R. H. KEAYS.

TUNNEL BORING DEVICE.

APPLICATION FILED DEC. 30, 1905.

912,575.

Patented Feb. 16, 1909.

2 SHEETS—SHEET 1.

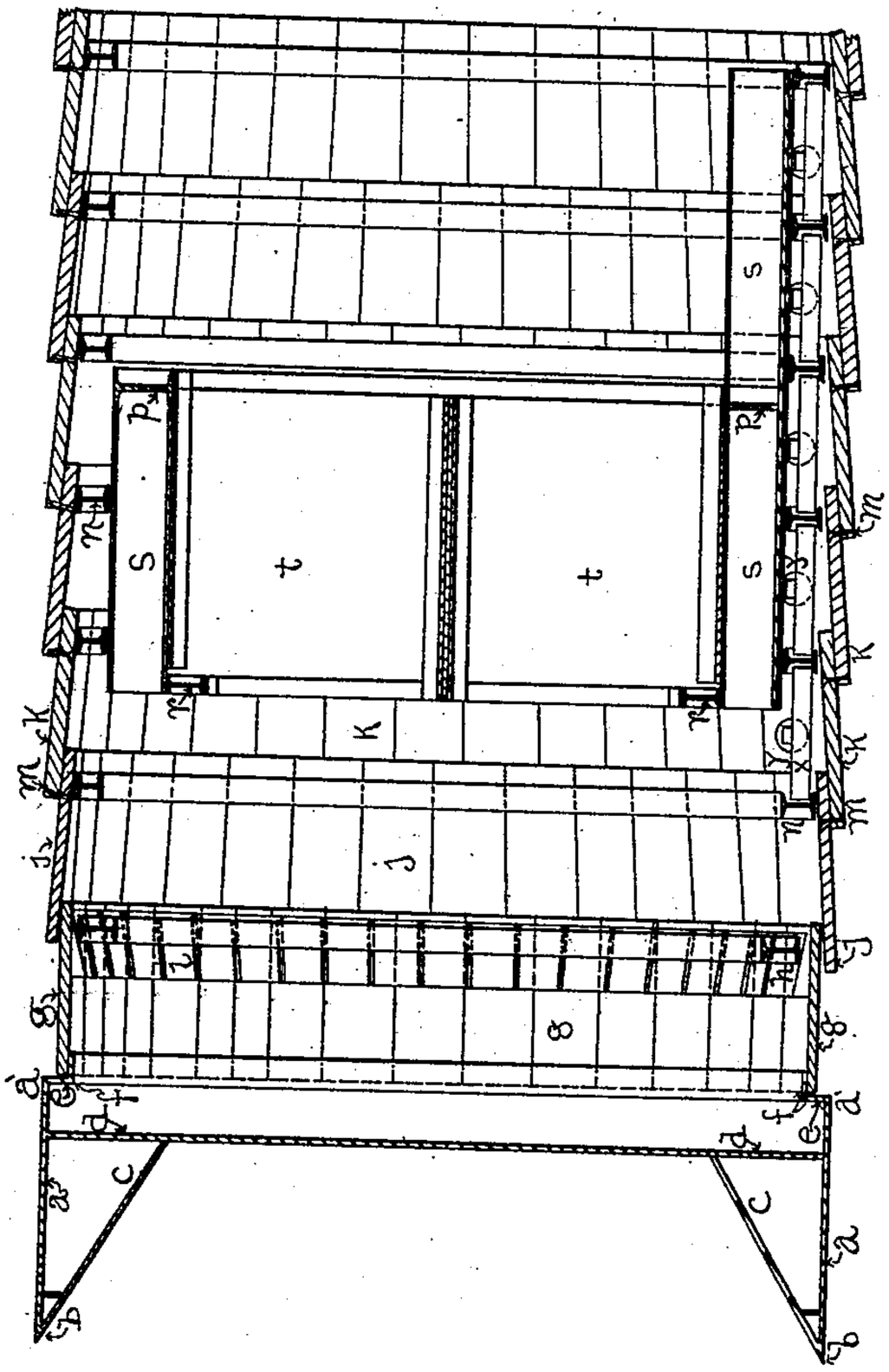

FIG 1

WITNESSES:

M. Hamilton.

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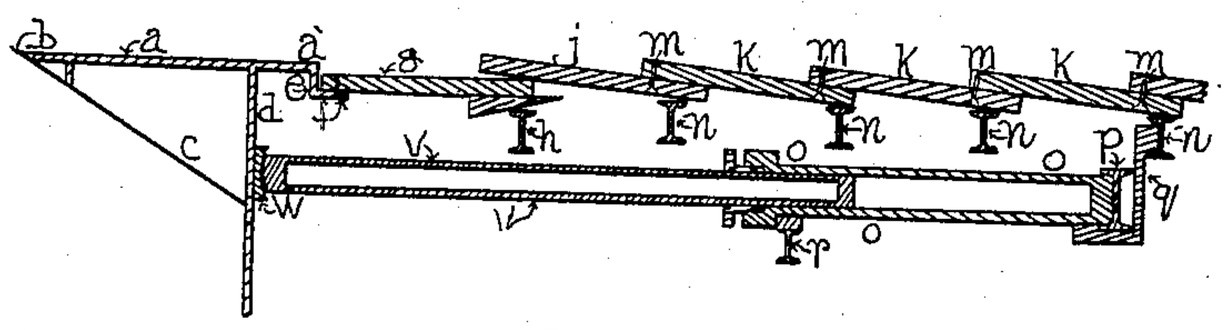

FIG. 2

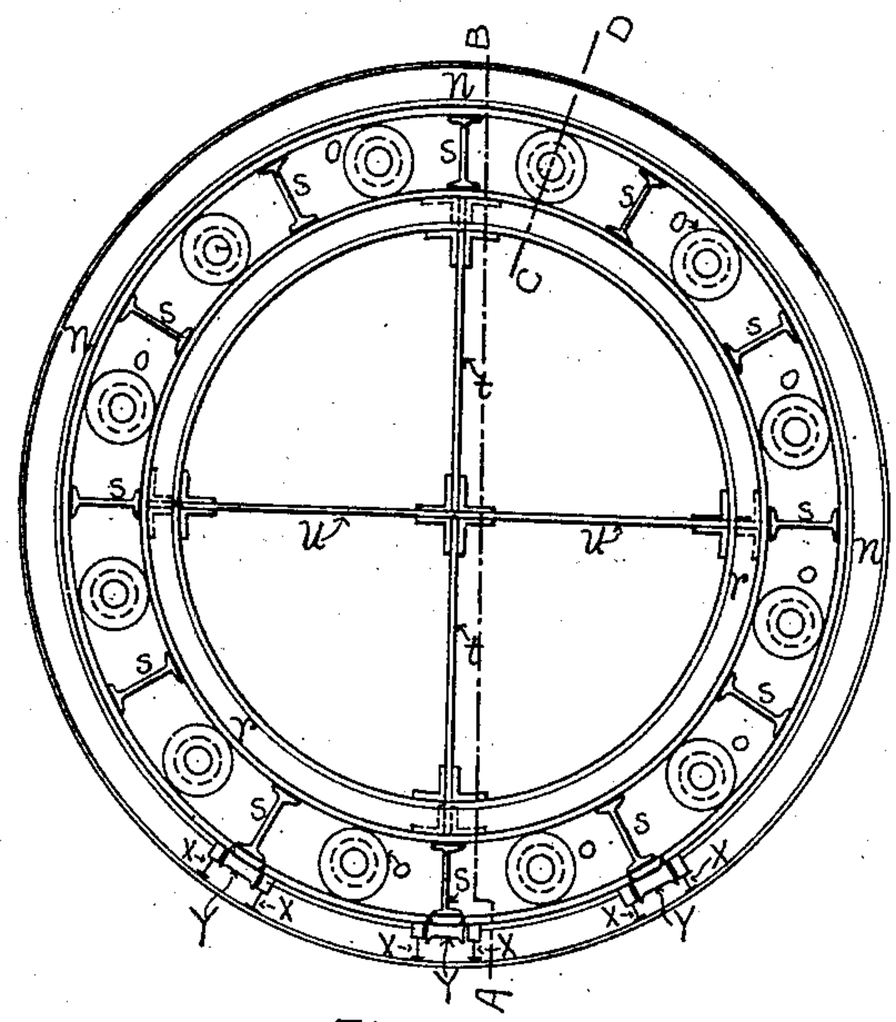

FIG. 3

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UNITED STATES PATENT OFFICE.

REGINALD HORTON KEAYS, OF NEW YORK, N. Y.

TUNNEL-BORING DEVICE.

No. 912,575. Specification of Letters Patent. Patented Feb. 16, 1909.

Application filed December 30, 1905. Serial No. 293,874.

To all whom it may concern:

Be it known that I, REGINALD HORTON KEAYS, a resident of the city of New York, in the county of New York and State of New York, a citizen of the United States, have invented certain new and useful Improvements in Tunnel - Boring Devices, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to improvements in devices for boring a tunnel and drawing the outer shell members thereof into place; and the object of my invention is to provide such a device which will be simple in construction and efficient in operation.

The features of my invention will be best brought out by describing the tunnel-boring device now in common use and then pointing out the main differences together with the advantages resulting therefrom. The type of shield now in common use comprises a smooth cylindrical shell of uniform external diameter and provided at its front end with a cutting edge. By means of a transverse diaphragm the shield is divided into two parts, the rear portion being known as the tail of the shield. Vertical and horizontal plates extend longitudinally of the shield and serve to strengthen it as well as to divide it into sections. The transverse diaphragm is pierced with openings through which access is obtained to the cutting edge of the shield. Just inside the shell of the shield are arranged concentrically a series of hydraulic rams, the cylinders of which are firmly mounted upon the shield and the piston-rods of which extend parallel with the axis of the shield and take a bearing against the completed portion of the tunnel. The external diameter of the tunnel is slightly less than the inside diameter of the tail of the shield and the tunnel is built up in sections within the tail of the shield. The length of the shield is governed by the length of the ram. As pressure is introduced into the cylinder of the hydraulic ram, the shield is forced forward, the cylinder sliding over the piston-head and the piston-rod being supported against backward movement by the completed part of the tunnel.

In my new device, the tunnel boring apparatus is made up of two separate parts, namely, the shield proper and the jack carrying frame or jack-frame. By this separation into two parts two important advantages are obtained; to wit, the shield proper may be made of shorter length and the hydraulic rams or jacks and the piping thereto connected are placed out of the way. The shield proper is provided with a transverse diaphragm pierced with openings to permit access to be obtained to the cutting edge and with blocks against which the piston-rods or rams of the hydraulic jacks have a bearing. Suitable braces transmit the pressure from the transverse diaphragm to the cutting edge. The tail of the shield (or that portion in rear of the diaphragm) is formed with an inwardly-projecting offset or shelf to which the successive rings of lagging are attached for drawing into position and from which they are detached after having been properly positioned by the forward movement of the shield proper, as more particularly described in my Patent No. 839,856, granted January 1st, 1907. This shelf serves also to protect the edges of the lagging or outer shell members as they are being pulled into position. The outer diameter of the shield proper is substantially the same as that of the outer shell members of the completed tunnel and hence no filling in is required between the surface of the surrounding earth and the outer shell members. As is obvious, the diameter of the shelf is much less than that of the completed tunnel and the front edges of the ring of lagging which is being pulled into place is held away from the surrounding earth and is thereby protected from danger of being loosened from the shelf.

The jack carrying frame or jack-frame is made up of a curved **I**-beam against which the rear of the cylinder of the hydraulic jack abuts, a curved **I**-beam by which the front end of the said cylinder is supported and longitudinal **I**-beams between which the cylinders of the hydraulic jacks are mounted and the lower ones of which are extended and rest upon rollers mounted in blocks secured to the bottom of the completed tunnel. The jack-frame is suitably braced by means of vertical and horizontal girders extending longitudinally thereof. By means of reaction blocks the jack-frame is connected to the **I**-beam of the completed tunnel which in this way is made to take up the backward thrust of the jacks. Since the jack-frame is rigidly supported against rearward movement by the completed tunnel, the rams of

the hydraulic jacks are forced forward, when pressure is exerted thereon, and carry with them the shield proper. As often as may be necessary, the rams are retracted within the cylinders of the jacks and the jack-carrying frame is moved forward on its rollers.

In the drawings illustrating the principle of my invention and the best mode now known to me of applying that principle, Figure 1 is a central, vertical, longitudinal, sectional view, the cutting plane being identified by the line A—B, Fig. 3; Fig. 2 is a longitudinal sectional view, the plane of section being along the line C—D of Fig. 3; and Fig. 3 is an end elevation of the jack carrying frame or jack-frame.

The shield proper comprises a shell *a* which is generally cylindrical and which is provided with a cutting edge *b* from which braces *c* extend to a transverse diaphragm *d* separating the shield proper into two parts, the portion *a'* in rear being commonly known as the tail of the shield. An inwardly-projecting flange *e* is formed upon the rear of the tail of the shield and from this flange *e* extends rearwardly a shell *f* which serves as a shelf for the support of the front end of the ring of lagging *g* which is being pulled into place as the shield proper is advanced, the rear end of said ring being held up by the temporary I-beam *h* between which and the rear end of said ring is a wedge *i* which is driven in or rearwardly to maintain the front end of the ring *j* in position. The rings *k* of lagging are permanently positioned and are secured by lag-screws *m* to form outer shell members of the tunnel which is suitably braced by permanent curved I-beams *n*, all as more particularly explained in my application above referred to.

The hydraulic jacks are carried by a separate portion or member, called by me a jack-carrying frame or jack frame. This arrangement of parts enables me to reduce the length of the shield proper and to place the piping and other accessories used in conjunction with the jacks out of the way of the working party at the place of excavation. The rear end of each jack-cylinder *o* abuts against a curved I-beam *p* which forms a part of the jack-carrying frame or jack-frame and to which is secured a reaction-block *q* which transmits the thrust of the cylinder to the permanently-positioned curved I-beam *n*. The front end of each jack-cylinder *o* is supported by a curved I-beam *r* which forms a part of the jack-carrying frame or jack-frame. The jack-cylinders *o* are arranged in a concentric series and between each pair of jack-cylinders runs a longitudinal I-beam *s* which is best shown in Fig. 3. The girders *t* and *u* arranged at right angles to each other within the jack-carrying frame or jack-frame serve to brace the same suitably.

The rams *v* of the hydraulic jacks extend forward from the jack-cylinders *o* and each takes a bearing against a block *w* mounted upon the diaphragm *d*. As pressure is exerted by the fluid in the jack-cylinder, the ram *v* is forced to move forward out of its cylinder, since it is impossible for the cylinder to move to the rear; and forward movement of the rams is accompanied by an advance of the shield proper.

Upon the floor of the completed tunnel are mounted journal-blocks *x* which support rollers *y* upon which rest three of the longitudinal I-beams *s*. The jack-carrying frame or jack-frame may thus be readily advanced as often as may be necessary and the reaction-blocks *q* brought to bear against the front face of the I-beam *n* next in advance.

What I claim is:

1. In a structure of the class described, the combination of a shield; a jack-frame in rear thereof and separated therefrom; and forcing devices mounted in said jack-frame and interposed between said jack-frame and shield.

2. In a structure of the class described, the combination of a shield; a jack-frame in rear thereof and separated therefrom; and jacks mounted in said jack-frame and interposed between said jack-frame and said shield.

3. In a structure of the class described, the combination with permanently-positioned tunnel-members of a shield; a jack-frame independent thereof and supported by said tunnel-members; and forcing devices mounted in said jack-frame and interposed between said shield and said jack-frame.

4. A tunnel shield provided with a suitably-braced transverse diaphragm and an outer shell; the tail end of said shell being bent inwardly for the attachment of lagging members.

5. A tunnel shield provided with an outer shell and a suitably-braced transverse diaphragm; the tail end of said shell being bent inwardly and then outwardly for the attachment of lagging members.

6. A tunnel shield made up of an outer shell having its front end formed with cutting edges and its tail end formed with means for the attachment of lagging; and a transverse diaphragm within said shell.

7. A tunnel shield made up of an outer shell having its front end formed with cutting edges and its tail end formed with a shelf for the attachment of lagging; and a transverse diaphragm within said shell.

8. A tunnel shield which is made up of a shell circular in cross-section and having its rear end bent inwardly and then rearwardly for the attachment of lagging members.

9. A jack-frame made up of a curved beam for the support of the rear ends of

jack-members; a curved beam for the support of the front ends of jack-members; longitudinal beams connecting said curved beams; and girders within said curved beams to brace the same.

10. The combination of a pair of curved beams; longitudinal beams connecting said curved beams; and jack-members mounted between said longitudinal beams and carried by said curved beams.

11. In a structure of the class described, the combination with permanently-positioned tunnel-members of a shield; a jack-frame independent thereof; forcing devices mounted in said jack-frame and interposed between said shield and jack-frame; and reaction blocks interposed between said jack-frame and tunnel-members.

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Witnesses:

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