LE ROY W. CAMPBELL.

TUNNELING MACHINE.

APPLICATION FILED APR. 5, 1916.

1,371,224. **Patented Mar. 15, 1921.**

4 SHEETS—SHEET 1.

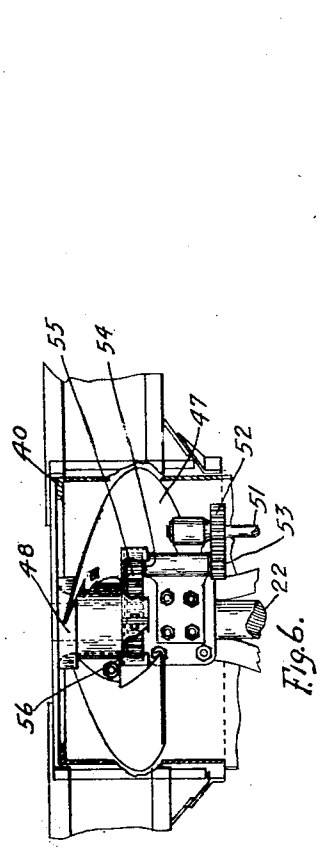


Fig. 6.

Fig. 1.

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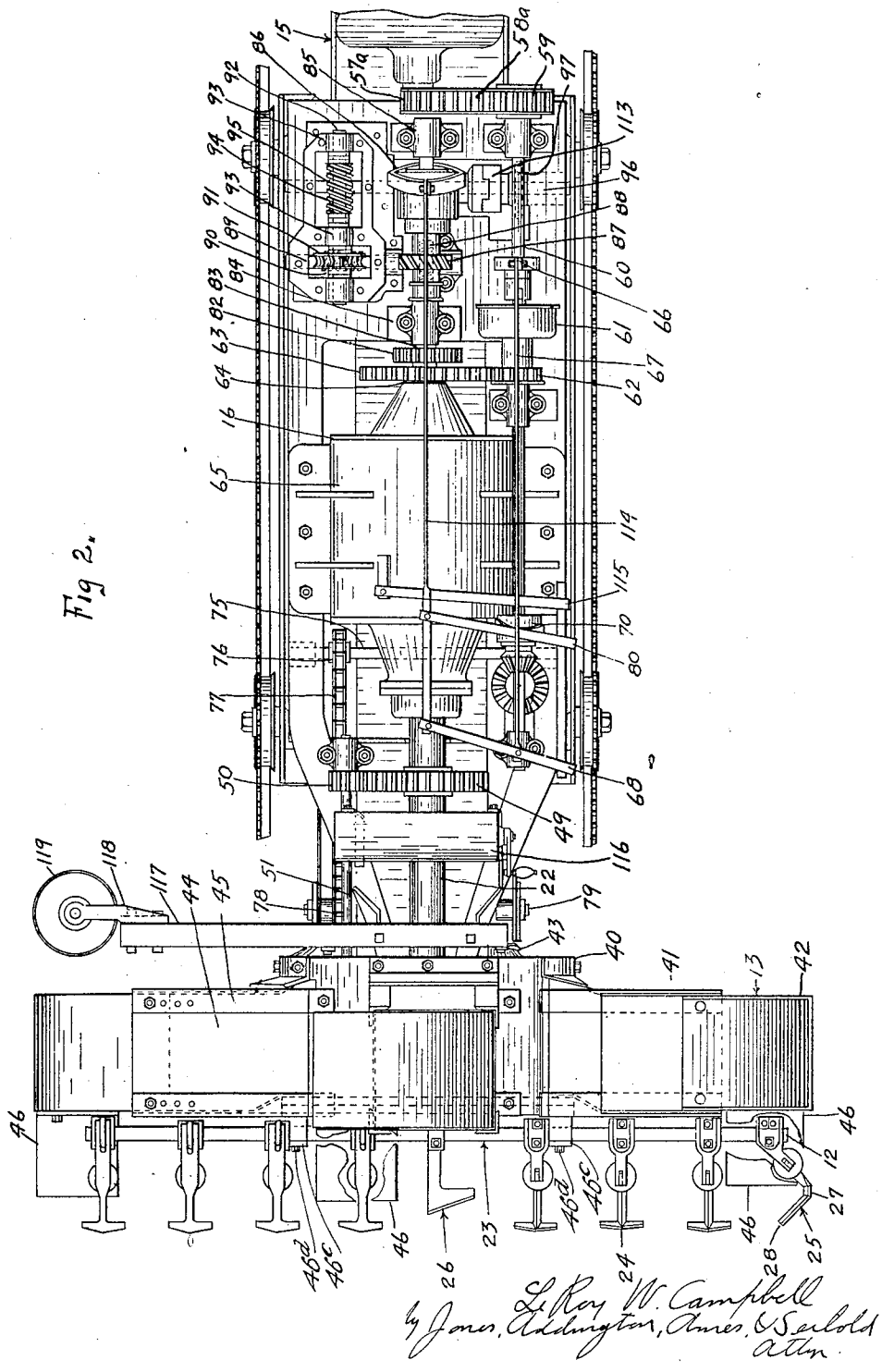
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4 SHEETS—SHEET 2.

Fig 2.



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4 SHEETS—SHEET 3.

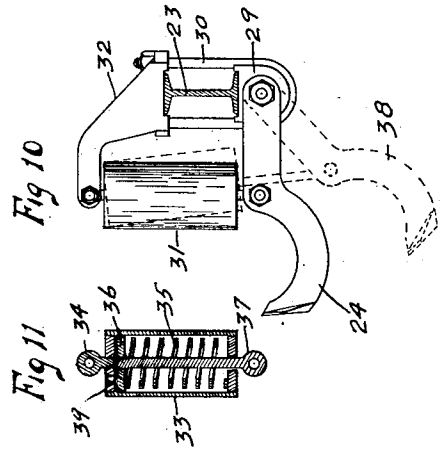


Fig 10

Fig 11

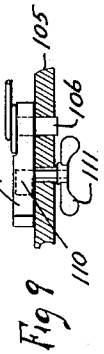


Fig 9

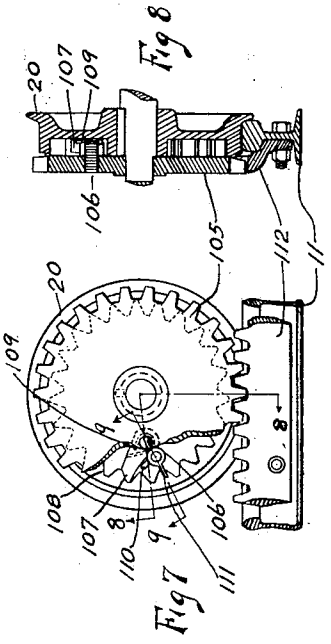


Fig 8

Fig 7

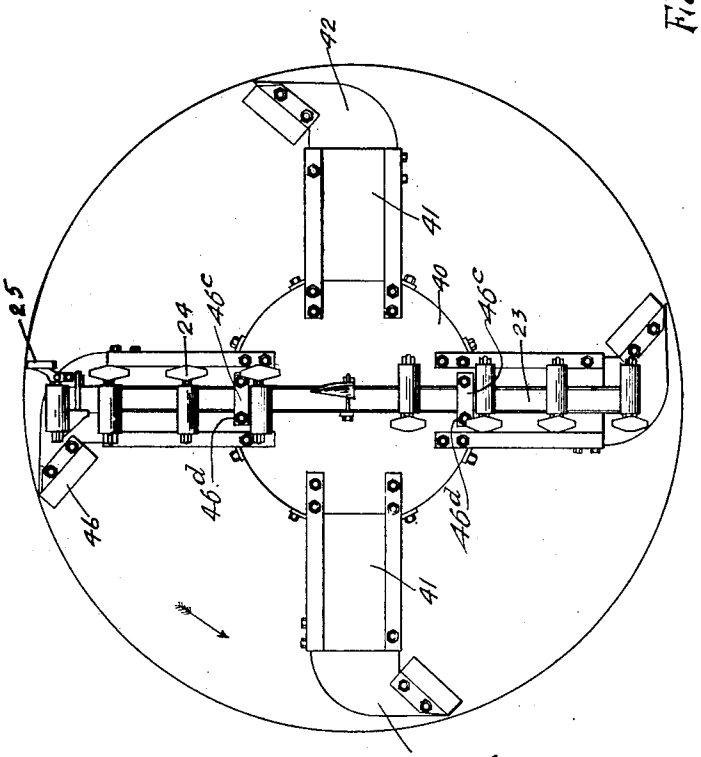


Fig 3.

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4 SHEETS—SHEET 4.

Fig 5.

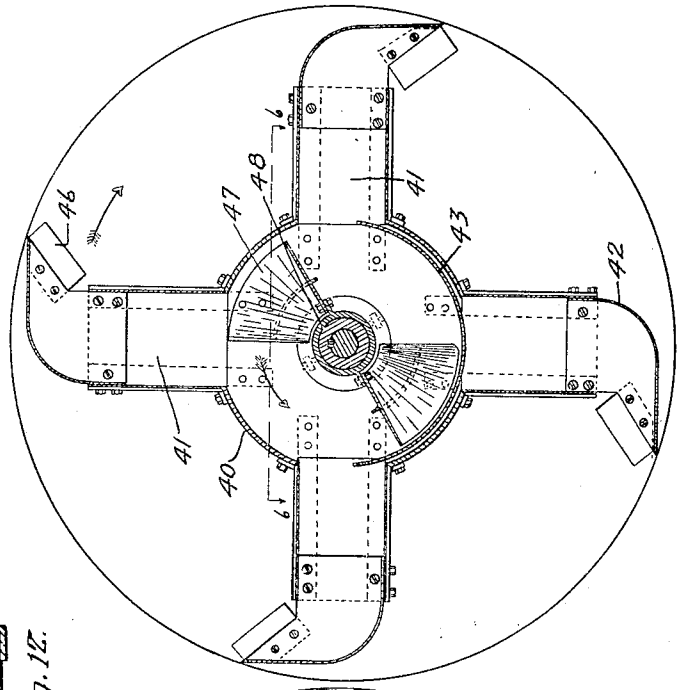


Fig. 12.

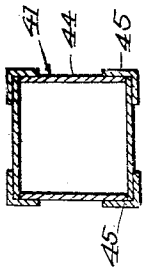
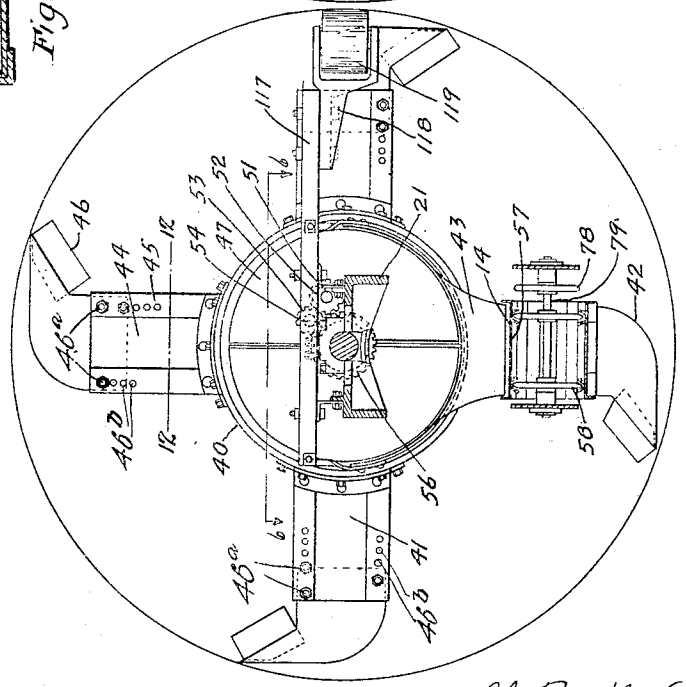


Fig 4.



LeRoy W. Campbell
by Jones, Addington, Ames & Seibold
Attys

UNITED STATES PATENT OFFICE.

LE ROY W. CAMPBELL, OF GRAND RAPIDS, MICHIGAN, ASSIGNOR TO THE TUNNEL & SEWER MACHINE ENGINEERING COMPANY, OF BUFFALO, NEW YORK, A CORPORATION OF NEW YORK.

TUNNELING-MACHINE.

1,371,224. Specification of Letters Patent. Patented Mar. 15, 1921.

Application filed April 5, 1916. Serial No. 89,044.

To all whom it may concern:

Be it known that I, LE ROY W. CAMPBELL, a citizen of the United States, residing at Grand Rapids, in the county of Kent and State of Michigan, have invented new and useful Improvements in Tunneling-Machines, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to tunneling machines and more specifically to the pick-up mechanism; that is, the mechanism for scraping up the material as it is excavated, delivering it to a central section from which it is discharged to a suitable conveyer or to a place where it can be easily removed, and to a hinged cutting knife with spring attachment permitting the cutting edge to be forced back when encountering a stone or other obstruction and when released returning the cutting edge to normal position without jar, and to the traction drive by means of a rack attached to the track and a geared wheel attached to the traction wheels that may be released when desired.

Among the objects of my invention is to provide such a tunneling machine which will be simple and practical in construction and efficient in use.

In the drawings, in which I have shown one embodiment of my invention—

Figure 1 is a side elevation of a tunneling machine;

Fig. 2 is a plan view thereof;

Fig. 3 is a front elevation of the excavating and pick-up mechanism;

Fig. 4 is a section on the line 4—4 of Fig. 1;

Fig. 5 shows a section through the pick-up arms and buckets;

Fig. 6 is a section on the line 6—6 of Fig. 4;

Fig. 7 is a side view of the traction wheel and gear wheel;

Fig. 8 is a section on the line 8—8 of Fig. 7;

Fig. 9 is a section on the line 9—9 of Fig. 7;

Fig. 10 is a side view of the hinged knife with the spring case;

Fig. 11 is a vertical section of the spring case shown in Fig. 10; and Fig. 12 is a section on the line 12—12 of Fig. 4.

Referring now to the drawings in detail, the tunneling machine shown comprises a carriage 10 mounted to roll on a track 11, excavating mechanism 12, pick-up mechanism 13 for scraping up the excavated material, a motor 15 supported by the carriage 10 for driving the various mechanisms, mechanism 16 for transmitting power from the motor to the excavating and pick-up mechanism, mechanism 17 for transmitting power to the conveyer, and mechanism 18 for transmitting power to advance the carriage along the track.

The carriage 10 comprises a frame 19 of any suitable type which may be built up of structural material, wheels 20 for engaging the track 11, and a base 21 of any suitable construction which may take the form of a casting for supporting the motor transmission mechanism, etc. The excavating mechanism 12 comprises a shaft 22 mounted in suitable bearings on the base 21, a cross-head 23 secured to rotate with the shaft 22, a plurality of cutters 24, secured on the cross-head 23 for removing the greater part of the excavated material, a trimmer 25 for truing up the circumference of the tunnel, and an auger 26 for taking out the central portion of the bore. The trimmer 25 consists of the trimmer portion proper 27 and the wing 28 which cuts into the face at an angle leaving a beveled surface that tends to support the sides of bore and throws the excavated material back from the face toward the pick-ups 13. Where excavating material free from large stones the cutters and trimmers would be fixed to the cross-head 23, but where stone are encountered they are hinged to the block 29 which is bolted to the cross-head 23 by the bolt 30. The cutters and trimmers are held in cutting position by a compression spring combination 31 which is also attached to cross-head 23 through the bracket 32. The compression spring combination 31 consists of a case 33 having a ring bolt 34 fastened to its top and which bolts to the bracket 32. The spring case contains a compression spring entered into the case under pressure sufficient to hold the cutter and trimmer to normal duty, and with the lower end bearing on the bottom of the case 33 and its upper end bearing on the plunger 36 into which is fastened the plunger rod 37. When the

cutting edge of the cutter 24 encounters a stone, as the cross head 23 revolves, the cutting edge is detained and the cutter 24 moves back toward the dotted position 38 sufficient to slide past the stone when the cutter would be brought back to normal position by the compression spring but for the air compression between plunger 36 and the interior of the case 33. The velocity of return of the plunger 36 is regulated by the hole 39 in the top of the case 33.

The pick-up mechanism comprises a central hollow frame-work or drum-like casing 40 mounted to rotate with the shaft 22, a plurality of radially extending hollow arms 41 in communication with the casing 40, and pick-up buckets 42, one carried by each of the arms 41 for scraping up the excavated material and delivering it to the hollow arms. A chute or hopper 43 extends within the casing 40 to receive the excavated material as it slides down inside of the hollow arms 41. The arms 41 may be constructed in any suitable manner, as from steel plates 44 connected by angle irons 45. If desired plows 46 may be attached to the buckets 42 to guide the excavated material adjacent the buckets into the path of the buckets; also, if desired, some of the arms may be off-set with respect to the others so that they will not travel in the same path as they rotate.

In order that the buckets may be adjusted longitudinally with respect to the arms 41 to take care of cuts of different diameters, the buckets are telescopically mounted in the arms and can be secured in various adjusted positions by means of bolts 46^a inserted through openings in the buckets 42 and insertible through any one of a series of openings 46^b in the arms 41. The cross head 23, which carries the different excavating tools, such as the cutters 24 and the trimmer 25, is detachably secured to rotate with the shaft 22 by means of a pair of cleats 46^c which extend across the face of the cross head 23 and are secured in place by means of bolts 46^d.

Under some conditions the excavated materials, when discharged by the hollow arms 41 onto the chute 43, do not discharge freely onto the conveyer 14. To overcome this trouble and force the excavated material back from within the casing 40 helical screw blades or paddles 47 attached to a hollow hub 48 that rotates on the main hub of the casing 40 are installed. This hub rotates around the main shaft in a direction opposite to the excavating and pick-up mechanism and forces the excavated material back onto the conveyer. The transmission mechanism for rotating the hollow hub 48 comprises a spur gear 49 secured to the main shaft 22 and rotating with it, a spur gear 50 meshing with the spur gear 49, a shaft 51 on which the gear 50 is secured, mounted in suitable bearings on the base 21, a spur gear 52 secured on shaft 51, a spur gear 53 meshing with the gear 52, and secured on a shaft 54, and a spur gear 55 secured on the shaft 54 and meshing with the spur gear 56 secured to the rear end of the hollow hub 48.

The conveyer mechanism comprises a link belt 57 of any suitable construction located in position to receive the material from the chute 43 and sprocket wheels 58 mounted in suitable bearings on the carriage 10 over which the linked belt 57 passes.

The transmission mechanism 16 comprises a sprocket 57^a secured on the motor shaft, a chain belt 58^a engaging the sprocket 57^a, a sprocket 59 engaged by the chain belt 58^a, a shaft 60 on which the sprocket 59 is secured, mounted in suitable bearings on the base 21, a clutch 61 associated with the shaft 60, a gear 62 controlled by the clutch 61 and mounted on the shaft 60, a gear 63 meshing with the gear 62, a shaft 64 on which the gear 63 is mounted, the shaft 22 previously referred to which rotates the cross-head 23, and a suitable gear reducer 65 which may be a planetary gearing for transmitting power from the shaft 64 to the shaft 22.

The clutch 61 is operated by means of a lever 66 engaging the clutch, a link 67 connected with the lever 66 and a hand lever 68 connected with the link 67. The transmission mechanism 17 for the conveyer comprises a beveled pinion 69 secured on the shaft 60, a beveled gear 71 meshing with the pinion 69, a shaft 72 on which the gear 71 is secured, mounted in suitable bearings on the base 21, a spiral gear 73 secured on the shaft 72, a spiral gear 74 meshing with the spiral gear 73 and secured on a shaft 75 mounted in suitable bearings on the base 21, a sprocket 76 secured on the shaft 75, a sprocket chain 77 engaging the sprocket 76 and a sprocket wheel 78 engaged by the chain 77 and secured on the shaft 79 on which the sprockets 58 are secured.

The transmission mechanism 17 is controlled by means of a clutch 70 operated by the hand lever 80. The transmission mechanism 18 for advancing the carriage comprises a gear 81 secured on the shaft 64, a gear 82 meshing with the gear 81, a shaft 83 on which the gear 82 is secured, mounted in bearings 84 and 85 on the base 21, a clutch 86 associated with the shaft 83, a spiral gear 87 controlled by the clutch 86 and mounted on the shaft 83, a spiral gear 88 meshing with the gear 87, a shaft 89 on which the gear 88 is secured, mounted in suitable bearings on the base 21, a worm 90 secured on the shaft 89, a worm gear 91 meshing with the worm 90, a shaft 92 on which the worm gear 91 is secured, bearings 93 in which the shaft 92 is mounted, a worm 94 secured on the shaft 92, a worm gear 95 meshing with

the worm 94, a shaft 96 on which the worm gear 95 is secured, mounted in bearings on the base 21, a sprocket 97 secured on the shaft 96, a sprocket chain 98 engaging the sprocket 97, a sprocket 99 engaged by the chain 98 and secured on the rear axle 100 on which the wheels 20 are secured. The front wheels 20 are driven by means of a sprocket chain 101 engaging a sprocket 102 secured on the front axle 103.

To prevent the traction wheels 20 slipping on the rails the gear wheel 105 is associated with the axles 100 and 103. The pin 106 secured to the gear wheel 105 carries the dog 107 designed to mesh with the gear teeth 108 on the interior of the wheel 20, where it is held by means of the spring 109. The latch 110, associated with the thumb lever 111, enables the dog 107 to be lifted to clear the teeth 108 when desired. With the dog 107 in mesh with the teeth 108, when the wheel 20 rotates forward the tooth 108 bears on the dog 107, transmitting rotary motion to the gear wheel 105 through the pin 106. The gear wheel 105 meshes with the rack 112 bolted to the rail 11 and forces the machine forward.

The dog 107 and teeth 108 constitute a ratchet and pawl connection between the gear wheel 105 and the traction wheel 20. This ratchet and pawl connection has several advantages. For instance, it is sometimes desirable to jack the machine up to take its weight off the rails 11, to permit these rails to be shoved forward. If the gear wheels 105 were constructed so that they could not rotate independently of the axles, the machine would have to be jacked up until the gear wheels 105 cleared the racks 112. However, by making the gear wheels rotatable independently of the axles, it is only necessary to jack up the machine until the weight is off the rails, when the latter can be shoved forward, the gear wheels 105 rotating without causing the axles to rotate. Also, if the gears 105 were not rotatable independently of the axles it might happen that the gears on the two sides of the machine would not mesh properly with their corresponding racks, which would put a severe strain on the teeth of the gears, racks and axle.

By means of the ratchet and pawl connection, if the parts are assembled so that one of the dogs 107 comes into driving relation with its gear before the dog on the other end of the axle comes into driving relation with its gear, the drive will be from one side only, but strain on the teeth of the gears, rack and axle referred to above will be avoided. Furthermore, by throwing the dogs 107 on one side of the machine out of operative position, the direction in which the tunneling machine cuts can be guided somewhat, as a drive from one side only of the machine will tend to force the machine over the opposite side.

A jaw clutch 113 is associated with the shaft 96 for disconnecting the sprocket 97 from the worm gearing 94, 95, etc., when it is desired to move the carriage 10 quickly by hand. The clutch 86 is controlled by means of a link 114 connected therewith and a hand lever 115 located in a convenient position for the operator. A controller 116 is provided for the motor 15.

To take care of the side thrust on the shaft 22 due to the scraping of the buckets 42 on the floor of the tunnel as they are gathering up the excavated material, an arm 117 is secured on the base 21 on which arm the yoke 118 is mounted which carries a roller 119 which engages the side wall of the tunnel to take care of the side thrust.

The method and operation of the machine is as follows: With all of the clutches disconnected the motor is started. The conveyer clutch is first thrown in to cause the link belt 57 to travel in the proper direction through the transmission mechanism 17 previously described. The clutch 61 is then thrown in to cause rotation of the excavating mechanism 12 and the pick-up mechanism 13 through the transmission mechanism previously described. The clutch 86 is then thrown in to cause the carriage 10 to travel in a forward direction bringing the cutter 24, trimmer 25, etc., into engagement with the face of the tunnel to be excavated. These cutters and trimmers loose the material which falls to the bottom of the bore and is deflected back to the buckets 42 by means of plows 46 carried by the buckets. Rotation of the arms 41 forces the excavated material into the buckets which falls back as the arms rotate and slides down inside of the hollow arms as they pass the horizontal position. When the necesary inclination has been reached by the arm which will depend upon the nature of the material excavated, the material will slide down the hollow arm toward the casing 28 and will fall onto the chute 43 which directs it onto the link belt 57 which conveys it to the rear of the machine. The speed of excavation can be varied by throwing the clutch 86 in and out.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:—

1. A tunneling machine for making a substantially horizontal tunnel, comprising a cutter-head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, means for picking up the loosened material which falls to the bottom of the bore, comprising a pick-up member, means for causing said pick-up member to travel in a definite path at the bottom of said bore, and means whereby the path of

said pick-up member at the bottom of said bore may be varied to enable it to be used with tunnels having bores of different dimensions.

2. A tunneling machine for making a substantially horizontal tunnel, comprising a cutter-head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, means for picking up the loosened material which falls to the bottom of the bore comprising a pick-up member, means whereby said pick-up member is caused to travel in a definite path at the bottom of said bore, means whereby the path of said pick-up member at the bottom of said bore may be varied to enable it to be used with tunnels having bores of different dimensions and a conveyer to which said pick-up means delivers the loose material, for conveying the material away from the face of the cut.

3. A tunneling machine for making a tunnel having a substantially horizontal bore, comprising a cutter-head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, means for picking up the loosened material which falls to the bottom of the bore comprising a pick-up member, means for causing said member to travel in a circular path at the bottom of said bore, and means whereby the radius of said circular path may be varied whereby said member may be used in tunnels having bores of different dimensions.

4. A tunneling machine for making a substantially horizontal tunnel, comprising a boring head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, means for picking up the material which falls to the bottom of the bore, comprising a pick-up member, means for causing said pick-up member to travel in a definite path at the bottom of said bore, in a plane to which the axis of said boring head is substantially perpendicular, and means whereby the path of said pick-up member at the bottom of said bore may be varied to enable it to be used with tunnels having bores of different dimensions.

5. A tunneling machine for making a substantially horizontal tunnel, comprising a boring head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, a series of pick-up buckets for picking up the material which falls to the bottom of the bore, mounted to travel in a plane to which the axis of said boring head is substantially perpendicular, a hopper located within the orbit of said pick-up buckets, to which said buckets deliver the loosened material, means operating in said hopper for removing the material therefrom, and a conveyer for receiving the material removed from said hopper and carrying it away from the face of the cut.

6. A tunneling machine for making a substantially horizontal tunnel, comprising a boring head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, a series of pick-up buckets for picking up the material which falls to the bottom of the bore, mounted to travel in a plane to which the axis of said boring head is substantially perpendicular, a hopper located within the orbit of said pick-up bucket, means rotatable in said hopper in a plane to which the axis of said boring head is substantially perpendicular for removing the material from said hopper, and a conveyer for receiving the material removed from said hopper and carrying it away from the face of the cut.

7. A tunneling machine for making a substantially horizontal tunnel, comprising a boring head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, a series of pick-up buckets for picking up the material which falls to the bottom of the bore, mounted to travel in a plane to which the axis of said boring head is substantially perpendicular, a hopper located within the orbit of said pick-up buckets, means rotatable about the same axis as said boring head, operating in said hopper for removing the material from said hopper, and a conveyer for receiving the material removed from said hopper and carrying it away from the face of the cut.

8. A tunneling machine for making a substantially horizontal tunnel, comprising a boring head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, means for picking up the loosened material which falls to the bottom of the bore, comprising a rotatable arm having a passage therein, and a bucket carried by said arm for picking up the loosened material and delivering it to the passage in said arm, and means whereby said bucket may be adjusted longitudinally on said arm whereby the path of said bucket at the bottom of said bore may be varied to enable it to be used in tunnels having bores of different dimensions.

9. A tunneling machine for making a substantially horizontal tunnel, comprising a cutter-head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, and means for picking up the loosened material which falls to the bottom of the bore comprising a rotatable substantially radially-extending arm having a passage therein, and a bucket carried by said arm for picking up the loosened material and delivering it to the passage in said arm, and means whereby said bucket may be adjusted radially on said arm, whereby the

path of said bucket at the bottom of said bore may be varied to enable it to be used with tunnels having bores of different dimensions.

10. A tunneling machine for making a substantially horizontal tunnel, comprising a cutter-head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, a centrally located hopper, means for picking up the loosened material which falls to the bottom of the bore and delivering it to said hopper, comprising a rotatably mounted arm having a passage therein, and a bucket supported on said arm for picking up the loosened material and delivering it to the passage in said arm, the loosened material being delivered from the passage in said arm to said hopper, and means whereby said bucket may be adjusted radially on said arm whereby the path of said bucket at the bottom of said bore may be varied to enable it to be used with tunnels having bores of different dimensions.

11. A tunneling machine for making a substantially horizontal bore, comprising a cutter-head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, a centrally located hopper, means for picking up the loosened material which falls to the bottom of the bore, comprising a pick-up member for picking up the loosened material and delivering it to said hopper, means operating in said hopper for removing the material therefrom and a conveyer for receiving the material removed from said hopper and carrying it away from the face of the cut.

12. A tunneling machine for making a substantially horizontal tunnel, comprising a boring head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, a series of pick-up buckets for picking up the material which falls to the bottom of the bore, a centrally located hopper to which said pick-up buckets deliver the loosened material, means operating in said hopper for removing the material therefrom, and a conveyer for receiving the material removed from said hopper and carrying it away from the face of the cut.

13. A tunneling machine for making a substantially horizontal bore, comprising a boring head rotatable about a substantially horizontal axis, for loosening the material at the face of the cut, a series of pick-up buckets rotatable with said boring head for picking up the material which falls to the bottom of the bore, a hopper located within the orbit of said pick-up buckets, to which said buckets deliver the excavated material, means operating in said hopper for removing the material therefrom, said means being rotatable in a direction opposite to that of the boring head, and a conveyer for receiving the material removed from said hopper and carrying it away from the face of the cut.

14. A tunneling machine for making a substantially horizontal tunnel, comprising a boring head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, a series of pick-up buckets for picking up the material which falls to the bottom of the bore, a hopper located within the orbit of said pick-up buckets, to which said buckets deliver the loosened material, screw means rotatable in said hopper for removing the material therefrom and a conveyer for receiving the material removed from said hopper and carrying it away from the face of the cut.

15. A tunneling machine comprising a rotatable shaft, a cross-arm secured to rotate with said shaft and extending transversely with respect thereto, an excavating tool pivoted to said cross-arm, and yielding means for normally holding said tool in operative position and for permitting it to yield when an obstruction is encountered and for returning it when the obstruction is passed, comprising a link pivotally connected to said excavating tool, and a coil compression spring surrounding said link and supported by said cross-arm.

16. A tunneling machine comprising a rotatable head, an excavating tool pivoted to said head, and yielding means for normally holding said tool in operative position and for permitting it to yield when an obstruction is encountered and for returning it when the obstruction is passed, and means for retarding the return of said tool.

17. A tunneling machine comprising a rotatable head, an excavating tool pivoted to said head, and yielding means for normally holding said tool in operative position and for permitting it to yield when an obstruction is encountered and for returning it when the obstruction is passed, means for retarding the return of said tool, said yielding and retarding means comprising a cylinder and piston dash pot, a connection between said piston and tool, and a spring in said cylinder bearing on said piston.

18. A tunneling machine for making a substantially horizontal bore, comprising a boring head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, a series of pick-up buckets for picking up the material which falls to the bottom of the bore, a central rotatable hollow drum for supporting said pick-up bucket, and a hopper located within said drum to which said buckets deliver the loosened material.

19. A tunneling machine for making a substantially horizontal tunnel, comprising a boring head rotatable about a substantially horizontal axis for loosening the ma-

terial at the face of the cut, a series of pick-up buckets for picking up the material which falls to the bottom of the bore, a central rotatable hollow drum on which said buckets are mounted, a hopper located within said drum, to which said buckets deliver the loosened material, and means operating in said hopper for removing the material therefrom.

20. A tunneling machine comprising a rotatable shaft, a cross-arm secured to rotate with said shaft and extending transversely with respect thereto, an excavating tool pivoted to said cross-arm to move about an axis substantially parallel to said cross-arm, and yielding means for normally holding said tool in operative position and for permitting it to yield when an obstruction is encountered and for returning it when the obstruction is passed, comprising an axially-acting coil spring acting between said pivoted tool and said cross-arm.

21. A tunneling machine for making a substantially horizontal bore, comprising a boring head rotatable about a substantially horizontal axis for loosening the material at the face of the cut, and means for scooping up the loosened material which falls to the bottom of the bore, comprising a rotatably mounted hollow arm and a bucket movably mounted with respect to said arm at the outer end thereof, whereby the path of said bucket at the bottom of said bore may be varied to enable it to be used with tunnels having bores of different dimensions.

22. A tunneling machine for making a substantially horizontal tunnel comprising a boring head rotatable about a substantially horizontal axis, a cutter carried by said boring head and rotatable about an axis substantially perpendicular to the axis of said boring head, and yielding means for holding said cutter in its operative position whereby the cutter can yield when it encounters an obstruction.

23. A tunneling machine for making a substantially horizontal tunnel, comprising a boring head rotatable about a substantially horizontal axis, a boring bar carried by said boring head extending substantially perpendicular the axis of said boring head, a cutter pivotally mounted on said boring bar to swing about an axis substantially parallel to said boring bar for loosening the material at the face of the cut, and spring means for holding said cutter in its operative position whereby the cutter can yield when it encounters an obstruction.

24. A tunneling machine for making a substantially horizontal tunnel, comprising a horizontal rotatable boring bar, a cutter-head for loosening the material at the face of the cut, secured to said boring bar and rotatable therewith and readily detachable with respect thereto, whereby different cutter-heads may be interchangeably used, means for picking up the loosened material which falls to the bottom of the bore, comprising a pick-up member, means for causing said pick-up member to travel in a definite path at the bottom of the bore whereby the path of said pick-up member at the bottom of said bore may be varied to enable the machine to make tunnels having bores of different dimensions.

25. A tunneling machine for making a substantially horizontal tunnel, comprising a cutter-head rotatable about a substantially horizontal axis for loosening the material from the face of the cut, said cutter being readily detachable with respect to the machine, whereby cutter-heads of different dimensions may be interchangeably used, means for picking up the loosened material which falls to the bottom of the bore, comprising a pick-up member, means for causing said pick-up member to travel in a definite path at the bottom of said bore, and means whereby the path of said pick-up member at the bottom of said bore may be varied to enable it to be used with tunnels having bores of different dimensions.

26. A tunneling machine for making a substantially horizontal tunnel, comprising a carriage movable in a substantially horizontal direction, and means whereby said tunneling machine can be made to make tunnels having bores of different dimensions, comprising a removable boring bar and a plurality of cutters secured to said boring bar for making a substantially circular face cut.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

LE ROY W. CAMPBELL.

Witnesses:
CHAS. M. WILSON,
LOUIS W. ANDERSON.