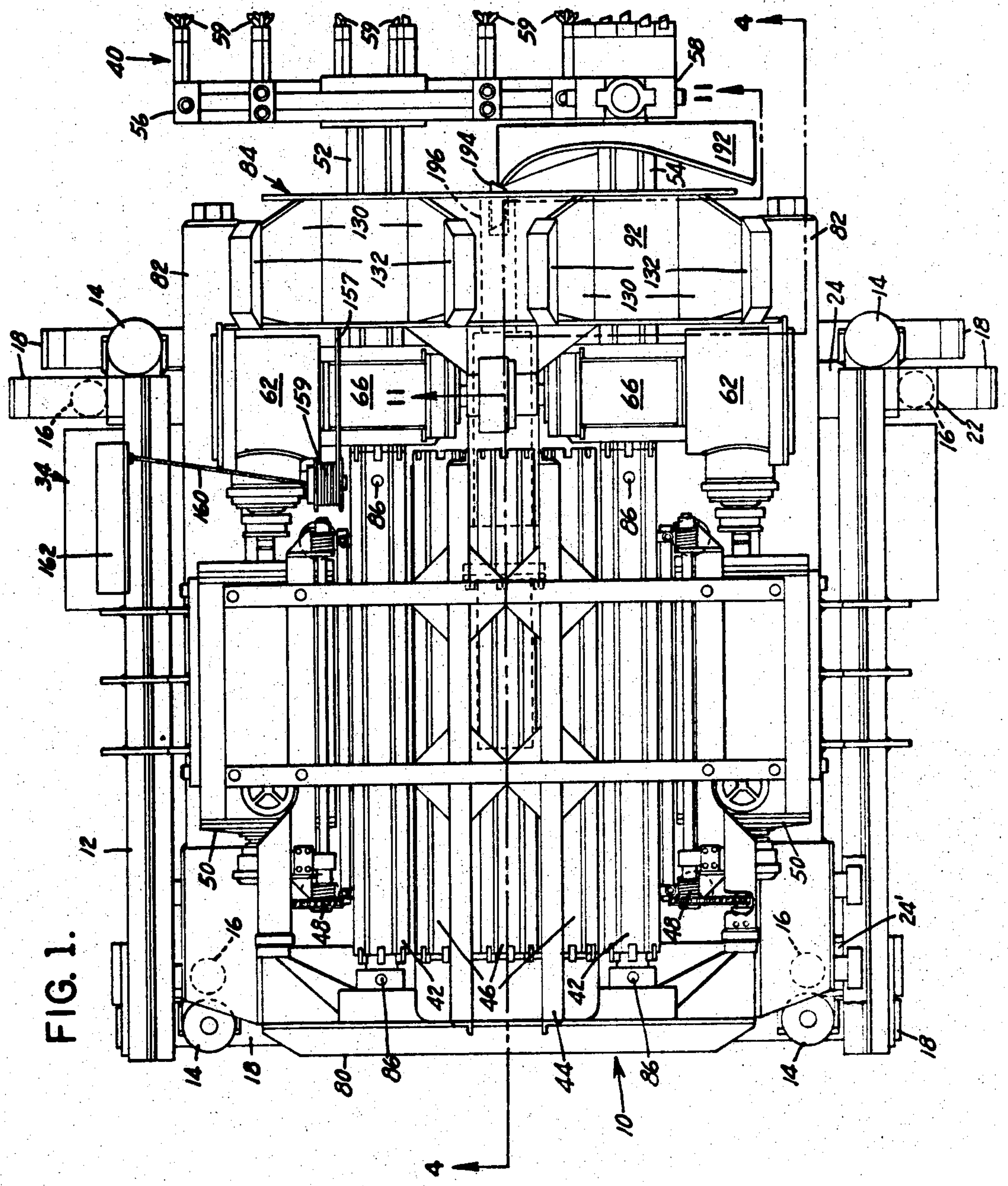

FIG. 1.

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RIB EXTRACTOR WITH A STEERABLE DRILLING HEAD STRUCTURE

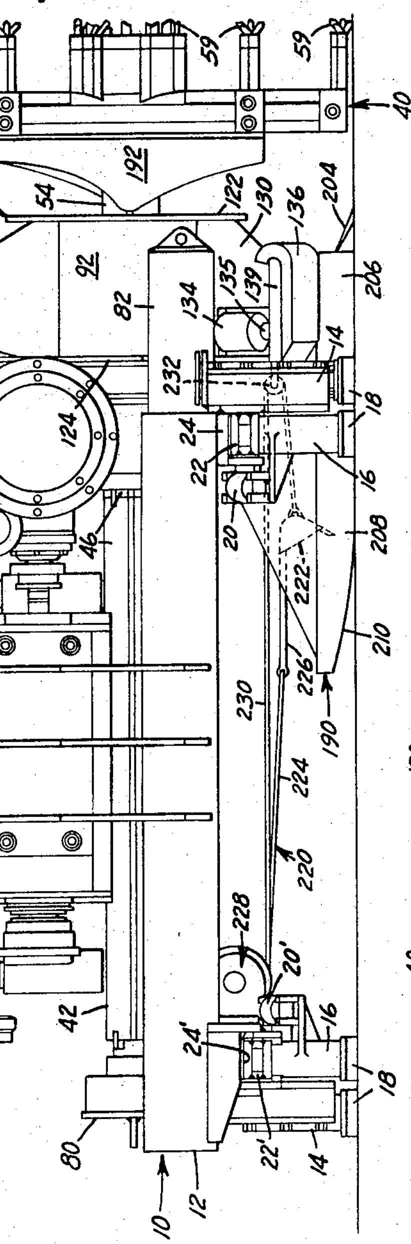

FIG. 2.

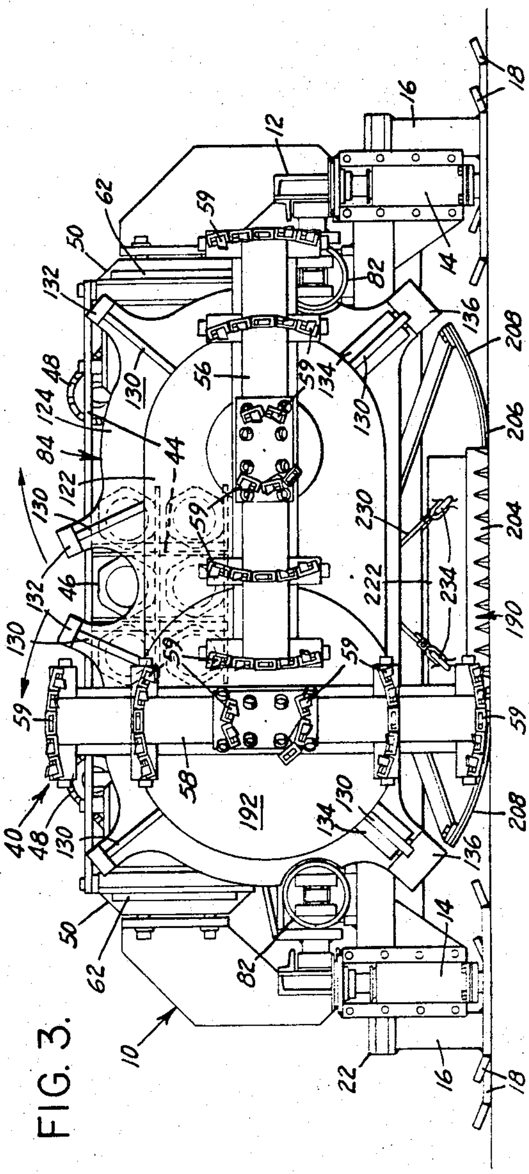

FIG. 3.

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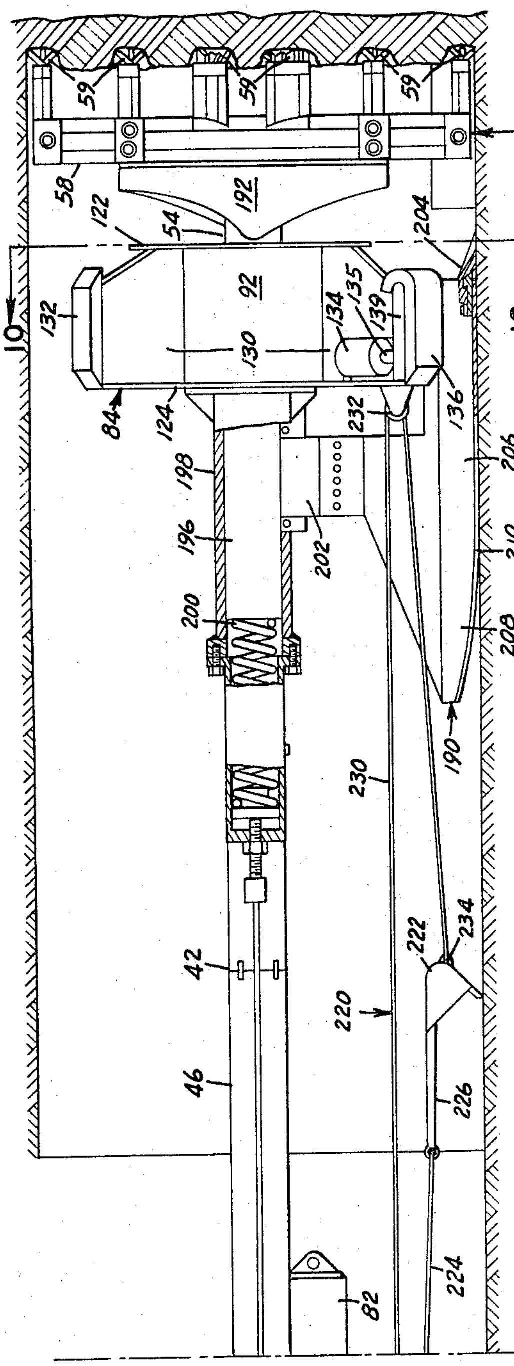

FIG. 4b.

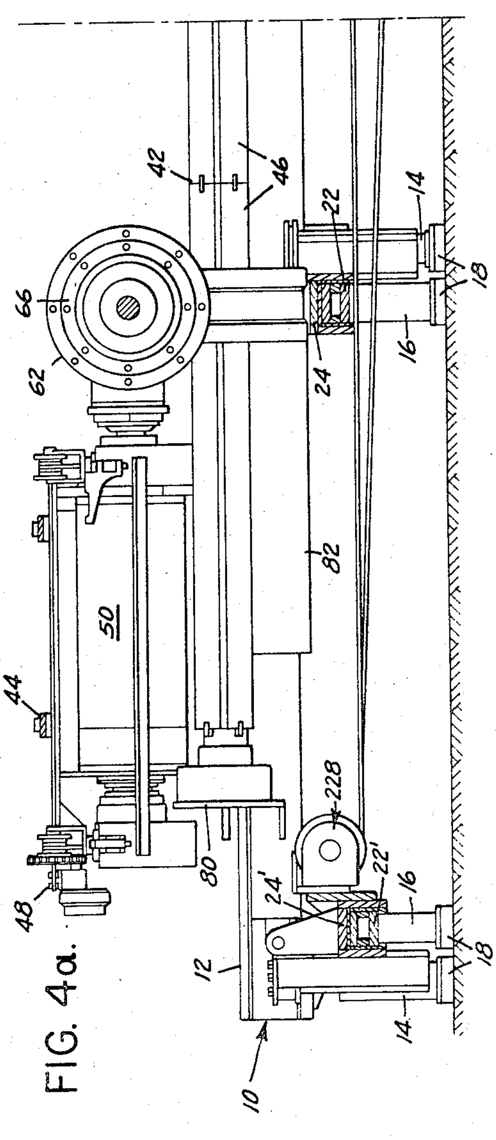

FIG. 4a.

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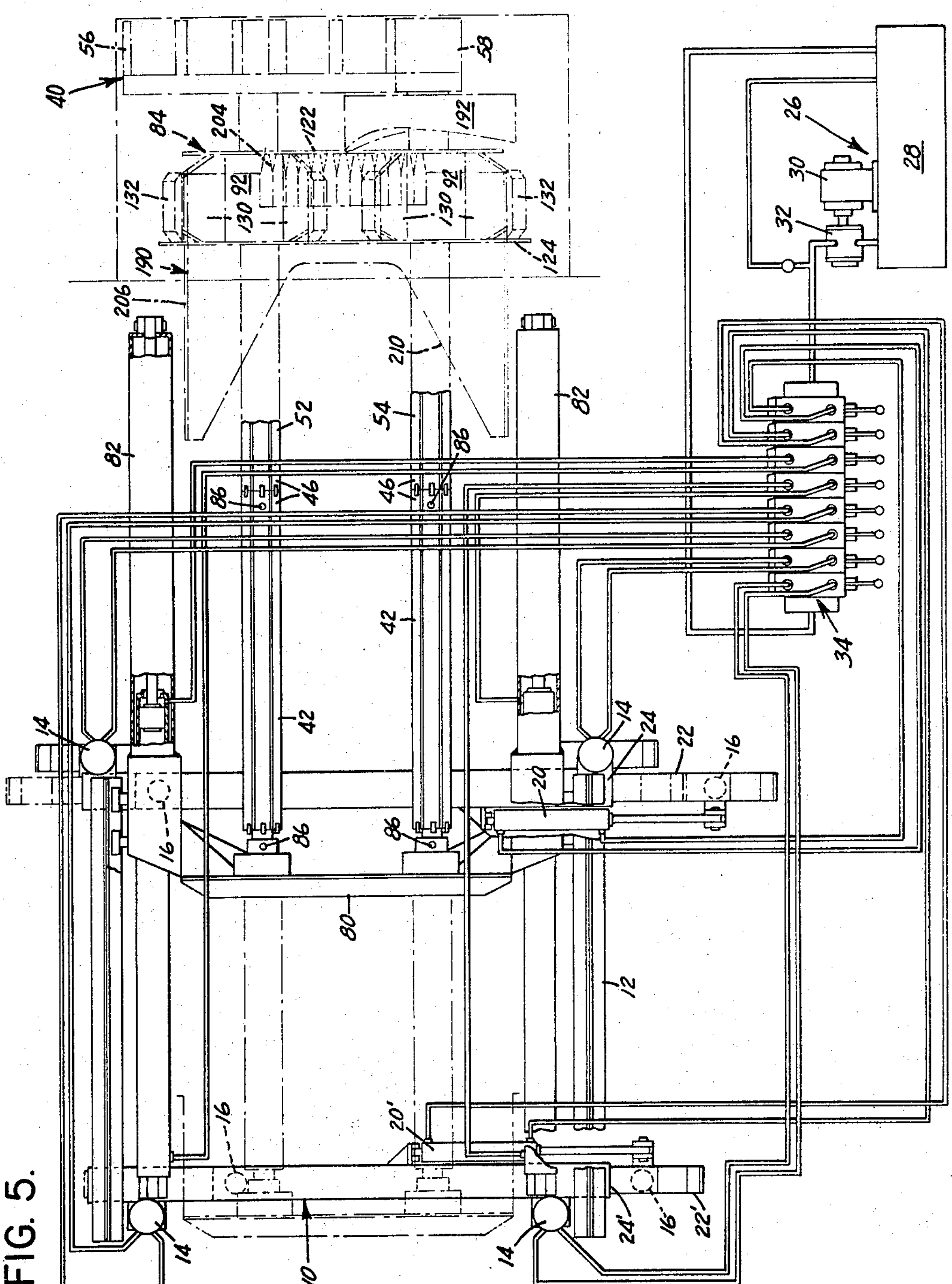

FIG. 5.

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FIG. 7.

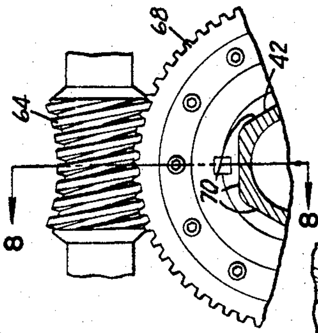


FIG. 8.

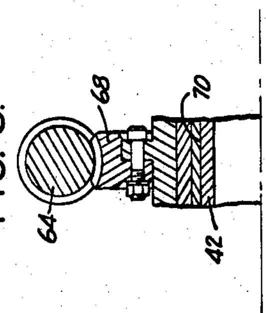
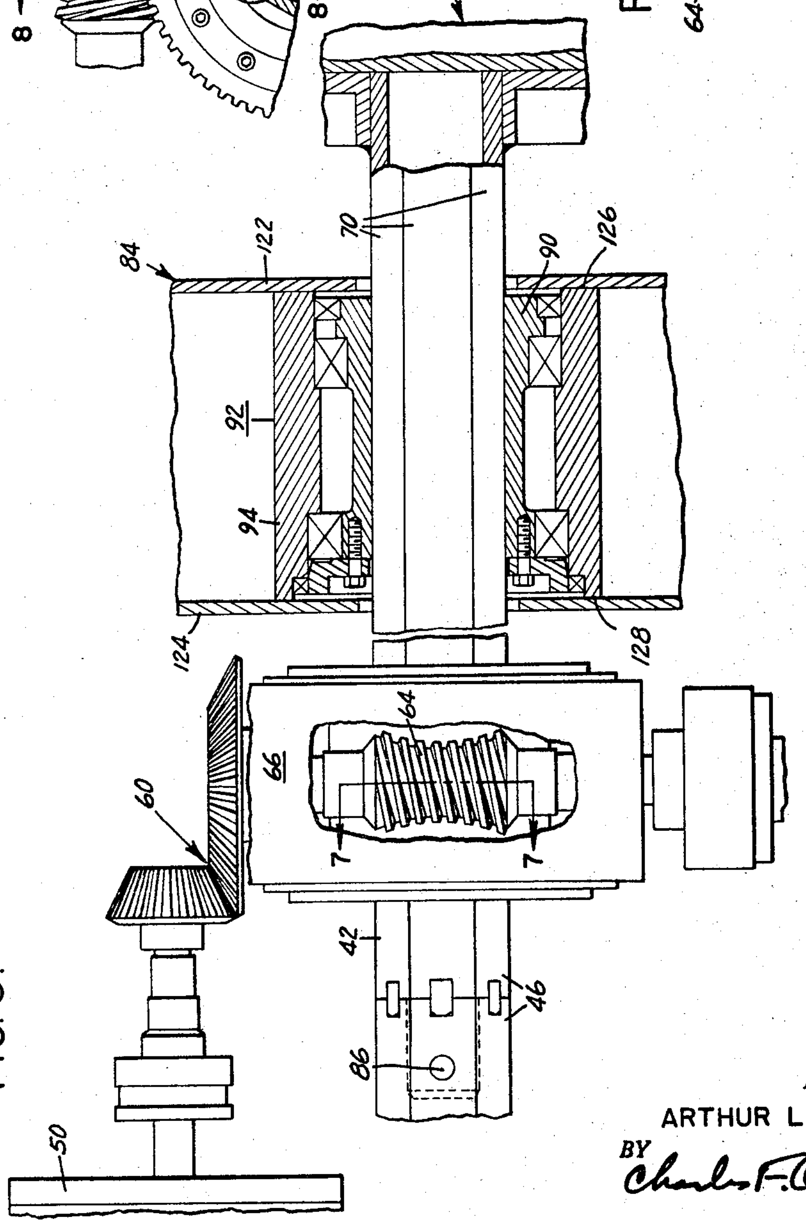


FIG. 6.



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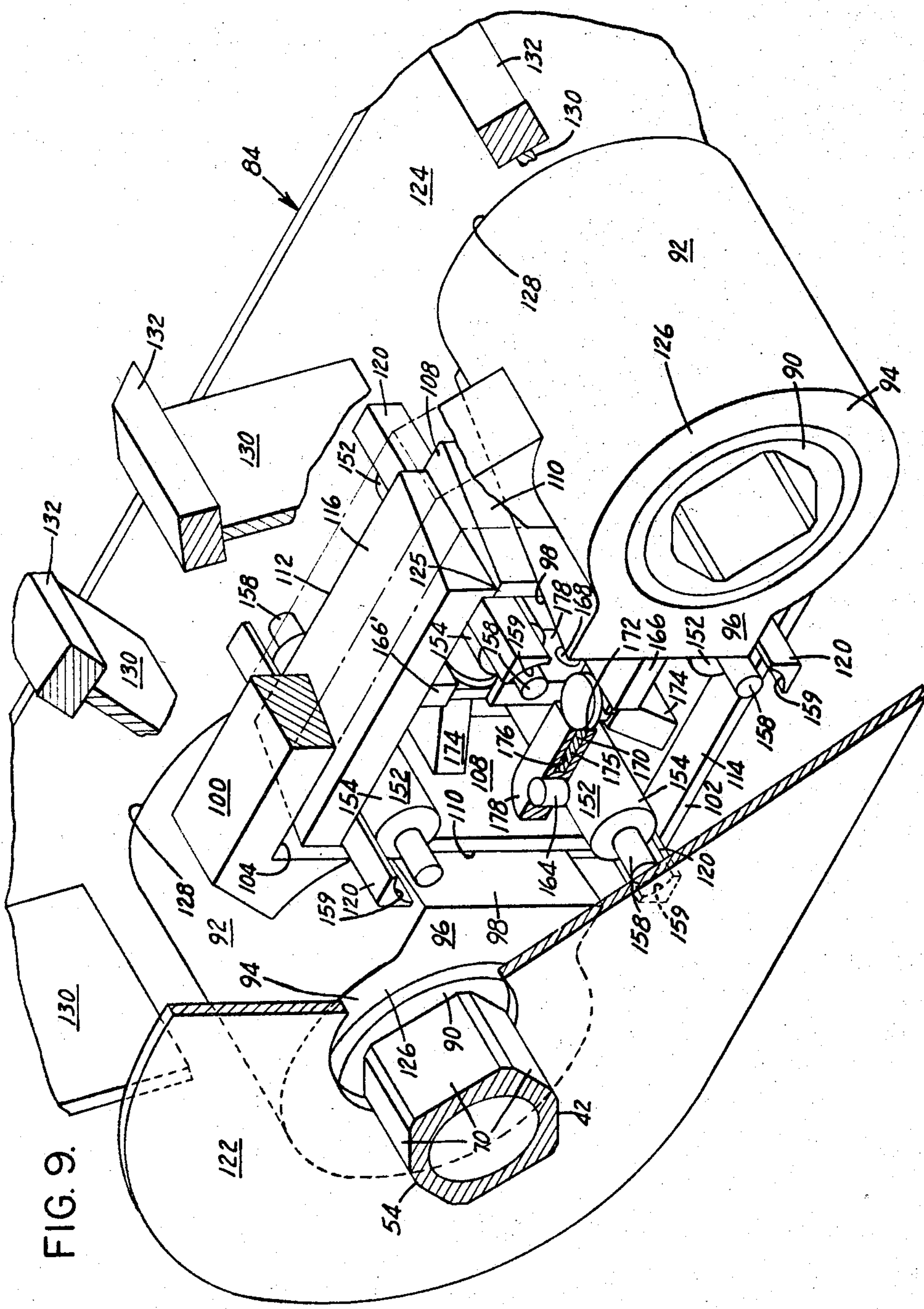

FIG. 9.

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FIG. 10.

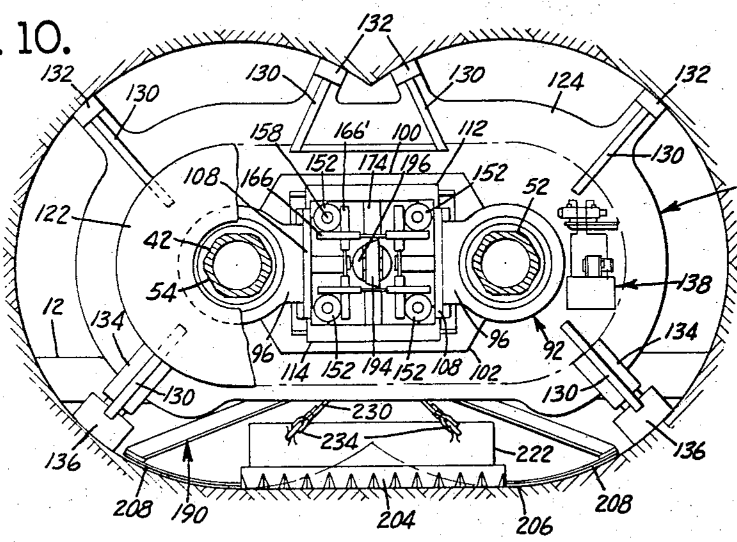
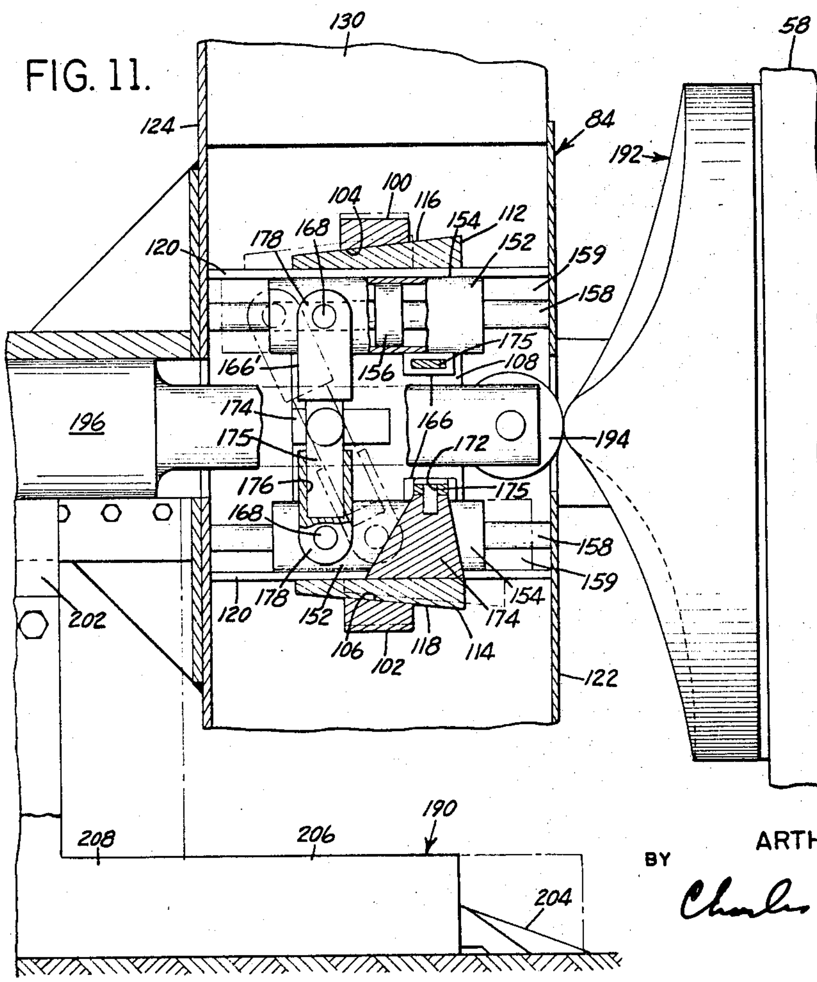


FIG. 11.



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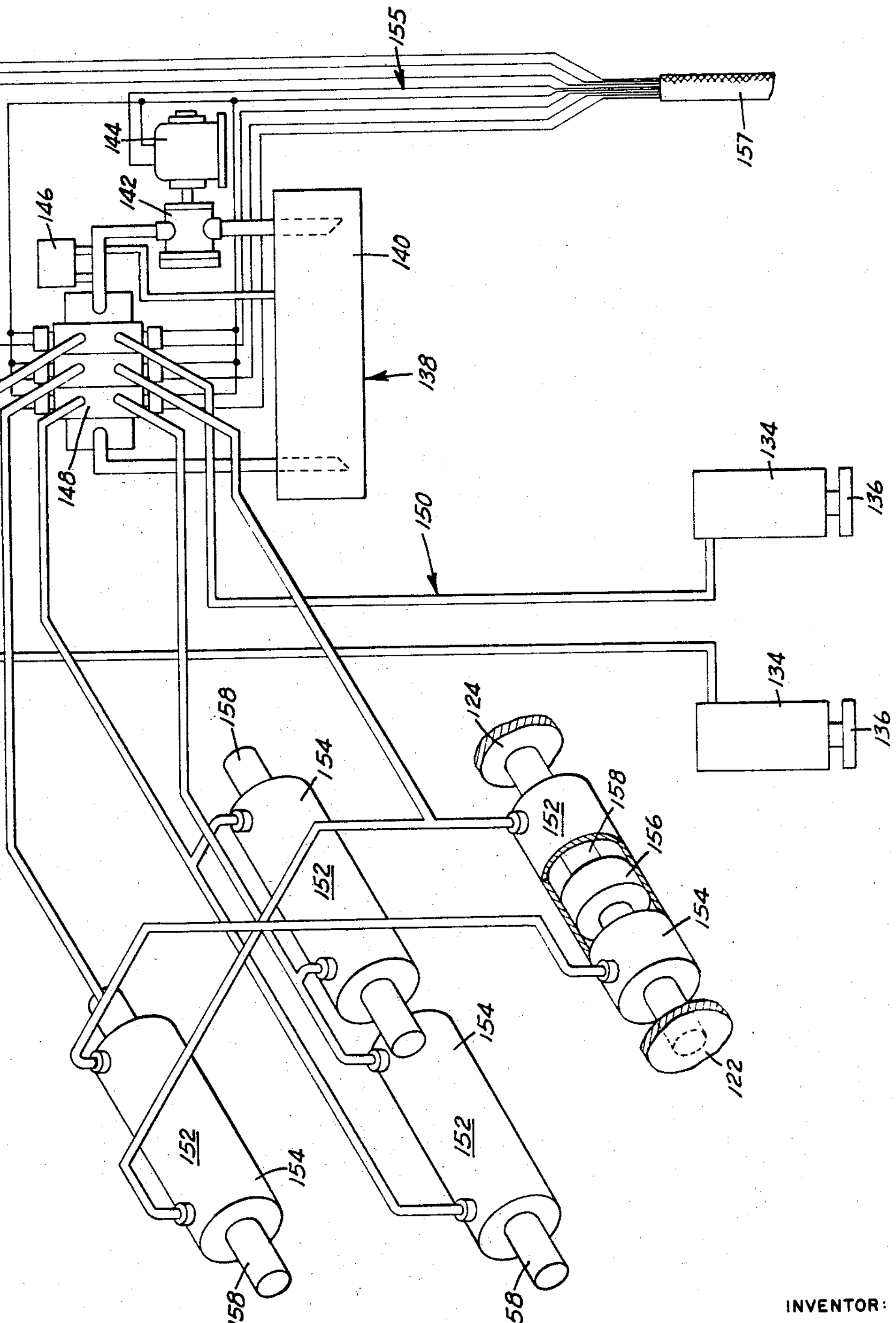

FIG. 12.

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FIG. 16.

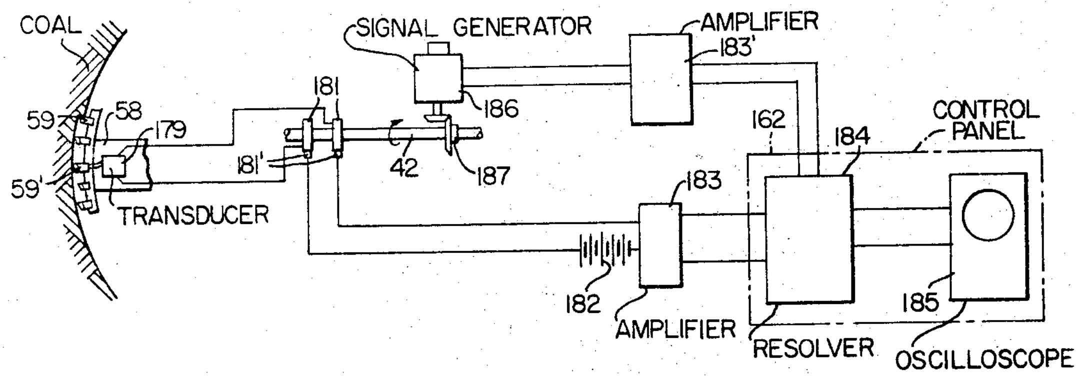


FIG. 17

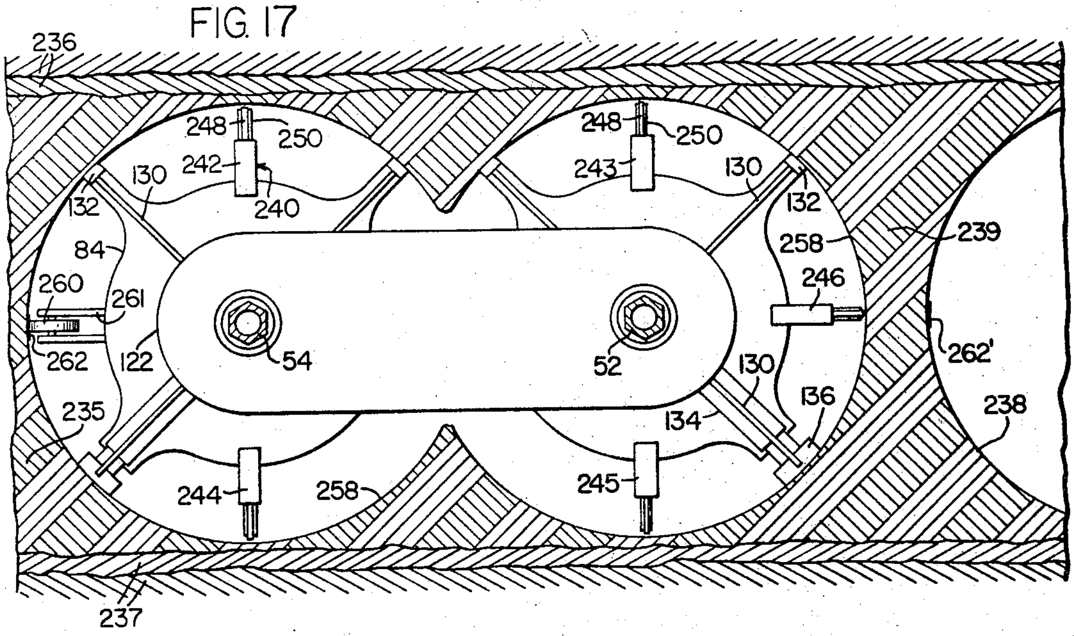
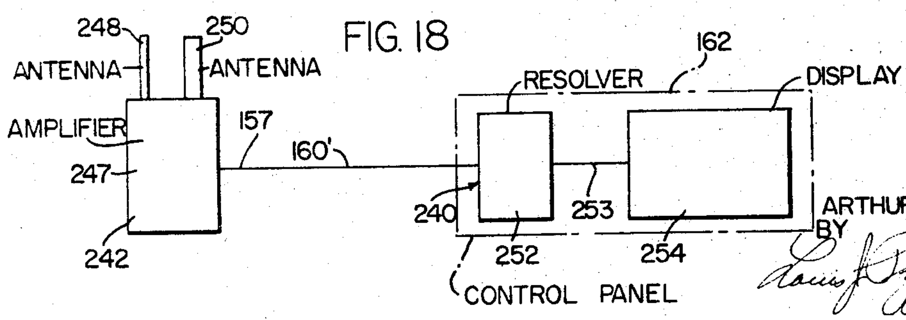


FIG. 18



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Louis [signature]
AGENT

FIG. 13.

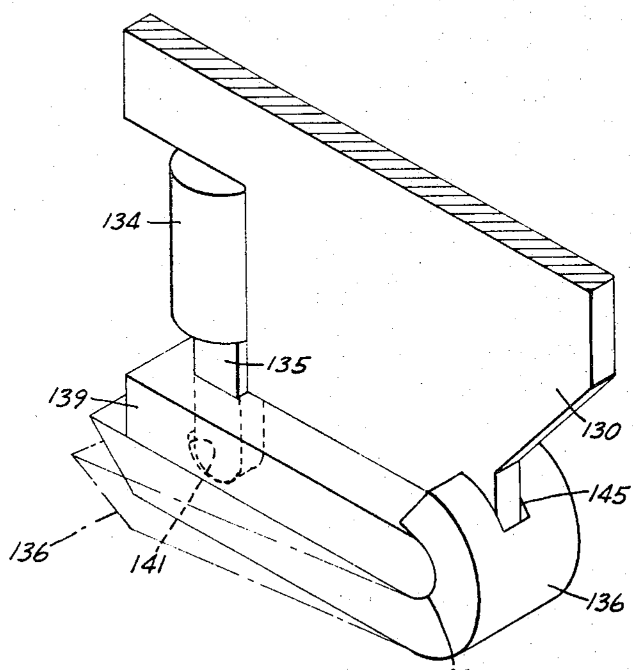


FIG. 15.

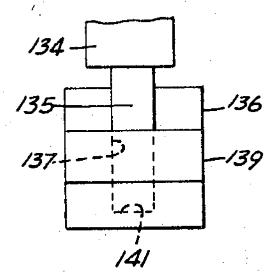
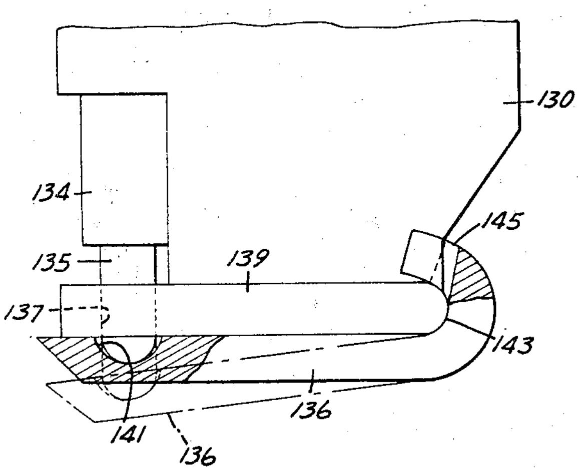


FIG. 14.



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United States Patent Office

3,421,796

Patented Jan. 14, 1969

1

3,421,796

RIB EXTRACTOR WITH A STEERABLE DRILLING HEAD STRUCTURE

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Continuation-in-part of application Ser. No. 202,642, June 11, 1962. This application July 11, 1966, Ser. No. 570,109

U.S. Cl. 299—59 8 Claims

Int. Cl. E21c *1/02;* E21c *5/00;* E21c *37/04*

ABSTRACT OF THE DISCLOSURE

A mining machine having a power base activating a steerable mining head structure with a pair of rotatable cutter heads thereon to advance the structure into a mineral vein. Steering means on the mining head structure to vary the positioning of the structure within bores formed by the mining heads and guide means within the structure to vary the positioning of the heads with respect to the structure.

This application is a continuation-in-part of my application Ser. No. 202,642 filed June 11, 1962 (now abandoned) which is in turn a continuation-in-part of my earlier application Ser. No. 751,316 filed June 28, 1958.

This invention relates to a mining machine and more particularly to means for guiding the advance of an auger drilling head structure from a mining machine base.

Mining machines have been developed wherein a machine base may be positioned at a mineral vein on a hillside, at the side of a strip mining cut or at a wall or mineral rib within a mine excavation for the advance therefrom of an auger drilling head structure into the mineral. Also to some extent auger drilling head type machines have been used in underground mining. Although these machines have generally been successful they have presented a problem of drilling head wander as the head structure is advanced deeper and deeper into the mineral.

It is therefore a major object of the present invention to provide an improved mining machine having improved steering means for guiding the advance of an auger head structure from a mining machine base.

Another object of this invention is to provide improved steering guide means for an auger drill head structure utilizing steering wedge means reacting between auger drill head means and a drill head support and guide frame which advances with the auger drill head.

A further object is to provide improved power control means for positioning steering wedges for vertical as well as horizontal steering corrections.

A still further object is to provide an improved linkage means permitting vertical or horizontal steering adjustment by selective use of multiple power units which are common actuators for both steering control axes.

Another object is to provide improved skid means for a drilling head frame support with power controlled skid angle positioning means for controlled correction of drilling head structure tilting.

Another object is to provide an improved positioning of circumferential edge drilling head teeth so as to cut enough clearance for any steering corrective shifting of the auger drill head structure as it continues to advance.

A further object is to provide an improved mining machine base having improved walking means for base positioning and equipped with a frame carrying motive

2

power units and shaft extension segments in a rack with means for connecting successively drive shaft segments in the drive shafting from the machine base to the drill head structure as the latter is advanced.

Another object is to provide improved hydraulic feed cylinder means mounted on the walking base of the machine to supply advancing force through the shafting to the boring head structure during the mineral boring operations.

Another object is to provide an improved boring head structure having two parallel boring heads driven by a pair of motors mounted on the machine base through parallel shafting with the boring heads arranged to drill overlapping side by side parallel bores.

A further object is to provide an improved shaker cutter driven by cam means which rotates with a boring head to give a shaking action to the cutter means effective to cut the bottom cusp between parallel overlapping boring heads as the boring head structure and the shaker cutter are advanced.

A still further object is to provide for the bottom cusp cutter means an improved apron so shaped that the shaking action of the cutter means and apron is effective to move dislodged mineral to the center of the bore-bottoms immediately behind the cusp cutter means.

Another object is to provide an improved slusher type mineral moving means for conveying mineral from the boring head structure rearwardly beneath the mining machine base.

A specific object of this invention is to provide an improved mining machine having remotely controlled steerable auger heads provided with sensing means to continuously determine the position of the auger heads with respect to earth strata above and below a mineral vein in which the auger heads are working and having remote indicating means connected therewith to display positional information.

Another specific object of this invention is to provide a new and improved mining machine having auger heads mounted upon a remotely controlled, steerable auger head frame which frame is provided with sensing means to continuously determine the location of bores produced by the auger heads with respect to earth strata above and below a mineral vein in which the auger heads are working, and also with respect to a bore in the mineral vein produced by a previous pass of the auger head, such sensing means being connected to remote indicating means to display information regarding the bore location.

A further specific object of this invention is to provide an improved mining machine such as that hereinabove described in which the aforesaid sensing means is responsive to material deposited in a bore in the mineral vein produced during a previous pass of the auger heads.

Further objects and advantages will appear from the following description and appended claims when read in conjunction with the attached drawings, wherein:

FIG. 1 is a top plan view of my improved mining machine showing the mining machine base and frame from which drill heads are advanced with the drill heads in the retracted starting position;

FIG. 2 is a side elevation view of the same mining machine and with the drill heads in the same position as in FIG. 1;

FIG. 3 is a front view looking toward the cutting face of the drill head structure of the same mining machine shown in FIGS. 1 and 2;

FIGS. 4*a* and 4*b*, taken substantially along line 4—4 of FIG. 1, show the mining machine of FIGS. 1 through

3 partially cut away and sectioned with the drilling head structure advanced from the base into mineral and illustrates detail of a cam driven shaker cusp cutting means and slusher mineral conveying means for conveying dislodged material from the boring head structure rearwardly beneath the mining machine base;

FIG. 5 illustates a hydraulic system, partially sectioned, used for walking of the mining machine base and advancing the drive shafts to the drill heads and the drill head structures and cusp cutter apron detail;

FIG. 6 illustrates means, partially sectioned, for supporting and driving an extensible drive shaft for a drill head;

FIG. 7 and FIG. 8 taken along line 8—8 of FIG. 7 illustrate a drill head drive shaft drive means detail;

FIG. 9 illustrates, partially cut away the wedge steering means for controlled positioning of the drilling heads relative to the drill head frame skid equipped supporting structure and cooperative linkage and power control means for the steering control wedges;

FIG. 10 is a front view of the boring head support structure, in section on line 10—10 of FIG. 4*b* with the boring heads removed, illustrating the steering wedge control structure, shaker cusp cutter detail and skid guide means for the drill head support structure within the bore opening;

FIG. 11 is a cutaway and sectional view, taken on line 11—11 of FIG. 1 primarily through the drill head supporting structure, illustrating steering wedge power control and linkage detail and shaker cusp cutter cam drive detail;

FIG. 12 is a schematic view illustrating the electric wiring which extends through a conduit from a control panel on the base to hydraulic valve means in a complete hydraulic system self-contained within the drill head supporting structure for the control of the starting wedge power control means and for the control via hydraulic power cylinders of the angle of drill head tilt control skids;

FIGS. 13, 14 and 15 illustrate various detail features of variable angle drill head tilt control skids;

FIG. 16 is a diagrammatic representation of a bore location sensing device and a remotely located indicating means together with subsidiary apparatus and electrical connections therefor;

FIG. 17 is a front elevational view partly in section of an auger head support frame constructed according to the principles of this invention having bore location sensing means thereon, and

FIG. 18 is a schematic representation of a location sensing means connected to a remotely located bore location indicating means.

In my improved mining machine **10**, shown in various attitudes in FIGS. 1, 2, 3, 4*a* and 4*b*, a machine base **12** is shown to be supported interchangeably at each of four corners by one hydraulically extensible and retractable jack **14** and one rigid post **16**, each equipped with ground engaging shoe pads **18**. A horizontally disposed hydraulic power means **20** is operatively connected to the machine base **12** and to a front rail **22** which is transversely slidable in frame guide means **24** of the base **12** and which mounts both front posts **16**. Similarly, a horizontally disposed hydraulic power means **20'** is connected to the base **12** and a rear rail **22'** which is transversely slidable in frame means **24'** and which mounts both rear posts **16**.

The hydraulic system **26** shown in FIG. 5 has a fluid supply tank **28**, motor **30**, pump **32**, control valve box **34** and piping for various functions all carried by the machine base **12**. Appropriate controlled extension and retraction of jacks **14** and of hydraulic power means **20** and **20'** in suitable sequence and degree of actuation is effective to walk the machine transversely from side to side and even turn the machine base **12** as desired.

Boring head structure **40** is connected to the base **12**, advanced therefrom and retracted thereto by drive shafting **42**. Storage rack **44** is provided in the base **12** for storage of shaft extension units **46** which are taken therefrom and positioned for connection in drive shafting **42**, as the boring head structure **40** is advanced, by elevator conveying means **48**. Elevator means **48** also removes shaft extension units **46** to the storage rack **44** as the boring head structure **40** is being retracted relative to the base **12**.

A drive motor **50** is provided for rotatably driving each of two drive shaft units **52** and **54** which comprise drive shafting **42** for two parallel counter-rotating boring heads **56** and **58** equipped with mineral boring teeth **59** in the boring head structure **40**. Each motor **50** has a drive output gear train including (as shown in FIGS. 6, 7 and 8) bevel gearing **60** within gear casing **62** and worm **64** within a gear casing **66** with worm gear **68** which, in turn, slidably nonrotatably engages the multi-sided **70** drive shafting **42** of respectively drive shaft **52** and drive shaft **54**.

Although the boring heads **56** and **58** are shown as arm type boring heads, the use of any mineral attacking and disintegrating means such as hollow, cylindrical boring heads or helically flighted auger type boring heads is contemplated as being within the scope of the present invention.

Carriage frame structure **80** is supported for back and forward movement along guide means of the base **12** as controlled in forward movement and return movement by base **12** side mounted parallel double acting power cylinders **82**. Forward movement of carriage **80** is effective to advance the drive shafting **42** and the boring head structure **40** and, in addition, a boring head support skid equipped guide frame structure **84** hereinafter described. Retractive movement of carriage frame structure **80** by power cylinders **82** as controlled by the control valve box **34** is effective to, in turn, retract the boring head structure **40** and the boring head support and guide frame structure **84**, unless pins **86** connecting the carriage frame **80** are removed, in which case the carriage is returned to provide for insertion of additional shaft extension units **46** for drive shafting **42** and the continued advance of shafting **42** through fixed worm gears **68**.

Boring head support and guide frame structure **84** is fixed in closely spaced relation behind boring heads **56** and **58** of boring head structure **40** (as shown in FIGS. 1, 2, 4*b*, 6 and 11) by inner races **90** of bearing assemblies **92** on shafts **52** and **54**. The outer races **94** of bearing assemblies **92** are equipped with inwardly directed wedge guide extensions **96** which have oppositely directed wedge guide surfaces **98** (see FIG. 9). Outer race members **94** are rigidly connected together by upper and lower wedge bridge members **100** and **102** respectively, which have oppositely directed wedge guide surfaces **104** and **106** respectively.

Axially movable side wedge control members **108** have oppositely directed wedge guide surfaces **110** which engage respective wedge guide surfaces **98** of wedge guide extensions **96**. Axially movable upper and lower wedge control members **112** and **114** have respectively oppositely directed wedge guide surfaces **116** and **118** which engage wedge guide surfaces **104** and **106** respectively.

Side wedge control members **108** and upper and lower wedge control members **112** and **114** are supported and guided by four support frame members **120** which extend between and are fastened to a front plate **122** and rear plate **124** of boring head support and guide frame structure **84**. Wedge control members **108** and **112** and **114** further mutually guide and support each other by side sliding contact **125** as shown. Front plate **122** is in slidable abutment with forward surfaces **126** of bearing outer races **94**, and rear plate **124** is in slidable abutment with rear surfaces **128** of bearing outer races **94**.

Elements of webbing **130** extend between and connect front plate **122** and rear plate **124** for upper bore following and bore head guide skids **132**. Webbing **130** is also provided between front and rear plates **122** and **124** for lower power controlled power cylinder **134** equipped direction correcting lower skids **136**. A complete hydraulic system **138** (see FIG. 12) equipped with a fluid supply tank **140**, pump **142**, electric drive motor **144**, hydraulic accumulator and relief valve **146**, by electrically actuated control valve box **148** and hydraulic piping **150**, is contained within boring head support and guide frame structure **84** for the control of power cylinders **134** and the slope of lower skids **136** individually or together, as desired. Referring also in FIGS. 13 and 14 and 15, the output rod **135** of each power cylinders **134** projects through a guide opening **137** in the respective skid mount pad **139** for operative engagement with a groove **141** in a skid **136**. Each skid **136** pivots about circular portion **143** on the front of the respective skid mount pad **139** and has a tongue and groove relation **145** with webbing **130** above the skid mount pad **139** to prevent transverse movement of skids **136**.

Selective activation of the power cylinders **134** to extend or retract either of the skids **136** is used to control tilt (transverse inclination of the plane in which the axes of the boring heads **56** and **58** lie) in relation to the machine base **12**.

Valves of control valve box **148** are also provided for the operation of double acting power cylinders **152** in various combinations of actuated cylinders, for cylinder casing **154** travel of selected cylinders **152** relative to respective pistons **156** and piston rods **158** which extend through and are fastened to respective front and rear plates **122** and **124**. Cylinder casings **154** are supported and guided by curved inner surfaces **159** of respective support frame members **120** (see FIG. 9). Electric circuitry **155** for electric power to motor **144** and for controlling valves of electrical actuated valve control box **148** pass through a cable **157** which extends from a resiliently tensioned cable drum **161** on machine base **12** to boring head supports and guide frame structure **84**. A suitable line connection **160** is provided from control panel **162** to the cable drum **161** for cable **157**.

Actuation of double acting power cylinders **152** may be controlled to shift side wedge control members **108** for lateral movement of bearing assemblies **92** and shafts **52** and **54** and the boring head structure **40** relative to boring head support and guide frame structure **84**. These power cylinders **152** may also be controlled for shifting upper wedge control member **112** and lower wedge control member **114** for controlled respective up or down corrective steering movement of bearing assemblies **92** and the boring head structure **40** relative to guide frame structure **84**. The outermost of boring head teeth **59** provide sufficient overcut in the mineral being bored to allow the space for corrective steering movement of boring head structure **40**.

Each casing **154** of four double acting power cylinders **152** is provided with a pivot pin **164** for pivotal connection with the respective horizontally extending upper or lower cross linkage structure **166** and a pivot pin **168** for pivotal connection with the respective one of two vertically extending cross linkage structures **166'**. Cross linkage structures **166** and **166'** have a central element **170** which is pivotally mounted **172** on a pivot post **174**, each of which projects inwardly from the respective wedge control members **108**, **112** and **114**. End projections **175** from each central element **170** are slidingly received in openings **176** of respective end cap members **178**. Each end cap member **178** is pivotally mounted on a respective pivot pin **164** or respective pivot pin **168**. When it is desired to shift bearing assemblies **92** in the boring head structure **40** for a steering correction relative to guide frame structure **84**, two of the four power cylinders **152** are actuated for movement in one direction, and the other two are actuated as a pair for movement in the opposite direction. This is effective to move the cooperating pair of side wedge control members **108** or, for that matter, if desired for vertical correction upper wedge control member **112** and lower wedge control member **114** in opposite directions, one forward and one back, to accomplish by cooperative wedge action with the respective mating pair of wedge guide surfaces **98** or **104** and **106** wedge force corrective steering movement of the boring head structure **40** from support and guide frame structure **84**. When this is done, coss linkage members **166** or **166'**, as the case may be, pivot about and extend in length to permit the relative displarement forward and barkward of a pair of wedge control members **108** or **112** and **114** without moving the other pair of wedge lontrol membes **112** and **114** or **108** respectively.

Referring now to FIGS. 1, 2, 3, 4*b*, 5, 10 and 11, the shaker cusp cutter **190** is provided for cutting the bottom mineral cusp between overlapping bore heads **56** and **58**. The cam **192** for driving the cusp cutter is mounted on the back of boring head **58** for rotation therewith. Cam **192** is engaged by roller following means **194** mounted on a rod **196** which projects forward through the boring head wedge steering control means of guide frame structure **84** from the guide frame **198** mounted on the rear of back plate **124** of guide frame structure **84**, which is provided, in turn, as shown in FIG. 4*b*, with a spring return **200** for urging the rod **196** and roller to follow in reciprocating movement the surface of cam **192** during rotation thereof. A downwardly depending frame structure **202** extends from rod **196** to the cusp cutter **190** which has a forward cusp cutting toothed edge **204** and a metal apron **206** with upwardly curved sides **208** and, as best seen in FIG. 5, a largely cutaway indentation **210**. This apron **206** configuration is effective with the shaking action of the cusp cutter **190** to centralize mineral dislodged by boring head structure **40** and mineral cut by the forward cusp cutting toothed edge **204**. This piles the material to the rear of the cusp cutter **190** ideally for a slusher conveying system **220**.

Detail of the slusher conveying system **220** is best illustrated in FIGS. 2, 3, 4*a* and 4*b*. Slusher bucket **222** has a pull cable **224** which is fastened to arm **226** of the slusher bucket **222** which extends to cable winch structure **228** which may be operated by controls on base **12** to pull the slusher bucket **222** and mineral from cusp cutter **190** to beneath machine base **12**. There is a slusher bucket return cable **230** which extends to and around a cable pulley **232** which is mounted on guide frame structure **84** above cusp cutter **190**. Slusher bucket return cable **230** extends on from pulley **232** to a connection **234** with the rear of slusher bucket **222** in order that the bucket may be returned to cusp cutter **190** as desired for successive loads of mineral. Winch structure **228** has cable reels (not shown in detail) for pull and return cables **224** and **230** respectively, which are suitably tensioned and controlled for slusher bucket mineral conveying and return and for the extension of cables **224** and **230** suitable for any advanced position of boring head structure **40** and the boring head support and guide frame structure **84**.

In FIG. 16 there is shown a strata indicator or location sensing device similar to that described and claimed in U.S. Patent No. 2,620,386 and comprising a special boring tooth 59' resiliently mounted on the boring arm **58** in contact with an electrical transducer electrically connected to a pair of slip rings **181** rigidly secured upon and coaxial with the drive shaft **42** but electrically insulated therefrom. The slip rings **181** contacted by a pair of brushes **181'**, respectively, are electrically connected through a battery **182** with an amplifier **183** which is, in turn, connected through a signal resolver **184** to an indicating device **185** such as a cathode-ray oscilloscope or the like. A signal generator **186** driven by the shaft **42** through suitable bevelled gears **187** having a ratio of 1 to 1 is electrically connected through a second amplifier **183'** with the resolver **184** and furnishes a signal synchronized with the rotation of the boring head **58**. The synchronized signal is combined in the resolver **184** with a variable signal from the transducer **179** to give a visual indication, on the oscilloscope, of the type and condition of material being cut by the special tooth **59′** as described in the above mentioned U.S. patent. Such visual indication can be interpreted to give information as to the location of the boring head **58** within a mineral vein **235** best seen in FIG. 17, such as a vein of coal bounded on its upper side by layers of rock **236** and at its lower surface by rock strata **237** the roof and floor, respectively, of this mineral vein. It is to be appreciated that the equipment of FIG. 16 shown in relation to boring head **58** is duplicated for boring head **56** on the other side of the machine **12** so that visual indication of the kind and condition of material being cut by either arm is displayed on its respective oscilloscope. The oscilloscopes **185** are mounted upon or adjacent to the control panel **162** so that an operator stationed at the controls can observe the indications on the oscilloscopes **185** and make the proper adjustments of the control to correct any undesirous deviations in the progress through the mineral veins. For example, if the visual indications show that both the teeth **59′** are encountering rock at the uppermost part of their revolution, the obvious interpretation would be that either the machine is climbing within the vein or the vein itself is dipping downward, and in either case the appropriate action would be suitable activation of the power cylinders **152** as hereinbefore described to lower the boring heads **56** and **58** in relation to the frame **84** so that forward progress of the boring heads **56** and **58** would be slightly diverted downwardly to prevent further cutting into the roof **236**. Similar indications followed by suitable action on the part of the operator would prevent extensive cutting into the floor **237** in an entirely similar manner. If the indication on the oscilloscope shows that only the boring head **58** is too high, remedial action would take the form of actuating the lower power cylinder **134** on the side of the machine **12** where the boring head **58** is located so that only the boring head **58** cuts in a slightly downward path correcting what is known as tilt of the frame **84** in relation to the roof **236**.

The special tooth **59′** can also give an indication when one of the boring heads **56** or **58** cuts too closely adjacent to or breaks into a bore **238** in the mineral vein **235** produced on the previous passage of the boring heads through the mineral vein. Such indication depends upon the elastic deformation of the coal in the thin section between the bores produced in two successive passes or upon the absence of coal where a break through has occurred, and such indication will obviously be quite different from that shown when the special tooth **59′** is cutting coal rigidly secured in place by surrounding material.

In FIG. 17 and FIG. 18 there is shown a different type of location sensing device, generally indicated at **240**, useable with the steerable auger heads or boring heads **58** and **56** of this invention. Five electronic sensing units numbered **242** through **246** inclusive are shown in FIG. 18 secured to different portions of the guide frame structure **84** and each comprising an electronic amplifier **247** (see FIG. 18) and two spaced antennas **248** and **250** emitting and receiving antennas, respectively, for electro-magnetic radiation, said antennas being suitably shielded in a manner well known in the art. The sensing units **242** and **244** are a diametrically opposed pair in the vertical plane containing the axis of the drive shaft unit **54** and having their antennas vertically upwardly and vertically downwardly directed, respectively. The sensing units **243** and **245** are a similar pair in a verticle plane containing the axis of drive shaft unit **52** being upwardly and downwardly directed units, respectively. The sensing unit **246** is mounted in the plane of the axes of the two drive shaft units **52** and **54** and has its antenna horizontally directed towards the previously developed bore **238** at substantially the thinnest portion of a coal partition **239** remaining between the bore **238** and a bore **258** in the mineral vein **235** (the bore **258** being the one which the machine positioned as shown in FIG. 17 is actively engaged in producing).

Power supply and signal conducting electrical conductors from each of the sensing units **242** through **246** together with power supply and control conductors hereinbefore described as being part of cable **157** make up a multiple conductor cable **157′** (see FIG. 18) mounted in the same manner as the cable **157** of FIG. 1 and are connected through a line connection **160′** to the control panel **162** which is in turn connected to a suitable source of power (not shown). The signal carrying conductors from the sensing unit **242** through **246** connect with a suitable signal resolver **252** which is suitably connected by a multiple conductor cable **253** to a display unit **254** such as a multiple screen oscilloscope or other device for displaying the bore position indication received by the antennas **250** as hereinafter described.

In FIG. 17 there is also shown a material depositing means or paint wheel **260** pivotably mounted in brackets **261** which are rigidly secured on a portion of the frame structure **84** opposite to the mounting of the horizontally extending sensing unit **246** and substantially in the plane of the axes of the drive shaft units **52** and **54**. The paint wheel **260** is suitably supplied with a fast drying paint, containing radioactive material, by paint supply means not shown and continuously contacts a portion of the bore **258** farthest removed from the bore **238** to deposit a continuous paint stripe **262** similar to a paint strip **262′** shown as having been deposited in the bore **238** along the central part of the partition **239** during previous passage of the boring head **58** in the mining operation which produced the bore **238**.

In operation of the sensing device **240** shown in FIGS. 17 and 18 a substance which is a good emitter of gamma radiation or neutrons is mounted within the emitter antenna **248** of the sensing units **242** through **245** so that gamma radiation or neutrons are directed upon the portions of the mineral vein most nearly adjacent to the sensing units. Since different rates of back scattering of the gamma radiation or neutrons are assignable to coal or rock, the receiver antennas **250** will receive signals of different strength according to the thickness of the layer of coal between the emitter **248** and the layer or rock upwardly or downwardly adjacent the mineral vein **235**. Such signals through the action of the resolver **252** are translated into thickness indications and exhibited in the indicator devices of the display unit **254**. In the case of the sensing unit **246** the gamma radiation emitting material may be omitted from the emitter antenna **248** because the signal from the radio active material in the paint stripe **262′** received by the antenna **250** of the sensing unit **246** is inversely proportional to the thickness of the partition **239** and is used in the appropriate indicating units of the display **254** to show the thickness of coal remaining in the partition **239** after the boring head **58** has passed. Thus a complete set of bore location indications is available to an operator stationed at the control panel **162** to determine his actions in steering the boring heads **56** and **58** to follow undulations of the vein **235** and to correct any misalignment of the bore **258** within the mineral vein **235**.

It is to be appreciated that gamma ray or neutron emission and back scattering as hereinabove described is only one of several means which can be used with the sensing device **240** to give bore location information. For instance, other types of radiation such as radio frequency waves can be applied by the emitter to the coal and rock layers with reflected energy picked up by the receiver antenna **250** giving the desired information. When using a radio frequency emitter the paint stripes **262** and **262′** instead of being radio active would consists of tuned elements such as discreet lengths of electrically conductive paint deposited upon the wall of the bore **238** in the same position shown for the stripes **262** and **262′** or if necessary could consists of metallic rods of a suitable length to be tuned to the radio frequency radiation hereinabove mentioned. Such metallic rods could take the form of nails driven into the walls of the bores **238** and **258** by an appropriate mechanism (not shown) during successive passes of the boring heads **56** and **58** in forming of the bores **238** and **258**.

Instead of the radio active paint stripes **262** and **262'** a continuous stripe of electrically conductive paint or electrical conductors (not shown) fastened to the respective walls of bores **238** and **258** can be used. The electrical conductor in the bore **238**, being supplied with an alternating potential serves as a source of electro-magnetic radiation to be picked up by the receiver antenna **250** of the sensing unit **246**. It is to be realized that the particular type of radiation or particle emission used is in no sense a limitative feature of this invention.

It should also be appreciated that the placing of the radiation emitting or reflecting means represented hereinbefore by **262'**; in bore **238** need not be during the formation of such bore **238**. The placing of a radiation emitting or reflecting means in bore **238** can be made when the boring heads **56** and **58** are being retreated from bore **238**, or the placing can be made from a suitable source detached from and independent of either boring head **56** and **58**.

I have herein provided an improved mining machine with a base and boring heads which are advanced into mineral from the base. The invention provides steering means for guiding the advance of the boring heads through mineral. It provides a boring head steering means utilizing cooperating wedge means between the boring heads and a drill head suport and guide frame which advances with the boring heads. Power control means is provided for positioning steering wedges for vertical as well as horizontal steering corrections. It also provides linkage means joining power cylinders which permit vertical or horizontal steering adjustments by selective actuation of the multiple power cylinders in a steering control system in which the power cylinders are common power actuators for both vertical and horizontal steering control axes. I also provide skid means for a boring head frame support with power controlled skid angle positioning means primarily for tilt control of the boring head frame support and the boring head structure. I also provide for bore clearance for boring head steering corrective shifting by mineral overcutting circumferential edge boring head bore teeth. I also provide a mining machine base with walking means for base positioning. I provide a base which is equipped with a frame carrying boring head drive units and boring head shaft extension units for driving and advancing the boring head into mineral. I provide a boring head structure with parallel boring heads and a shaker cutter for cutting a cusp left in the bore by the parallel boring heads as the boring head structure is advanced. I also provide a cam drive means rotatable with a boring head for imparting shaking action to the shaker cusp cutter. I also provide for the shaker cutter to have a metal apron so shaped as to pile mineral dislodged by the boring heads and by the cusp cutter centrally immediately to the rear of the cusp cutter. I also provide a slusher conveying system for conveying material piled by the cusp cutter from the boring head support structure rearwardly beneath the mining base.

In conjunction with the above steerable mining machine of the auger head or boring head type, I have herein provided bore location sensing devices to provide maintainance of a desired distance between the mining machine and a laterally adjacent bore.

While I have shown and described one embodiment of my invention, various changes and modifications may be effected without departing from the spirit and scope of the invention as defined in the appended claims.

What I claim is:

1. A mining head structure comprising: a support; mineral dislodging elements disposed on said support; means for rotating said dislodging elements relative to said support within a mineral vein; guide means located

on said suport for varying the path of said dislodging elements within such a mineral vein without interrupting the progress of said dislodging elements into such mineral vein; steering means located on said support for varying the path thereof within the mineral vein; and selectively operable means located on said support for actuating said guide means and said steering means, respectively.

2. A mining head structure as set forth in claim **1** wherein said mineral dislodging elements can form contiguous bores in a mineral vein; and said steering means includes bore engaging means rearwardly spaced from and bodily movable with said dislodging elements for engaging spaced peripheral portions of such contiguous bores, said bore engaging means including power means which are continually and remotely adjustable for moving selected ones of said bore engaging means so that said dislodging elements may be bodily moved in a vertical plane.

3. A mining head structure as set forth in claim **1** wherein said steering means can vary the path of said dislodging elements in horizontal and vertical planes during bodily movement of said dislodging elements into a mineral vein.

4. A mining head structure as set forth in claim **1** wherein a reciprocable cutter means is mounted on said support and is responsive to the dislodging action of said dislodging elements for removing upstanding cusps resulting from the pattern formed in such mineral vein by said dislodging elements; a rearwardly extending camming surface secured to the rearward surface of said dislodging elements for actuating said cutter means and; an elongated longitudinally extending element having one end thereof in constant contact with said camming surface has the opposite end connected to said cutter means so that reciprocation of said last mentioned element reciprocates said cusp removing cutter means.

5. A mining head structure as set forth in claim **1** wherein said guide means includes skid portions including oppositely disposed inclined surfaces cooperable with respective wedge members; and said selectively operable means includes means connected to said wedge members for moving said wedge members in opposite directions so that said dislodging elements are bodily movable in orthogonal directions in a plane containing said skid portions.

6. A mining head structure as set forth in claim **2** wherein said guide means includes cooperable pairs of stationary and movable wedge members located in spaced relation; and said continually and remotely adjustable means moves said movable wedge members in opposite directions for effecting corresponding movement of said dislodging elements relative to said guide means.

7. A mining head structure as set forth in claim **1** including an elongated frame being longitudinally rectilinearly bodily movable relative to said support; said dislodging elements are rotatable and overlapping and are mounted on the forward portion of said elongated frame; said means for varying the path of said dislodging elements including a bore engaging frame secured to said elongated frame and being rearwardly adjacent said dislodging elements said bore engaging frame having individually movable cam members cooperating with stationary cam members for adjusting said dislodging elements in a plane at right angles to the axis of rotation of said dislodging elements; and said selectively operable means moves said elongated frame and said movable cam members with respect to said support and said bore engaging frame respectively.

8. A mobile mining apparatus comprising a mining head as specified in claim **1** powered by a separate frame structure comprising motor means and extensible cylinder means connected to the mining head structure to rotate the dislodging elements and advance the mining head structure into a mineral vein.

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