United States Patent

Drouet

[15] **3,695,369**

[45] **Oct. 3, 1972**

[54] **EARTH BORING MACHINE WITH A PIVOTAL HEAD**

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[73] Assignee: **Dresser Industries, Inc.**, Dallas, Tex.

[22] Filed: **Sept. 9, 1970**

[21] Appl. No.: **70,740**

[52] **U.S. Cl.**.....**175/45,** 175/53

[51] **Int. Cl.**.....**E21b 47/02,** E21c 23/00

[58] **Field of Search**.....175/45, 53, 85, 203, 122; 173/42, 39, 44, 20

[56] **References Cited**

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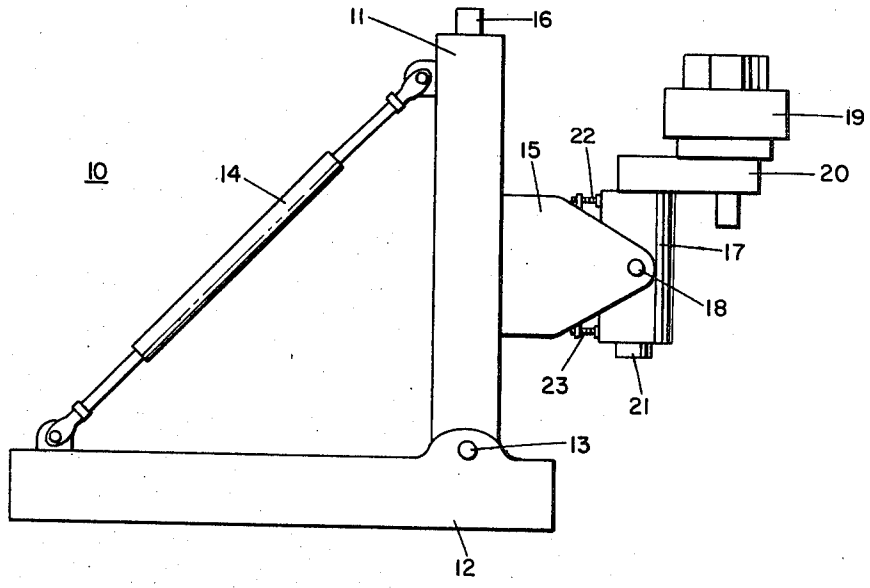
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3,220,494	11/1965	Cannon et al	175/53 X
1,954,957	4/1934	Smith	175/39 X
2,775,439	12/1956	McCarthy	175/53

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[57] **ABSTRACT**

The drill head of a raise drill is mounted to allow pivoting in one or more planes. Bending forces on the drill string and raise drill components are reduced, eliminated or controlled. An indicator provides the operator with information concerning alignment and misalignment.

9 Claims, 3 Drawing Figures



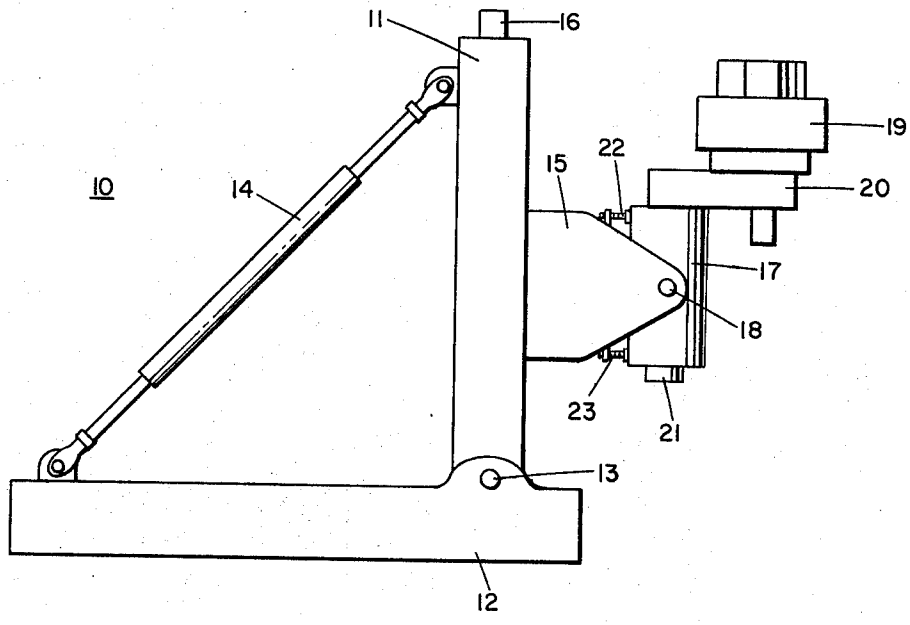


FIG. 1

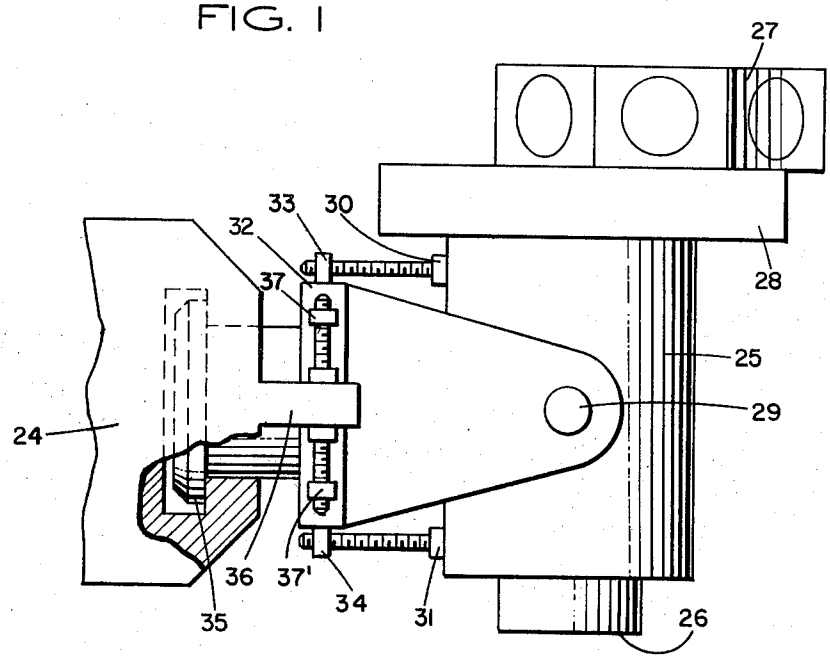


FIG. 2

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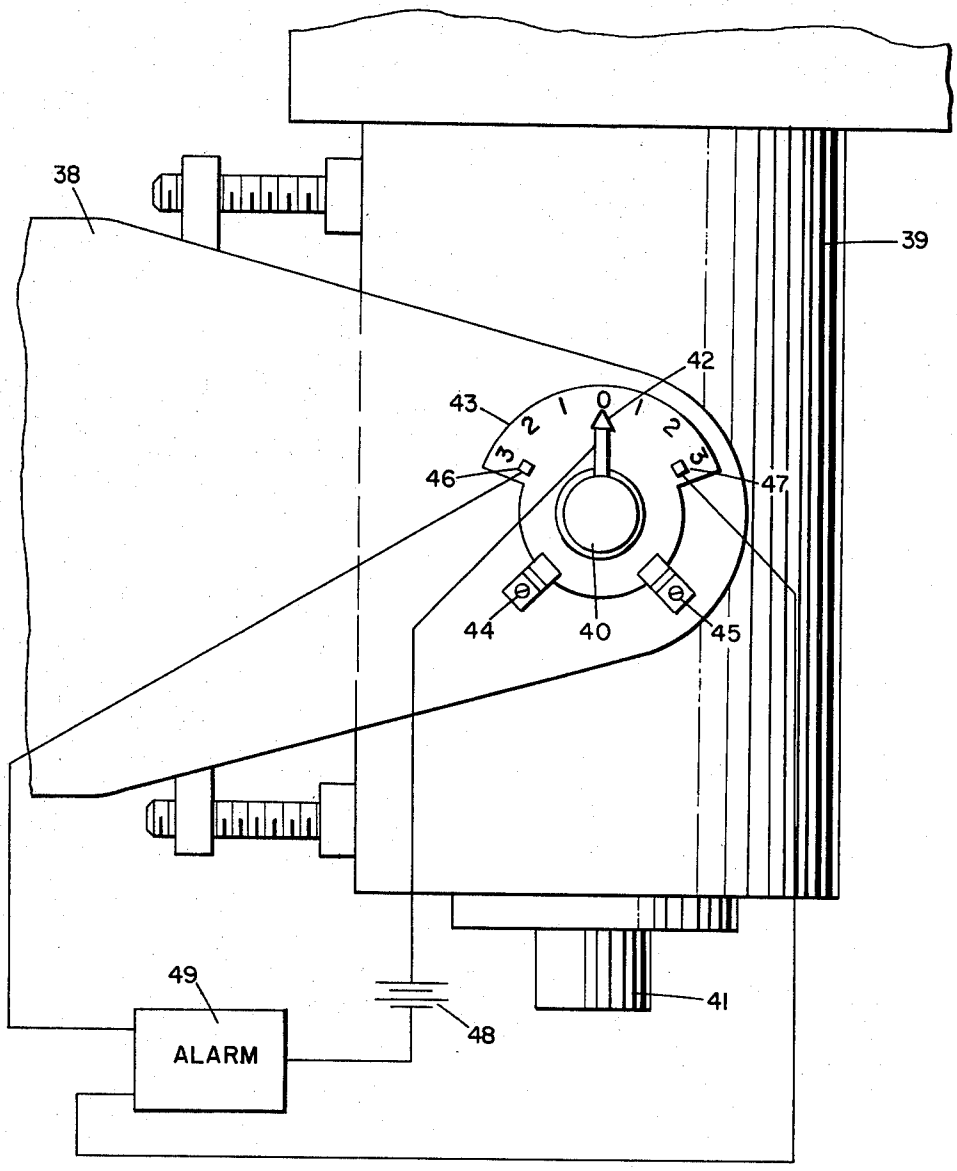


FIG. 3

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EARTH BORING MACHINE WITH A PIVOTAL HEAD

BACKGROUND OF THE INVENTION

This invention relates to the art of earth boring and more particularly to an earth boring machine with a pivotal drill head. This invention has special utility in raise drilling wherein the raise hole boring operation proceeds by the drilling of a relatively small pilot hole followed by enlargement of the hole to the desired size. A detailed description of a mechanized system of raise drilling is shown in U. S. Pat. No. 3,446,284 to N. D. Dyer et al. patented May 27, 1969.

While efficiency, performance and economy are considered in connection with all earth boring equipment, raise drilling imposes strict requirements because the equipment is generally operated inside of a mine shaft. The system must be compact, easy to transport and highly reliable. In addition, a tremendous amount of stress is placed upon the elements of the raise drill and the drill string.

Any misalignment between the drill string and the raise drill results in stresses and bending forces on both the drill pipe and elements of the raise drill. Once the raise drill is in place it is inconvenient and difficult to adjust its position. Misalignment of the drill head and drill string may occur in prior art devices. The misalignment may occur as drilling proceeds and the operator may be unaware of the misalignment. It is desirable to be able to correct misalignment and to enable the operator to be warned when misalignment exceeds a preset amount.

DESCRIPTION OF THE PRIOR ART

In U. S. Pat. No. 3,220,494 to R. E. Cannon et al. patented Nov. 30, 1965, an overall description of a conventional raise drill method is set forth. The operation begins by drilling a relatively small pilot hole to a shaft. The pilot bit is removed and a large raise bit attached to the drill string. The raise bit is rotated and hydraulically raised along the pilot hole to form the desired large diameter hole.

It can be appreciated that any misalignment during the raising operation wherein the raise bit is rotated and hydraulically raised along the pilot hole will result in a great amount of stress and bending force on the drill string elements and elements of the earth boring machine. Previous attempts to absorb the misalignment have been in the connection between the drill stem and drill pipe.

SUMMARY OF THE INVENTION

The present invention provides an earth boring machine with a pivotable drill head. The free pivoting movement of the drill head allows alignment of the pipe and head to effectively reduce bending forces on the pipe and elements of the earth boring machine. The present invention allows movement in one or more planes as required. The amount of misalignment is measured and the operator receives a warning signal when the misalignment exceeds predetermined limits. In addition automatic means may be connnected to the measuring system to adjust the drill head supports should misalignment exceed preset limits.

The present invention includes means for adjusting and controlling the position of the drill head. This allows the drill head to be properly positioned during certain drilling operations. In addition, the position of the drill head may be adjusted during drilling operations to control or correct deviation.

It is therefore an object of the present invention to provide an earth boring machine with a pivotable drill head.

It is a further object of the present invention to provide an earth boring machine that reduces stresses and bending forces on the drill string and elements of the earth boring machine.

It is a still further object of the present invention to provide an earth boring machine that provides a warning to the operator when misalignment of the drill string and drill head occurs.

It is a still further object of the present invention to provide an earth boring machine with means for controlling the position of the drill head.

It is a still further object of the present invention to provide an earth boring machine with means for controlling and correcting deviation.

The above and other objects and advantages of the present invention will become apparent from a consideration of the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of an earth boring machine that provides pivotal movement of the drill head in a single plane.

FIG. 2 shows the carriage, drill head and motor of another embodiment that provides relative movement in two planes.

FIG. 3 shows an indicator and alarm system that will provide the operator with an indication of misalignment.

DETAILED DESCRIPTION of THE INVENTION

Referring now to FIG. 1, a side view of a raise drill **10** of the the present invention is shown. A pair of support columns **11** are connected to a base member **12** at hinge **13** (the support columns **11** are parallel and only one is shown in this side view). A corresponding pair of adjustable braces **14** insure that support columns **11** will remain stationary in the desired vertical posiiton. A carriage **15** is mounted for movement along support columns **11**. Movement of carriage **15** along the support columns is provided by thrust cylinder **16**. A drill head **17** is pivotably connected to carriage **15** by hinge element **18**. Motor **19** supplies power to drive drill head **17**. The power from motor **19** is transmitted to drill head **17** through a suitable transmission **20**. Drill pipe may be connected to chuck **21** located on the lower portion of rotary drill head **17**. A pair of adjustable jack elements **22** and **23** are positioned on each side of hinge **18** and between the drill head **17** and carriage **15**. The adjustable jacks **22** and **23** provide an adjustable connection between carriage **15** and drill head **17**.

The raise drill **10** is moved into position in a mine shaft or other location wherein a raise boring operation is to be conducted. The base **12** is firmly implanted. Support columns **11** are aligned substantially parallel to the desired drill line. Although the drill line is shown

perpendicular to the base, it can be appreciated that the drill line may be at any angle to the base. Carriage 15 is moved upward by actuation of thrust cylinder 16. Elements of rotary drill string are connected to drill head 17 at chuck 21. Motor 19 is energized to drive drill head 17 thereby rotating the rotary drill string (not shown). Carriage 15 is moved downward as drilling proceeds. When carriage 15 reaches it lowermost position the drill string is disconnected from chuck 21 and carriage 15 again moved upward. A new element of the drill string is attached to chuck 21 and connected to the other elements of the rotary drill string and the operation proceeds as previously explained. Generally in raise boring, this operation continues until a small pilot hole is drilled to an opening somewhere below. The pilot bit is removed from the drill string and a larger raise bit attached. The raise bit is then rotated and hydraulically raised to enlarge the pilot hole to the desired size.

Any misalignment of the raise drill 10 and the drill string will cause substantial bending forces upon the various elements. In order to eliminate or substantially reduce undesirable bending forces, the connection 18 between carriage 15 and drill head 17 is allowed to pivot freely. Adjustable jacks 22 and 23 between carriage 15 and drill head 17 are placed in the retracted position and the drill head 17 is free to pivot thereby absorbing stresses from the drill string and correcting for any misalignment. It can be appreciated that nearly any raise boring operation will encounter misalignment and stress problems. The pilot hole generally wanders from a true line and as the raise bit is moved along the pilot hole the attitude of the raise bit and elements of the drill string changes. The raise drill is subjected to varying forces from the power units driving the drill head, the hydraulic cylinders and other units of the raise drill as well as from the drill string. Consequently the orientation of the body of the raise drill with respect to the drill line may change. The present invention provides an effective solution to the above-mentioned problems.

The pivotable drill head of the present invention provides an accurate system of aligning the drill string as the boring operation proceeds. Once the raise drill 10 is in place, the adjustable jacks 22 and 23 allow the drill head 17 to be accurately positioned when spudding in with the pilot bit. In combination with the indicator to be hereinafter described, the adjustable jacks 22 and 23 provide precise placement of the pilot bit. Adjustable jacks 22 and 23 then insure that drill head 17 remains firmly locked in place during the pilot hole drilling operation.

As the pilot hole drilling operation proceeds, the hole tends to wander from a true drill line. This may be the result of a number of factors, such as encountering different formations, drilling speed, gravity, etc. In order to correct alignment and insure that the pilot hole remains as true as possible, the following method may be employed. Jacks 22 and 23 are adjusted to move drill head 17. A sufficient amount of stress is placed upon the drill string by adjustment of jack 22 and 23 to cause the pilot bit to return to a true line. Thus by appropriate adjustment of the position of drill head 17, the pilot hole may be held to as near a true line as possible.

Referring now to FIG. 2 another embodiment of the present invention is shown wherein pivotable movement of a rotary drill head is provided in two planes. A carriage 24 is shown which may be mounted for travel along support columns in a manner similar to that described in connection with FIG. 1. A rotary drill head 25 is connected to carriage 24. Drill pipe may be connected to rotary drill head 25 at chuck 26. The drill pipe is rotated by power from motor 27 transmitted to rotary drill head 25 by a suitable transmission 28. A hinge 29 allows pivotal movement of drill head 25 in a first plane. A pair of adjustable jacks 30 and 31 are connected to an intermediate support element 32. Jacks 30 and 31 are mounted in jack receiving elements 33 and 34 connected to intermediate element 32. The threaded jack elements 30 and 31 engage the matching threads of jack receiving elements 33 and 34. It can be appreciated that by proper rotation of jack elements 30 and 31 to alignment of the drill head and drill string may be adjusted in a first plane and that the drill head may be firmly connected to intermediate element 32 or it may be free to rotate in a first plane. A second pivot 35 is provided between intermediate element 32 and carriage 24. This second pivot 35 provides movement of the drill head in a second plane. Pivot 35 is a cylindrical element extending from intermediate support element 32 into a cylindrical receiving socket in carriage 24. The end of pivot 35 is enlarged to prevent it from being pulled out of the retaining socket. A flange element 36 extends from carriage 24 and cooperates with a pair of adjustable jacks 37 and 37' to control the amount of pivotal movement provided by pivot 35. Jacks 37 and 37' are connected to intermediate element 32 and may be adjusted to control the movement of drill head 25 in a second plane. A second pair of jacks and a flange element could be positioned on the opposite side of intermediate element 32 in order to provide additional strength and control.

Referring now to FIG. 3 another embodiment of the present invention is shown. A carriage 38 is shown that may be positioned for movement along support columns in a manner similar to that described in connection with the embodiment of FIG. 1. A rotary drill head 39 is pivotably connected to carriage 38 by a hinge element 40. Drill pipe may be connected to rotary drill head 39 at chuck 41. Power to drive drill head 39 and thereby rotate the drill pipe is provided by a motor and transmission (not shown). A pointer 42 is firmly affixed to hinge element 40. Any movement of drill head 39 relative to carriage 38 is reflected by pointer 42. A visual indicator plate 43 is positioned proximate pointer 42. Plate 43 is held in place by adjustable tabs 44 and 45. The tabs may be tightened to hold visual indicator plate 43 firmly in place.

Once the boring machine is in place, the visual indicator plate 43 is positioned so that pointer 42 is on the zero mark. Tabs 44 and 45 are tightened and plate 43 is held firmly in place. Any pivotal movement of drill head 39 will be reflected by pointer 42 and an accurate indication of movement may be read out on visual indicator plate 43. A pair of movable electrical contacts 46 and 47 are mounted on plate 43. Movable contacts 46 and 47 are placed in the position of the maximum allowable pivotal movement of drill head 39. A source of electrical energy 48 and an alarm 49 form

part of a normally open electrical circuit including pointer **42** and movable contacts **46** and **47**. Should the amount of pivotal movement of drill head **39** reach the preset limit, the pointer **42** will come into contact with one of the movable contacts **46** or **47** thereby closing the electrical circuit and actuating alarm **49**. The pointer **42** and contacts **46** and **47** are electrically insulated from plate **43**, hinge **40** and the other elements of the earth boring machine.

A representative method of operation will now be considered. The raise drill is moved into position and the base firmly implanted. The indicator plate **43** is firmly affixed in its normal operating position. If the raise drill includes means for movement in two planes, two indicators are to be used. A single indicator is described for simplicity in explanation. The drill string with pilot bit is attached to the drill head **39** at chuck **41**. The adjustable jacks are manipulated until pointer **42** is on the zero mark of plate **43**. The pilot bit is spudded in and drilling of the pilot hole proceeds. Any misalignment may be detected by reference to the indicator. The jacks are then adjusted to bring pointer **42** back to the zero mark.

As previously explained, the pilot hole may wander from the straight line. Once a deviation is detected, the adjustable jacks may be used to impart stress to the drill string and bring the pilot hole back to true line. The pilot hole drilling operation proceeds until the pilot hole emerges at the desired location.

The pilot bit is then removed and a large raise bit attached. The jacks are retracted and the drill head is allowed to pivot freely. The raise bit is rotated and hydraulically drawn along the pilot hole to form a large diameter raise hole. A tremendous amount of stress is placed on the raise drill during this operation. The pilot hole may deviate from a true line at various locations along its length and additional stress will be applied to the drill string when the raise bit is being drawn past these locations. The pivotal movement of the drill head absorbs some of the stress.

The amount of pivotal movement may exceed preset limits and the alarm actuated. This will alert the operator to the condition and corrective measures may be taken. This may be in the form of adjusting the position of the support columns, moving the base or other corrective measures.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An earth boring machine with pivotable drilling means comprising:
- support means;
- carriage means adapted for travel along said support means;
- drilling means for rotating a rotary drill column;
- means between said carriage means and said drilling means for providing relative movement of the drilling means in at least one plane, said means including a hinge between said carriage means and said drilling means; and
- adjustable means positioned between said carriage means and said drilling means for selectively preventing and controlling relative movement of the drilling means.

2. The earth boring machine of claim **1** including pivot means between said carriage means and said drilling means for providing relative movement of the drilling means in a second plane.

3. The earth boring machine of claim **1** including means for providing an indication of the degree of relative movement of said drilling means.

4. The earth boring machine of claim **3** wherein said means for providing an indication of the degree of relative movement of said drilling means includes a pointer connected to said means for providing and controlling relative movement of the drilling means and a visual indicator plate.

5. The earth boring machine of claim **4** including alarm means for providing an alarm when the relative movement of the drilling means exceeds predetermined limits.

6. A raise drill with a pivotable drill head, comprising:
- a base;
- support column means pivotally connected to said base;
- a carriage adapted for travel along said support column means;
- a drill head;
- power means connected to said drill head; and
- means between said carriage and said drill head for providing relative movement of the drill head in at least one plane, said means including a hinge between said carriage and said drill head, and wherein said raise drill includes adjustable means positioned between said carriage and said drill head for selectively preventing and controlling relative movement of said drill head.

7. The raise drill of claim **6** including means for providing an indication of the degree of relative movement of said drill head.

8. A method of drilling a large diameter hole from a first level to a second level, comprising:
- positioning a raise drill at said first level, said raise drill including a drill head pivotally mounted and adapted to pivot in at least one plane;
- establishing a drill line;
- adjusting the position of said drill head by causing said drill head to pivot until the drill head is aligned with said drill line;
- locking said drill head to prevent it from pivoting;
- rotating and passing a pilot bit along said drill line to form a pilot hole;
- removing said pilot bit;
- attaching a raise bit;
- unlocking said drill head to allow it to pivot freely;
- rotating and hydraulically raising the raise bit along said pilot hole to form a large diameter hole;
- detecting deviations of the pilot hole from said drill line;
- adjusting the position of said drill head by causing said drill head to pivot; and
- continuing to rotate and pass and pilot bit along said drill line.

9. A raise drilling apparatus adapted to be positioned in a mine to drill a large diameter raise hole from one level of the mine to another level of the mine by rotation of a rotary drill string; comprising:
- a base adapted to be positioned at one level of the mine;

at least one support pivotally connected to said base;

a carriage movably connected to said at least one support for travel along said support;

rotary drilling means carried by said carriage for drilling a large diameter raise hole from one level of the mine to another level of the mine, said rotary drilling means including a rotary drill head for connecting said drill string to said rotary drilling means and a power unit for transmitting rotary power to the drill head;

pivot means connecting said drill head to said carriage for allowing free pivoting movement of the drill head to provide proper alignment of the drill string and drill head; and

means connected to said pivot means for controlling the degree of free pivoting movement of the drill head.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,695,369 Dated October 3, 1972

Inventor(s) James M. Drouet

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, claim 8, line 22 of claim, change "and" , second occurrence, should read -- said --.

Signed and sealed this 27th day of March 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents