and crank to measure out the stroke. This was housed in the

[2] The writer paid a visit to the pumping plant in 1925, and saw it under steam. The day is well remembered for it is recorded in our cruise log for that year while we were on a boating trip to Annapolis, as being Sunday, September 6th. At the time of this inspection, it was noted casually that the valve mechanisms were suffering from long years of use and that even careful nursing could not hide the hesitating gait of these elderly engines in their declining years.

[3] Mr. Toward N. Loraine was born in 1862, and was, up until his retirement in 1927, chief engineer of the canal. Starting as a water boy at the pumping station in 1876, he became a coal passer at 16 and worked at this job for thirteen months. In 1879, Mr. Loraine became a journeyman mechanic for five years to gain a thorough knowledge of general engineering. On his return to Chesapeake City in 1884, he was made assistant engineer and in 1900 took full charge of the entire canal as its chief engineer. The white house shown in the general view of the pumping plant is where Mr. Loraine was born and was originally built for his father who had been sent from Merrick and Sons in Philadelphia to erect the first of the beam engines in 1852. The canal company, however, persuaded him to remain on as chief engineer, which he did until his death.




THE CHESAPEAKE AND DELAWARE CANAL
FLOOR PLAN OF THE PUMPING PLANT

*Drawing by the Author*

## KEY TO THE FLOOR PLAN OF THE POWER HOUSE CHESAPEAKE AND DELAWARE CANAL

A—Engine with the Stevens valve gear.
B—Engine with the Sickels cut-off gear.
C—Alleyway connecting the two engine rooms.
D—Brick chimney.
E—The lift wheel.
F—Race leading to the canal.
G—Axle of the lift wheel.
H—Driving shaft connecting the engines.
I—The well tunnel from Back Creek to the sluice gates.
J—Steps leading down to the Sewell pumps.
K—Present heating plant for the garage.
L—Sluice gates controlling the flow of water to the lift wheel.
M—The old blacksmith shop.
N—Various doors.
O—Door now converted into a window.
P—Site of the steam boilers.

NOTE—Only the boilers supplying steam for the beam engines were housed in this building. The boilers for the first pumping engine were installed in the stone building referred to as the Old Pump House.

FIG. 1
The Pumping Plant from the South

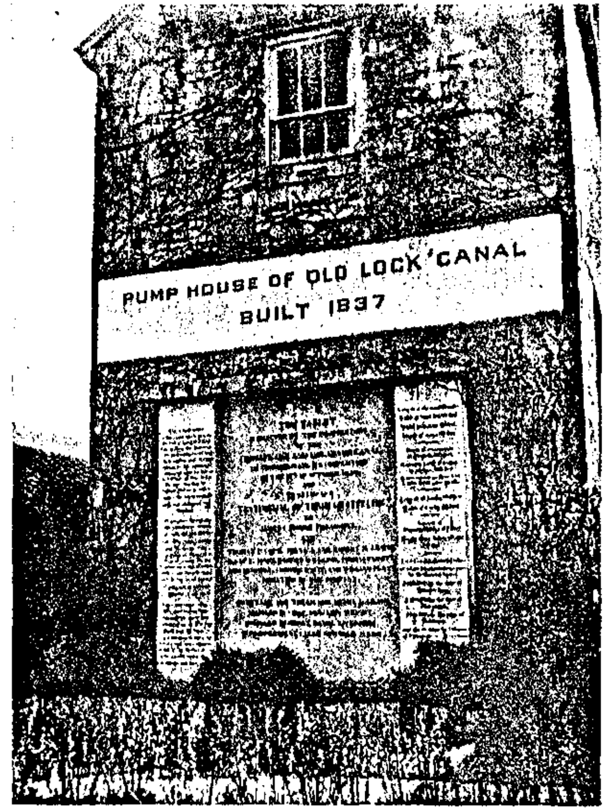



FIG. 2
Commemorative Tablet on the Wheel House

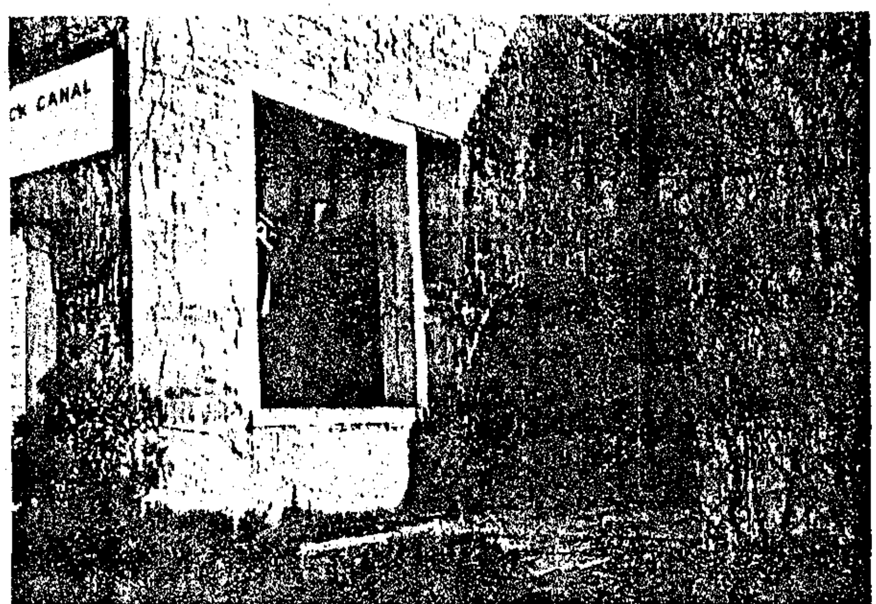


FIG. 3
The old discharge port of the Wheel

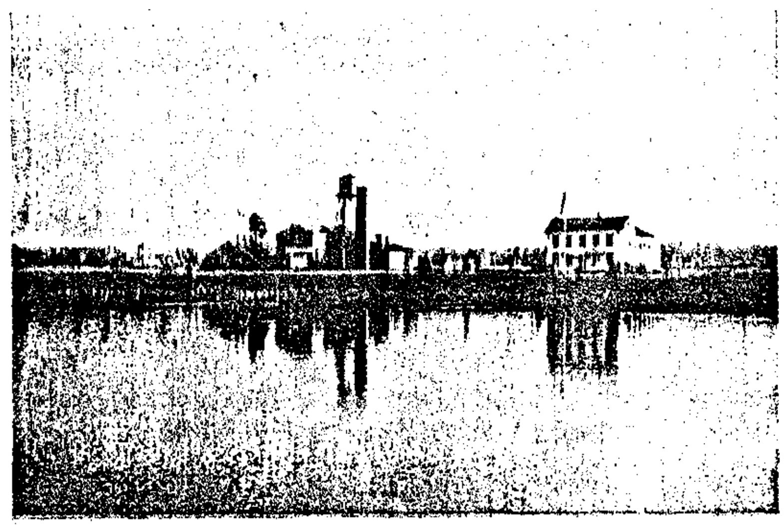


FIG. 4
The Pumping Plant Administration Building

building on the east side of the present engine house and Mr. Loraine says that as a boy he used to play over it as it lay dismantled in the yard.

In the early days of the canal's operation, water was supplied by several small feeder canals. These and this early steam pump were capable of taking care of the water lost through the opening and closing of the lock gates.

By 1850, the increasing water borne traffic taxed the original steam plant beyond its capabilities and it was decided to install a water wheel, similar to those then in use in the Fens districts of Lincolnshire in England. The water had to be lifted fourteen feet and a wheel was constructed 40 feet in diameter having 12 curved buckets of wood 7 feet 3 inches wide with 13 inch openings at the lips. This wheel with its massive wooden spokes and hub, turned on an iron axle 11 inches at the journals. The bucket boards are made of white pine, tongued and grooved, averaging 10 inches wide by 1¾ inches thick. A considerable amount of iron bracing entered into the construction as the weigh of water to be lifted was enormous—130 tons per minute at 1-1/3 revolutions of the/ Around the periphery of the /wheel. wheel, one on each side, are the cast iron gears that engage with the two pinions (Fig. 6) on the engine shaft. These two gear rings are 12 inches wide on the face with the teeth spaced 4 inches apart. This ring of teeth is cast in twelve segments, each of which weighs 1860 pounds. The wheel itself is housed in a stone well 10 feet 8 inches wide and 22 feet deep. The well was fed by water through a stone tunnel from Back Creek which runs just behind the engine house. The water raised and delivered from the buckets passed out from each side (Fig. 3) of the wheel house into two open conduits which united and discharged into the main canal.

When this wheel lift was first planned, only one engine was considered necessary for the work and a condensing beam engine with Stevens wiper gear[4] was bought from Merrick and Sons, owners of the Southwark foundry[5] at Washington and Federal Streets in Philadelphia.

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[4] The poppet valve steam engine with one eccentric to open and close the four valves, was first used by Robert L. Stevens in 1828 on the steamboat *New Philadelphia*. In 1841 Francis Bowes Stevens, a nephew of Robert L. Stevens, patented an improvement on this by which two eccentrics instead of one were used which enabled the two steam valves to be opened and closed independently of the exhausts. On the Stevens engine under notice, the simplified gear is used, with only one eccentric.

[5] The Southwark Foundry was started by Samuel Vaughan Merrick in 1836, as a foundry for castings only. It quickly developed into a first class manufactory of machinery of all kinds. In 1858, the buildings alone occupied a space of sixty-three thousand six hundred and fifty square feet. This firm was one of the first to use the Nasmyth steam hammer in their smiths shop in 1842, and by 1858, they then had two, one of 10 cwt. and one of 5 cwt. The boring mill was able to bore steam cylinders 11 feet in diameter and 14 feet long. The firm also had an immense planing machine capable of machining work 8 feet wide, 30 feet long and 15 feet under the tool. The regular staff averaged 350 to 500 workmen.

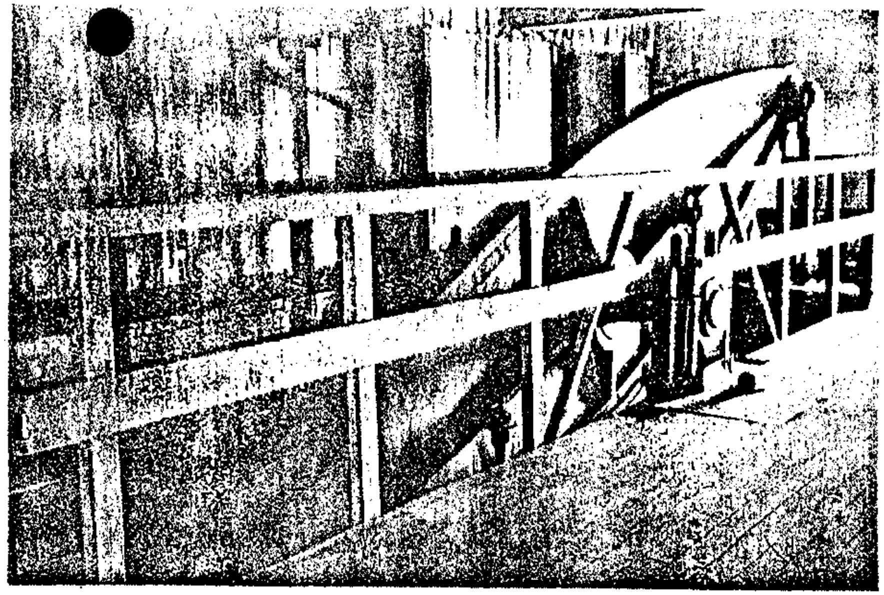

Fig. 5
Beam of the Engine with the Stevens Valve Gear

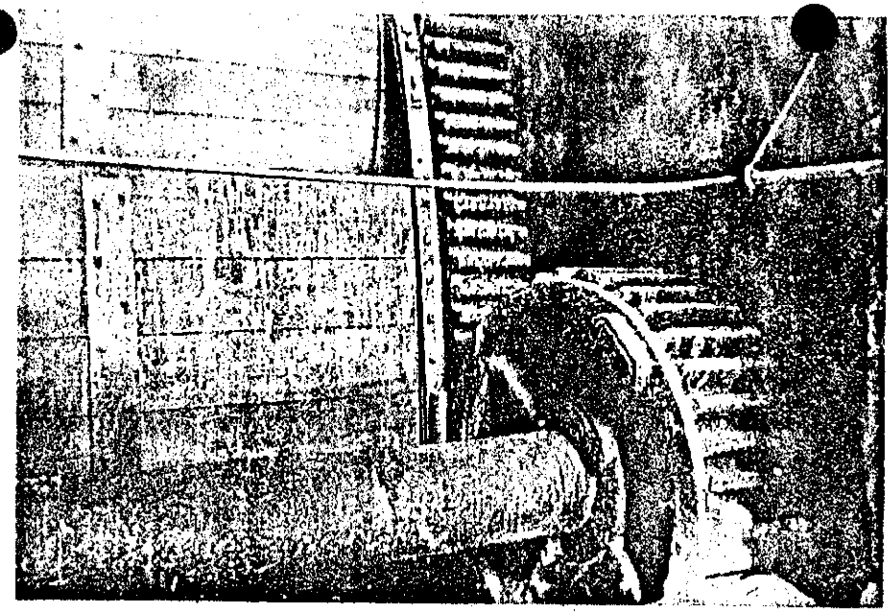

Fig. 6
One of the Pinion Wheels driving the Liftwheel

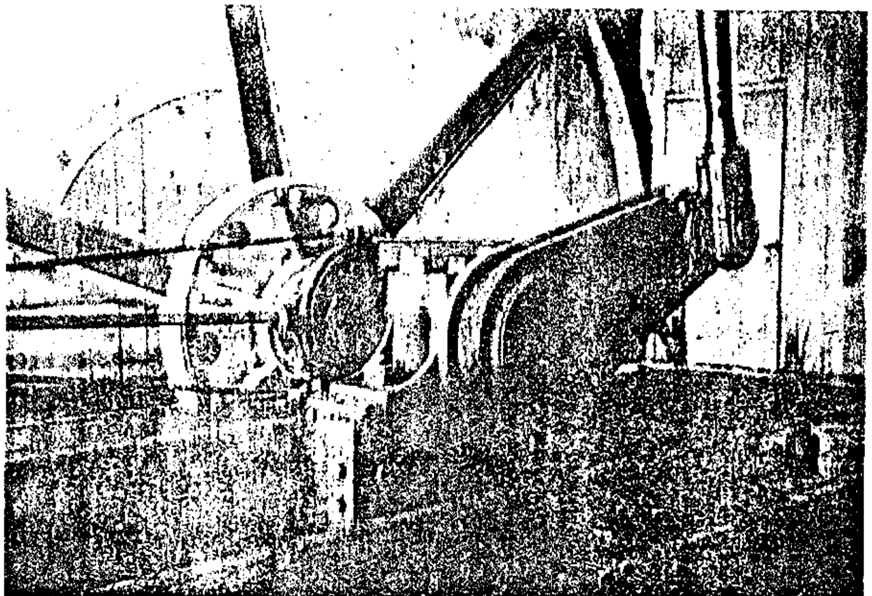

Fig. 7
The Crankshaft of the Engine with the Sickels Valve Gear

# Pumping Plant of the Chesapeake and Delaware Canal

In 1852 this engine (Fig. 8) was erected in the stone building which is shown on the left of the ground plan, at letter A. It was then coupled to a shaft of 13 inches diameter that carried the two cast iron pinions, each weighing 3360 pounds, with half shrouded teeth 14 inches wide and 54 inches diameter, which drove the lift wheel. The engine was capable of producing one hundred and seventy-five horse-power, but it was found that one engine alone was inadequate for turning the wheel under all conditions of tide and winter weather. A second engine was contracted for from the same firm in 1854, and during that year another engine house was built at the right of the lift wheel. The pinion shaft was extended to couple onto the new engine. This engine was of identical construction to the first one except that it had the Sickels expansion gear.[6] This valve gear (Fig. 11) was especially adaptable to the beam engine. The release catches for the steam valves were operated from the cylinder end of the beam by means of a long lever and rod operating on the sleeve of the wiper shaft. This enabled the steam valves to be dropped back onto their seats at any point during the revolution of the crank, thus cutting off the steam and allowing expansion to continue on during the power stroke. The economy in working with this gear was very marked by comparison with the Stevens gear (Fig. 9) used on the first engine. The two exhaust valves

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[6] Frederick Ellsworth Sickels of New York patented May 20th, 1842, a trip valve gear or cut-off, specially applicable to the poppet valve type of steam engine. Sickels designed this gear in 1841, while still an apprentice at the Allaire Works in New York. Peter Hogg, also of New York, claimed in 1844 that he had used a similar gear on a steamboat about 1840, but could not prove his case. The cost of fitting the Sickels gear to an existing engine was $250. The special advantages of this gear were the use of dash pots to return and ease the valves to their seats. These were placed in the bonnets of the valve chests and at first water was used to cushion the pistons of the dash pots, but shortly afterwards, oil was permanently adopted for this purpose. Sickels' patent was adapted to stationary engines by Thurston, Greene and Company, Providence, R. I., Merrick and Sons of Philadelphia, and others. Apart from this invention, Sickels was an engineer of much personal ability, but his professional reputation received a severe setback through his choice of Edward N. Dickerson, a patent attorney, as a partner. Dickerson, through influence, had secured the designing and superintendence of the engines of the U. S. warship *Pensacola* in 1858. Sickels unfortunately allowed his partner too free a hand and so many fantastic mechanical details were incorporated into the machinery that it was the despair of the engine room staff. One of the *Pensacola's* engineers, Robert Weir, suffered long but not in silence, for he wrote and illustrated a satire on Dickerson and Sickels' engines that completely blocked all further opportunity for the Sickels gear being used in the navy. A sample of Weir's literary humor is worth quoting:

"The D———n dash-pots are gleaming like gold,
And are brimming with oil as full as they'll hold;
Neither odor nor sheen more delightful could be—
They are pungent to smell and refulgent to see.
Diddle dol dee diddle dol dee
O the D———n dash-pot's the dash-pot for me."

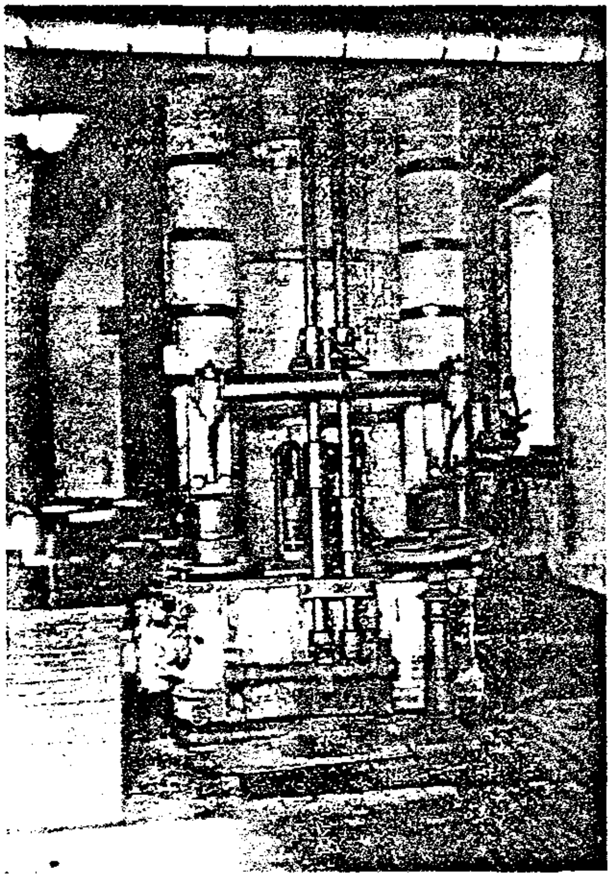

FIG. 9. The Stevens Gear and Valves

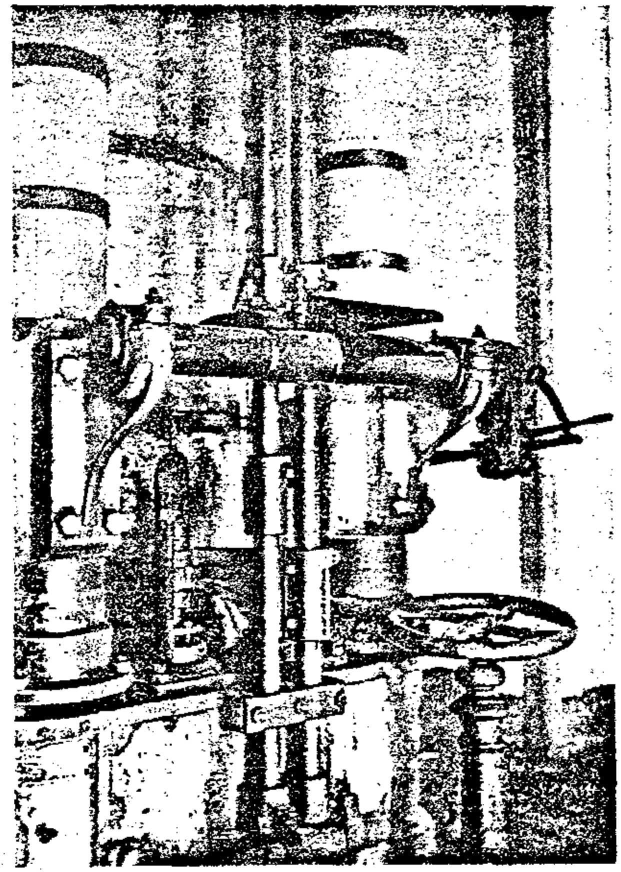

FIG. 10. Detail of the Stevens Gear

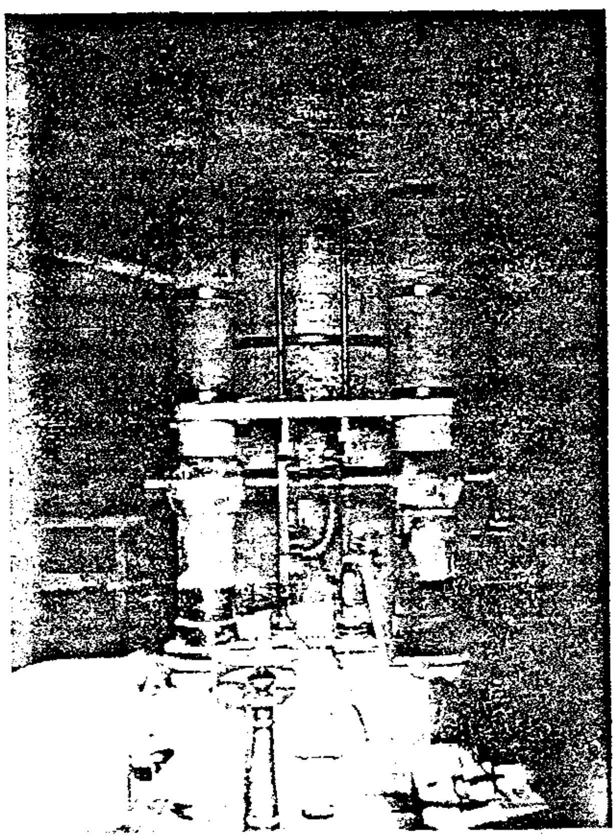

FIG. 11. The Sickels Gear and Valves

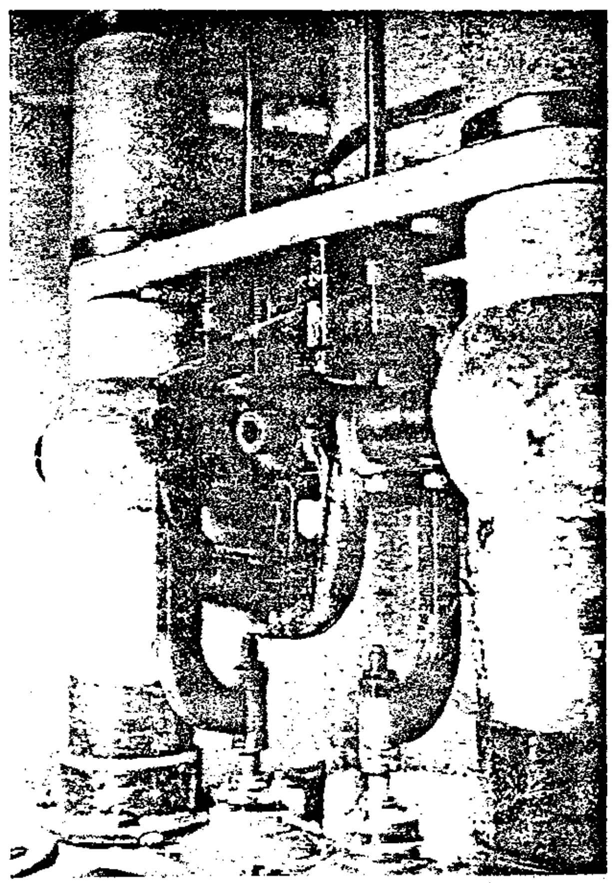

FIG. 12. Detail of the Sickels Cut-off and Trip Gear

*Photography by A. Williams Postel*

were operated in the ordinary way as in the Stevens gear, from an eccentric on the crankshaft. The engines were started by "barring them over." This was done by using a long iron bar thrust into a lower horizontal shaft having two small cams which alternately lifted first one pair of valves and then the other. The eccentric gab end was lifted off the arm of the wiper shaft temporarily until the engine was under way. The specifications and dimensions of these engines are as follows:

| | |
|---|---|
| Length of bed-plate | 25 feet 6 inches |
| Width of bed-plate | 7 feet 3 inches |
| Total height of engine, from top of bed-plate to top of beam | 19 feet 3 inches |
| Total length of beam | 20 feet 4 inches |
| From center of gudgeon to piston rod and also center of connecting rod | 9 feet 4 inches |
| The beam gudgeon | 9 inches diameter at center and 5½ inches diameter at journals |
| Outside length of cylinder | 8 feet 1 inch |
| Outside of cylinder lagging | 43 inches diameter |
| Diameter of cylinder bore | 36 inches |
| Stroke of piston | 7 feet |
| Diameter of piston rod | 4 inches |
| Diameter of fly-wheel | 18 feet |
| Diameter of crankshaft | 11 inches |
| Connecting rod centers | 16 feet 1½ inches |
| Largest diameter of connecting rod | 6 inches |
| Air pump piston | 24 inches diameter x 36 inches stroke |
| Air pump cover over condenser | 48 inches diameter |
| Plunger of feed pump | 4¼ inches x 36 inches stroke |
| Diameter of cast iron steam pipes | 9½ inches outside |

The first boilers used to supply steam for these engines were ordinary riveted wrought iron tubes 40 feet long and about 5 feet diameter. set in brick work and under-fired, similar to those invented by Oliver Evans in 1805, and later, in 1814, adopted by him for use with all his high pressure steam engines. These plain cylindrical boilers were in use up to 1865, when they were replaced by a pair of locomotive boilers which did duty until 1894 when, due to corrosion and a general thinning of the plates, they were discarded in favor of a pair of round return tube boilers (Plate II) supplied by Pusey & Jones of Wilmington. These boilers were set in fire brick with cast iron fronts and doors. They were fired by two furnaces under each boiler, the flames passing to the dry back in the rear, thence returning through forty-seven tubes of 5 inches diameter to the front end. The gases then passed along the upper sides of the boiler and so out to the stack. A reference to the plan, and some general dimensions that follow, will indicate the general layout of the boilers which were the last used for supplying steam to the old engines.

| | |
|---|---|
| Total length of the two boiler casings | 22 feet 8 inches |
| Width of the casing | 19 feet 6 inches |
| Height of the casing | 11 feet 9 inches |
| Diameter of each boiler | 6 feet |
| Length of each boiler | 18 feet |

Shell built in 3 sections of 7/16-inch plate with triple riveted butt joints and 7/8-inch rivets.
The other laps were only single riveted.
There were four safety valves set to blow off at 50 pounds.

| | |
|---|---|
| Heating surface for the two boilers | 2616.94 square feet |
| Grate area of each boiler | 65 square feet |
| Water capacity of each boiler | 432.92 cubic feet |
| Required horse-power of each boiler was | 174.46 |

Fuel used was buckwheat coal.

These boilers continued in use until the final shutting down of the pumping station in 1926. They were capable of producing 500 horse-power, but the steam pressure required for the engines was only 45 pounds per square inch, a modest pressure which was never exceeded.

Averaging some 71 years of useful life, these old beam engines proved very reliable. The cylinders have only been rebored once, which was done by the Port Richmond Iron Works[7] in Philadelphia during Mr. Loraine's tenure as chief engineer. On one occasion the pinion shaft driving the lift wheel broke in two, due to ice formation which jammed up the wheel in the well pit. Of tragedy, there is only one event recorded. In 1854, during the erecting of the second engine, the tackle holding up the cylinder head gave way and a workman named Wiley, who was working on the piston, was decapitated.

Some interesting mechanical peculiarities in these early engines may be noted here. The cast iron engine beams (Fig. 5) have flat wrought iron straps 6 inches wide and 2 inches thick shrunk on their outer edges. One of these having come loose, iron wedges have been inserted here and there. It might be inferred from this repair that the beam developed cracks under work, probably after the ice jam in the well pit, when everything was brought up standing. The same method has been used on the crank-arms which are also of cast iron, 2 feet in diameter at the shaft, and 8 inches wide, each crank (Fig. 7) having two wrought iron bands shrunk onto them. It was also noticed that both of the bed-plates had cracked under the crankshaft pedestals, as iron plates were bolted on here to

[7] The Port Richmond Iron Works was founded by Levi Morris and Company in 1828, at Market and Schuylkill Seventh Street. In 1846, the firm moved down to the Delaware River on Richmond Street. Freedley says in his *Philadelphia and its Manufactures*, 1858, that this company had "a boring mill possessing also the qualities of a horizontal lathe which will bore out a cylinder 16 feet in diameter and 18 feet long."

strengthen this part. Another peculiarity is the construction of the fly-wheels which are built up from a number of separate castings, viz. keyed to the shaft is the hub with a large flange to which are bolted the six spokes of the wheel. The rim is formed of six unturned segments, the flat of each spoke holding these together at their joints by large bolts and nuts. As the engine only turned over at 13 revolutions per minute, this piecemeal method has undoubtedly served its purpose.

The parallel motion used so exclusively on contemporary beam engines of British construction, is missing here. In fact, it never had any vogue in America. A pair of slide bars is used to guide the piston rod, and two links connect the crosshead (Fig. 5) to the beam, evidently a satisfactory method, for on these particular engines very little wear was noticeable on these parts.

The pedestals for the main gudgeon of the beam are bolted to a cast iron entablature, supported from the bed-plate by two cast iron fluted columns (Fig. 8) of somewhat classical design, 12½ inches in diameter. The end bracing of this entablature is secured by tie rods through the engine house walls which are of granite 38 inches thick.

The air pump rods are fixed at a point 41 inches from the main gudgeon, and on the engine having the Stevens gear, there is a boiler feed pump on the connecting rod end of the beam. The cylinders, originally lagged with mahogany wood, were subsequently sheathed in iron with brass bands.

Situated in a small brick building between the two engine houses, and several feet below the level of the ground, is a pair of direct acting Sewell steam pumps.[8] These pumps appear to have been installed some ten years after the erection of the engines for the purpose of more efficiently circulating cold water to the condenser cisterns. They also fulfilled the purpose of emptying the wheel pit when repairs to the lift wheel had to be made. Mr. Loraine was unable to tell just when these were first used, but remembers that they were in operation when he was a boy. These auxiliary pumping engines are of curious design, being about 8 feet 3 inches over-all, and have a fly-wheel of 4 feet diameter, and the crank measures out the stroke of the pumps. These pumps are double acting with 12 inch pistons. The steam cylinders appear to be 18 inches in diameter and an ordinary three port slide valve is used, being driven from a small crank on the end of the main crankshaft. So cramped were the surroundings that it was found impossible to photograph these engines.

[8] On each of the air vessels of these pumps is a cast plate which states that they are "Sewell's steam pump, patented 1862, Sewell and Cameron Union Steam Works, 22 and 2nd Ave., New York." William Sewell was by profession a steam engineer who entered the United States Navy in 1845. He was appointed one of the chief engineers in the newly created "Engineer Corps of the Navy" enacted in 1842, Sewell ranking third on the Commission List. In 1853, Sewell resigned and returned to his profession in civil life. About 1862, he entered into partnership with A. S. Cameron, a manufacturing engineer of New York, to build direct acting steam pumps. A patent under their joint names covering these pumps was granted May 10th, 1864.

# Pumping Plant of the Chesapeake and Delaware Canal

It would appear from the date of the Sewell pumps that for nearly ten years the steam engines must have obtained the water used for the condenser system from a portion lifted by the wheel. In their present state, the engines show no evidence of ever having had pumps worked off the beam.

With regard to the small plunger feed pump now remaining on one of the engines, this had probably not been used for thirty years and by now all the water connections and pipes have disappeared, but it must have served its purpose for nearly half a century.

Henri Giffard invented his injector for boilers about 1852, but it was many years after this before they were manufactured and sold by William Sellers and Company of Philadelphia under the inventor's American patents. It is recorded that after 1894 when the locomotive type boilers were installed at the pumping station, the Sellers injector formed part of the boiler equipment.

As this completes the description of the pumping machinery, a few details concerning the working of the locks may be timely. The lock walls, built of granite, were originally 22 feet wide by 100 feet long, but were later enlarged to 24 feet wide by 220 feet long to accommodate the increasing size of the steamboats that traversed the canal between Philadelphia and Baltimore.[9] On the low water side, facing down Back Creek, and also on the Delaware River end, an ordinary pair of swing gates with sluices was installed, but on the other end of these locks drop gates were used which lay flat on the bottom of the canal to allow the boats to pass into the locks. When ready, these were hoisted up flat against their vertical abutments by wire cables wound on drums. This machinery was worked by a small steam engine of 12 horse-power. The Chesapeake City lock, as before mentioned, had a 14 foot drop, so to save half the water when lowering boats into Back Creek, there was a sluice gate placed at the bottom of the lock that communicated with a receiving basin. When the water had fallen to half way, this sluice was closed and the outlets in the lock gates were used to drain out the remainder of the water. Then when the lock had to be filled, the receiving basin returned its water until the lock was half full, the receiving basin was then cut off and the filling of the lock was completed by water from the high level in the canal. At St. Georges, there was a 10 foot fall and at Delaware City only 4 feet.

The complete history of this pioneer canal would make a lengthy story, and in the past much has been written about its early promoters, builders and owners, but the mechanics of this old waterway have hitherto received but scant attention. Nevertheless this aspect of the canal was of paramount importance during its many years of successful operation.

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[9] The earliest steamboats to use the Chesapeake and Delaware Canal were the Ericsson Line of Steam Propellers, between Philadelphia and Baltimore. This company was chartered February 25, 1844, and commenced business with two vessels. By 1884, the line owned five boats. This pioneer service of freight and passenger vessels is still in active operation through the canal.