

J. P. KARNs.
TUNNELING MACHINE STRUCTURE.
APPLICATION FILED MAY 25, 1909.

957,687.

Patented May 10, 1910.

2 SHEETS—SHEET 1.

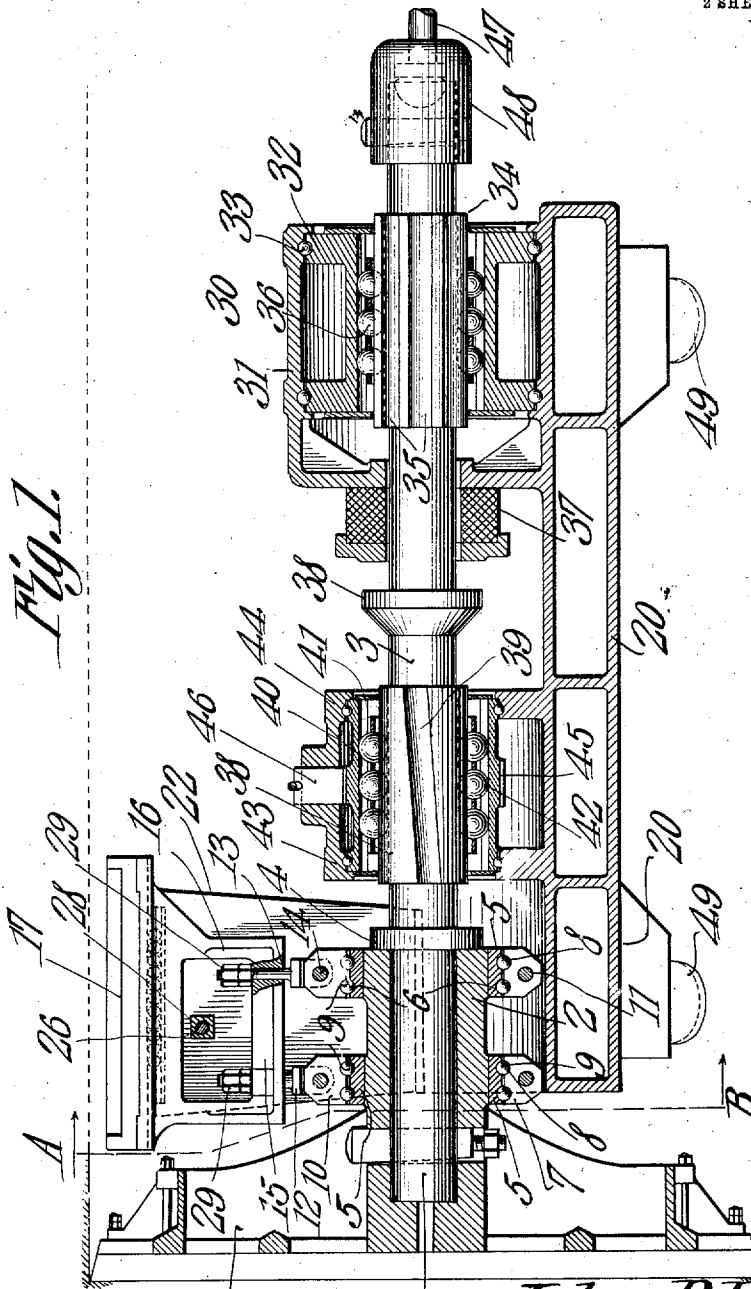


Fig. 1.

Witnesses
E. J. Hunt
H. J. Chapman.

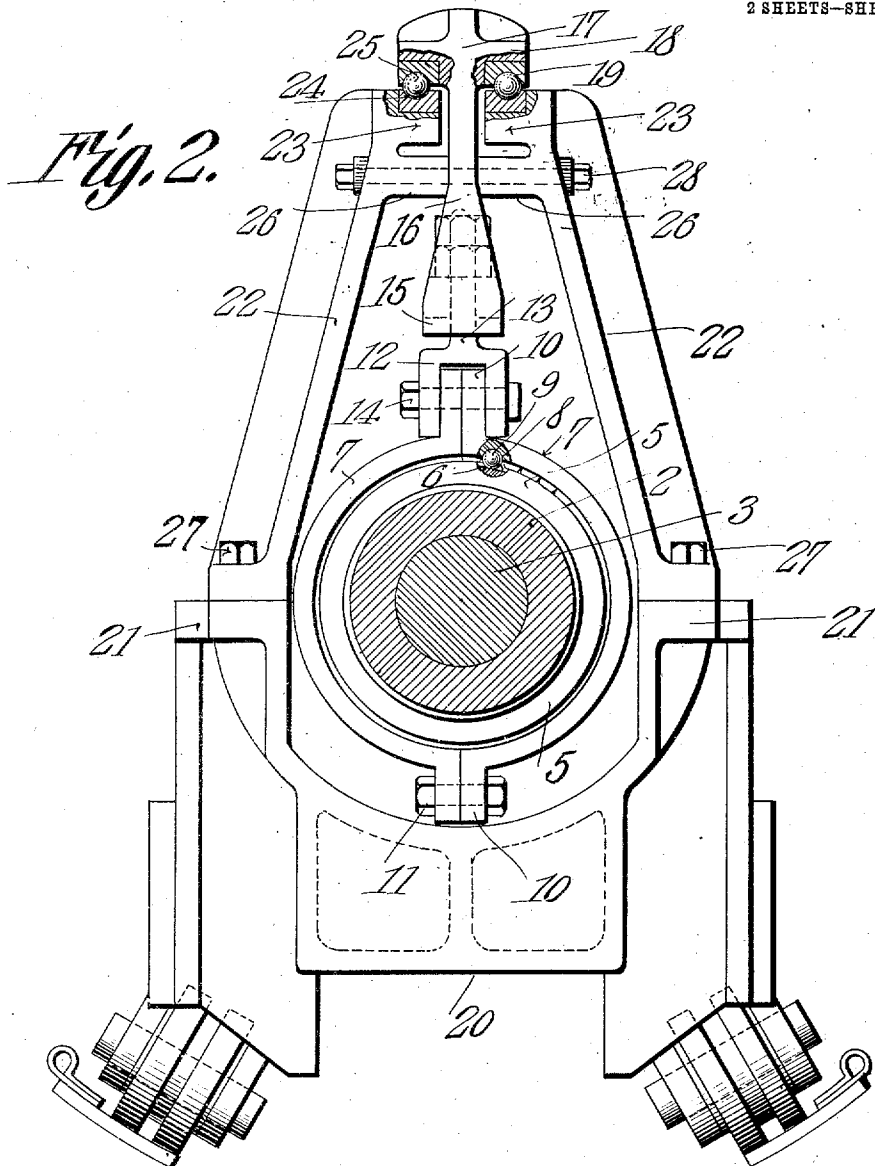
Inventor
John P. Karns.
C. Snow & Co.
Attorneys

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Witnesses
E. J. Stuart
H. T. Chapman

Inventor
John P. Karns.
By *C. Brown & Co.*
Attorneys

UNITED STATES PATENT OFFICE.

JOHN PRUE KARNS, OF BOULDER, COLORADO, ASSIGNOR TO J. P. KARNS TUNNELING MACHINE CO., OF BOULDER, COLORADO.

TUNNELING-MACHINE STRUCTURE.

957,687.

Specification of Letters Patent.

Patented May 10, 1910.

Application filed May 25, 1909. Serial No. 498,245.

To all whom it may concern:

Be it known that I, JOHN PRUE KARNS, a citizen of the United States, residing at Boulder, in the county of Boulder and State of Colorado, have invented a new and useful Tunneling-Machine Structure, of which the following is a specification.

This invention has reference to improvements in tunneling machine structures and is directed more particularly to the front bearing of the shaft carrying the cutter head of the machine, which bearing being located closely adjacent to the center line of gravity of the reciprocating parts of the machine consequently has to sustain the greater portion of the weight of these reciprocating parts.

The present invention is an improvement upon the tunneling machine shown and described in Letters Patent No. 892,849 granted July 7, 1908, on an application filed by me for improvements in drilling machines.

The object of the present invention is to provide a front bearing for a machine of this type wherein anti-friction balls may be employed and at the same time many points of contact are provided each of which shall bear a share of the weight to be sustained and therefore the danger of injury or breakage be reduced to a minimum.

The invention will be best understood from a consideration of the following detail description taken in connection with the accompanying drawings, forming a part of this specification, in which drawings,

Figure 1 is a longitudinal section with parts in elevation of a tunneling machine embodying the present invention. Fig. 2 is a section on the line A—B of Fig. 1 looking toward the rear of the machine, and with some of the distant parts omitted.

In the drilling machine shown in the aforesaid Letters Patent, there is provided a suitable drilling head mounted upon a shaft so that the drill head may be reciprocated in the longitudinal axis of the shaft and toward and from the breast of the tunnel being drilled and the shaft is journaled upon a suitable truck or carriage so that the reciprocatory movements may be imparted to the shaft by a suitable power apparatus and at the same time the shaft is given a slow progressive rotative movement

through mechanism actuated by the reciprocatory movement of said shaft.

In the structure shown in the accompanying drawings, there is a drill head 1 adapted to deliver blows against the breast of the tunnel being constructed by a bodily movement of said drill head and at the same time to be slowly rotated to cause suitable cutters carried by the drill head to engage fresh surfaces of the breast of the tunnel and so cut or chip the rock or other material in the path of the drill or cutter head and thereby form the tunnel.

The drill or cutter head 1 is provided with an elongated hub 2 projecting rearwardly, that is in the direction away from the active face of the cutter head, and this hub has an axial passage or bore for the reception of the corresponding end of a shaft 3 designed to support the cutter head and through which shaft the necessary movements are imparted to the cutter head. The forward end of the shaft 3 abuts against the front wall of the bore of the hub 2 while the rear end of the hub engages an annular flange 4 formed at this point on the shaft 3. The shaft is secured to the hub by a key extending through matching slots in the hub and shaft and held in place in any suitable manner.

Shrunk on or otherwise secured on the hub 2 of the cutter head 1 are spaced rings exterior to the hub and each formed with ball races 6 extending circumferentially of the rings on the outer face thereof, each ring being shown in the drawings as provided with two ball races which is the preferred though not necessarily the only construction which may be employed.

Surrounding each ring 5 are two matched half rings 7 each having a pair of ball races 8 formed on its inner face, the ball races and the matched half rings agreeing with the ball races 6 in the rings 5 and in these ball races are lodged circular series of balls 9, each complete ball race being practically filled with balls, although it is customary to use one or two less balls than is necessary to completely fill a ball race.

The abutting ends of the two half ring members 7 are formed with radial ears 10 matching each other. Two of these ears, namely the ones located below the shaft 3

and hub 2 are connected together by a bolt 11 while the other two ears 10 are embraced by the legs of a yoke 12 formed on one end of a stem 13, and the yoke 12 is connected to the ears 10 by a bolt 14.

In the structure shown there are two rings 5 and two pairs of half rings 7 embracing the rings 5 and there are two yokes 12 with their stems 13, these members being in spaced relation on the hub 2 of the cutter or drill head 1. The stems 13 extend through suitable passages in the lower member 15 of a rectangular frame 16 the upper member of which frame is made thinner than the lower member as it recedes therefrom and finally terminates in a head 17 extending in the direction of the longitudinal axis of the shaft 3 in a plane radial thereto and this head is formed with oppositely disposed longitudinal over-hanging flanges 18 in the lower face of each of which there is formed a ball race 19 parallel with the vertical longitudinal plane of the frame 16.

The tunneling machine as a whole is provided with a truck or carriage, the body portion 20 of which may be in the form of a casting of cellular or web construction and this body portion has upturned side members which at the front are formed along their upper edges with outwardly directed flanges 21 with the upper edges substantially in a plane cutting the longitudinal axis of the shaft 3. At the front of the carriage body 20 and bolted to the flanges 21 are opposed standards or uprights 22 terminating at their upper ends in inwardly directed ledges 23 having their upper surfaces formed with ball races 24 matching the ball races 19 in the overhanging flanges 18. While the ball races 19 and 24 have been described as formed in the under faces of the flanges 18 and the upper faces of the ledges 23, it is of course evident that these ball races may be formed in suitable blocks inset in the respective flanges 18 and ledges 23 so that in case of undue wear these blocks may be renewed without the necessity of renewing the frame 16 or standards 22.

Seated in the ball races are series of balls 25, which latter because of the length of the ball races may be comparatively small and the ball races and balls are so proportioned that the lower faces of the members in which the ball races 19 are formed are elevated a short distance above the upper faces of the members in which the ball races 24 are formed, thus preventing these faces from coming into contact and also providing room for ball retaining cages should such be desired.

The upper ends of the standards 22 approach each other and below the ledges 23 these standards are provided with meeting bosses 26 serving as a spacing means for the

upper ends of the standards so as to relieve the fastening devices shown as bolts 27 by which the lower ends of the standards are secured to the flanges 21 of the carriage 20. The upper ends of the standards 22 are secured together by a bolt 28 extending through the two bosses 26.

The stems 13 are suitably threaded for the reception of nuts 29, which may be two in number for each stem so as to serve as lock nuts.

The remainder of the structure, though shown in the drawings, and briefly described hereinafter, forms no part of the present invention, it being shown and described in detail in another application, Serial No. 498,246, filed May 25, 1909, for improvements in drilling machines.

At the end of the carriage body 20 remote from the drill head is a bearing 30 comprising a journal casing 31 fast on or secured to the carriage body 20 and this journal casing incloses a cylinder 32 held in the casing against movement in the direction of the longitudinal axis of the shaft 3 but free to rotate about such axis by series of balls 33 held in suitable ball races formed in the casing and cylinder respectively. The inner surface of the cylinder 32 is formed with a circular series of longitudinal grooves and the shaft 3 is formed at this point with a cylindrical enlargement 34 having matching longitudinal grooves 35 while balls 36 seated in the grooves in the enlargement 34 and inner wall of the cylinder 32 permit longitudinal movement of the shaft through the cylinder 32 but cause the simultaneous rotative movement of the shaft and cylinder.

In front of the bearing 30 the shaft 3 is surrounded by an elastic buffer 37 in the path of an annular head 38 formed on the shaft.

Between the front and rear bearings of the shaft the latter is formed with a cylindrical enlargement 38 having on its outer surface grooves 39 pitched slightly with relation to the longitudinal axis of the shaft.

A pitch of 5° will usually be found ample for the purposes of the structure, but this pitch may be greater or less as may be found desirable. The cylindrical enlargement 38 is inclosed by a cylinder 40 having matching grooves 41 formed in its inner face and lodged in the grooves are balls 42 constituting anti-friction splines connecting the cylinder 40 to the shaft 3. The cylinder 40 is mounted in a suitable casing 43 carried by the body 20 of the truck or carriage and the cylinder is mounted in the casing through the intermediary of series of balls 44 permitting the rotative movement of the cylinder about the longitudinal axis of the shaft 3 but preventing any movement of the cylinder in the direction of said longitudinal axis.

The cylinder is provided with an exterior circular series of ratchet teeth 45 and in operative relation to these ratchet teeth are pawls 46.

5 The ratchet structure just described is similar to the ratchet structure shown and described in the aforesaid Letters Patent and the purpose of this ratchet structure is to cause the slow progressive step by step rotation of the shaft 3 and cutter head 1 by the longitudinal reciprocation of the shaft which longitudinal reciprocation is brought about by the application of suitable power through a connecting rod 47 and a coupling 15 48 fast on the rear end of the shaft 3.

The carriage body 20 is mounted upon suitable wheels or rollers 49, but as the manner of connecting the wheels or rollers to the carriage forms no part of the present invention and is disclosed in the aforesaid application Serial No. 498,246, it is not deemed necessary to show or describe these features herein.

25 The tunneling machine structure is designed for the drilling of tunnels, drifts, airshafts, and the like and the drill or cutter head is designed to act on the entire breast of the tunnel at the same time so that the structure is necessarily massive and correspondingly heavy and moreover must stand severe shocks and strains. It follows therefore that unusual problems enter into the construction of such a machine. Ordinary bearings for the shaft 3 will not answer and 35 consequently special bearings adapted to the conditions present must be provided in order that the machine will properly stand up in operation. This will be the more evident when it is considered that the machine is 40 designed to bore continuously a full-size tunnel through even the hardest rock and must be resistant to heavy shocks and jars without breakdown or other interference with the continued progressive operation of the machine and without material wear of 45 the parts.

Because of the large size and necessarily heavy construction of the drill or cutter head, the center line of gravity of the reciprocating parts of the machine is immediately adjacent to the rear of the front bearing of the shaft and consequently this bearing sustains the major portion of the weight of the reciprocating parts. Furthermore, to prevent excessive waste of power from friction losses it is necessary to introduce antifriction bearings between moving parts, but because of the great weight of the structure such bearings should be made particularly 60 extensive.

Because of the longitudinal and rotative movement of the shaft 3 extended ball bearings cannot be provided, especially for the longitudinal movement of the shaft, with-

out unduly lengthening the machine. Furthermore, to provide for both movements of the shaft with ball bearings disposed about the axis of the shaft, requires that there shall be many inactive series of balls to provide for the longitudinal movement of the 70 shaft. By the present invention this difficulty is avoided by hanging that portion of the journal bearing in which provision is made for the turning of the shaft about its longitudinal axis from an overhead member 75 which may be made as long in the direction of the longitudinal movement of the shaft as may be necessary since the space above the machine is not utilized for the accommodation of any other structures. Consequently 80 all bearings providing an extended support in the direction of the length of the axis of the shaft may be provided and all the balls are active at all times and these balls may be made of comparatively small diameter so 85 that many active points of support are present and consequently the liability of wear or breakage is reduced to a negligible minimum.

What is claimed is:—

90 1. In a tunneling machine, a cutter head, a shaft carrying the same, and a journal bearing for the shaft having a member adjacent to the shaft and provided with circumferential series of balls, another member carrying the first named member, a support for the last named member in which it is movable in the direction of the longitudinal axis of the shaft, and balls between the second named member and the support 100 therefor.

2. In a tunneling machine, a cutter head, a shaft carrying the same, a journal bearing therefor having a member movable with the shaft in the direction of the longitudinal axis of the latter and with reference to which the shaft is rotatable, a carrier for the said member movable therewith in the direction of the longitudinal axis of the shaft, and a support for the carrier along which the latter is also movable in the direction of the longitudinal axis of the shaft. 110

3. In a tunneling machine, a cutter head, a shaft carrying the same, and a journal bearing therefor having a member rotatable 115 with the shaft and movable with the shaft in the direction of the longitudinal axis of the latter, another member surrounding the first member and movable therewith in the direction of the longitudinal axis of the shaft, annular series of balls between the members, a carrier for the last named member movable therewith in the direction of the longitudinal axis of the shaft, a support for the carrier along which the latter is also 120 movable in the direction of the longitudinal axis of the shaft, and balls introduced between the carrier and the support therefor 125

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and extended in the direction of the movement of said support.

4. In a tunneling machine, a carriage, a cutter head, a shaft carrying the same, standards mounted on the truck and extending above the shaft on each side thereof, longitudinally disposed bearings formed on said standards at the upper end thereof, a support movable on said bearings on the standards in the direction of the longitudinal axis of the shaft, ring-shaped members carried by the longitudinally movable member and surrounding the shaft and bearings interposed between the shaft and the ring-shaped member and constrained to rotative movement only therein, said last named bearings, ring-shaped members, and longitudinally slidable member participating in the longitudinal movement of the shaft.

5. In a tunneling machine, a cutter head, a shaft for the same, said shaft being capable of rotative and reciprocatory motion, bearings sustaining the shaft and participating in the longitudinal movements of the shaft, said bearings permitting the rotative movement of the shaft, and a hanger

for said bearings movable in the direction of the longitudinal axis of the shaft.

6. In a tunneling machine, a cutter head provided with an elongated hub, a shaft entering said hub and secured thereto, bearings encircling the hub and in which the cutter head and shaft are rotatable, and a hanger for said bearings movable therewith in the direction of the longitudinal axis of the shaft.

7. In a tunneling machine, a cutter head provided with an elongated hub, a shaft entering and secured to said hub, said shaft and cutter head being capable of rotative and reciprocatory movement, spaced bearings exterior to the hub and with relation to which the hub and shaft are rotatable, and a hanger common to the bearings and movable therewith in the direction of the longitudinal axis of the shaft.

In testimony that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

JOHN PRUE KARNS.

Witnesses:

JOHN DAVIS,
BOTTIS STROTHER.