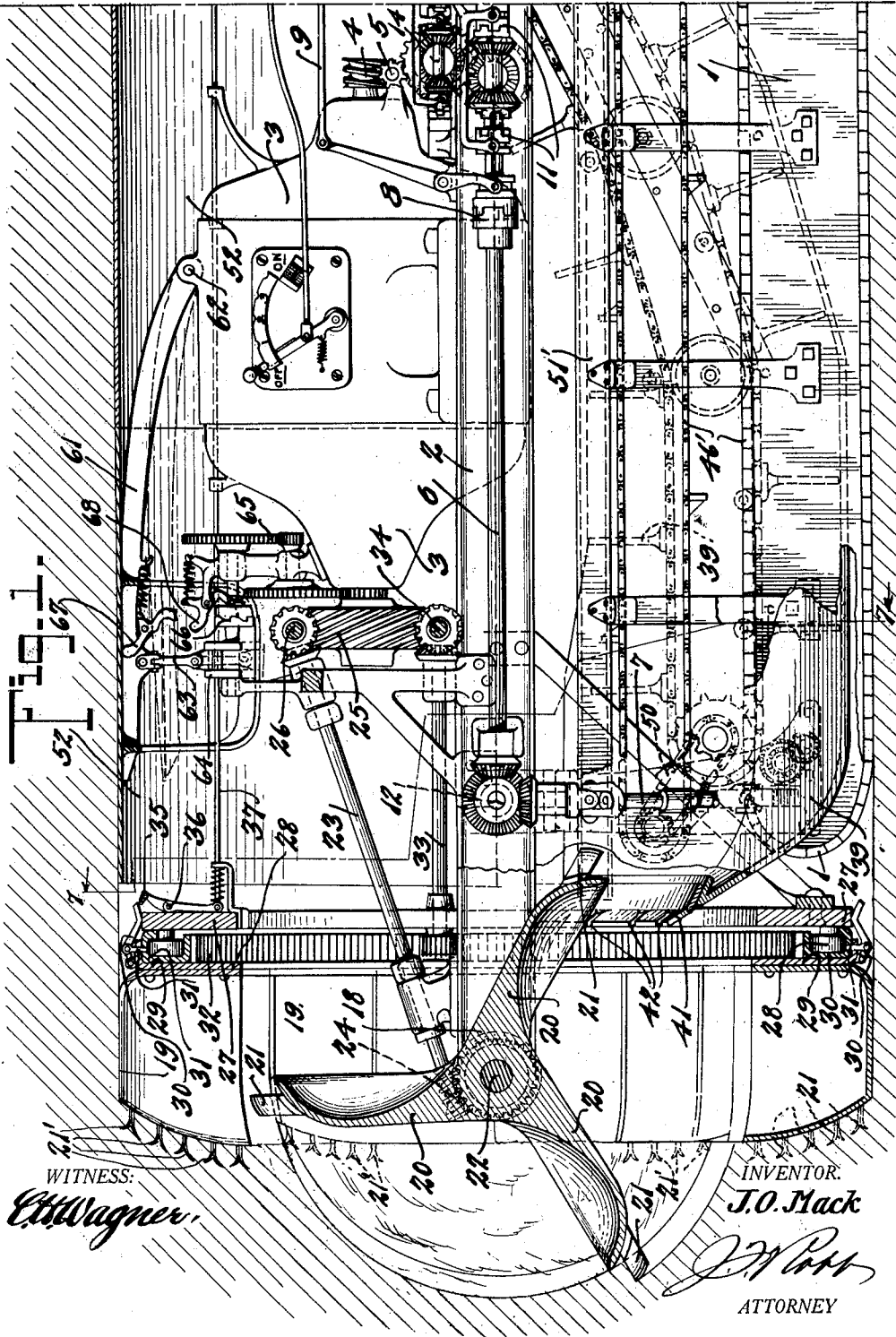


J. O. MACK.
TUNNELING APPARATUS.
APPLICATION FILED MAY 21, 1918.

1,338,237.

Patented Apr. 27, 1920.

7 SHEETS—SHEET 1.



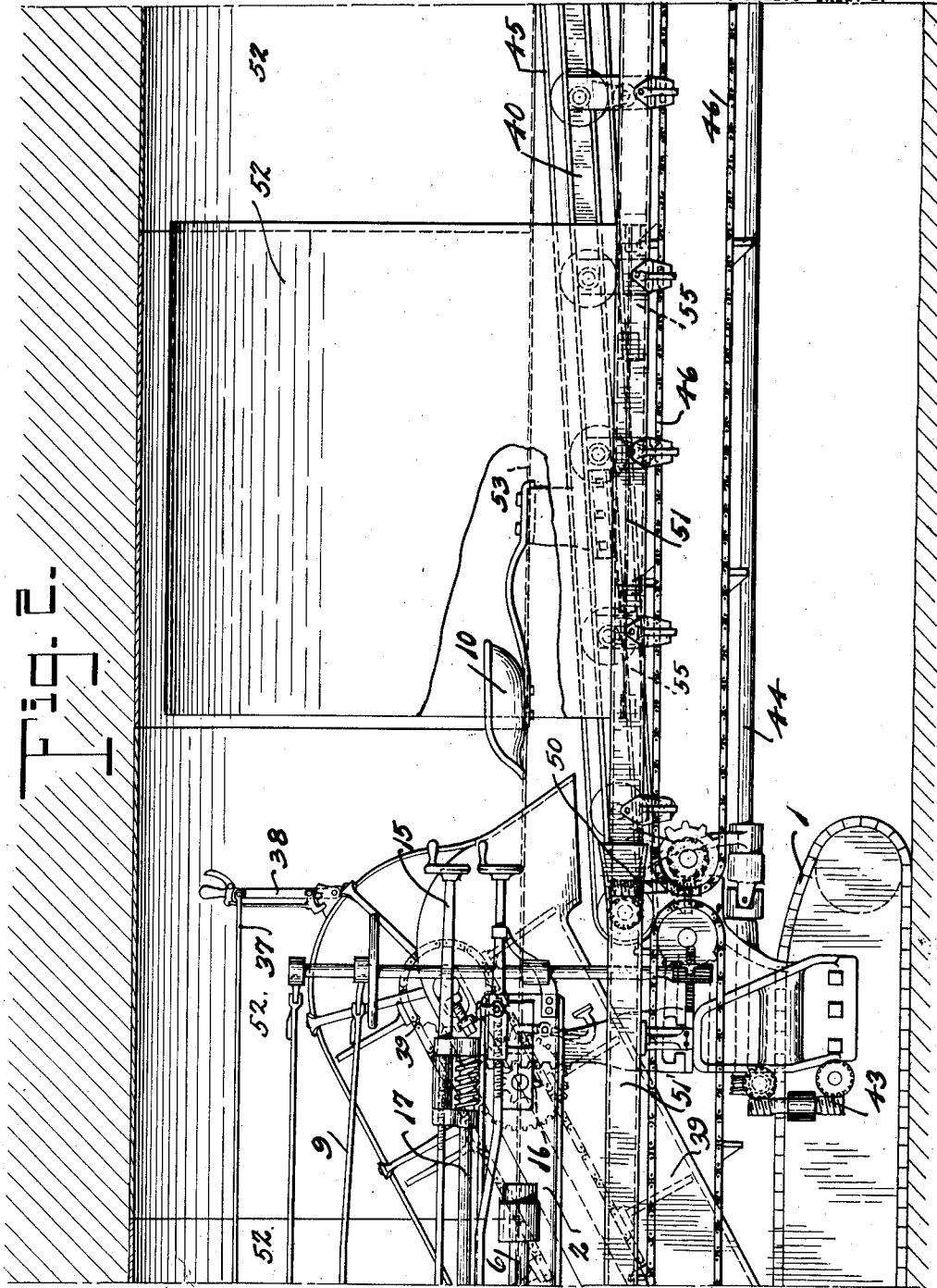
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7 SHEETS—SHEET 2.

Fig. 2.



WITNESS:
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INVENTOR

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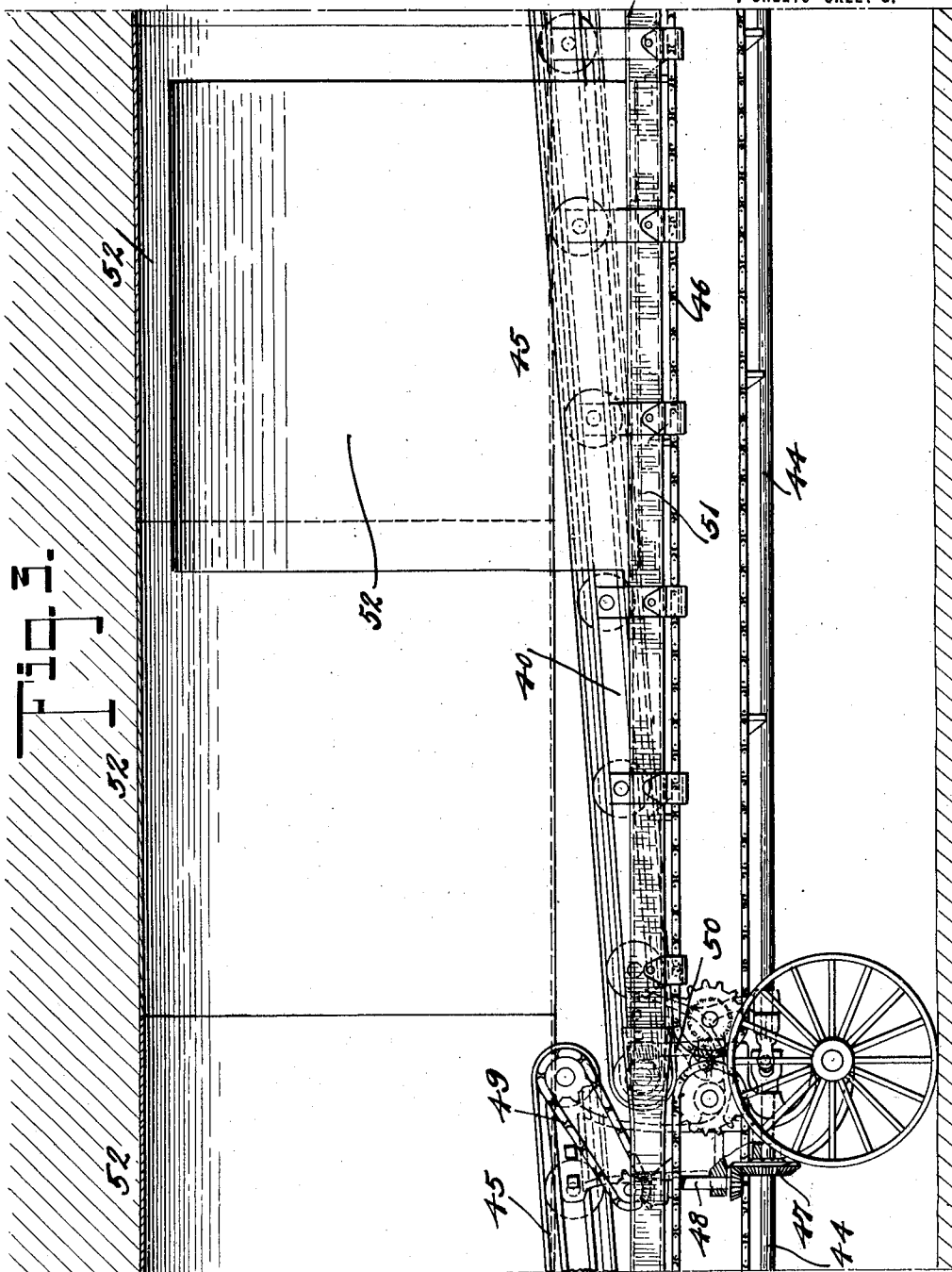
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1,338,237.

Patented Apr. 27, 1920.

7 SHEETS—SHEET 3.



WITNESS:

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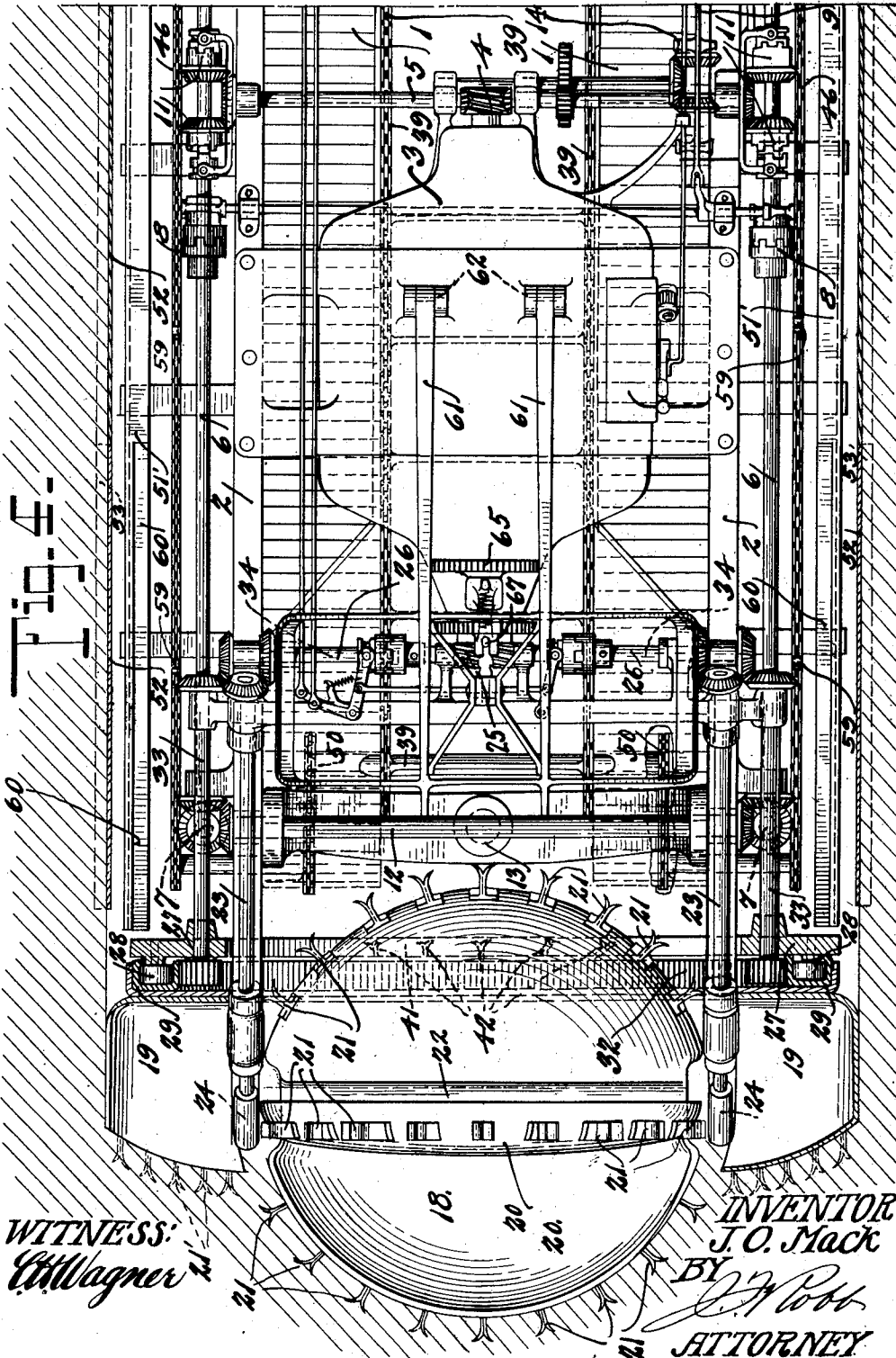
ATTORNEY

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7 SHEETS—SHEET 4.

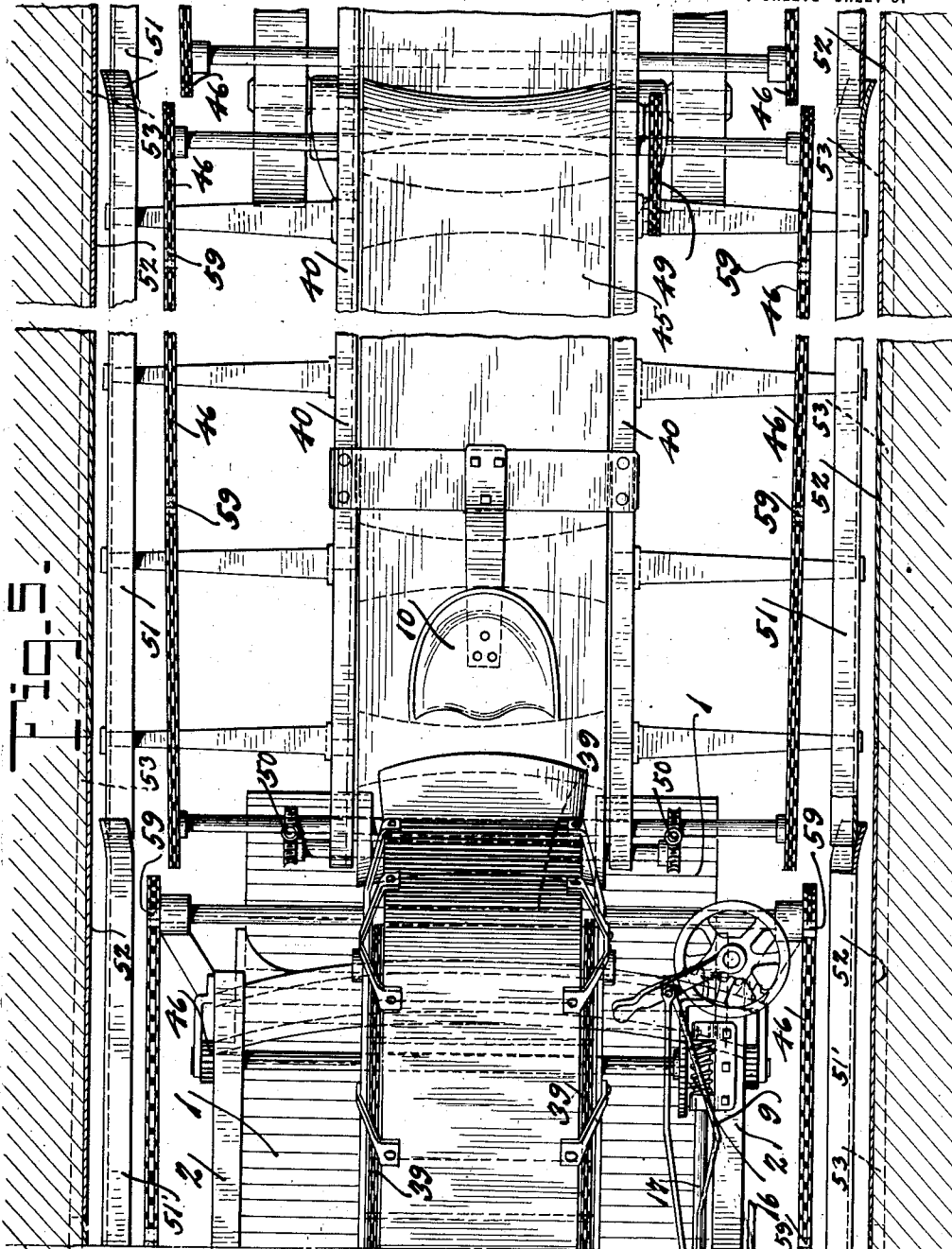


J. O. MACK.
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1,338,237.

Patented Apr. 27, 1920.

7 SHEETS—SHEET 5.



WITNESS:
E. Wagner.

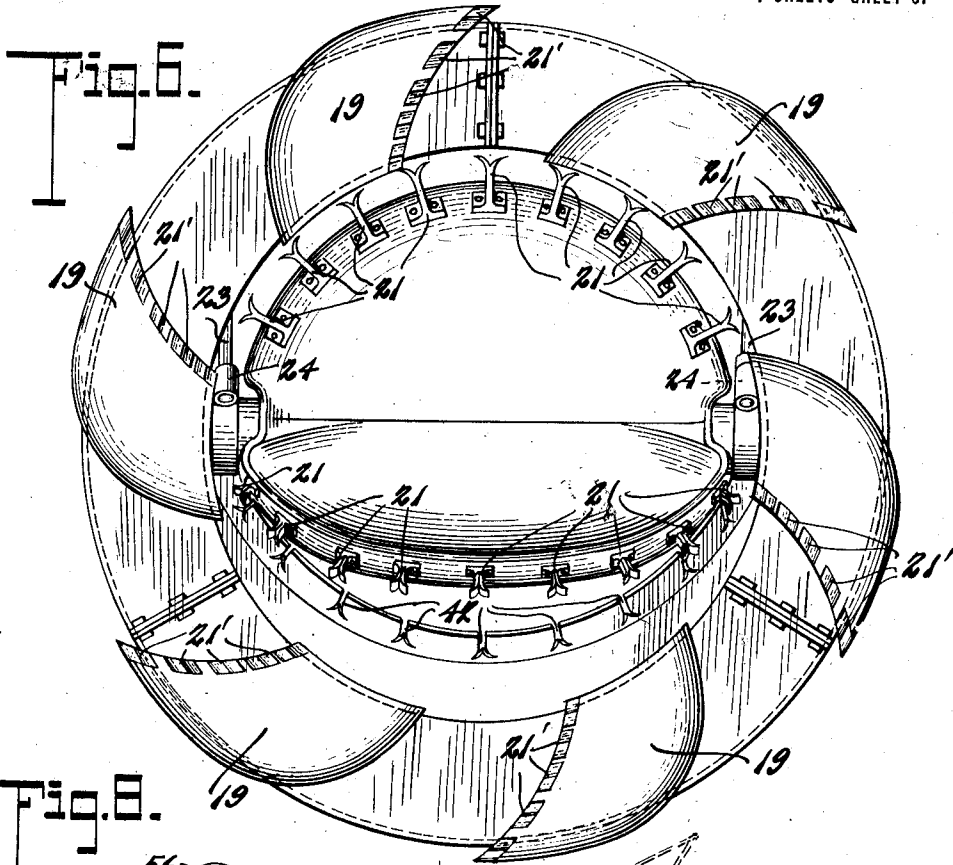
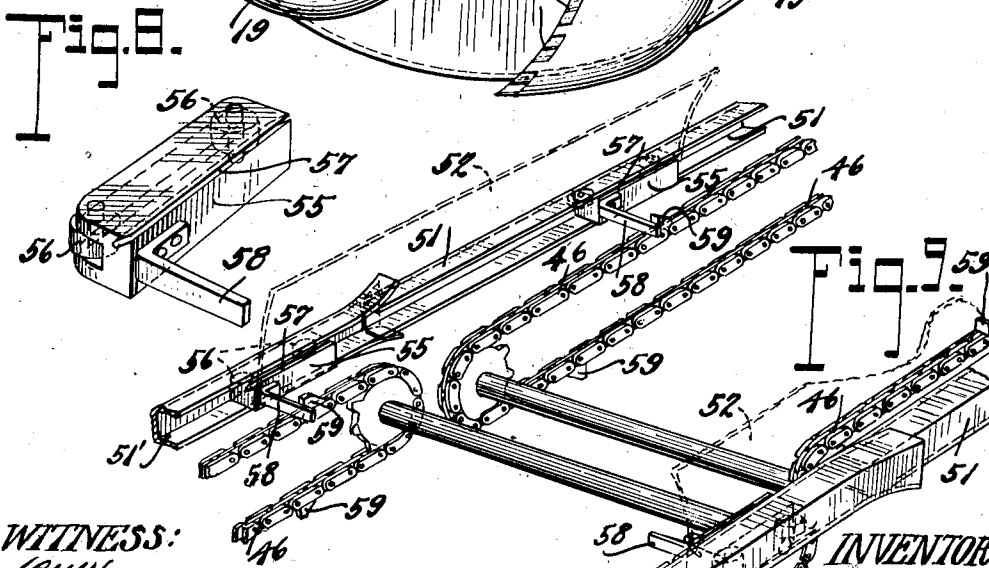
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APPLICATION FILED MAY 21, 1918.

1,338,237.

Patented Apr. 27, 1920.

7 SHEETS—SHEET 6.



WITNESS:
W. Wagner,

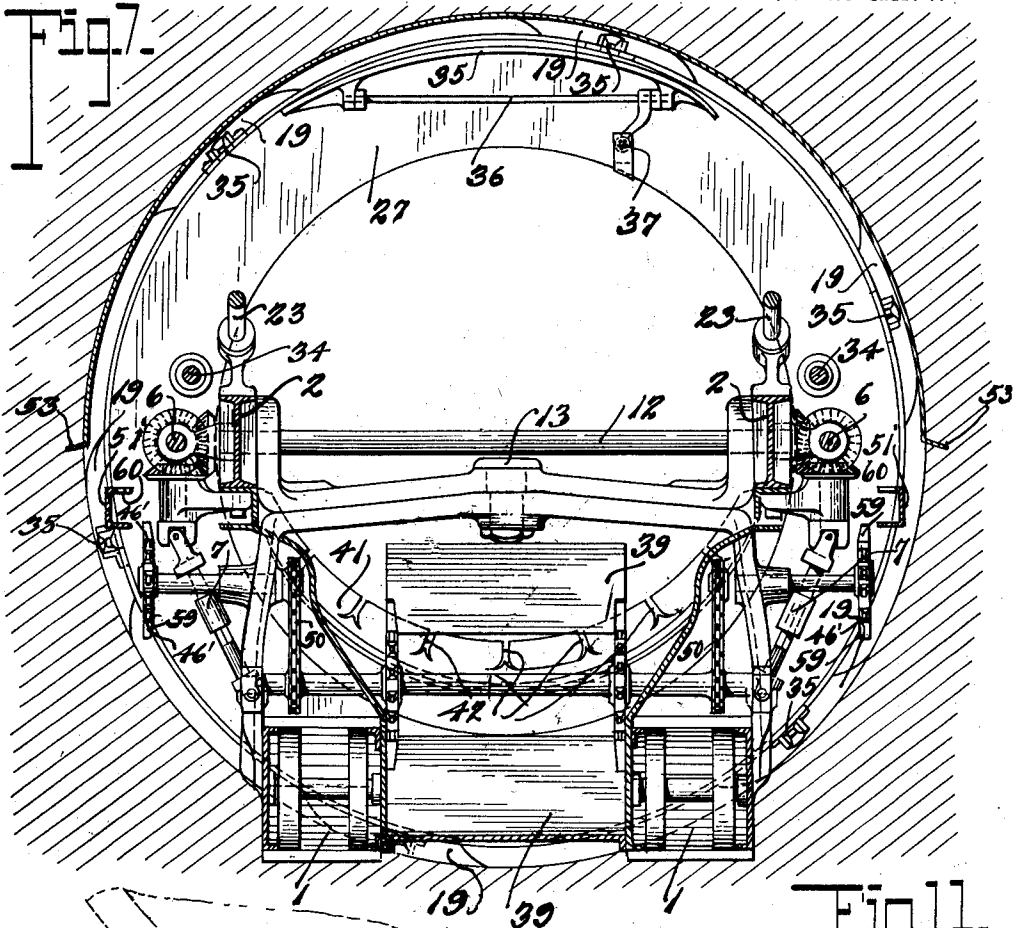
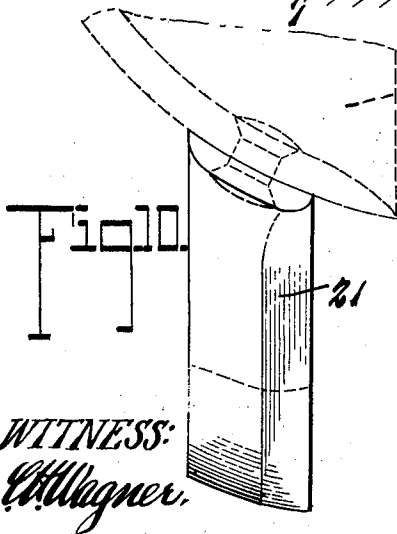
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J. O. MACK.
TUNNELING APPARATUS.
APPLICATION FILED MAY 21, 1918.

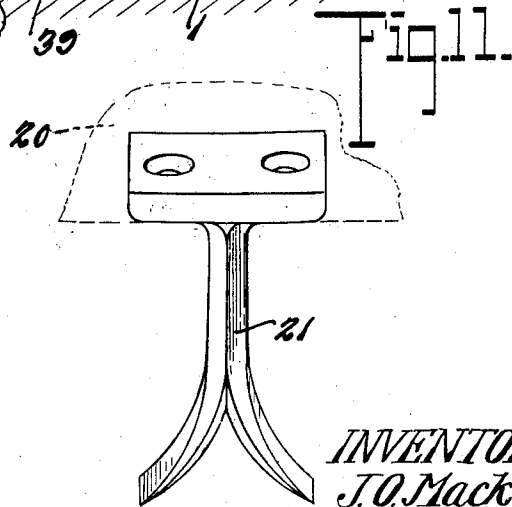
1,338,237.

Patented Apr. 27, 1920.

7 SHEETS—SHEET 7.



WITNESS:
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UNITED STATES PATENT OFFICE.

JAMES O. MACK, OF ALEXANDRIA, LOUISIANA.

TUNNELING APPARATUS.

1,338,237.

Specification of Letters Patent.

Patented Apr. 27, 1920.

Application filed May 21, 1918. Serial No. 235,808.

To all whom it may concern:

Be it known that I, JAMES O. MACK, a citizen of the United States, residing at Alexandria, in the parish of Rapides and State of Louisiana, have invented certain new and useful Improvements in Tunneling Apparatus, of which the following is a specification.

The present invention represents a development of that type of tunnel excavating apparatus disclosed in my co-pending application Serial Number 221,703, filed March 11th, 1918, these improvements having as their object the combination with the excavating instrumentalities of means for applying a lining to the excavation as the operation proceeds. Involved in this arrangement is the further combination of means for conveying the lining elements continuously to the machine and to the applying means aforesaid so that the tunnel is driven and lined automatically at a high rate of speed.

More specifically my invention consists in the combination with excavating instrumentalities driven from a suitable source of power, of conveying means for removing the material to the exterior of the tunnel as it is excavated, and including means for conveying into the tunnel a series of lining members, and mechanism normally inactive but designed to be brought into play intermittently by these lining member themselves as they reach the approximate point of application, said mechanism being tripped to establish operating connection with the power to thereby elevate the particular lining member from the conveying means into wall engaging position.

A not unimportant object of my present device is to provide novel excavating means which are so constructed as to very materially aid in facilitating the rapidity of cutting action of the cutters by utilizing peculiar ribboning knives which act upon the earth previous to the removal by the shovels. A still further object lies in the provision for quickly detaching the main cutter head from the apparatus so that the latter may run rearwardly out of the tunnel if need be, without displacing the lining.

Among other objects may also be mentioned the provision of special conveying means for the lining elements so constructed as to retain the lining members in slightly

contracted form until they are separated from the conveying means by the applying mechanism heretofore referred to and allowed to expand, and in so expanding automatically attach themselves to the wall of the excavation.

These and such other objects as may hereinafter appear are attained by the novel construction, combination and arrangement of parts to be hereinafter specifically described and claimed. Reference will now be had to the accompanying drawings forming a part of this specification, wherein:—

Figure 1 is a longitudinal sectional view through the forward portion of an excavating machine constructed in accordance with the present invention;

Fig. 2 shows an elevation of the rear portion of the apparatus and the forward end of a conveyer unit attached to the machine;

Fig. 3 is also a side elevation showing a further portion of the trailing conveyer used with this device;

Fig. 4 is a top plan view of that portion of the apparatus shown in Fig. 1;

Fig. 5 is a top plan view of that portion of the apparatus which is shown in Fig. 2, certain parts being omitted for the purposes of clearness;

Fig. 6 is a front elevation of the cutting instrumentalities;

Fig. 7 is a vertical sectional view taken about on the line indicated by the line 7—7 of Fig. 1, one of the cutting elements being omitted;

Fig. 8 is a perspective view of a carrier block for the liners;

Fig. 9 is a diagrammatic view in perspective of contiguous end portions of the conveyer showing more clearly how the liners are transferred from one conveyer unit to the next;

Fig. 10 is a side elevation of one of the ribboning knives for the excavators;

Fig. 11 is a front elevation of one of said knives.

Throughout the following detail description and on the several figures of the drawings, similar parts are referred to by like reference characters.

It will be understood that the apparatus which forms the subject matter of this invention is especially designed for excavating beneath the surface of the ground and has a wide range of utility in work of this

character. It should be stated, however, that my object is more especially to provide a machine which is useful in war operations along lines which have been specified in my previous application hereinbefore referred to. It further possesses advantages for providing for communication with the first line trenches, with dugouts, with ammunition dumps access to which over the surface is practically impossible under present methods of warfare owing to the exposure incident to bringing up of the supplies to the points referred to. Owing to the fact that the present machine is capable of excavating a relatively small bore at a considerable speed, its value in this type of operation will be apparent to those skilled in the art to which the invention appertains.

With this explanation and referring particularly to Fig. 1, it will be observed that the machine proper is carried by a suitable frame mounted upon caterpillar members 1, the frame supporting a shiftable beam 2 by means of which the direction of excavation either upwardly, downwardly, or laterally, is controlled by devices hereafter more specifically pointed out. The apparatus carries a high power motor 3 which is supplied with current from a suitable source of power preferably arranged at the entrance to the excavation. The power is taken off from said motor at its rear extremity through the worm 4 and the jack shaft 5 which transmits motion to longitudinal shafts 6 one at either side of the machine, and in turn to the vertical shafts 7 at the forward portion of the apparatus. These latter shafts are so constructed as to permit of relative movement of the beam with regard to the supporting frame. For the purposes of convenience I provide main clutches designated 8 for the shafts 6 which are operated by the rod 9 from a point convenient to the seat 10 for the operator. In addition to said main clutches by means of which drive to the caterpillar is entirely disconnected from the motor, I provide auxiliary clutches 11 which permit of independent control of the caterpillar elements for reversal or forward drive of both or each.

Directional changes of the apparatus may be effected somewhat after the manner of the apparatus in my previous application, the beam being pivotally mounted upon the axis 12 at the forward end of the frame for vertical movement and being pivotally connected by the king bolt 13 (see Fig. 7) for lateral shifting. Vertical movement is imparted to this beam by any suitable lifting jack arrangement through the instrumentality of the clutch control 14 operated by the manual shifting means 15 so as to operate the rack and pinion 16 through the shaft 17 from the motor drive.

65 Passing now to the excavating instrumen-

talities, I employ two distinct excavators—the inner cutter 18 and the outer or annular cutter head 19. The first mentioned cutter comprises preferably three shovels designated 20, each of which at its cutting edge is provided with a series of peculiarly shaped ribboning knives 21, shown most clearly in Figs. 10 and 11. The object of these knives is to cut the earth into strips so that the shovel following will scrape the loosened earth and carry the same about the axis of the cutter for dumping it upon the conveyer to be mentioned hereinafter.

The construction of this cutter is such that when the rearmost shovel is in the position shown in Fig. 1 it receives the earth from the uppermost shovel upon its bottom and thus each shovel in its turn acts to transfer the excavated material into the conveyer. This excavator operates about the transverse axis 22 which is actuated through the instrumentality of the inclined shafts 23 through worm and gear connection indicated 24, power being furnished by the motor 3 and taken off at the forward end of the same through the worm 25 and transverse shaft 26. This excavator, it should be furthermore noted, is designed to excavate a relatively small bore while said bore is enlarged by the outer annular cutter 19 now to be more specifically described.

The said last mentioned cutter is likewise at its cutting edges provided with ribboning knives 21' and said cutter is mounted upon an annular frame piece 27 which is provided with suitable anti-friction rollers 28 operating in the channel 29, said cutter head being detachably connected through the instrumentality of the levers 30, a suitable number of these being provided, each having a pin 31 which passes through and into the channel piece 29 which piece, it will be observed, is internally toothed as indicated at 32 to provide a rack by means of which the cutter head is operated from the motor 3 through the shafts 33 having driving connection with the worm 25 through the lower transverse shaft 34.

Mounted upon the frame 27 at the top thereof is a segmental cam 35, best seen in Fig. 7. This cam is pivotally mounted upon the shaft 36 and has connected to its lower end an actuating rod 37 connected with the hand lever 38 so that whenever it is desired to disconnect the cutter head from the apparatus this segmental cam is shifted until it lies in the path of the levers 30 above described. The free ends of these levers ride upon the cam and pull their respective pins 31 out of the channel piece 29 allowing the cutter head to fall from its place when the machine is rearwardly moved with respect to said cutter head.

The dirt or excavated material from these excavators is deposited upon the flight con-

veyer, indicated generally at 39, where it is removed to the rear portion of the apparatus and dumped upon the trailing conveyer the forward portion of which is seen in Fig. 2 and indicated 40. At this point it may be desirable to mention that a guard plate 41 is arranged at the forward extremity of the main conveyer 39, mounted upon the beam 2 so as to cooperate with the excavator 18. This plate is suitably notched as indicated at 42 so as to permit the passage of the ribboning knives 21 therethrough during the rotation of the excavator. This plate therefore constitutes a cleaner for these knives and insures that the excavated material will be transferred onto the conveyer 39 as described.

As in my previous application, the trailing conveyer consists of a series of units having pivotal connection one with the other and at the forward extremity of the complete conveyer it is also pivoted to the rear portion of the excavating apparatus itself. The conveyer is actuated through operative connection with the motor 3. In the particular disclosure this drive is obtained indirectly from the caterpillar drive by means of the worm and gear connection indicated at 43 (see Fig. 2), and the longitudinal shaft or shafts 44 mounted upon the respective trailer units. The drive from the main motor is preferably utilized for a certain number of these units, after which the subsequent units may be supplied with a motor drive of their own which operates synchronously with the main drive.

The trailing conveyer performs two functions. It is provided with the conveyer belt, speaking with reference to a single unit, 45 by means of which the dirt is moved toward the rear to the entrance of the tunnel. It is further provided with conveyer belts 46 for the purpose of carrying in the opposite direction certain lining elements by means of which the bore of the tunnel is provided with a lining in the manner hereinafter specified. The drive for these respective conveyer belts is obtained from the main conveyer drive shafts 44, each shaft carrying a gear 47, see Fig. 3, driving a shaft 48 from which motion is imparted to the chain or belt 49. At the opposite end the drive from this dirt conveyer is imparted to the liner conveyer through the worm shaft 50 or any other suitable operative connection.

The frame of the conveyer units carries at each side a channel rail 51 (see Fig. 9) and said rails constitute the supporting means for the liner elements one of which is distinctly seen in Fig. 2 and designated 52. It will be observed that each liner is semi-circular in form and the ends of the same, as seen in Fig. 7, are flanged laterally as indicated at 53. I employ this particular type

of liner element because it is designed to be self attaching, the flanges 53 being utilized as the means for holding the liner plates in position upon the wall of the tunnel. Each of these plates is preferably carried into the tunnel by the conveyer by means of special anti-friction devices one of which is particularly shown in Fig. 8 and designated 55. At one side this carrier is provided with suitable rollers 56, and at the other side is formed a groove 57 to receive the flange of the liner plate upon which said carrier block is disposed. These blocks operate in the channel rails and have in addition to the foregoing a laterally projecting finger 58 which is designed to extend into the path of fingers 59 upon the conveyer chains 46.

When the liner plate is mounted in position upon the conveyer it is slightly contracted and it will pass from one unit of the conveyer to the other until it reaches the main portion of the machine which is also provided with side channel rails 51'. However, these channel rails at the forward portion of the machine are slightly cut away as indicated at 60 in Fig. 4 for the purpose of readily separating the plates from the conveyer by mechanism now to be described.

Mounted upon the excavator at a suitable place, in this instance upon the top of the motor casing, is a lifting lever 61 pivoted at 62. This lever is curved and lies in the path of travel of the liner plates, the normal inoperative position of the lever being indicated in dotted lines in Fig. 1. The free or forward end of the lever 61 is connected to a pitman 63 which is mounted upon the crank shaft 64 driven from the motor 3 by a train of gearing generally indicated by the numeral 65, a clutch 66 being interposed in order to interrupt the drive in the manner hereinafter described. Pivotally mounted upon the lever 61 is a trip lever or trigger 67, the lower end of which contacts with the clutch lever 68 and holds the clutch in disengaged position. The upper end of this lever 67 projects above the upper surface of the elevating lever 61 so that when the liner plate advances over this lever 61 it will impinge the upper extremity of lever 67 and disengage the same from the clutch lever 68. This latter being spring-actuated throws in the clutch 66, whereupon the crank shaft is rotated and the lever 61 through the instrumentality of the pitman 63 is elevated, carrying with it the liner plate which has by this time reached the proper position for being disengaged from the channel rails 51' at the cut-away portion 60. Immediately the liner plate has been pressed against the top of the tunnel the ends springing from their rail support engage with the wall and fasten themselves

in position. This permits the lever 67 to assume a vertical position as the crank shaft turns over and the continuation of the operation of the crank shaft for the lever 61 lowers the said lever 61 until the clutch lever 68 is again impinged by the lever 67, resulting in a throwing out of the clutch 66. Shortly thereafter, and at the proper time, the succeeding liner element again impinges the lever 67 and the operation just described is repeated, so that we have an intermittent actuation of this mechanism which results in an automatic application of a liner plate to the tunnel bore as the machine progresses with the tunneling operation.

By such arrangement the dirt is prevented from caving in from the ceiling and sides of the tunnel, leaving the bore clear for access and for removal of the apparatus at the proper time. Of course when the machine moves rearwardly for the purpose of receding from the excavated tunnel the cutter head 19 is detached in the manner hereinbefore described, said cutter head being subsequently recoverable if desired when the machine has been removed, the head being made of bolted sections capable of being separated to facilitate removal. I might also state at this point that in the application of the lining elements to the tunnel wall in the manner hereinbefore described, the carrier blocks 55 detach themselves from the flanges of the liner plate and may also be subsequently recovered if desired.

I do not wish, however, to be restricted to this specific method of transmission of the lining units to the point of application as other methods may readily be adopted to perform the operation, as will be apparent to those skilled in the art of this apparatus. Many of the other details may also be modified without in any way departing from the spirit of the invention and within the scope of the claims hereto appended.

Having thus described my invention, what I claim as new is:

1. In excavating apparatus of the class described, the combination with excavating means, a support therefor adapted to carry tunnel lining members and means for moving the support, of mechanism for automatically applying said lining members to the wall of excavation during the excavating operation.

2. In excavating apparatus of the class described, the combination with excavating means, a support therefor adapted to carry tunnel lining members and means for moving the support, of intermittently operated mechanism on the support for applying said lining members to the wall of the excavation from the support during the operation of the excavating means.

3. In excavating apparatus of the class described, the combination with excavating

means, a support therefor adapted to receive tunnel lining members and means for moving the support, of mechanism for applying said lining members to the wall of the excavation from said support, and means forming a part of said apparatus and operable therewith for conveying the lining members into position for application by said last mentioned means.

4. In tunnel excavating and lining apparatus of the class described, the combination with excavating means, and a support therefor adapted to sustain lining members, of mechanism rendered operative by said lining members for applying the same to the wall of the excavation.

5. In excavating apparatus of the class described, the combination with excavating means, a support therefor adapted to convey lining members for the excavation and means for operating the excavating means and moving the support, of mechanism adapted to be operated by the actuating means aforesaid and to be rendered operative by said lining members for applying the same to the wall of the excavation.

6. In excavating apparatus of the class described, the combination with excavating means, a support therefor adapted to convey lining members for the excavation and means for operating the excavating means, of mechanism adapted to be operated by the actuating means aforesaid and to be rendered operative by said lining members for applying the same to the wall of the excavation, and means for conveying said lining members to the applying mechanism aforesaid.

7. In excavating apparatus of the class described, the combination with excavating means, a support therefor adapted to convey lining members for the excavation and means for operating the support, of means for successively and automatically applying the lining members from the support to the wall of the excavation as the excavating means advances.

8. In a tunnel excavating and lining machine of the class described, adapted to emplace lining members on the wall of the excavation, the combination with excavating instrumentalities, means for operating the same and for advancing the machine, and means forming a part of said machine and operable therewith for conveying the lining members thereto during the operation of the machine.

9. In a tunnel excavating and lining machine of the class described, adapted to emplace lining members on the wall of the excavation, the combination with excavating instrumentalities, means for operating the same and for advancing the machine, of means operable with the machine for conveying the lining members to the ma-

chine during the operation thereof, and means for actuating said lining members to thereby shift them from the conveying means into wall engaging position.

10. In a tunnel excavating and lining machine, the combination of excavating instrumentalities, means for operating the same and for advancing the machine, and conveying means for removing the material excavated out of the tunnel, said conveyer also constituting means for simultaneously conveying lining material into the tunnel.

11. In tunnel excavating and lining apparatus of the class described adapted to emplace lining material during excavation operation, the combination of excavating mechanism, mechanism for applying said lining material comprising a lifting member, means for actuating said lifting member when the lining material is in operative position with respect thereto, and trip means for holding said actuating means inoperative until the material is in the position aforesaid.

12. In tunnel excavating and lining apparatus of the class described adapted to emplace lining material during excavation operation, the combination of excavating mechanism, mechanism for applying said lining material comprising a lifting member, means for actuating said lifting member when the lining material is in operative position with respect thereto, means for holding said actuating means inoperative until the material is in the position aforesaid, and means for conveying the material into said position to thereby render operative the actuating means aforesaid.

13. In tunnel excavating and lining apparatus of the class described adapted to emplace lining material in the excavation, the combination of excavating mechanism, mechanism for applying said lining material comprising a lifting member, means for actuating said lifting member when the lining material is in operative position with respect thereto, means for holding said actuating means inoperative until the material is in the position aforesaid, and means for directing said material into the operative position to be acted upon by the lifting means aforesaid, said material effecting release of the holding means.

14. In tunnel excavating and lining apparatus of the class described adapted to emplace lining material in the excavation, the combination of excavating mechanism, mechanism for applying said lining material comprising a lifting member, actuating means therefor, a tripping member for holding said actuating means inoperative until the material is in operative position and operable by the lining material to effect release of said lifting member for applying said material to the wall.

15. In tunnel excavating and lining apparatus of the class described adapted to emplace lining material in the excavation, the combination of excavating mechanism, mechanism for applying said lining material comprising a lifting member, power instrumentalities with which the lifting member is operatively connected and normally inactive until the material is brought into applying position, and means for establishing operating connection between the power instrumentalities and the lifting member whereby to apply the lining material to the wall of the excavation.

16. In tunnel excavating and lining apparatus of the class described adapted to emplace lining material in the excavation, the combination of excavating mechanism, mechanism for applying said lining material comprising a pivotally mounted lifting member, a crank shaft connected to said lifting member, and means for actuating said crank shaft to effect lifting operation of the lifting member and application of the lining material to the wall.

17. In tunnel excavating and lining apparatus of the class described adapted to emplace lining material in the excavation, the combination of excavating mechanism, mechanism for applying said lining material comprising a pivotally mounted lifting member, a crank shaft connected to said lifting member, driving means for said shaft normally disengaged with respect to the shaft, and means for establishing connection between the driving means and the shaft by the lining material.

18. In tunnel excavating and lining apparatus of the class described adapted to emplace lining material in the excavation, the combination of excavating mechanism, mechanism for applying said lining material comprising a pivotally mounted lifting member, a crank shaft connected to said lifting member, driving means for said shaft normally disengaged with respect to the shaft, and means for establishing connection between the driving means and the shaft through the lining material, said means being operative to interrupt the driving connection when the material has been lifted into wall engaging position.

19. In tunnel excavating and lining apparatus of the class described adapted to emplace lining material in the excavation, the combination of excavating mechanism, mechanism for applying said lining material comprising a lifting arm arranged in the path of movement of the lining material, means for directing said material into position to be engaged by said arm, and means for actuating said arm including a clutch and a trip member for controlling the clutch and operable by the lining material as the latter is moved into engaging position with

respect to said arm whereby to establish connection between the actuating means and the arm.

20. In tunnel excavating apparatus, the combination of excavating mechanism, mechanism for applying lining material to the tunnel wall without interruption of the excavating means, power instrumentalities common to said excavating and lining mechanisms, and means for establishing operative connection between the power instrumentalities and the applying mechanism at a predetermined time.

21. In tunnel excavating apparatus, the combination of excavating mechanism, including a support arranged to carry lining plates adapted to be applied to the wall of the excavation as the excavating operation proceeds, means for conveying said plates to wall applying position, and means for disengaging said plates successively from the conveying means when the plates reach a predetermined point in their travel to permit them to spring into engagement with the wall.

22. In tunnel excavating apparatus, the combination of excavating mechanism, including a support arranged to carry lining plates adapted to be applied to the wall of the excavation composed of spring material, means for conveying said plates into wall applying position in contracted condition, and means for disengaging the plates from the conveying means and applying them to the wall, said plates having wall engaging elements for holding them in their engaged position.

23. In tunneling apparatus of the class described, the combination of mechanism for applying lining material to the wall of the tunnel, supporting means therefor, and means for moving the support simultaneously with the lining operation.

24. Apparatus for lining tunnels comprising a support adapted to carry lining material into an excavation, means for moving said support through the tunnel, movable means for carrying said material on the support, and means for applying said material to the wall of the tunnel when said material reaches a predetermined point in its movement upon the support.

25. In apparatus of the class described for excavating and lining tunnels, the combination of a cutter head, means detachably connecting said cutter head in operative position, a support therefor movable as the excavation proceeds, mechanism carried by the support for lining the tunnel, and means for disconnecting the cutter head when it is desired to permit movement of the support from the tunnel.

26. In a tunnel lining machine of the class described, a conveyer for conveying lining material to the point of application of the tunnel and having means for engaging and holding lining plates in contracted bowed form to permit of movement of the same into the tunnel for releasing said plates to permit the same to spring into engagement with the wall of the tunnel.

27. In a tunnel lining machine of the class described, a conveyer for conveying lining material to the point of application and comprising means for holding bowed lining plates in slightly contracted form to permit of movement of the same into the tunnel, carrier devices upon which said lining material is mounted for movement on the holding means aforesaid, and means for disengaging the lining material from the carrying and holding means aforesaid to apply the same to the tunnel wall.

In testimony whereof I affix my signature.

JAMES O. MACK.