THE PROPOSED PNEUMATIC BALANCE LOCKS FOR THE ERIE CANAL.

The principles upon which the pneumatic balance lock is constructed are very simple, and may be illustrated by the experiments shown in the accompanying diagrams. If an inverted tumbler be held in a vertical position and pushed downward into a pail of water, the water, as everyone knows, will rise only a small distance within the tumbler, the elasticity of the contained air serving to exclude it. If all downward pressure be removed, and care be taken to maintain the tumbler in a vertical position, it will float. In this condition the air within the tumbler is compressed, and the pressure will depend upon the weight of the tumbler and the area of the surface of the water contained within it. If we take another inverted tumbler, similar in size and weight to the former, and depress it in the water, at the same time tilting it slightly, so that the contained air can escape and the water enter until only an inch or so of air space remains, and if we connect the air-space in the tumblers by a U-pipe, as in Fig. 1, we have exemplified the principles on which the balance lock operates.

If a weight be now placed on the elevated tumbler it will begin to descend, driving the air through the U-pipe into the depressed tumbler and causing it to rise, until the positions are reversed, as in Fig. 2. If the excess weight be transferred to the other tumbler, the air will be forced back through the tube and the tumblers will assume their former relative positions. If, however, we wish to secure the tumblers in the positions, Fig. 2, we can do so by admitting water into the bend of the U-tube, as shown in Fig. 3, for we shall then find that even if we transfer the weight to the elevated tumbler, it will fail to lower it, the water in the tube preventing the flow of the air. If, now, we wish to make sure that the elevated tumbler shall maintain its position at a predetermined height, we can provide a stop above it as shown, and introduce compressed air below it by means of a pipe (see Fig. 3). In this condition the difference of air pressure in the two tumblers will be shown by the difference of elevation of the water in the two legs of the U-pipe, and if there is no leakage of air in the pipes, the tumblers will remain in these relative positions indefinitely, even though the weight be changed from the depressed to the elevated tumblers as in Fig. 4, in which case all that is necessary to reverse the positions is to shut off the compressed air supply, and let the water out of the U-pipe, whereupon the air will begin to flow and the tumblers will assume their new positions.

The simple principles above illustrated have been utilized by Chauncey N. Dutton, a civil engineer of this city, in the operation of a system known as the Pneumatic Balance Locks, which are designed to raise or lower quickly the largest seagoing vessel at a single lift through vertical distances of 100 feet or over. On our front page will be found illustrations of two sets of locks of this type which it is proposed to build on the route of the Erie Canal, one at Lockport, near Lake Erie, and the other at Cohoes, the eastern terminus of the canal. The former locks are to have dimensions to suit the size of canal boat adopted, and an extreme lift of 62½ feet. The Cohoes locks will have the same length, breadth and draught, but the extreme lift will reach the extraordinary height of 144 feet, or many times as much as the extreme lift of the loftiest locks now in existence. Our drawings are made from the plans adopted by the Canal Board and represent this great work as it will appear when completed. The present series of locks of the old type at these two places include the heaviest lifts on the Erie Canal, and together they make up over two-thirds of the total rise of about 572·9 feet from the Hudson River to Lake Erie.

The locks at present in use in the Erie Canal are of the type with which we are all familiar. The vertical distance is overcome in short lifts, and hence many locks are required with a consequent long delay in the passage of boats. Thus at Lockport there are five locks with an average lift of about 11½ feet, and it takes a couple of hours for a tow of five boats (four barges and a steamer) to pass through. At Cohoes, again, sixteen locks with an average lift of about 9 feet are necessary to raise the boats from the Mohawk River to the upper level, and here, in busy times, it is estimated that half a day is consumed in the passage of a tow. A pneumatic lock will save in time and towage the equivalent of one-eighth of a cent a bushel in the freight charge an all east-bound grain.

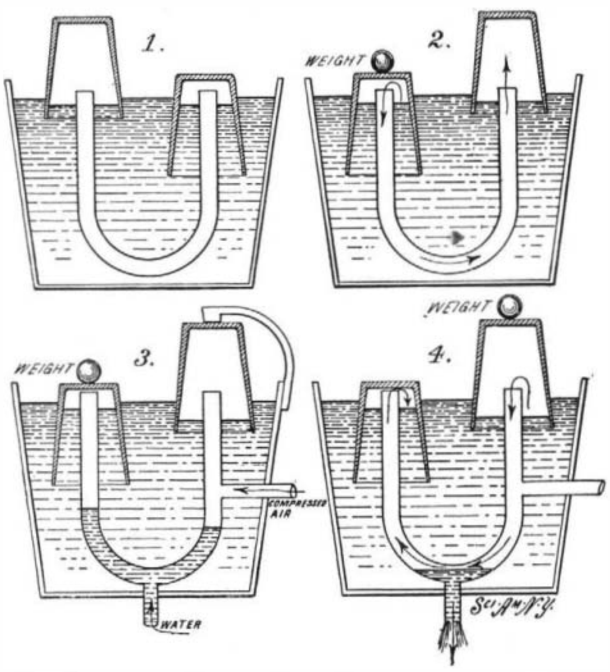
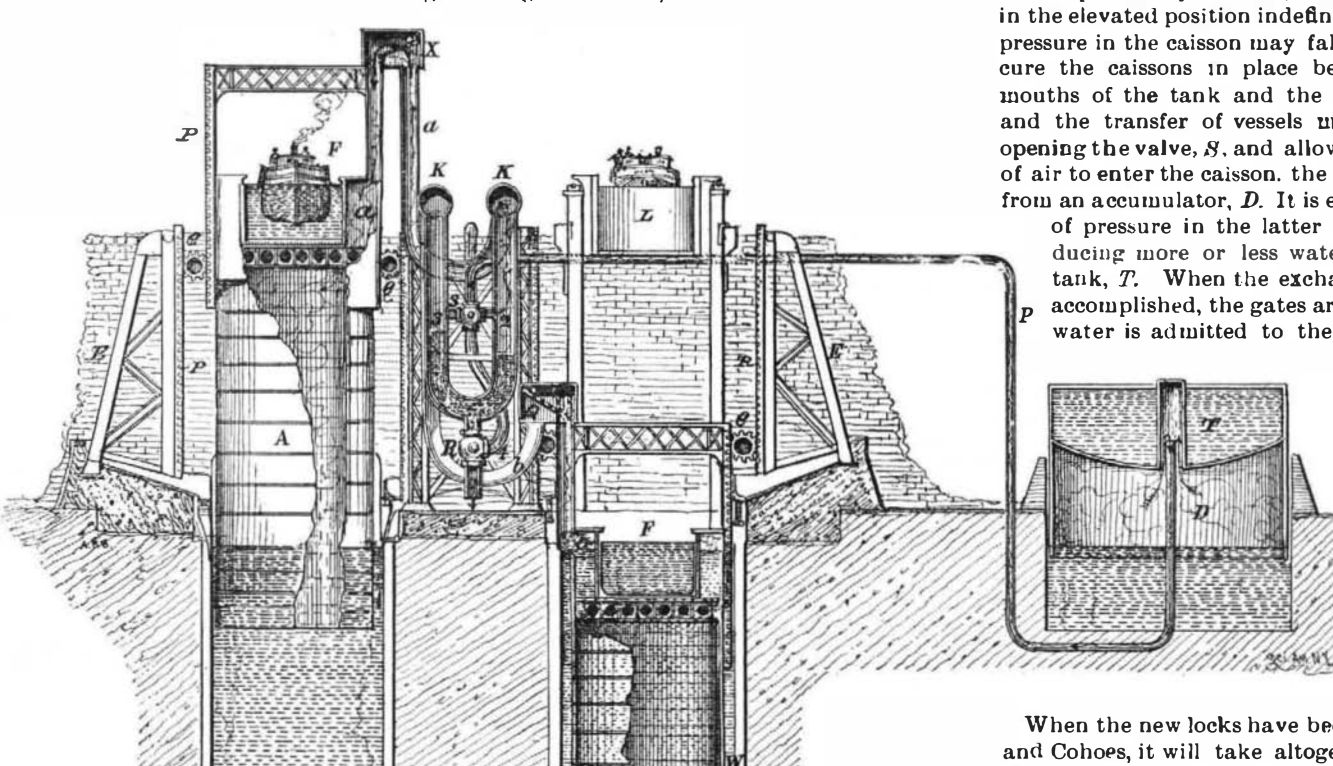


DIAGRAM ILLUSTRATING PRINCIPLES OF OPERATING THE PNEUMATIC LOCKS.

Referring to the drawing of the Cohoes locks on the front page, it will be noticed that the upper level of the canal is carried by a steel aqueduct up to and beyond the edge of the high banks of the river. Here it terminates in two mouths closed by gates, standing vertically 144 feet above the river. Immediately below, and in line with the upper level, are excavated in the bed of the river two great pits, each about 50 feet wide, 320 feet long, and 175 feet deep. In each pit is placed a huge rectangular caisson, whose dimensions are somewhat smaller than those of the pit, so as to allow it to move vertically within the latter. In the cross-sectional drawing given herewith the pits are indicated by the letters *W W*, and the caissons by *A* and *B*. Above the roofs of the caissons are carried tanks, *F F*, which are 32 feet wide, 12 feet deep, and 315 feet long, and whose mouths are closed with watertight gates, similar to the gates, *L*, that close the mouths of the basins at the upper level.



TRANSVERSE SECTION THROUGH COHOES LOCKS.

Now the bottom of the caissons being open and the roof and sides airtight, it follows that when they are immersed in the pits they will float in the same way as the tumblers in the pail of water, and if the air-space in the two caissons be connected by piping, they will balance each other. In the sectional view, the caisson, *A*, is shown raised to its full height of 144 feet; the surface of the water in the tank, *F*, is at the same level as the water in the upper canal, and a barge is shown in the act of entering the tank. The caisson, *B*, is in the lowered position and the mouths of its tank, *F*, are open so that it connects with the Mohawk River, and barges can enter and leave it.

The air-space in the caisson, *A*, is connected by flexible pipes, *a. a*, and an emergency valve, *X*, with the right hand leg, 2, of a huge U-pipe, *K*, *K*, 10 feet in diameter, and the air-space in the caisson, *B*, connects through the flexible pipes, *b. b*, and emergency valve, *Q*, with the other leg, 3, of the U-pipe. Water is fed to and wasted from the bend of the U-pipe through the pipe, 4, by way of the 3-way valve, *R*, and compressed air is led in from an accumulator, *D*, by the pipe, *P*, by way of the valve, *S*, which introduces the air to leg 2 or leg 3 of the U-pipe, as desired.

The great caissons are maintained in a true vertical and horizontal position by means of massive vertical braced guides, *E*, *E*, and horizontal rolling shafts, *e*, *e*, which extend the full length of the caissons one on each side, and are provided each with four big gear wheels which engage vertical racks, *P*, *P*, on the guides and on the caissons. The rolling shafts are heavy built-up steel tubes, 4 feet in diameter, and of great rigidity, and they serve as a positive parallel motion to keep the caissons absolutely level and prevent any tendency to rocking or binding in the water pits.

The operation is as follows: Let us suppose that the caisson, *B*, is elevated with its tank, *F*, registering its gate with a gate, *L*, of the upper level. If an excess of water be admitted to the tank, *F*, over that contained in the tank of the now depressed caisson, *A*, so that the former will be heavier, the latter will begin to rise and caisson, *B*, to sink, the air passing by way of the pipe, *b*, the U-pipe, *K*, and the pipe, *a*, from caisson, *B*, to caisson, *A*. When *A* has reached the upper level, as shown in the cut, it becomes necessary to lock it in position and prevent the air from flowing back through the pipes. This is done by opening the valve, *R*, and admitting water to the U-pipe, as shown in the sectional drawing. If now there were no change of temperature or of barometer to affect the pressure of the air in caisson, *A*, and no possibility of leaks, the caissons would remain in the elevated position indefinitely; but since the air pressure in the caisson may fall, it is necessary to secure the caissons in place before the gates of the mouths of the tank and the upper level are opened and the transfer of vessels made. This is done by opening the valve, *S*, and allowing an excess pressure of air to enter the caisson, the pressure being derived from an accumulator, *D*. It is evident that the amount of pressure in the latter may be varied by introducing more or less water into the accumulator tank, *T*. When the exchange of boats has been accomplished, the gates are closed, a foot more of water is admitted to the elevated tank than is contained in the lower tank, the water valve, *R*, is opened, allowing the water to drain out of the U-pipe through the waste pipe, *O*, and the air at once begins to flow from the caisson, *A*, to caisson, *B*, the former descending and the latter rising to its new position.

When the new locks have been installed at Lockport and Cohoes, it will take altogether about ten minutes to make the transfers of a tow of barges at each of these points.

Although the system as installed on the Erie Canal will handle only canal boats and vessels of limited size and draught, any one who is acquainted with civil and mechanical structural work will see that there is no reasonable limit to the size of the locks that could be constructed, or to the height of the lift. As compared with hydraulic locks, this system floats the huge weight instead of concentrating it in one point, and it is not handicapped by having to raise the dead weight of a ponderous column of water. The air column within the caisson, however high it may be, does not reduce the efficiency of the system by adding to the weight handled. It would be quite possible, for instance, in the unlikely event of the ship canal being built on the route of the present Erie Canal, to construct pneumatic locks at Cohoes that would lift the 704-foot liner "Oceanic" with as much ease, in spite of her 28,000 tons dead weight, as the Cohoes locks will lift a canal boat.

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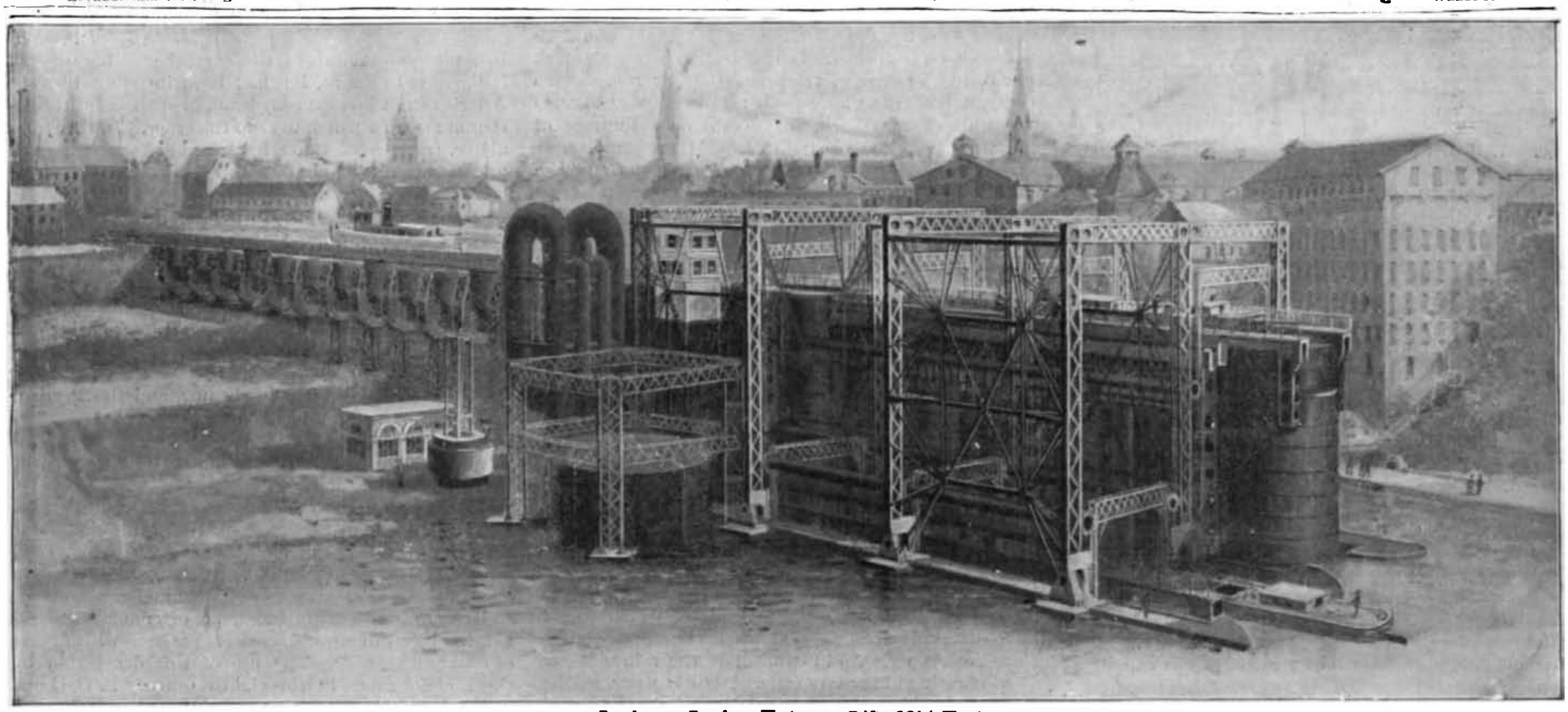
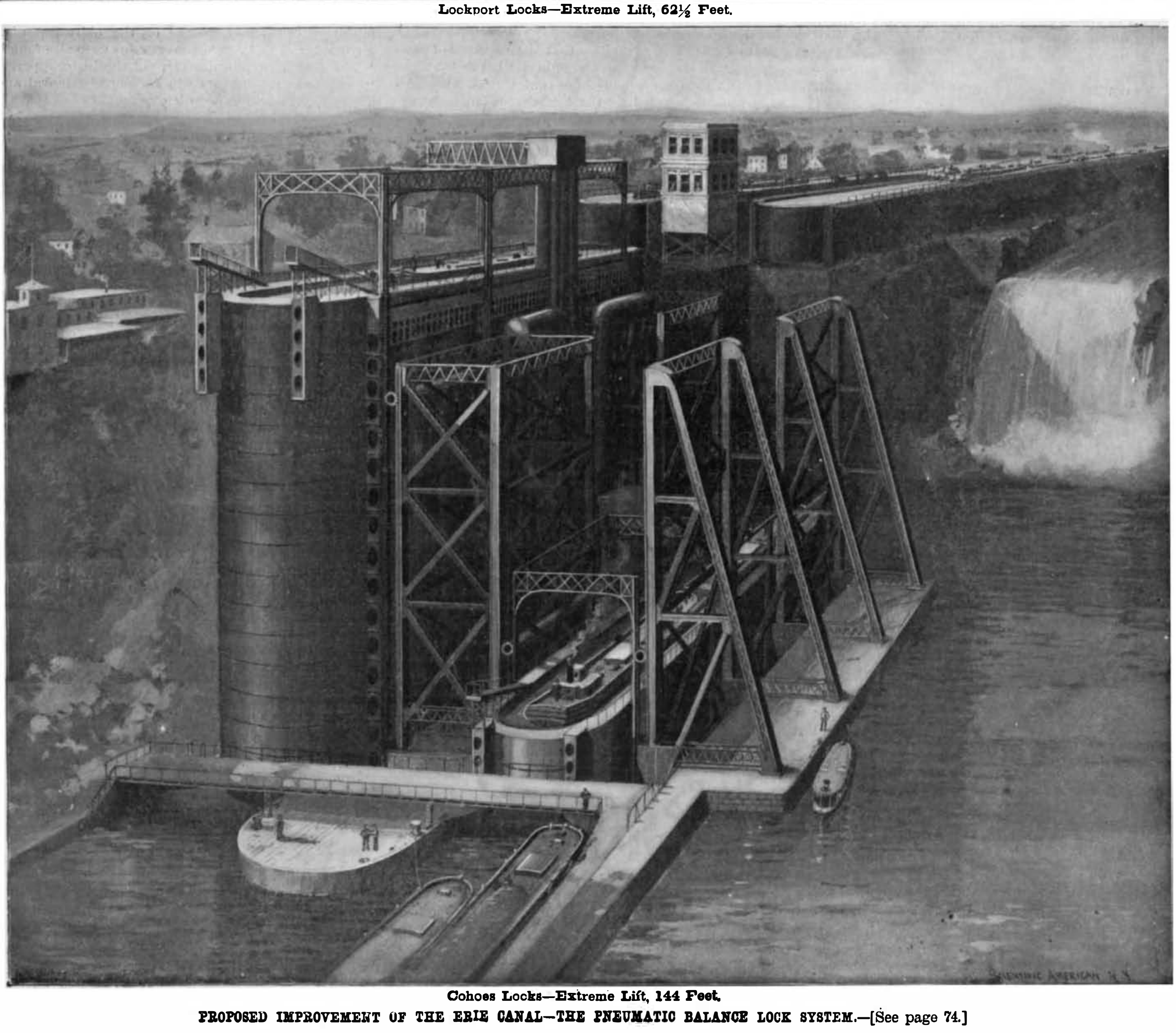


Lockport Locks—Extreme Lift, 62½ Feet.



Cohoes Locks—Extreme Lift, 144 Feet.

PROPOSED IMPROVEMENT OF THE ERIE CANAL—THE PNEUMATIC BALANCE LOCK SYSTEM.—[See page 74.]