(No Model.)

# H. H. HALL.

## APPARATUS FOR LAYING SUBMARINE TUNNELS AND TUBES.

No. 311,656. Patented Feb. 3, 1885.

Fig. 1.

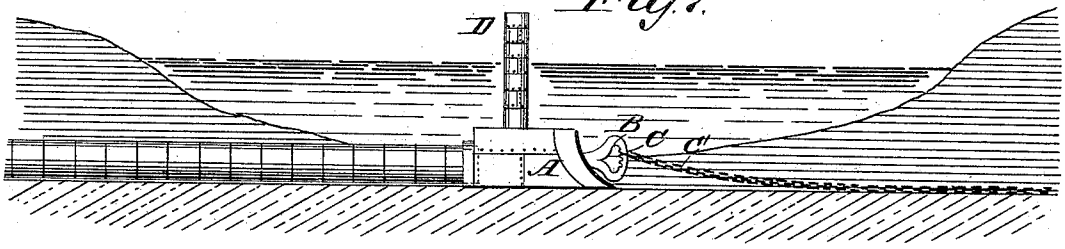



Fig. 2.

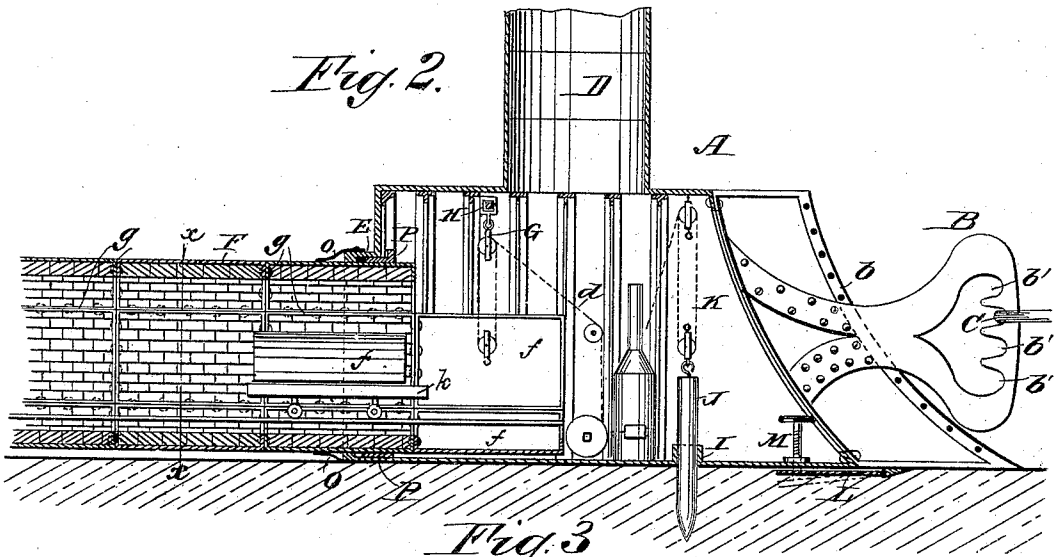



Fig. 3

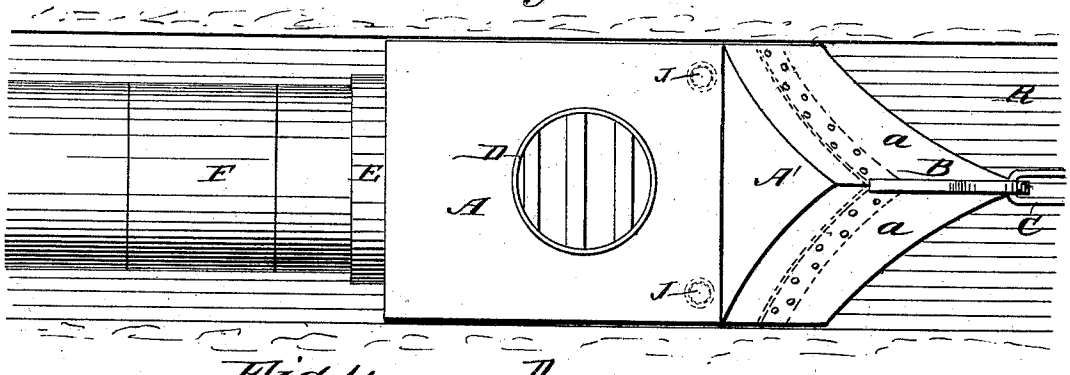
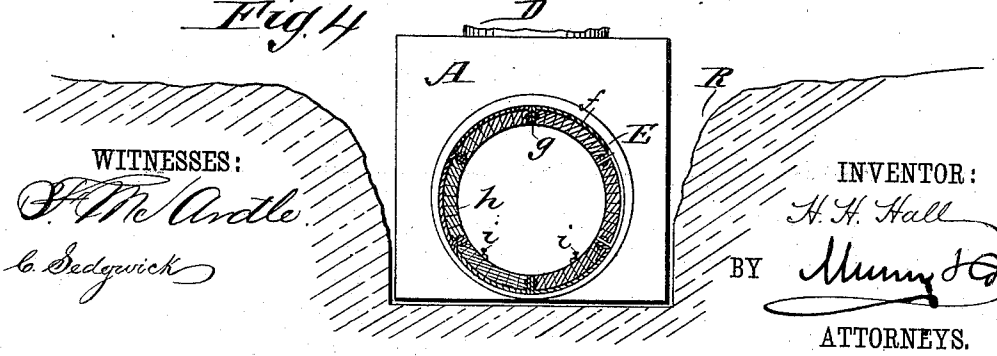



Fig. 4




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# UNITED STATES PATENT OFFICE.

HAYDEN H. HALL, OF NEW HAMBURG, NEW YORK.

## APPARATUS FOR LAYING SUBMARINE TUNNELS AND TUBES.

SPECIFICATION forming part of Letters Patent No. 311,656, dated February 3, 1885.

Application filed November 8, 1883. (No model.)

*To all whom it may concern:*

Be it known that I, HAYDEN H. HALL, of New Hamburg, in the county of Dutchess and State of New York, have invented a new and Improved Apparatus for Laying Submarine Tunnels and Tubes, of which the following is a full, clear, and exact description.

The object of my invention is to provide a new and improved apparatus for laying submarine tunnels and tubes rapidly without requiring the use of compressed air.

The invention consists in a movable caisson provided with a prow and means for attaching a draft chain or cable at one end, and at the opposite end with a neck adapted to receive the end of the tunnel-tube, which caisson is provided with an air-shaft or hatchway extending above the surface of the water.

The invention also consists in a draft-clevis secured to the caisson, and in numerous other parts and details and combinations of the same, as will be fully described and set forth hereinafter.

Reference is to be had to the accompanying drawings, forming part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a longitudinal elevation of my improved apparatus for submarine tunneling and part of the tunnel formed by the same. Fig. 2 is an enlarged longitudinal sectional elevation of my improved apparatus, showing the internal arrangements and a portion of the tunnel. Fig. 3 is a plan view of the same. Fig. 4 is a cross-sectional elevation of the same on the line *x x*, Fig. 2.

A caisson or other vessel, A, made watertight, is provided at its front with a prow, A′, formed of two mold-boards, *a*, united to form a cutting-edge, *b*, at the front edge of the caisson, which cutting-edge is curved and inclined from the top downward and outward, so as to remove all obstructions in its passage. From the front of the cutting-edge a very heavy and strong clevis, B, projects, which is firmly secured to the front of the caisson, which clevis has a series of draft-notches, *b′*, for receiving the end link or loop, C, of a heavy chain or cable, C′. A shaft or hatchway, D, extends upward from the top of the caisson A, and must be of such height that its upper end is above the surface of the water, as shown in Fig. 1. On or in the rear end of the caisson an outwardly-projecting neck, E, is formed, which is adapted to receive the end of the tunnel-tube F. The tunnel-tube F is formed of one piece, or of a series of sections, *f*, made of cast or wrought iron or other material, the outer surface being covered with a non-corrosive substance, the sections having inwardly-projecting flanges *g* along the longitudinal and end edges, which sections *f* are united by bolts or rivets passed through the flanges. The tunnel-tube will thus be entirely smooth on the outer surface, and will have projecting transverse and longitudinal ridges formed on the inside by the united flanges. A tunnel arch or lining made of brick is formed, if required, on the inside of the tube. The bricks *h* are wedge-shaped, and are placed in the tunnel in the direction of their length, the bricks being of such depth or thickness that their inner surfaces will be flush with the inner edges of the flanges, as shown in Fig. 4, so that the interior of the tunnel will be finished entirely smooth. Within the caisson an engine is provided for operating the ropes or chains of a traveling crane, G, running on a transverse beam, H, in the top of the caisson, which traveling crane is used to raise and position the segmental plates or sections *f* forming the tunnel-tube. The bottom of the caisson is provided with two openings, I, one at each side, through each of which a heavy iron pin or spile, J, can be passed for the purpose of anchoring the caisson. The spiles J can be raised or lowered by tackle K suspended from the top of the caisson. A plate, L, for the purpose of raising and lowering the front end of the caisson, is hinged to the bottom of the caisson a short distance from the front end, the free end of the said plate L being toward the rear end of the said caisson. The free end of the plate L is connected with a screw-shaft, M, or other device, whereby the free end of the said plate L can be raised or lowered, as may be desired. The neck E is made eccentrically, so that it will be thicker or wider at the top than at the bottom. The end of the tunnel-tube is passed through the neck, in which it fits closely, and a wide gutta-percha band or belt, O, is passed around the outer surface of the neck and the tunnel-tube, which band is pressed by the water on the

outer surface of the tunnel-tube and on the outer surface of the neck, and thus forms a close joint. Between the inner surface of the neck and the outer surface of that part of the tunnel-tube projecting into the rear end of the caisson a packing-ring, P, is placed, which is thicker at the top than at the bottom.

The object in making the neck E and the packing-ring P thicker at the top than at the bottom is to get the bottom of the tunnel-tube as close as possible to the bottom of the caisson.

The caisson A, or other water-tight vessel, is to be made of wrought or cast iron or any other suitable metal or wood, or wood and metal combined, and it is to be provided with a non-corrosive outer coating. The caisson may be made of any desired shape.

The tunnel is constructed in the following manner: If the banks of the river or other channel to be tunneled are abrupt, and if the tunnel on account of its height would obstruct navigation, it will be necessary to cut the ditch or channel R from the water-level inland to meet a railroad-track or other roadway. The caisson then being launched or floated into the ditch with the neck E projecting inland, with the lower edge of its opening on a level with the water, the first length of the tunnel is constructed at the water-level with its end projecting a short distance into the caisson. The next length is then put together inside of the caisson. The caisson is then drawn forward, ready to receive the next length, and so on until the tunnel is completed. Should the banks of the river or other channel slope gradually and the water be so deep that the height of the tunnel would not obstruct navigation, it will only be necessary to remove obstructions and smooth off the surface of the bottom of the channel to be tunneled. To accomplish this, the caisson is placed in position in the manner described above and moved forward, as each tube-length is completed until reaching the opposite shore.

For laying pipes only the caisson is started from the shore with the first length passed through the neck E. Provided each length is in one piece, the next length will be passed through the hatchway or air-shaft D into the caisson, where the sections are connected by bolts or rivets passed through inwardly-projecting flanges at the ends of the sections, or otherwise. Then the caisson is hauled forward and other lengths are added until the pipe is completed. The caisson will be provided with a water-tight cover for the neck E, in case the caisson is to be floated either into or out of position. When the caisson is in position, the cover is removed to admit the tunnel-tube. As the caisson proceeds into the water, ballast of any suitable material—such as pig metal or lead—must be distributed on the floor of the caisson, so that it will be equally balanced and sufficiently weighted to drag closely on the bottom of the channel. As soon as the tunnel is completed, tracks *i* are laid in the same, on which cars *k*, for conveying the tunnel-section plates, bricks, and other material into the caisson, may be run, and there will always be a communication between the caisson and one land end of the tunnel through the said tunnel. The caisson can be anchored in place at any time by means of the iron spiles J. The link C of the chain C′ can be passed into any one of the notches *b′* of the clevis B, according to the inclination of the draft-chain. If the clevis is near the shore toward which the chain is drawn, the link or loop C must be placed in an upper notch, *b′*, as otherwise the chain would have too great a tendency to raise the entire caisson out of place. The shaft D at all times projects above the level of the water and ventilates the caisson. All material is conducted into the caisson through the completed part of the tunnel or through the shaft D, and the workmen enter and leave the caisson through the tunnel or through the shaft D.

The caisson shown is adapted for the construction of one tunnel-tube; but if desired the caisson can be so constructed that two or more tunnel-tubes can be laid at the same time by means of the caisson, and the size of the caisson can be varied more or less, according to the size of the tunnel.

The method of propelling the caisson is by the chain C′ attached to the clevis B, and on the opposite shore to a winch or hydraulic ram driven by steam or other power. Communication between the caisson and the driving-point is established by means of an electric wire or telephone.

By my improvement submarine tunnels or tubes may be laid straight, or in either vertical or horizontal curves to conform to the bed of the river, or to the direction necessary to secure the desired terminus at either end, and any desired curvature may easily be secured by inclining the close-fitting end joints of the tube-sections, as will readily be understood.

Having thus fully described my invention, I claim as new and desire to secure by Letters Patent—

1. The herein-described apparatus for constructing submarine tunnels, consisting of a caisson provided with a prow and means for attaching a draft chain or cable at one end and with a neck for receiving the end of the tunnel-tube at the opposite end, substantially as set forth.

2. A caisson provided with the clevis B, having a series of notches, *b′*, substantially as herein shown and described.

3. The combination, with a caisson having a neck for receiving the end of the tunnel-tube, of a packing placed between the neck and the tunnel-tube, and a packing placed on the outer surface of the neck and the outer surface of the tunnel-tube, substantially as herein shown and described.

4. The combination, with a caisson, of a neck for receiving the end of the tunnel-tube,

the outer and inner edges of which neck are arranged eccentrically, so that the neck will be thicker or wider at the top than at the bottom, substantially as herein shown and described.

5. The combination, with a caisson having a neck adapted to receive the end of the tunnel-tube, of an eccentric packing placed around the tunnel-tube between the outer surface of the tunnel-tube and the inner surface of the neck, substantially as herein shown and described.

6. The combination, with a movable caisson, of a plate hinged to the same, so that the free end of the plate will be toward the rear end of the caisson, and of means for raising or lowering the free end of the said hinged plate, substantially as herein shown and described.

7. The combination, with a movable caisson, of a plate hinged to the same, so that the free end of the plate will be toward the rear end of the caisson, and of a screw-shaft, *m*, for raising or lowering the free end of the said plate, substantially as herein shown and described.

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Witnesses:
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