(No Model.) 3 Sheets—Sheet 1.

G. H. SHERMAN.

TUNNELING MACHINE.

No. 490,318. Patented Jan. 24, 1893.

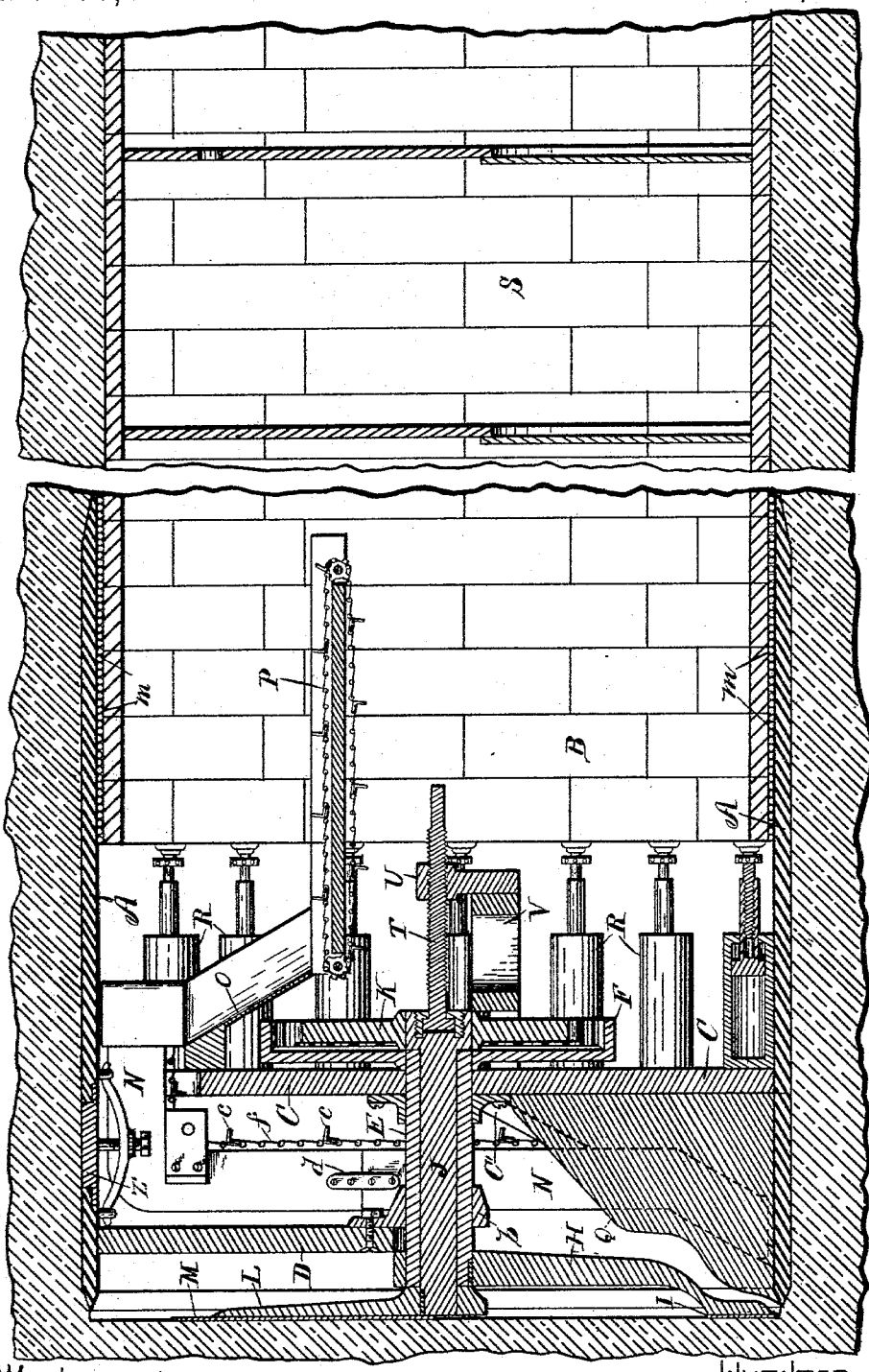

Fig. 1.

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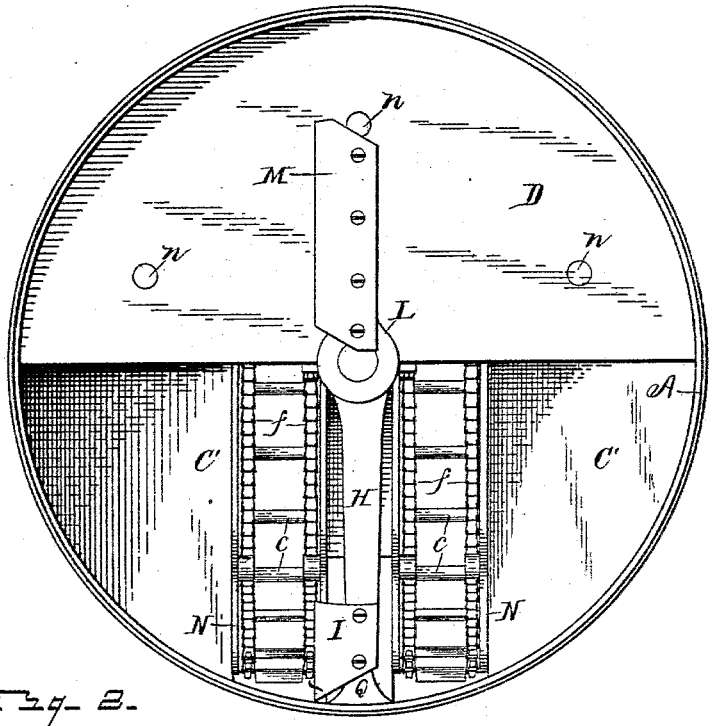

Fig. 2.

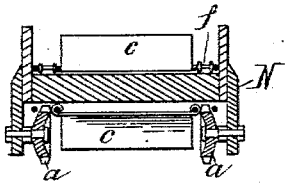

Fig. 4.

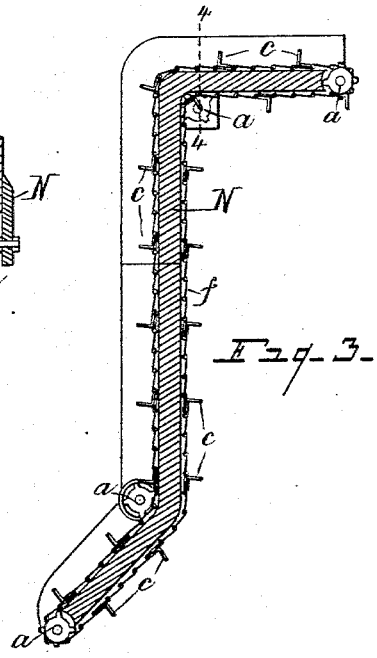

Fig. 3.

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TUNNELING MACHINE.

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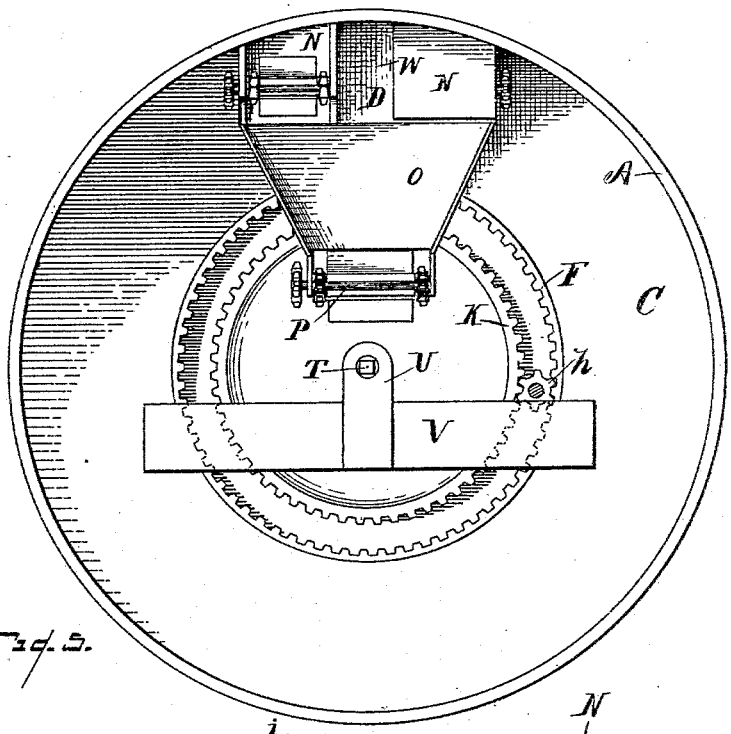

Fig. 5.

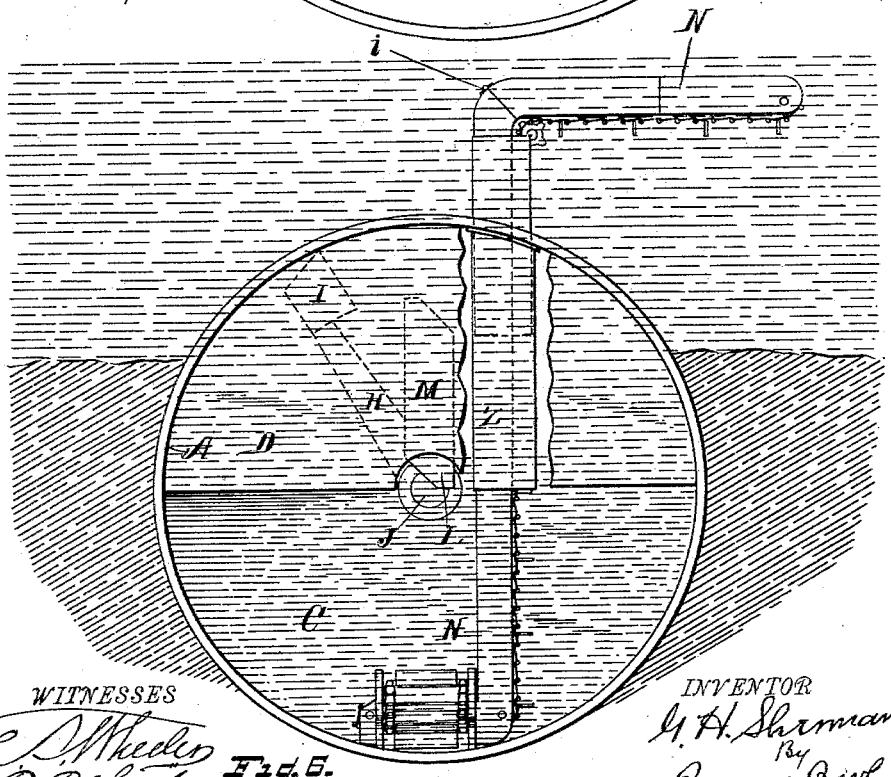

Fig. 6.

WITNESSES

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UNITED STATES PATENT OFFICE.

GEORGE H. SHERMAN, OF DETROIT, MICHIGAN.

TUNNELING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 490,318, dated January 24, 1893.

Application filed July 20, 1891. Serial No. 400,103. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. SHERMAN, a citizen of the United States, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Tunneling-Machines; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to new and useful improvements in tunneling machines, especially designed for use in the building of subaqueous tunnels; and it consists in a certain construction and arrangement of parts, as hereinafter fully set forth, the essential features of which being pointed out particularly in the claims.

The objects of the invention are; to provide means for rapidly and effectually removing the earth in advance of the construction end of the tunnel, and in such manner as to exclude the water therefrom; to obviate the caving-in of the earth as the tunnel is advanced; and to facilitate the carrying away of the earth removed from the heading. These objects are attained by the mechanism illustrated in the accompanying drawings, in which;—

Figure 1 is a central horizontal section through the shield or caisson carrying the operative mechanism, and a portion of the completed tunnel, showing the position of parts in the operation of tunneling. Fig. 2 is an elevation of the forward end of the caisson. Fig. 3 is an enlarged longitudinal section through one of the elevators removed from the caisson. Fig. 4 is an enlarged cross section through said elevator, as taken on dotted line 4—4 of Fig. 3. Fig. 5 is an elevation of the rear end of the caisson. Fig. 6 is an elevation of the front end of the caisson, a portion of the outer bulk-head being broken away, showing the employment of the elevator to carry the removed earth through the crown of the caisson, and discharge it at one side of the excavation.

Referring to the letters of reference, A designates the shield or caisson in which is located the mechanism for actuating the revolving knives that remove the earth in advance of the tunnel construction, and the conveyers that carry said earth away, also the jacks that force the caisson ahead as the earth is removed. The caisson is cylindrical in form, and its interior diameter is greater than the outer diameter of the tunnel, so as to enable the forward end of the tunnel B to be formed within the rear end of said caisson, as shown in Fig. 1.

C designates a head located within the caisson A. Between the head C and the outer end of the caisson is located a semi-circular or segmental bulk-head D, secured to and depending from the crown of the caisson so as to close the upper half thereof, there being considerable space between the adjacent faces of the heads C, D, forming an air-space or chamber, as hereinafter described.

E designates a sleeve, the inner end of which passes through and is journaled in the head C and carries the internal gear-wheel F, which is rigidly secured thereon. The outer end of said sleeve is journaled in the boxing *b* secured to the lower edge of the semi-circular head D, and is provided with a laterally extending arm H carrying at its outer end the knife-blade I, clearly shown in Figs. 1 and 2. Passing through the sleeve E and journaled therein, is a shaft J. Mounted on the inner end of said shaft is a gear-wheel K of less diameter than the internal-gear F and adapted to revolve within the perimeter thereof. The outer end of the shaft J projects beyond the sleeve E and carries the laterally extending arm L having the knife-blade M attached thereto. Located between the toothed surfaces of the gears F, K, and meshing therewith, is a pinion *h*, (see Fig. 5) which is driven by any suitable motor, whereby said gears are caused to revolve in opposite directions, thus imparting a reverse motion to the arms H, L, carrying the cutting knives, which are so mounted as to pass one another as they revolve.

Leading from the bottom of the caisson at the forward end, are the duplex elevators N, clearly shown in Fig. 2, that receive the earth cut away by the revolving knives and carry it upward through the air-space between the

heads C, D, where said earth is discharged by said elevators through the head C into the chute O, from which it is deposited onto the conveyer P extending into the body of the tunnel, shown in Figs. 1 and 5, and is carried away in the manner hereinafter set forth. Said elevators and conveyer being driven by a motor (not shown) to which they are preferably connected by chain and sprocket gear. The elevators N are divided at their lower ends by the partition Q, shown in vertical section in Fig. 1, which also forms a brace for the head C, standing at right angles thereto and extending along the lower wall of the caisson. The elevator hoods or casings are not permanently secured in place, and are made in detachable sections which are coupled by the coupling-plates *d*, this construction permits the elevators to be entirely removed when desired. On looking at Figs. 3 and 4, it will be seen that these elevators consist of an endless chain *f* passing over a series of sprocket-wheels *a* journaled in the casing or hood of the elevator, said chains carrying the elevating buckets *c*.

To prevent the earth that is removed by the excavating knives, packing into the end of the caisson against the head C, said caisson is provided with the inclined plates C′ secured to the vertical face of the head D and extending obliquely forward to the base of the caisson rim, whereby the removed earth that falls upon said plates is conveyed to the foot of the elevators N. It will now be apparent, that, by revolving the pinion *h* of Fig. 5, the gears F K will be turned in opposite directions, imparting a reverse motion to the arms H L carrying the cutting knives, whereby the earth in advance of the caisson is is cut away, and falling at the base of the elevators N is removed thereby. The knives traveling in opposite directions equalize the strain upon the parts, and the knife M moving in the smaller circle has a greater cutting surface, than the knife I traveling in the larger circle, thus equalizing the cutting area of the knives. As the earth is cut away the caisson is forced ahead by means of hydraulic-jacks R, shown in Fig. 1, placed between the head C of the caisson, and the end of the tunnel wall B. The tunnel is formed within the rear end of said caisson as it advances, and to prevent water passing into the caisson between the inner face thereof and the outer wall of the tunnel, a packing or filling *m* is placed between the adjacent faces of the tunnel and caisson as said caisson is advanced and the tunnel constructed therein.

In subaqueous tunneling where the line of the tunnel is but a short distance below the bed of the stream, a great deal of water will be encountered, which is excluded from the caisson and tunnel by maintaining a counterbalancing air-pressure therein, which is accomplished through the medium of an air-lock S, shown in Fig. 1, located at or near the mouth of the tunnel. This air pressure within the tunnel and caisson, keeps the water level, in the space between the head C and segmental head D, down nearly on a line with the lower edge of the head D, thereby forming an air-chamber in the upper portion of the space between said heads.

In Fig. 1 T designates a screw-shaft, one end of which is swiveled in the inner end of the shaft J, and the threaded portion of which passes through a tapped stud U mounted on the frame V secured to the head C of the caisson, the inner end of said shaft T being squared for the application of a wrench or crank thereto, whereby, by removing the box *b*, and turning the screw-shaft T so as to draw the shaft J and sleeve E inward, the arms H L upon said shaft and sleeve, respectively, may be drawn in past the lower edge of the bulk-head D, and swung upward within the air-space between the heads C D, as clearly shown by dotted lines in Fig. 6, in which position the excavating knives may be readily re-ground or repaired. Access to said air-space is effected through the man-hole W shown in Fig. 5, between the elevators N.

In Fig. 2, *n* designates a series of screw-plugged apertures in the bulk-head D. Said apertures afford means for the introduction of a drill, in case a bowlder is encountered in the upper arc of the heading, whereby said bowlder may be drilled and reduced by blasting.

By the employment of the segmental bulk-head D, and the maintenance of the air pressure in the tunnel and caisson, the excavating may be readily carried on, though a portion of the upper arc of the caisson and tunnel extends above the bottom of the stream into the water, as shown in Fig. 6. In which case I provide a vertical casing Z, which is secured to the under face of the caisson around the man-hole or opening Z′ therethrough, shown in Fig. 1. Said casing extends downward through the air-space between the heads C D, its lower end terminating on a line with the bottom or lower edge of the head D. Through this casing passes the elevator N, the upper section of which is hinged as shown at *i* in Fig. 6, so that, as said elevator is passed upward through said casing, if in a stream, the hinged section thereof will be carried by the force of the stream into a horizontal position, whereby the earth removed by the excavating knives may be carried upward by the elevator, through said air-space and the crown of the caisson, and discharged downstream, thus simply and effectually removing the earth from in front of the advancing tunnel. And by employing the headed caisson, that advances into the excavation as rapidly as it is formed, disastrous "cave-ins" are obviated.

Having thus fully set forth my invention, what I claim as new and desire to secure by Letters-Patent, is;—

1. In a tunneling machine, the combination of the movable support or caisson, the revoluble excavating knives mounted therein to

travel in opposite directions, and mechanism for driving said excavating knives, substantially as specified.

2. In a tunneling-machine, the combination of the movable caisson having the outer segmental bulk-head therein depending from the crown of the caisson and terminating at the axis thereof, the inner head crossing the entire diameter of the caisson some distance in the rear of said outer-head its upper edge terminating some distance above the lower edge of said outer head, forming an air-space between said heads, the revoluble excavating knife mounted in said caisson so as to be withdrawn within said air-space, and mechanism for revolving said knife.

3. In a tunneling-machine, the combination of the movable caisson, the shaft journaled therein, the outer-bulk-head depending from the crown of the caisson and terminating at said shaft, the inner head extending diametrically across the caisson its upper edge terminating above the lower edge of the outer head, forming an air-space between said heads, the revoluble excavating knife mounted on the outer end of said shaft and adapted to be withdrawn in under the outer head and into said air-space, and mechanism for driving said knife.

4. In a tunneling machine, the combination of the caisson provided with the head C, the segmental bulk-head in advance of the head C, and having the air-space between said heads, of the elevator passing through said air-space and discharging through the crown of the caisson, the revoluble excavating knife journaled in said caisson, and the mechanism for operating said parts, as set forth.

5. In a tunneling machine, the combination of the caisson, the sleeve journaled therein carrying a gear-wheel on its inner end and an excavating knife on its outer end, the shaft passing through said sleeve, also having a gear-wheel on its inner end and carrying an excavating knife at its outer end, and means for rotating said gears so as to revolve the excavating knives in opposite directions.

6. In a tunneling machine, the combination of the caisson having the head C, the segmental bulk-head in advance thereof, and having the air-space between said heads, of the shaft carrying the excavating knife journaled in the head C so as to slide longitudinally, and means for adjusting said shaft endwise to withdraw the excavating knife within said air-space, as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

GEORGE H. SHERMAN.

Witnesses:
E. S. WHEELER,
R. B. WHEELER.