Jan. 19, 1971 T. H. FIKSE 3,556,599

METHOD OF TUNNELING AND TUNNELING SHIELD WITH A DRAG LOADER

Filed Dec. 10, 1968 4 Sheets-Sheet 1

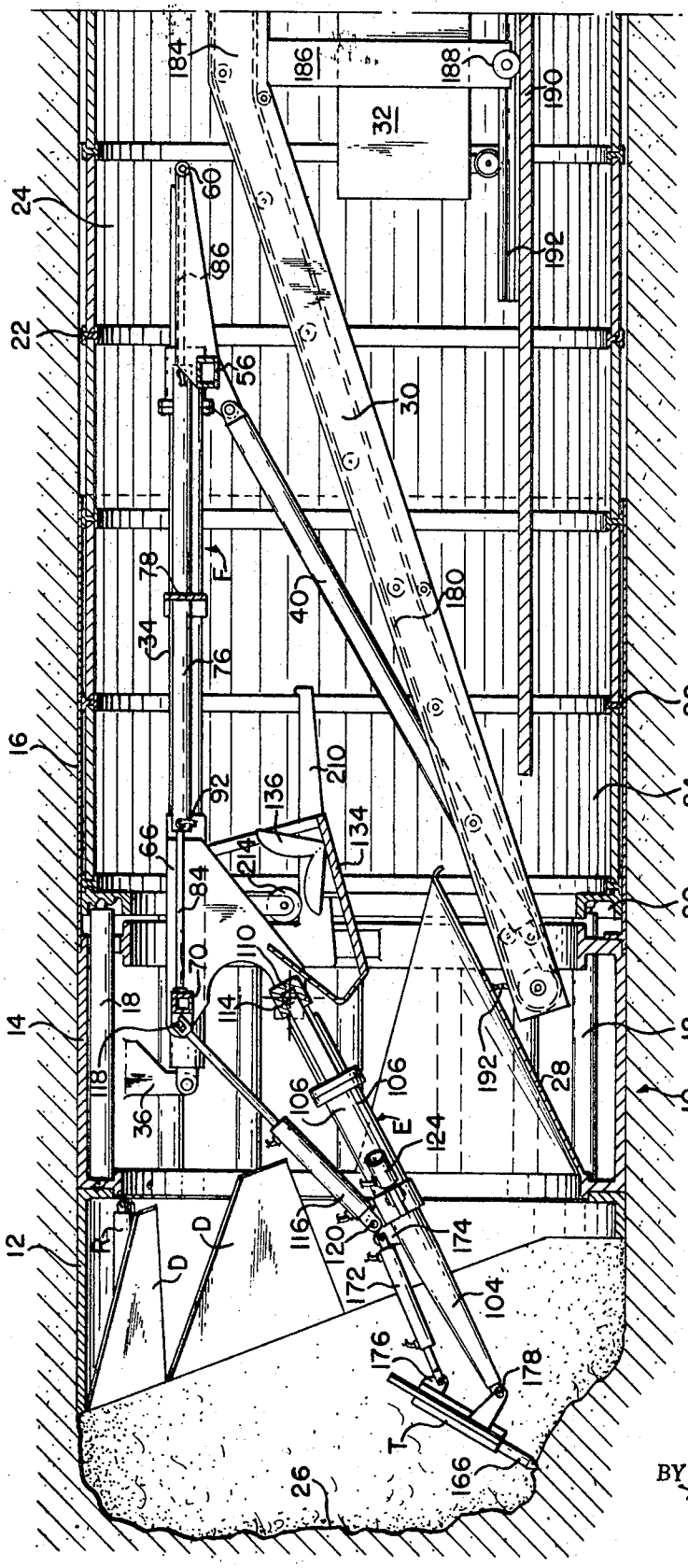


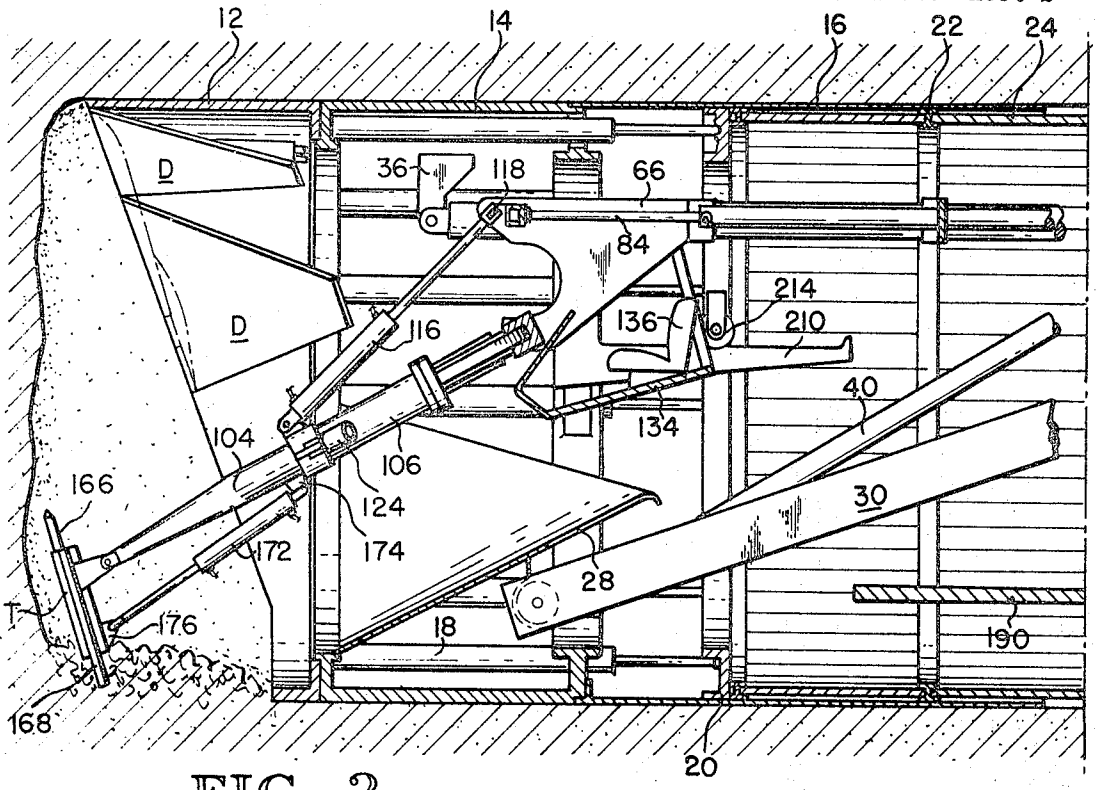
FIG-1

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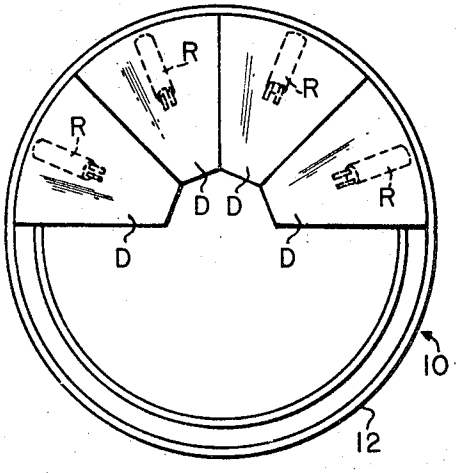
METHOD OF TUNNELING AND TUNNELING SHIELD WITH A DRAG LOADER

Filed Dec. 10, 1968 4 Sheets-Sheet 2

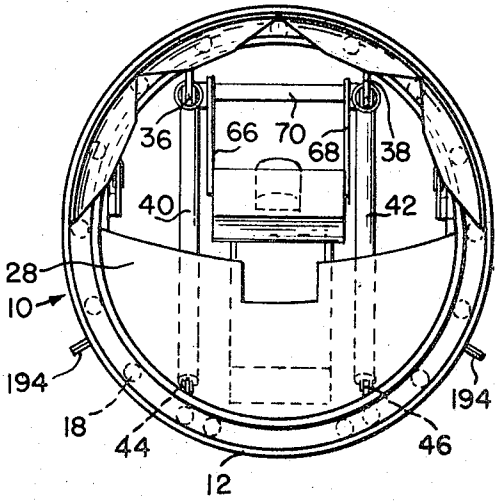


FIG—2

FIG—3



FIG—4



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METHOD OF TUNNELING AND TUNNELING SHIELD WITH A DRAG LOADER

Filed Dec. 10, 1968 4 Sheets-Sheet 3

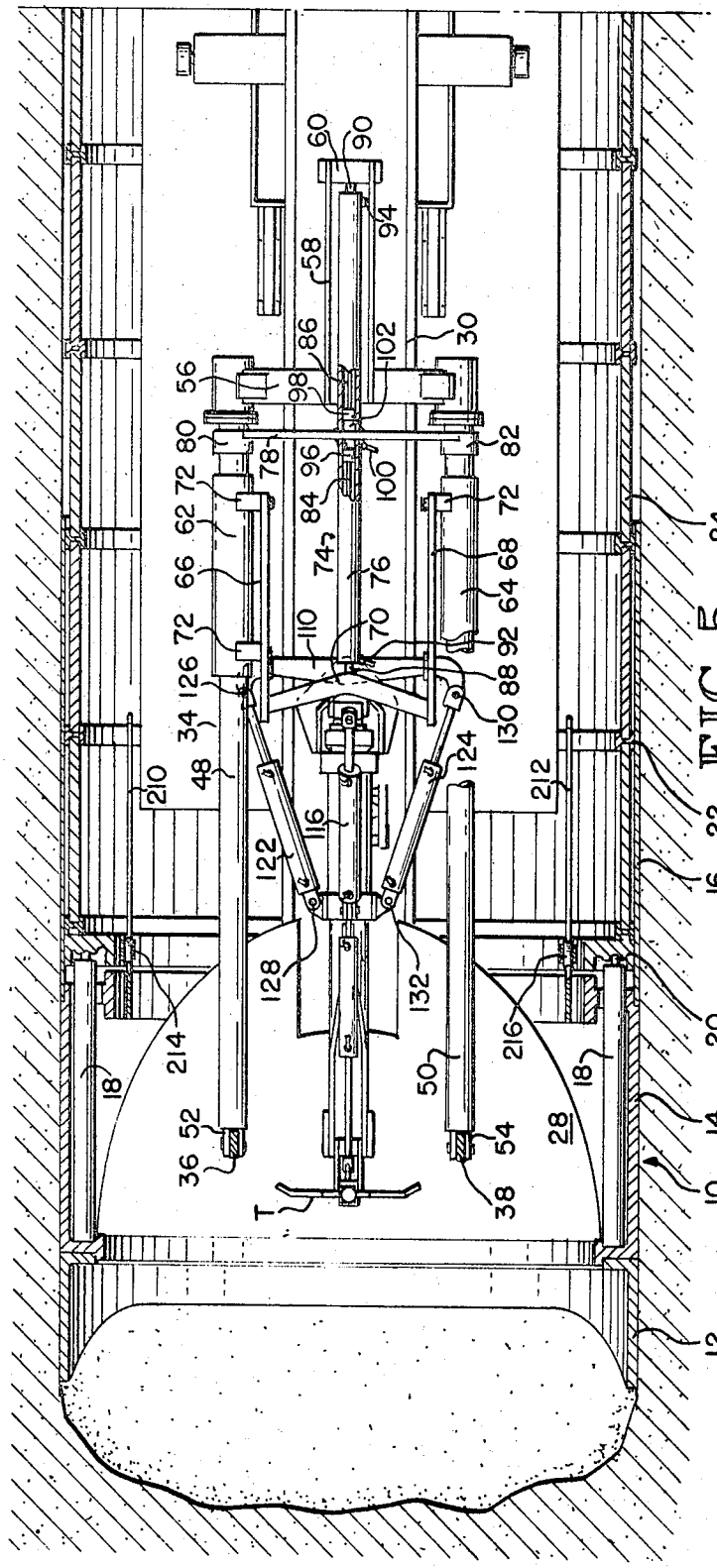


FIG. 5

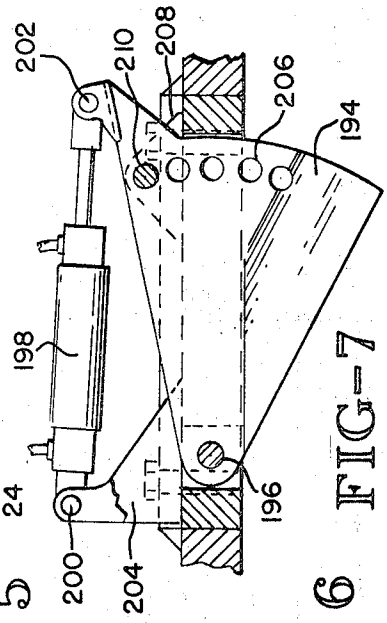


FIG-6

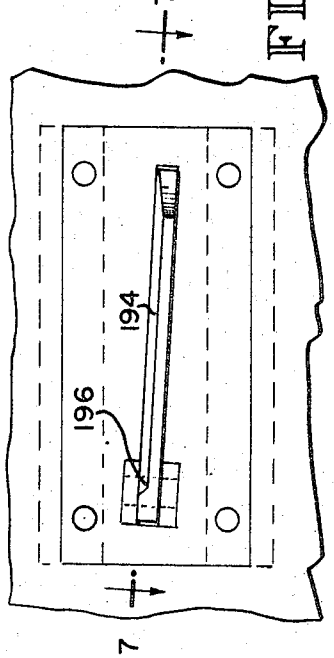


FIG-7

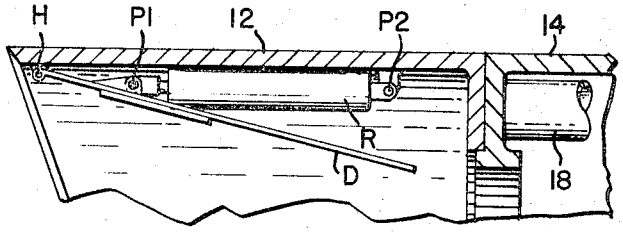
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METHOD OF TUNNELING AND TUNNELING SHIELD WITH A DRAG LOADER

Filed Dec. 10, 1968 4 Sheets-Sheet 4

FIG-8



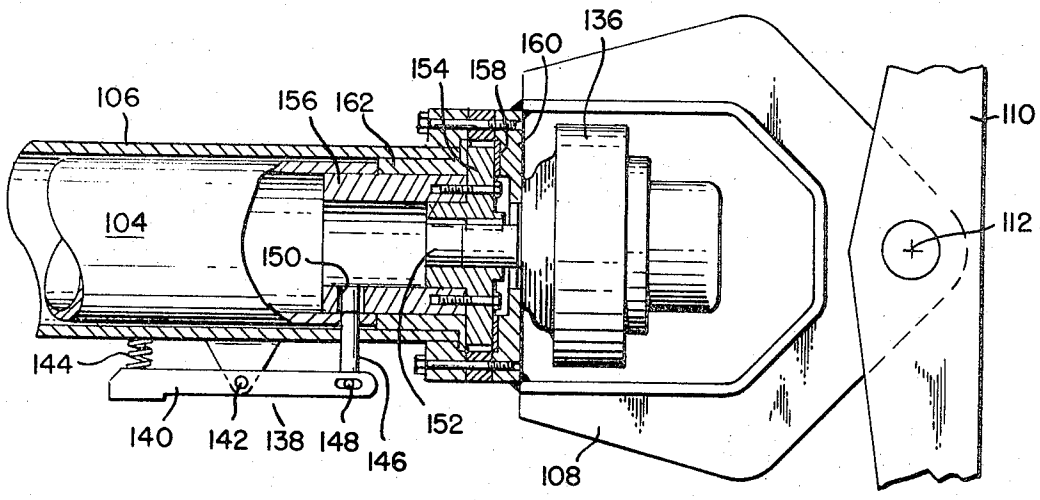


FIG-9

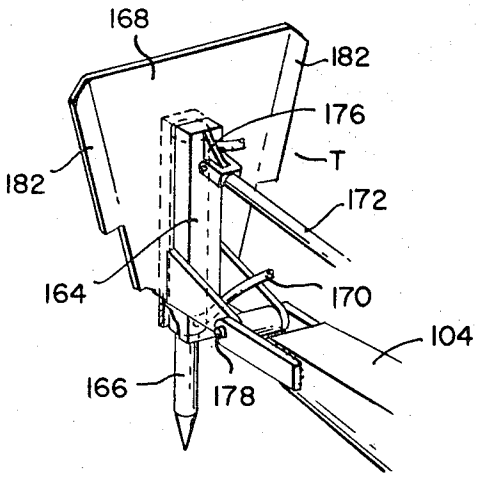


FIG-10

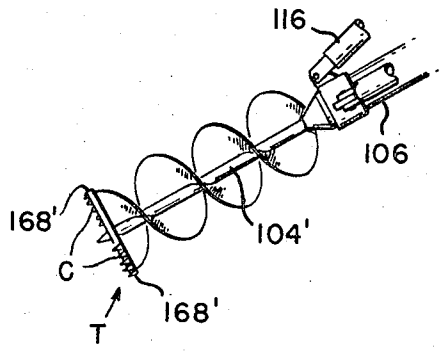


FIG. 11

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United States Patent Office 3,556,599
Patented Jan. 19, 1971

3,556,599

METHOD OF TUNNELING AND TUNNELING SHIELD WITH A DRAG LOADER

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Filed Dec. 10, 1968, Ser. No. 782,567
Int. Cl. E01g 3/03
U.S. Cl. 299—11 18 Claims

ABSTRACT OF THE DISCLOSURE

At its forward end the boom supports both a power tool, adapted for digging at the tunnel face, and to a hoe. The rear end of the boom is pivotally connected to a carriage which is supported inside the shield for fore and aft movement over both the forward portion of a conveyor and a ramp which discharges onto the conveyor. The tool is used first to dig the tunnel face, and then is retracted and the hoe is used to draw mined material up the ramp and onto the conveyor.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to power excavating equipment and its arrangement within a tunneling shield, and to a tunneling technique.

Description of the prior art

It is know to equip a tunneling shield with a forward ramp leading upwardly and rearwardly to a discharge position over the forward end position of an endless belt conveyor, and to utilize the forward motion of the shield to move loose material up the ramp. This basic arrangement is disclosed by Canadian Pat. No. 340,463, granted Mar. 27, 1934, to Warner et al.

It is also known to equip such a ramp with a rotating screw type conveyor for moving the material up the ramp. An arrangement of this type is disclosed by U.S. Pat. No. 3,355,215, issued Nov. 28, 1967, in connection with a machine which also includes an oscillating cutterhead for mining the tunneling face.

U.S. Pat. No. 2,836,408, issued May 27, 1958, to A. L. Barrett, discloses combining a screw conveyor with a rotary cutterhead in a non-shield type mining machine, and using such screw conveyor for moving the mined material up a ramp and onto a power conveyor.

A different type of power excavator for a tunneling shield is disclosed by French Pat. No. 1,388,527, published Feb. 5, 1965. It includes a frame supporting a forwardly extending boom which carries a cutting tool at its forward end. The boom is operable for moving the cutting tool in all directions across the tunnel face. The frame is track mounted for fore and aft movement axially of the tunnel. In use the tool is used to pick up material from the tunnel face. The frame is then moved rearwardly along the track to place the tool over a take-out conveyor, and the boom and tool are rotated to deposit the material onto the conveyor.

SUMMARY OF THE INVENTION

According to the present invention a tunneling machine is provided with a rectractable boom carrying a combined digging and hoeing tool at its forward end. The tool is first moved forwardly and used to dig or mine the tunnel face, with the mined material being allowed to drop. Periodically the digging is stopped, the shield is shoved forwardly, and the tool is retracted and used in hoe fashion to draw the mined material up a ramp and onto a conveyor. A principal advantage of this arrangement is that

the digging and rearward movement of the material may be performed by selective operation of a single power operated mechanism.

Other aspects of the invention are hereinafter described in connection with the illustrated embodiment.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing like element designations refer to like parts, and:

FIG. 1 is a view partially in vertical axial section and partially in side elevation of a tunneling machine typifying the present invention, such view showing the machine in an inuse position within a tunnel, and showing an air hammer portion of the excavating tool being used for digging the tunnel face;

FIG. 2 is a shortened view similar to FIG. 1, showing the shield in the process of being jacked forwardly, and the hoe portion of the excavator tool being used for drawing material rearwardly and up the ramp onto the conveyor;

FIG. 3 is a front elevational view of the tunneling machine showing the breasting doors relatively tight together in extended or breasting positions, with the internal elements of the tunneling machine omitted for the sake of clarity of illustration;

FIG. 4 is a view similar to FIG. 3, but showing the breasting doors in their retracted positions, and showing the elevating ramp for the mined material and the frame portions only of the excavating equipment in front elevation;

FIG. 5 is a view partially in horizontal axial section and partially in top plan of the tunneling machine, with portions of some elements cut away for clarity of illustration of internal parts;

FIG. 6 is a fragmentary side elevational view of one of two attitude control wings which are embedded in the lower outer side portions of the shield;

FIG. 7 is a sectional view taken substantially along line 7—7 of FIG. 6, and presenting a top plan view of the attitude control wing;

FIG. 8 is a fragmentary vertical section view taken through the upper forward portion of the shield and presenting a side elevational view of one of the upper breasting doors in its retracted position;

FIG. 9 is an enlarged scale view of the rearward mounting portion of the tool boom, such view being partially in top plan and partially in horizontal axial section;

FIG. 10 is a fragmentary pictorial view of the forward end portion of the boom and the preferred form of dual purpose tool carried thereby; and

FIG. 11 is a view similar to FIG. 10, but showing a second form of dual purpose tool.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The tunneling shield **10** includes a forward section **12** which may be beveled back from top to bottom as illustrated; an intermediate section **14**; and a tail section **16**. The shield **10** is moved forwardly by a plurality of thrust rams **18** having cylinder portions carried by the intermediate section **14** and rearwardly extendible pistons which react against a husky ring beam **20**.

As is conventional in the tunneling field, the tunnel lining is continuously added onto and extended forwardly as the shield is advanced forwardly. The illustrated form of tunnel lining is composed of axially spaced girth ribs or beams **22** and wooden plank lagging **24** bridging the spaces between the beams **22**. The ring beam **20** abuts against the forward rib **22**. After the shield has been shoved forwardly an amount approximately equal to the full throw of the thrust rams **18**, the thrust rams **18** are

retracted, the ring beam **20** is moved forwardly, and a new section of lagging and a new forwardmost girth rib **22** are installed under cover of the tail section **16**. As should be apparent, the shield **10** serves to support the earth formation in the region where excavation is taking place and the tunnel lining supports the tunnel in its extent rearwardly of the shield **10**.

According to the invention a boom including power excavator E is provided for both (1) digging or mining the tunnel face **26** and (2) drawing the mined material rearwardly and up a ramp **28** to be discharged therefrom onto an endless belt type conveyor **30**, or the like, which moves such material rearwardly and deposits it into mining cars **32** or some other form of material carry-out means.

The excavating equipment E includes a main support frame F which is in the nature of a structural triangle. It includes an upper carriage support portion **34** which is secured at its forward end to two side placed support ears **36, 38** which depend from an intermediate portion of the shield section **14**. Carriage support portion **34** is disposed generally horizontally and extends from its connection points to the ears **36, 38** axially rearwardly through the tail section region **16** and possibly also into the region of the tunnel rearwardly of the tail section **16**. The rear end of the carriage support portion **38** is supported only by a pair of side located struts **40, 42**. The rear ends of the struts **40, 42** are pin connected to the carriage support portion **34** and the forward ends of struts **40, 42** are pin connected to lower portions of the shield's intermediate section **14**. Thus, the support frame F is structurally connected only to the relatively husky intermediate section **14** of the shield **10** and extends through free space both vertically between and rearwardly of the securement points **36, 38, 44, 46**.

Referring to FIG. 5 in particular, the carriage support portion **34** is shown to comprise a pair of laterally spaced, parallel, tubular rails **48, 50**. It is the front end portions **52, 54** of the rails **48, 50** which are connected to the mounting ears **36, 38**. The rear ends of the rails **48, 50** are interconnected by a cross frame **56** which includes a box-like central extension **58** having its own rear end cross member **60**. A carriage is mounted on the rails **48, 50** by a pair of mounting sleeves **62, 64**, respectively. The carriage frame comprises a pair of vertical side plates **66, 68** interconnected by a lateral beam **70**. The side plates **66, 68** are connected to the mounting sleeves **62, 64**, such as by tie members **72**.

A two-piston thrust ram assembly **74** is interconnected between the cross beam **70** and the end member **60**. Such assembly **74** comprises an elongated cylinder **76** supported between its ends by a cross member **78** carrying guide sleeves **80, 82** at its opposite ends which surroundingly engage the tubular rails **48, 50**. A first piston **84** is housed within the forward portion of cylinder **76** and a second piston **86** is housed in the rearward portion of cylinder **76**. The forward end portion **88** of the piston rod for piston **84** is connected to the cross beam **70** and the rearward end **90** of the piston rod for piston **86** is connected to the cross member **60**. Fluid supply and vent lines **92, 94** are provided through the cylinder wall on the rod sides of the piston heads **96, 98** and a supply and return line **100** is provided for delivering fluid into the space between the piston heads **96, 98**. In FIG. 5 the carriage is shown in a rearmost or retracted position. The carriage is moved forwardly or extended by directing fluid through line **100** into space **102** while at the same time removing fluid via lines **92, 94**.

Referring now to FIGS. 1, 2, 5 and 9, in particular, the excavating equipment is shown to comprise a boom means supported from the forward portion of the carriage. More specifically, the boom means is shown to comprise a rotatable tool shaft **104** carrying a mining or excavating tool T at its forward end. A mounting sleeve **106** surrounds the rearward portion of shaft **104** and at its rear

end is connected to a yoke **108** which is pivotally connected to a cross beam **110** for sideways pivotal movement about an axis **112**. The beam **110** is itself mounted for pivotal movement about a generally horizontal axis **114** (FIG. 1).

The pivotal connections providing swinging movement of the boom means about axes **112** and **114** serve to mount the boom means, and hence the tool T carried thereby, for universal movement within the confines of the shield's forward section **12**. In the illustrated embodiment three independently controllable hydraulic rams are provided for swinging the boom means. The first ram **116** is pivotally connected at one of its ends to an upper forward portion of the carriage, for pivotal movement about a horizontal axis **118**. At the opposite end it is connected to a forward portion of the mounting sleeve **106** for pivotal movement about a generally horizontal axis **120**. Second and third rams **122, 124** are provided on opposite sides of the boom means. Ram **122** is pivotally connected at one end to a forward right side extension of the rotatable beam **110**, for sideways pivotal movement about an axis **126**. The opposite end of ram **122** is pivotally connected to the mounting sleeve **106** for sideways pivotal movement about an axis **128**. The rear end of ram **124** is pivotally connected to an opposite end extension of beam **110**, for sideways pivotal movement about an axis **130**. The forward end of ram **124** is pivotally connected to the sleeve **106** for sideways pivotal movement about an axis **132**. Rams **122, 124** are situated in a common plane with the boom shaft **104**, and axes **126, 128, 130, 132** are substantially perpendicularly related to such plane. As should be evident, retraction of the piston in one of side rams **122, 124** accompanied by extension of the piston in the other side ram causes a sideways movement of the boom means and the excavator tool T. Extension and retraction of the piston in ram **116** causes vertical movement of the boom means and the tool T.

In preferred form, an operator's station **134** is suspended from the carriage between the side plates **66, 68**. The operator sits on a seat **136** and has the controls for the rams **116, 122, 124** in front of him.

As earlier mentioned, the tool shaft **104** is rotatable. As shown by FIG. 9, it is rotated by a hydraulic motor **136**, or the like coupled to the rear end of shaft **104** and supported within the open center of the yoke **108**. The motor **136** may be used to merely rotate or revolve the shaft **104**, and the tool T, a portion of one revolution, or to continuously rotate the shaft **104** and the tool T. This latter arrangement will be hereinafter described in greater detail.

To some extent the hydraulic motor **136** can be used to hold or position the shaft **104** and the tool T. However, since some rotary hydraulic motors have a tendency to creep, a position lock mechanism **138** may be provided for holding the shaft **104** in one or more set positions. In FIG. 9 the lock mechanism **138** is shown to consist of a lever **140** pivotally supported near its middle at **142**. A compression spring **144** is situated between the forward end of the lever **140** and the support sleeve **106**. The opposite end of the lever **140** carries a lock pin **146**. The lock pin **146** is shown to be pivotally connected to the lever **140** by a pin means **148** which extends from pin **146** through a longitudinal slot in lever **140**. The inner end of pin **146** is shown to project through first an opening in support sleeve **106** and then into an opening or socket **150** in the shaft **104**. When it is desired to lock the shaft **104** in position relative to sleeve **106**, the pin **146** is set in place. Plural openings **150** circumferentially spaced about the shaft **104** may be provided so that there is a choice of set positions for the shaft **104** and the tool T. As should be evident, the shaft **104** and the mounting sleeve **106** may be easily decoupled by the user merely depressing the spring end of lever **140** until the pin **146** is free of both openings. Once it is out of the opening in sleeve **106** it can be swung to one side until it is again desired to use the lock mechanism **138**.

As shown by FIG. 9, the drive shaft **152** of motor **136** is keyed to a circular rear end member **154** which is bolted to a reduced diameter plug member **156** constituting a rearward portion of the shaft **104**. A radial thrust bearing **158** is interposed between the rear surface of member **154** and the support wall **160**, and a combination bearing **162** is interposed radially between plug **156** and the wall of sleeve **106** and axially between the forward surface of butt plate **154** and rear end surfaces of the tubular portion of shaft **104** and sleeve **106**.

In preferred form, the excavating tool T comprises a pneumatic hammer **164** having a point **166** directed generally perpendicularly of the boom shaft **104**, and an oppositely directed paddle or hoe portion **168**. An air supply line **170** is provided for leading air into the hammer **166**.

As best shown by FIGS. 1 and 2, a thrust ram **172** is interconnected between a mounting ear **174** projecting laterally from the shaft **104** adjacent where it immerges from sleeve **106**, and a mounting ear **176** offset towards the hoe portion of the tool T from the point of connection of the tool T to the shaft **104**. Tool T is pivotally connected to the forward end of shaft **104** for pivotal movement about a transverse axis **178**. The two ends of thrust rams **172** are pivotally attached to their support ears **174**, **176**, respectively, for movement about axes which are parallel to axis **178**. Thrust ram **172** is independently controlled by the operator. The operator control panel includes a set of controls for this thrust ram in easy reach of the operator. Thrust rams **116**, **122**, **124** and **172** individually and collectively constitute attitude control means for the boom means and the tool T carried thereby.

In operation, the boom means is suitably moved by the operator to place the point **166** of the digging tool at the spot where it is desired to cut or mine the face material. During operation of the pneumatic hammer the thrust rams **116**, **122**, **124**, **172** are selectively operated to suitably brace the boom means and resist the reaction forces imposed on it by the reciprocating point **166** as it works on the tunnel face **26**.

The shield **10** may be shoved forward by the rams **18** during the mining process, or the shield **10** may be intermittently thrust forwardly during the periods the tool T is used for drawing the mined material rearwardly up the ramp **28** and onto the traveling belt **180** of the conveyor **30**. The operator readies the tool T for this latter function by rotating the shaft **104** from the position it is in for digging into the position shown by FIG. 2. The thrust ram **74** is then operated to move the carriage rearwardly, carrying with it the boom means and the tool T. As the tool T moves rearwardly the hoe portion **168** collects mined material in front of it and moves it rearwardly up the ramp **28**. As shown by FIG. 10 the hoe portion **168** may be provided with a pair of rearwardly turned side fins **182** dihedrally related to the general plane of the hoe portion **168** for the purpose of minimizing spillage around the sides of the hoe portion **168**.

As shown by FIG. 1, the rear portion **184** of the conveyor **30** is elevated, and is supported in the elevated position by a traveling support **186**, preferably in the form of one or more pairs of laterally spaced support members having wheels **188** at their lower ends which ride on the floor **190**, or on tracks therefor. During construction of a tunnel it is common to build a slightly elevated floor **190** in the tunnel so as to provide a flat base surface of substantial width. Muck car tracks **192** are secured to the floor **190**. These tracks are sectional and are continuously extended forwardly in the tunnel as the shield is moved forwardly and the tunnel itself is extended.

According to the invention, the forward end of the conveyor **30** is secured to the shield **10**, such as by a cross chain **192** which is secured intermediate its ends to the conveyor frame and at its ends to lower opposite side portions of the ramp **28**. The rear portion of the conveyor **30** is supported only by its mobile support **186**. Hence, the conveyor **30** is coupled in trailer fashion to the shield and is pulled forwardly by the shield as the shield advances.

The chain type support has the effect of substantially isolating the conveyor **30** from roll movement the shield may experience as it is thrust forwardly. As shown by FIGS. 4, 6 and 7, retractable attitude control wings **194** are provided on the side of the shield **10** and may be operated to at least partially compensate for shield roll. As shown by FIG. 7, the wings are pivotally mounted at their forward ends, such as by a single pin **196**. A hydraulic ram **198** is interconnected between two pivot pins **200**, **202**, one carried by a fixed mount **204** secured to the shield wall and the other carried by the wing **194**. An arcuate roll of openings **206** may be provided in the rear portion of the wing **92** so as to be movable over an opening provided in a fixed member **208** secured to the shield wall, so that the wing **194** can be locked into position by dropping a lock pin **210** through one of the openings **206** and the opening in member **208**. As shown by FIG. 6, the wings are not horizontal, but rather sloped downwardly from front to rear. This gives them a slight angle of attack so that as the shield is moved forwardly with both wings extended a lifting force will be opposed on the wings causing the shield to veer upwardly somewhat. At other times one wing **194** is retracted and the other alone is used so as to impose an upwardly directed force at only one side of the shield for correcting roll.

Referring to FIGS. 1, 2 and 5, according to the invention the intermediate sections **16** of the shield includes a pair of stabilizing and guide rails **210**, **212**, one on each side of the shield. These members **210**, **212** are substantially parallel and are spaced laterally apart from each other and about midway between the top and bottom of the shield. Grooved follower wheels **214**, **216** are carried by the thrust ring **20** and follow along the upper edges of the guide tracks **210**, **212**. The guide tracks **210**, **212** and the follower wheels **214**, **216** serve to stabilize and facilitate movement of the ring **20**.

A plurality of breasting doors D are mounted on the forward section **12** of the shield **10**. Each door is generally pie shaped but has a blunt rather than a sharp small end. The curvature of the arcuate ends of the doors is made to at least closely match the curvature of the shield wall **12**, and the arcuate outer ends of the doors D are pivotally connected to the inner surface of wall **12**. The arrangement shown by FIG. 3 includes four doors which together substantially close the upper half of the forward opening in the shield. Preferably the doors D are sized so that when they are extended (FIG. 3) the side edges of adjacent doors substantially contact each other and there is at least some semblance of mutual bracing at such edges and structural continuation of the doors D. Preferably, rather than being planar the doors are convexly curved on their forward sides and concavely curved on their rearward sides, so that there is some degree of keying together of the doors when they are all extended. Each door is provided with its own independently controllable thrust ram R. One end of each ram R is pivotally connected to its door D at a pivot point P1 that is longitudinally spaced along the door D from the hinge H which connects the door to the shield wall **12**. The opposite end of the ram R is pivotally connected to the wall **12** at a more rearward position P2. The pivotal axes are substantially perpendicularly related to a radial plane, and the ram R is positioned so that it moves within said radial plane as the door D is extended and retracted.

When soft ground is encountered and the tunnel face does not stand up but rather tends to flow into the shield the doors D are extended so as to substantially close off the upper portion of the entrance into the shield **10**. When the doors are in their breasting position the soft material will slope from the lower edges of the two lower doors

downwardly and inwardly to a point of intersection with the ramp **28**, with the angle of repose varying in accordance with the composition and flow characteristics of the material. An important feature of the doors is that they can be quickly moved into a breasting position. This is quite often necessary because a breakdown of the tunnel face with an inward rush of the material quite often happens without any warning to the personnel working inside the shield. Although the rams R are independently operable, the control system therefor should be adapted for also moving all doors at once, so that they can all be quickly moved together into a breasting position in the event a sudden and unexpected flow occurs.

The excavating tool T' shown by FIG. 11 is designed to be continuously rotated and to cut into the tunnel face as it is rotated. To facilitate cutting it is shown to comprise a plurality of cutters C. It is also shaped so that it can be used in hoe fashion to draw the mined material up the ramp and onto the conveyor **30**.

The purpose of the illustrated embodiment is to provide an understanding of the invention. The following claims set forth the legal limits of the invention.

What is claimed is:

1. A tunneling machine comprising:

a tunneling shield including means providing overhead protective cover at the face region of the tunnel, and support frame means therefor adapted to be advanced as mining progresses;

an endless conveyor for moving mined material rearwardly to a pickup station, said conveyor having a forward end portion within the protective confines of said shield, and supported on a lower portion of said frame;

a ramp within the protective confines of said shield, said ramp having a lower forward end, said ramp rising rearwardly and having an after portion overhanging the forward end portion of said conveyor;

boom means having front and rear ends;

elevated support means within the protective confines of said shield at a level above the levels of said ramp and at least the forward portion of said conveyor;

carriage means mounted on said support means for both forward and rearward movement generally axially of the tunnel;

means pivotally connecting the rear end of said boom means to said carriage means;

an excavator tool mounted at the forward end of said boom means, said tool having a broad hoe portion;

means for advancing and retracting said carriage along said support means, and in turn said boom means and said tool carried thereby, relative to the tunneling shield and longitudinally of the tunnel; and

attitude control means for placing said hoe portion in a position for drawing mined material rearwardly and upwardly over said ramp as said carriage, boom means and tool are being retracted.

2. The tunneling machine of claim **1**, wherein said shield includes means for advancing it axially forwardly, and said conveyor has an elevated rear end portion and includes a mobile support for said rear end portion, with said conveyor being secured at its front end to said shield and in use being towed by said shield in trailer fashion.

3. The tunneling machine of claim **1**, wherein said boom means comprises a rotatable tool shaft and means for supporting same, and said excavator tool is mounted on the tool shaft, so as to be rotatable therewith, and wherein said excavator tool further includes a second excavating portion differing in character from said hoe portion and situated circumferentially about the tool shaft from said hoe portion.

4. The tunneling machine of claim **3**, wherein said second excavating portion is a reciprocating point type hammer, and extensible brace means extends between said carriage and said boom means for bracing said boom means during use of said hammer.

5. The tunneling machine of claim **1**, wherein said boom means comprises a rotatable tool shaft and support means which at least partially surrounds the rear portion of said shaft and rotatably supports said shaft, wherein the means pivotally connecting the rear end of said boom means to said carriage means is interconnected between said carriage means and said tool shaft support means, and wherein said attitude control means comprises at least one hydraulic ram pivotally connected at one of its ends to an upper forward portion of said carriage and pivotally connected at its other end to said tool shaft support means, and at least one additional hydraulic ram pivotally connected at one of its ends to a side portion of said carriage and pivotally connected at its other end to said tool shaft support means.

6. The tunneling machine of claim **1**, wherein said excavator tool includes a rotary boring means having side portions which constitute the said broad hoe portion.

7. The tunneling shield according to claim **1**, wherein said elevated support means comprises a pair of parallel, elongated rods, and said carriage means includes a support sleeve surroundingly engaging each said rod and frame means interconnected between said sleeves.

8. The tunneling machine of claim **1**, wherein the means for advancing and retracting said carriage comprises a compound thrust ram assembly comprising an elongated cylinder extending in the direction of carriage movement, first and second piston rods inside said chamber, each having a piston head at its inner end, means connecting the forward end of the forward piston rod to one of said shield frame and said carriage means, means connecting the rearward end of the rear piston rod to the other of said shield frame and said carriage means, and means for supplying fluid into, and draining fluid out from, the space between the two piston heads.

9. The tunneling machine of claim **1**, further comprising means pivotally mounting the excavator tool at the forward end of said boom means, and wherein said attitude control means includes a hydraulic thrust ram pivotally connected at one end to the excavator tool and at its other end to the boom means, for both swinging the excavator tool in position relative to the boom means and bracing the excavator tool in a set position relative to the boom means.

10. The tunneling machine of claim **9**, wherein the excavator tool is elongated and the said broad hoe portion is at one end thereof, wherein a percussion hammer is at the opposite end of said tool, wherein the means pivotally connecting the excavator tool onto the boom means is located intermediate the ends of the excavator tool, and wherein the thrust ram controlling the attitude of the tool is connected at its forward end to the excavator tool on the hoe portion side of the pivot means.

11. The tunneling machine of claim **9**, wherein said boom means comprises a rotatable tool shaft and support means therefor which at least partially surrounds the rear portion of said shaft, wherein the means pivotally connecting the rear end of said boom means to said carriage means is interconnected between said carriage means and said tool shaft support means, and wherein said attitude control means also comprises at least one hydraulic ram pivotally connected at one of its ends to an upper forward portion of said carriage and pivotally connected at its other end to said tool shaft support means.

12. The tunneling machine of claim **11**, wherein said attitude control means comprises at least one additional hydraulic ram pivotally connected at one of its ends to a side portion of said carriage and pivotally connected at its other end to said tool shaft support means.

13. The tunneling machine of claim **1**, wherein said boom means comprises a rotatable tool shaft and a support means for said shaft located to the rear of said boom means, and wherein the means pivotally connecting the rear end of said boom means to said carriage means comprises a support member mounted on said carriage means

for angular movement about an axis extending transversely of the tunnel, and means connecting the boom shaft support means to said transverse member for pivotal movement about an axis which is substantially perpendicular to the said transverse axis.

14. The tunneling machine of claim **13**, wherein the said attitude control means comprises a pair of side placed thrust rams, each of which is pivotally connected at its forward end to a portion of said boom shaft support means and at its rearward end to the end portion of the transverse member on its side of the boom means.

15. The tunneling machine of claim **13**, wherein said attitude control means comprises at least one thrust ram pivotally connected at its forward end to the said tool shaft support means and at its rearward end to an upper portion of the carriage means.

16. The tunneling machine of claim **13**, wherein said boom means further comprises a motor mounted in the rear end region of the boom means forwardly of the two pivot axes, and drive transmission means interconnected between said motor means and the rear end of the boom shaft.

17. A tunneling method comprising:

digging a tunnel face by use of a digging tool supported at the end of an elongated boom which is itself supported within a tunneling shield;

swinging the boom sideways and/or up and down as necessary to place the digging tool in contact with a location on the tunnel face where digging is desired;

following accumulation of some mined material at the lower front portion of the shield, retracting the entire boom so as to move the tool axially rearwardly through said shield, and while retracting said boom using a portion of the tool in hoe fashion to draw the accumulated material rearwardly up a material ramp supported in the shield, and onto a removal conveyor extending rearwardly through the tunnel from a receiving position below the after end of said ramp; and

progressively jacking the tunneling shield forwardly accompanied by a continuous extension of a lining for the tunnel rearwardly of the shield.

18. A tunneling method according to claim **17**, further comprising using a percussion hammer type digging tool and bracing said boom from its side generally towards the direction of hammer movement into the face material, so that the brace means carries some of the hammer generated forces.

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U.S. Cl. X.R.

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