

March 12, 1968

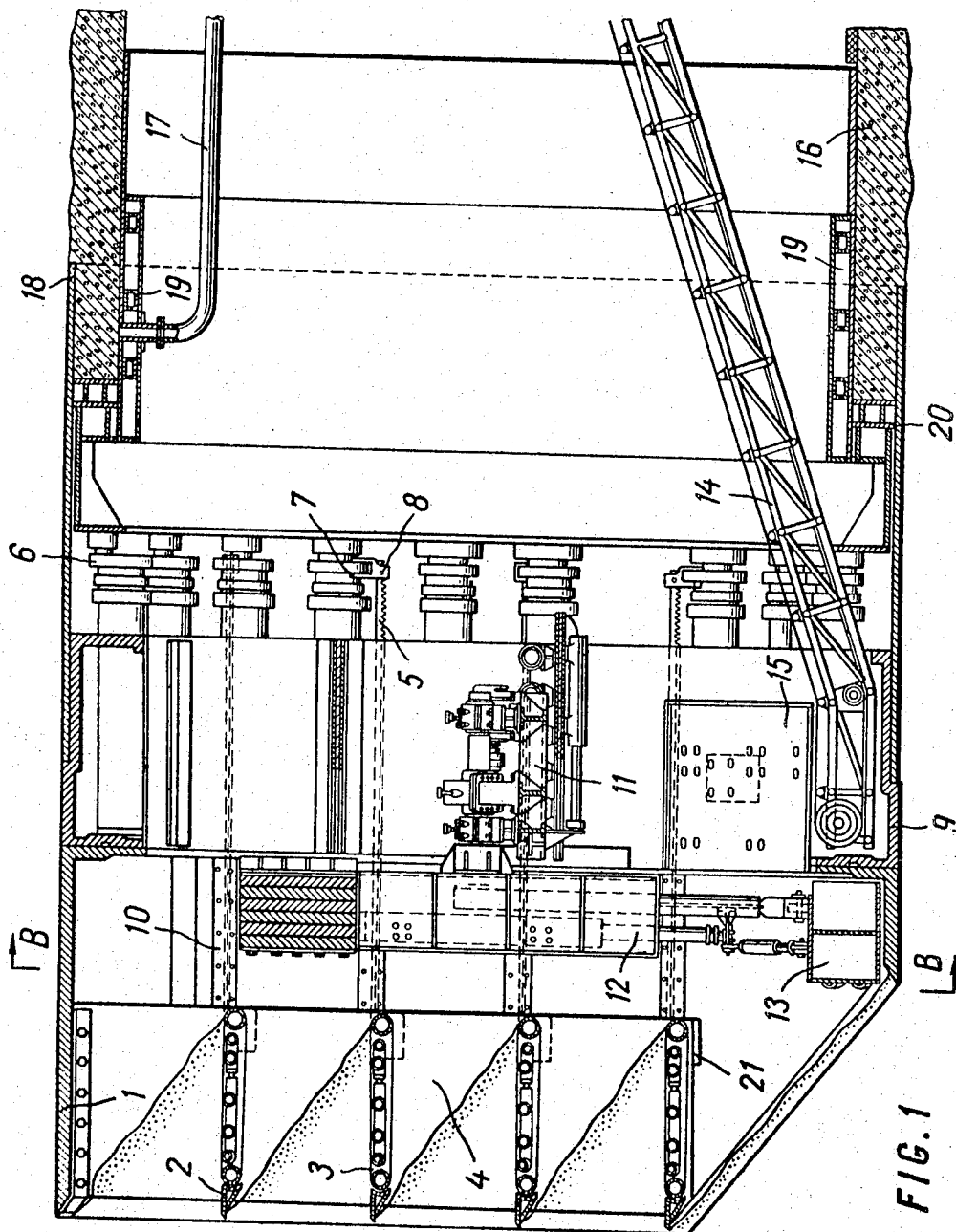
V. P. SAMOILOV ET AL

3,372,553

UNIT FOR DRIVING TUNNELS IN LOOSE GROUND

Filed May 12, 1964

4 Sheets-Sheet 1



March 12, 1968

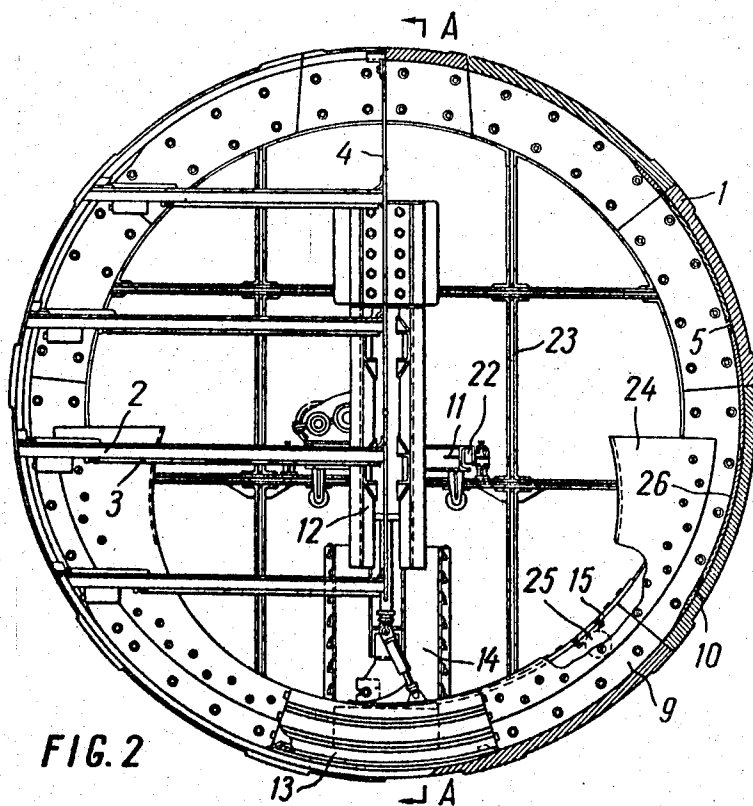
V. P. SAMOILOV ET AL.

3,372,553

UNIT FOR DRIVING TUNNELS IN LOOSE GROUND

Filed May 12, 1964

4 Sheets-Sheet 2



March 12, 1968

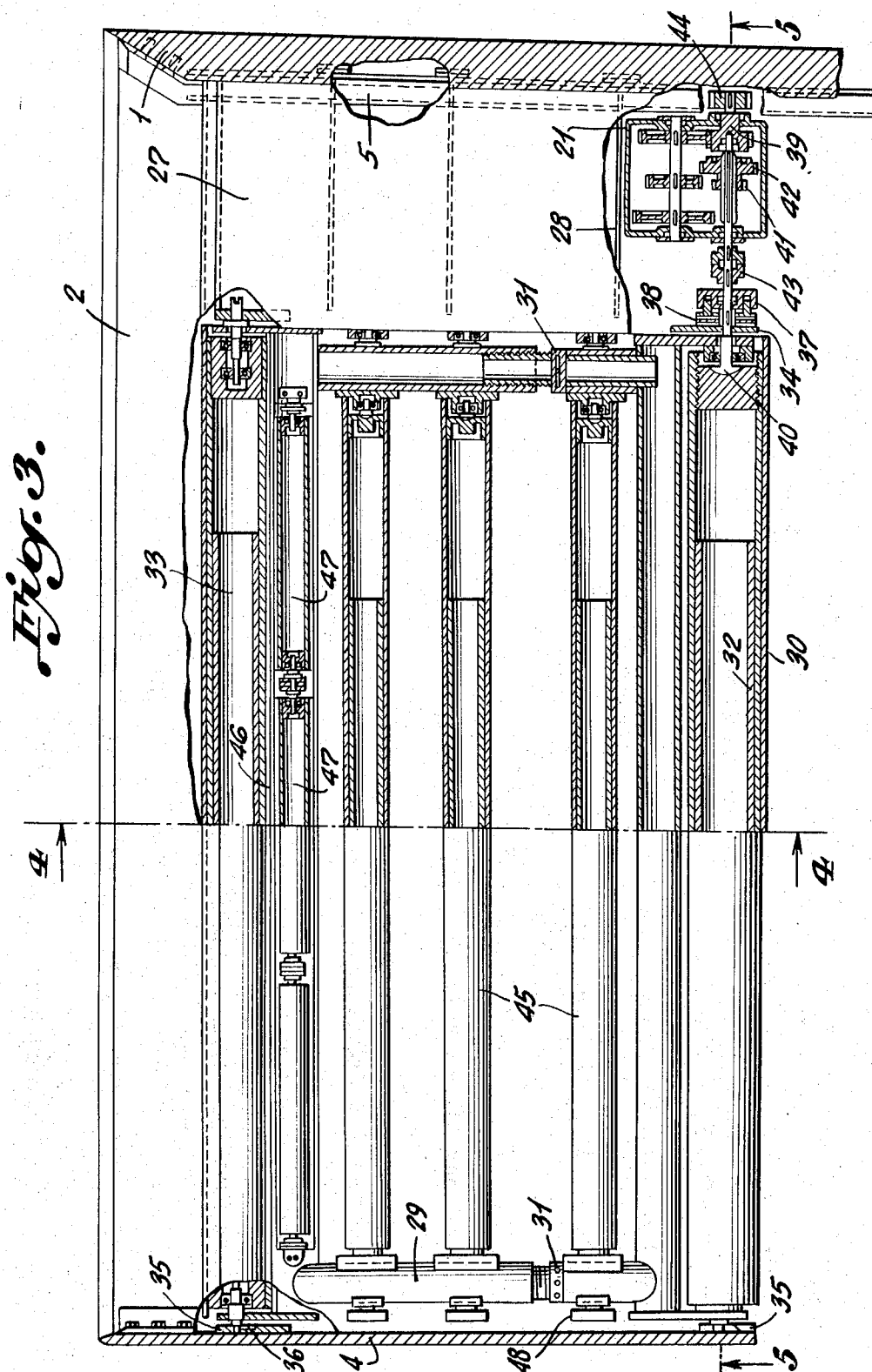
V. P. SAMOILOV ET AL

3,372,553

UNIT FOR DRIVING TUNNELS IN LOOSE GROUND

Filed May 12, 1964

4 Sheets-Sheet 3



March 12, 1968

V. P. SAMOILOV ET AL

3,372,553

UNIT FOR DRIVING TUNNELS IN LOOSE GROUND

Filed May 12, 1964

4 Sheets-Sheet 4

Fig. 4.

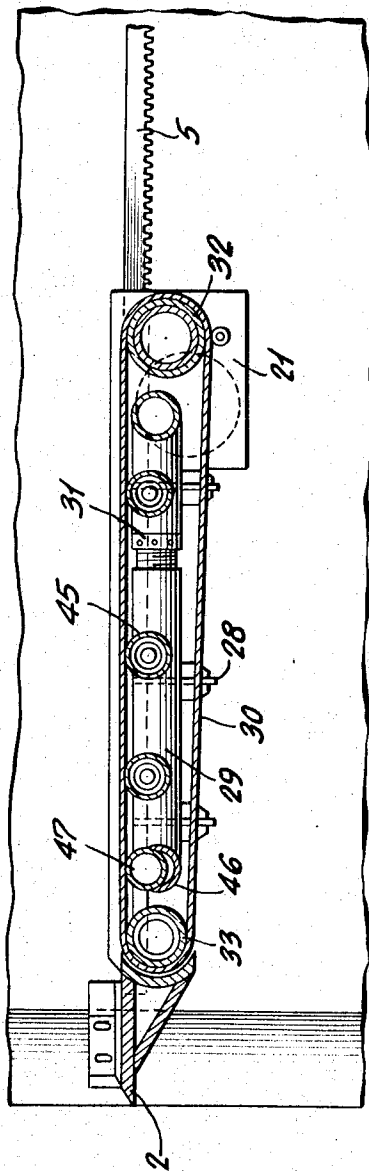
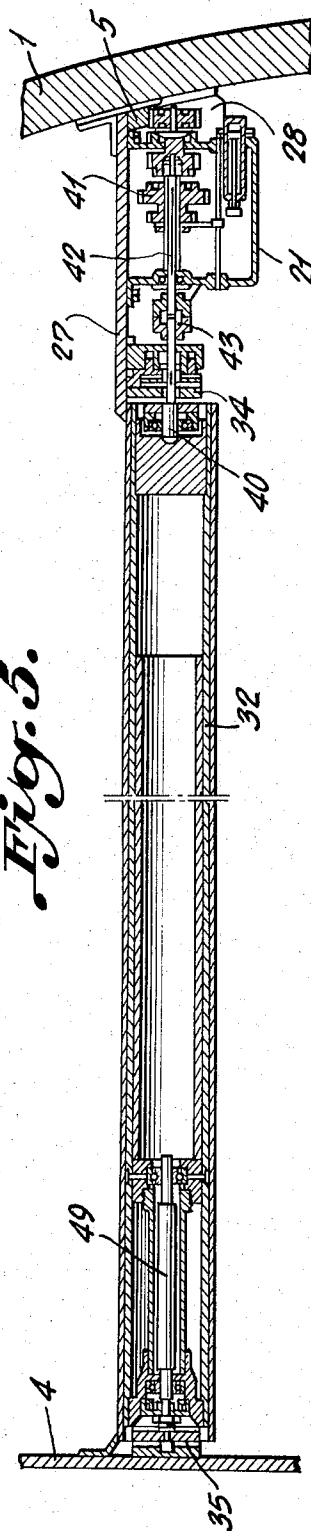


Fig. 5.



1

3,372,553

UNIT FOR DRIVING TUNNELS IN
LOOSE GROUNDVladimir Pavlovich Samoilov, Moscow, U.S.S.R., assignor
to Nauchno-Issledovatel'skiy Institut Osnovaniy i Pad-
zemnykh Sooruzheniy

Filed May 12, 1964, Ser. No. 366,804

5 Claims. (Cl. 61—85)

The invention relates to apparatus for driving tunnels in loose soil or ground, and more particularly has reference to tunnel shields.

The shields previously used for tunnelling in loose ground have the following disadvantages. First, a considerable resistance to penetration is caused by the friction of the muck against the surfaces of the horizontal components which divide the cutting portion of the shield into compartments or segments. Since such horizontal components are either fixed to the shell of the shield or in the form of liners movable along guides relative to the shield, it is impossible to control the force of resistance to penetration of the shield, with such force being dependent on the magnitude of the sliding friction of the muck against the horizontal components.

Second, a principal means for control of the advance of the shield is effected by shield jacks and to turn the shield in one or the opposite direction, a group of jacks are activated under an increased pressure while certain jacks are inactivated. The turning of the shield into a predetermined direction is assisted to some extent by the simultaneous removal of the muck from one side of the compartments but this measure does not ensure stable or sufficient results, since with the initiation of the shield advance, the cleared compartments are again rapidly filled with muck so that the primary problem is again placed before the jacks.

Third, when driving tunnels in loose ground a particularly high resistance to penetration is on the bottom part of the cutting ring which is located at that portion of a large thickness which equals the height of the supporting ring. The muck leaving the partitions is loaded onto the tunnel conveyances by means of chutes in the shields which may be provided with vibrators. However, in loose ground, and with the shield divided into a large number of compartments, a plurality of such chutes are necessarily involved and such arrangement closes the effective cross-section of the shield.

An object of the present invention is to provide apparatus for driving tunnels in loose soil or ground and especially tunnelling shields which overcome the above and other objectionable features existing in the art.

Further objects and advantages of the invention will become more readily apparent to persons skilled in the art from the following detailed specification and attached drawings, and in which drawings:

FIG. 1 is a view partly in elevation and partly in cross section of an embodiment of the invention,

FIG. 2 is a view taken along line 2—2 of FIG. 1, the view looking in the direction of the arrows,

FIG. 3 is a plan view partly in elevation and partly in cross section,

FIG. 4 is a view taken along the line 4—4 of FIG. 3, the view looking in the direction of the arrows, and

FIG. 5 is a view taken along the line 5—5 of FIG. 3, the view looking in the direction of the arrows.

The apparatus includes a cutting ring 1 (FIG. 1) for the shield which accommodates rigid sharp edged members 2 and conveyors 3 mounted behind the members 2 which constitute horizontal components dividing the face thereof into separate segments or compartments. A vertically extending partition 4 located midway of the cutting ring 1 divides the ring, and the conveyors 3 are attached to

2

the partition 4. The conveyors 3 are adapted to be driven by means of toothed racks 5 which extend axially of the apparatus and are connected with rods of jacks 6 and rear drive drum 32 of each of the conveyors. The connection of the rack 5 with the jack rod is effected through a fork 7 and a pin 8. Cover plates 10 attached to covering elements 26 protect the racks 5 from damage in the space between the conveyors 3 and a supporting ring 9.

A longitudinally movable carriage 11 located at the rear end of the cutting ring 1 is provided with a telescopic arm 12 having a two-sided scoop 13 attached to its end and the scoop serves to load the muck falling or leaving the conveyors 3 onto a transfer conveyor 14 which functions to move the muck from the face of the apparatus. To eliminate a piling or accumulation of the muck at the sides of the transfer conveyor 14, it will be seen that plates 15 provided with vibrators 25 are associated with the ring 9. A monolithic lining 16 for the tunnel is prepared with a concrete mix supplied through a pipe 17 into a space defined between a shell 18 for the shield and an inner movable shuttering 19 through a distributing ring 20. A sectional, such as a reinforced concrete lining, is placed in a conventional manner.

The shafts of the rear drum 32 of each conveyor 3 is connected with a gearbox 21 and the gearbox serves to adjust the speed of the conveyor 3. The telescopic arm 12 is mounted on the longitudinally movable carriage 11 which is movable via rollers 22 mounted on a shell 23 of the shield. A mucking plate 24 is mounted at the bottom part of the ring 1 and the vibrators 25 associated with the plates 15 of the ring 9 function to eliminate the accumulation of the muck while being loaded onto the conveyor 14 as previously mentioned.

The rigid sharp edged members 2 (FIG. 3) are attached at one end to the cutting ring 1, and at the opposite end—to the partition 4. The partition 4 and side plates 27 secured to the cutting ring 1 and provided with stiffeners 28 affix a tubular understructure 29 constituting a part of the conveyor 3. The understructure is extensible to provide a means for tensioning a conveyor belt 30 by means of a turnbuckle 31 (FIG. 4). The understructure 29 carries the rear drive drum 32 and a front driven drum 33 for the conveyor 3. The conveyor is secured in position by inserting the longer shaft ends of the front drum 33 and rear drum 32 into horizontal slits provided in vertical stiffeners 34 of the side plates 27 and small cover plates 35 for the vertical partition 4 and said drums being closed by stop blocks 36. A fluid clutch assembly 37 controlled remotely is disposed freely on the longer shaft 40 of the rear drum 32 and is attached underneath to the side plate 27. The piston of the clutch 37 transmits pressure to a friction disk 38 mounted on splines of shaft 40 of the rear drum 32.

The speed of the rear drum 32 and the belt 30 is adjusted by means of the gearbox 21 mounted beside the clutch 37.

By moving the carrier of gears 41 (FIGS. 3 and 5) over the splines of a driven shaft 42, three different speeds for the rear drum 32 can be obtained. The connection of the driven shaft 42 and the shaft 40 is effected by means of a spring loaded pawl coupling 43, which allows the transmission of movement from the driven shaft 42 to the shaft 40 in only one direction. A drive gear 44 actuated by its meshing engagement with the toothed track 5 is mounted on drive shaft 39 of the gearbox 21.

Intermediate rollers 45 extending transversely of the apparatus are secured to the understructure 29, while front tubular member 46 supports shorter transversely extending rollers 47, and which latter rollers reduce sagging of the belt in the conveyor section carrying the highest load. Rollers 48 located at the sides of the understructure 29 prevent the sagging of the belt 30.

From FIG. 4 it will be appreciated that the understructure 29 can be extended by the manipulation of the turn-buckle 31 and the drum 32 actuated by the gearbox 21 by the rack 5 moves belt 30 which slides over the rollers 45 and rollers 47. In FIG. 5 it can be seen that shafts 40 and 49 of the rear drive drum 32 slide in longitudinal slits of the vertical stiffeners 34 of the side plate 27, and the small cover plates 35 of the partition 4. The shaft 40 of the rear drum 32 is connected by the coupling 43 with the driven shaft 42 of the gearbox 21 which in turn is attached to the side plant 27.

The operation of the apparatus may be summarized as follows:

Upon completion of the insertion of the shield and simultaneously with the retraction of the rods of jacks 6, together with the distributing ring 20 and movable shuttering 19, a batch of concrete of the predetermined characteristics is pumped through pipe 17 into the space between the shell 18 and shuttering 19. At that time, depending on the physical-mechanical properties of the ground, and particularly the magnitude of cohesion, the gear carrier of the gearbox 21 is shifted into the required position. When the ground cohesion is low, the gear carrier 41 is moved into a neutral position which stipulates a speed for the belt 30 equal to that of the rack 5, that is equal to the rate of the shield advance (with the consideration of the magnitude of reduction of cross section of the corresponding compartment).

If the ground cohesion becomes lower, the gear carrier 41 is disengaged from the remaining gears, and forced movement is not transmitted from the toothed rack 5 to the conveyor 3. In such situation, the clutch 37 is activated, while the fluid under suitable pressure, depending on the magnitude of the ground cohesion, is supplied to the clutch. Thus, with the aid of the clutch 37 and the friction disk 38 the conveyor belt 30 can be completely stopped by a braking action.

In the opposite situation in which the ground cohesion is greater, the gear carrier 41 is moved into the extreme right position, which increases the speed of the belt 30 by 1.5-2 times over that of the toothed rack 5.

When the shield compartments must be immediately cleared from muck, the gear carrier 41 is moved into the extreme left position and the speed of the belt 30 is 3 to 4 times higher than that of the rack 5. The gearbox 21 and clutch 37 are controlled from a common control panel which affords easy automation.

Upon engaging the respective gears or upon building-up the required pressure in the clutch 37, the jacks 6 are brought into action. The jacks 6 bear through the distributing ring 20 against the concrete of the lining 16 and move the shield in a forward direction. The muck falling from the conveyors 3 into the bottom compartments is collected by the scoop 13 attached to the arm 12 and which scoop is open at the back end. The muck moving to the top of the mucking plate 24 falls therefrom onto the plates 15 of the supporting ring 9. When the muck piles up on these plates, the vibrator 25 is activated. If, during the advance of the shield, the properties and behaviour of the ground in one of the face sections are changed, the speed of the belt 30 or the pressure of fluid supplied to the clutch 37 is immediately changed correspondingly. The speed of the conveyors 3 and the pressure in clutches 37 are also changed for turning the shield in the horizontal or vertical planes. The muck loaded onto the transfer conveyor 14 is transported exteriorly and loaded onto other tunnel conveyances.

If the steering of the shield advance, for instance, in

the horizontal plane, by adjusting the speed of conveyors, is not sufficiently effective, a selective loading of the muck with the aid of the scoop 13 may be of substantial assistance.

Since the scoop 13 is movable both radially and about the pivot of its attachment, the selective loading of the muck may be easily effected and upon clearing of all of the muck behind the partitions, the scoop 13 is slightly raised and the arm 12 is retracted. This completes the cycle.

This invention is not to be confined to any strict conformity to the showings in the drawings but changes and modifications may be made therein so long as such changes and modifications mark no material departure from the spirit and scope of the appended claims.

I claim:

1. An apparatus for driving tunnels in loose soil and ground including a shield having a face end, a cutting ring for the face end, at least one horizontally disposed front rigid sharp-edged member and a conveyor extending across the width of, abutting and operably related to said member and constituting therewith a horizontal component, said conveyor including driving and driven drums and a belt trained about said drums, a drive member extending axially of the shield remaining stationary during advance of the shield, a gearbox attached to the shield for adjusting the speed of the conveyor, means drivingly connecting the gearbox to the drive member, a shaft driven by the gearbox, a shaft for said driving drum, coupling means between said shafts permitting rotation only in one direction for coordinating the rate of advance of the shield and of the conveyor belt, a clutch for the driving drum shaft adapted to transmit a drive between the driven shaft of the gearbox and the driving drum shaft, a longitudinally movable transfer conveyor within the shield behind the horizontal component and means for selectively loading muck behind the component onto the transfer conveyor.

2. The tunnel driving apparatus as claimed in claim 1 including an extensible arm mounted behind said component for turning movement about the longitudinal axis of the shield and a two-sided scoop for the arm movable in the plane of the cross section of the tunnel constituting the means for loading the muck onto the transfer conveyor.

3. The tunnel driving apparatus as claimed in claim 1 including plates for said ring adjacent the sides of said transfer conveyor and vibrators fixed to said plates for vibrating said plates to eliminate accumulation of the muck at the sides of the transfer conveyor.

4. The tunnel driving apparatus as claimed in claim 1 including a vertical partition located midway of said ring and means connecting the conveyor to the vertical partition.

5. The tunnel driving apparatus as claimed in claim 4 including a plurality of spaced apart horizontal components for dividing the face end into separate compartments.

References Cited

UNITED STATES PATENTS

774,546	11/1904	Aims	61-85
1,240,446	9/1917	Hastings	61-85
1,277,107	8/1918	D'Rourke	61-85

FOREIGN PATENTS

1,338,375	8/1963	France.
-----------	--------	---------

JACOB SHAPIRO, *Primary Examiner*.