(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 028 930**
B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **27.06.84**

(51) Int. Cl.³: **E 21 C 27/30**

(21) Application number: **80303996.5**

(22) Date of filing: **07.11.80**

(54) **Continuous excavating apparatus.**

(30) Priority: **09.11.79 US 93020**

(43) Date of publication of application:
20.05.81 Bulletin 81/20

(45) Publication of the grant of the patent:
27.06.84 Bulletin 84/26

(84) Designated Contracting States:
AT CH DE FR GB IT LI NL SE

(56) References cited:
DE - A - 2 155 590
DE - C - 359 131
DE - C - 578 555
DE - C - 2 328 207
US - A - 2 320 196
US - A - 3 035 821

SALZGITTER LADER, Prospect 155, Limbach 60303/1000. 2. 50. "5. Standsicherheit"

(73) Proprietor: **TERRADYNE LIMITED**
P.O. Box 1353
Georgetown Grand Cayman Island, British West Indies (KY)

(72) Inventor: **Roe, Jonas L.**
P.O. Box 2325, Santa Cruz
California (US)

(74) Representative: **Smith, Philip Antony et al,**
REDDIE & GROSE 16 Theobalds Road
London WC1X 8PL (GB)

EP 0 028 930 B1

Courier Press, Leamington Spa, England.

Description

The present invention relates generally to powered excavating apparatus and more particularly to a combined excavating and conveying apparatus arranged to dig and convey large quantities of material such as ore in a mining operation.

In many mining operations, digging or breakout forces in the neighborhood of 200,000 pounds (ca. 900 kN) are required, and at the same time, for practical utilization, the excavated material must be removed at rates approaching 100 tons per hour. With existent equipment these two practical requirements are not achieved. For example, mechanical devices such as backhoes and front end loaders could possibly deliver the requisite forces but have not the capacity to remove the material in such large quantities. On the other hand, certain boom-mounted rotary heads can remove the material at adequate rates but are not only incapable of delivering the requisite forces but also establish force components which tend to move the entire machine sideways so as to render its operation impractical.

Both problems are aggravated when one wishes to perform the excavating and conveying operation in a mining tunnel whose lateral dimensions conventionally are no more than six feet (1,80 m) high and five feet (1,50 m) wide, since the mentioned breakout or digging forces are sufficient to lift or transversely displace the mobile carrier for the equipment. The problems could be alleviated if it were possible, as in some surface applications, to mount a counterbalance weight behind, and in line with, the digging boom or arm, so as to be capable of swinging therewith. In the confined space of tunnel digging or mining, which the present device wishes to be capable of, such a solution is out of the question.

U.S.—A—2,320,196 shows a continuous excavating and conveying apparatus comprising a frame including frame members rigidly joined to form an elongated box-like structure, a pair of driven endless tracks on which said frame is mounted, a boom carrying an endless excavating bucket line and mounted on a gimbal to swing about a horizontal axis, the gimbal being supported between upper and lower frame members to swing the boom about a vertical axis and means for swinging the boom about said vertical and horizontal axes. While that apparatus was designed for operation in a tunnel and used the weight of the frame to counteract the digging forces it was not sufficiently compact to operate in tunnels of the small dimensions referred to above and would not provide adequate resistance to the forces generated when digging at the side of the machine, which tend to twist the machine about its longitudinal axis. The problem of resistance to the digging forces becomes greater as the overall dimensions of the apparatus are reduced.

The present invention is characterized by having heavy plates spaced apart and forming opposite sides of the frame to act as counterweights against digging forces which tend to rotate the frame about its longitudinal axis, the tracks being located substantially within the lateral extent of the frame defined by said side plates.

In this way the overall width of the apparatus is reduced while having counterweights at the sides of the machine to withstand the twisting forces about the longitudinal axis of the frame as well as the tilting forces about its transverse axis.

The preferred form of removing the material from the endless bucket chain is a conveyor means which extends upwardly and rearwardly from a point adjacent the front end of the machine to a point adjacent the rear of the frame and being located between the side-counterweights for receiving material from the bucket line.

A major problem encountered in operating in very small spaces is one of maintenance because of the inaccessability of the operating parts for repair. Items such as bucket teeth need frequent replacement and, in buckets of current design, uneven wear on the pins connecting the buckets together frequently results in failures. In view of the difficulty of access in very small spaces, necessary repairs frequently result in unacceptable downtime for the machines. Known machines have an endless sprocket-driven excavating bucket line which comprises a plurality of excavating buckets and a plurality of hinge pins. To overcome the problem of hinge pin wear which is present in such a bucket line, a particular embodiment of the present invention is characterized in that the hinge pins each commonly pivotally connect adjacent buckets by rotatably engaging in respective adjacent hinges on the buckets; and in that the hinge pins have enlarged opposite ends for engagement with bucket line drive sprockets to cause a center portion of each pin to rotate during operation. The rotation of the center portion of the pin, in contact with the hinges, evenly distributes pin wear and leads to longer pin life. These features form the subject of a Divisional Application No. 83 201298.3.

The present invention, as briefly summarized herein above, will be more fully understood by reference to the following detailed description of an exemplary structure shown in the accompanying drawings wherein:

Figure 1 is a side elevational view of a continuous excavating apparatus embodying the present invention,

Figure 2 is a top plan view thereof,

Figure 3 is a transverse sectional view taken along line 3—3 of Figure 1 illustrating the gimbal mounting of the excavating boom and details of the bucket structure,

Figure 4 is a fragmentary longitudinal sectional view through the excavating boom illustrating additional details of its construction, and

Figure 5 is a transverse sectional view taken along line 5—5 of Figure 4 illustrating additional structural details of the excavating boom.

With initial reference to Figures 1 and 2, the continuous excavating apparatus embodying the present invention includes a main frame 10 having most of its weight in substantially vertical side walls 12, 14, each formed preferably by a pair of contiguous plates which are welded or otherwise secured at their front, rear, and the top and bottom edges thereof. The frame plates are joined by transverse braces 16, 18 so that the overall configuration of the frame is in the form of a hollow channel or box-like configuration, within which certain additional elements of the apparatus can be housed, as will be explained in detail hereinafter.

To provide mobility of the heavy elongated main frame 10, a pair of conventional endless tracks 20 are mounted therebelow in a conventional fashion but at a position so that the endless tracks project at the forward end of the main frame 10 therebeyond but are recessed from the rearward end of the frame for a purpose which will become apparent hereinafter. As can be seen, particularly by reference to Figure 2, the endless tracks are confined within the lateral contours of the frame so that its overall width is less than five feet and the endless tracks have a height such that, when added to the height of the side plates, provides an overall vertical dimension of less than six feet. Thus the entire elongated frame and the mobile carriers therefor can pass readily through a tunnel having lateral dimensions no more than six feet in height and five feet in width.

To power the endless tracks and certain additional equipment to be described hereinafter, an electric motor 22 of appropriate power is mounted at the rearward end of main frame 10 on one of the mentioned transverse braces, the precise drive arrangement to the endless tracks being conventional and thus not described in further detail.

Adjacent the forward extremity of the elongated main frame 10 the mentioned upper and lower transverse braces 16, are joined rigidly to the side walls 12, 14 to support gimbal pins 24, 26 that rotatably carry an open rectangular gimbal frame which, as best shown in Figure 3, can pivot about a generally upright axis and is, in turn, arranged to pivotally support on a transverse shaft 30 the parallel side plates 32, 34 of an excavating boom, generally indicated at 36, enabling its pivotal adjustment about a transverse axis so that the excavating boom can be pivoted both vertically and transversely an amount sufficient so that its extremity can move beyond the lateral and upright contour of the described supporting frame, as indicated by phantom lines in Figures 1 and 2, thus enabling a tunnel to be excavated which will subsequently allow the passage of the entire frame therethrough.

The side plates 32, 34 of the excavating boom 36 are held in laterally spaced relation by simple rigid metal braces 38 and the outer surfaces thereof mount balls 40, 42 for universal connection to ball sockets 44, 46 at the forward ends of double-acting hydraulic rams 48, 50 whose opposite extremities are universally joined to a forward extension 10a of the main frame 10 by similar ball and socket joints 52, 54 to allow the excavating boom to be adjusted vertically or horizontally through actuation of the hydraulic rams 48, 50 by a hydraulic pump 56 that is driven by the previously described electric motor 22. One valve (not shown) is associated in a conventional fashion with each hydraulic ram and is arranged to supply hydraulic pressure to one or the other end of its associated ram so that, as will be apparent, if both valves are open in one direction, both hydraulic rams will extend or retract to raise or lower the excavating boom, whereas on the other hand, if one valve is open in one direction while the other is open in the opposite direction, a lateral motion of the boom will occur; for example, to the phantom-line disposition shown in Figure 2.

Between opposite ends of the described boom side plates 32, 34 laterally-spaced sprockets 58, 60 are mounted at the extremities of tubes 62, 64 which are keyed to mounting shafts, one of which is the previously described shaft 30 (see Figure 3) and the other of which is an idler shaft 66 (see Figure 4) rotatably supported between the side plates 32, 34 at the remote free end of the excavating boom 36. Each pair of sprockets engages the enlarged opposite ends of a hinge pin 68 which is arranged in bridging relationship between the laterally-spaced sprockets to rotatably extend through a piano-hinge connection in the form of interdigitated hinges 70, 72 at the front and rear of adjacent excavating buckets 74, which provide the material excavating elements of the unit. When it is remembered that considerable forces are encountered during the excavating operation, the enlarged ends of the pin 68 will rotate to provide only rolling friction with the engaged sprocket, thus to reduce sliding friction and extend the useful life of the elements to a considerable extent. Furthermore, it will be seen that each hinge pin 68 common to the foremost extremity of one bucket and the rearmost extremity of the adjacent bucket will rotate in the hinges 70, 72, thus to distribute wear and maintain the roundness of the hinge pin and the hinges.

In consideration of the extreme wear experiences by the digging ends of the excavating buckets, replaceable hard teeth 76 are utilized, and, as best shown in Figure 5, each tooth includes a tongue and groove connection 78 between it and its supporting element,

which in turn facilitates replacement thereof after continued wear over an extended period.

The line of buckets mounted on the sprockets is arranged for counterclockwise motion, as shown in Figure 1, when driven by a pair of hydraulic motors 80, 82 which are connected to opposite ends of the sprocket-mounting shaft 30 at the inner end of the bucket line by suitable gear reduction units 84, 86, such hydraulic motors each being capable of delivering as much as 150 horsepower when energized by the hydraulic pump 56 driven by the previously described electric motor 22.

Utilization of the described hydraulic actuating mechanism enables a ready variation in the requisite power dependent upon the resistance of the material being engaged by the line of excavating buckets. When the buckets engage the material, as can be readily visualized by reference to Figure 1, they will be moving in sequence in an upward direction, tending to rotate or pivot the entire machine about a transverse pivot formed at the forward end of the endless tracks. Since this pivot point is forwardly of most of the weight of the heavy frame and the elements mounted thereon, considerable forces may be generated without moving the frame about this transverse axis, thus to assure the requisite application of force during the excavating operation. Furthermore, if the excavating boom 36 is operating at a lateral angle such as indicated in phantom lines in Figure 2, the reactive force components tending to rotate the main frame 10 about its longitudinal axis will be counterbalanced by the weight of the opposite side wall.

Material excavated and carried by the excavating buckets will be dumped therefrom as they pass in succession over the rear sprocket 58 onto a suitable endless conveyor 88 which lies thereunder and is mounted for conveyance of material deposited thereon beyond the rear end of the frame at an upper elevation so that the material conveyed on the belt can be dumped into a suitable truck or other receptacle (not shown) for removal and subsequent processing. The conveyor 88 is supported between the frame plates and is powered by suitable connection to the motor 22.

Obviously, many variations and/or alterations in this structure as specifically described can be made without departing from the spirit of the invention, and the foregoing description of one embodiment is to be considered as purely exemplary and not in a limiting sense, and the actual scope of the invention is to be indicated only by reference to the appended claims.

Claims

1. Continuous excavating and conveying apparatus comprising a frame (10) including frame members (12, 14) rigidly joined to form an elongated box-like structure, a pair of driven endless tracks (20) on which said frame is mounted, a boom (36) carrying an endless excavating bucket line (74) and mounted on a gimbal to swing about a horizontal axis (30), the gimbal being supported between upper and lower frame members to swing the boom about a vertical axis (24—26), and means (48, 50) for swinging the boom about said horizontal and vertical axes, characterized by heavy plates (12, 14) spaced apart and forming opposite sides of the frame to act as counterweights against digging forces which tend to rotate the frame about its longitudinal axis, the tracks (20) being located substantially within the lateral extent of the frame defined by said side plates.

2. Apparatus as claimed in claim 1 characterized in that the means for swinging the boom comprise a pair of rams (48, 50) coupling the sides of the boom to spaced points (52, 54) at the forward end of the main frame at the level of the tracks.

3. Apparatus as claimed in claim 1 or 2 in which the heavy side plates overhang the rear end of the endless tracks.

4. Apparatus as claimed in claim 1, 2 or 3, characterized by a conveyor (88) located between the side plates (12, 14) for removal of material excavated by the bucket line.

5. Apparatus as claimed in any of claims 1 to 4 characterized in that the bucket line comprises buckets (74) pivotally connected each bucket to the next by a common hinge pin (68) which is engaged by pairs of sprockets (58, 60), each of the hinge pins (68) having enlarged ends which are engaged by the sprockets whereby the pin is caused to rotate during operation of the bucket line.

Patentansprüche

1. Vorrichtung zum kontinuierlichen Ausbaggern und Abtransportieren, enthaltend: einen Rahmen (10), der zur Bildung eines länglichen, kastenartigen Gebildes mit starr verbundenen Rahmenteilen (12, 14) versehen ist, zwei endlose, angetriebene Laufraupen (20), auf denen der Rahmen montiert ist, einen Ausleger (36), der eine endlose, zum Ausbaggern bestimmte Eimerkette (74) aufweist und um eine horizontale Achse (30) schwenkbar auf einem Tragbügel gelagert ist, der zwischen oberen und unteren Rahmenteilen abgestützt ist und eine Verschwenkung des Auslegers um eine vertikale Achse (24—26) ermöglicht, und eine Schwenkeinrichtung (48, 50) zum Verschwenken des Auslegers um die horizontale und vertikale Achse, gekennzeichnet durch mit Abstand angeordnete schwere Platten (12, 14), die entgegengesetzte Seiten des Rahmens bilden und als Gegengewichte gegen beim Ausbaggern entstehende Kärfte wirken, die dazu neigen, den Rahmen um seine Längsachse zu drehen, wobei die Laufraupen (20) im wesentlichen innerhalb der seitlichen Ausdehnung des durch die Seitenplatten gebildeten Rahmens angeordnet sind.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Schwenkeinrichtung für den Ausleger zwei Druckkolben (48, 50) aufweist, die die Seiten des Auslegers mit beabstandeten Punkten (52, 54) verbinden, welche am Vorderende des Hauptrahmens in Höhe der Laufraupen angeordnet sind.

3. Vorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die schweren Seitenplatten das rückwärtige Ende der endlosen Laufraupen überhängen.

4. Vorrichtung nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß zwischen den Seitenplatten (12, 14) ein Förderer (88) zum Abtransport des durch die Eimerkette ausgebaggerten Materials angeordnet ist.

5. Vorrichtung nach irgendeinem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß die Eimerkette Eimer (74) enthält, wobei jeder Eimer mit einem benachbarten Eimer mittels eines gemeinsamen Schwenkbolzens (68) schwenkbar verbunden ist, der von zwei Kettenzahnrädern (58, 60) ergriffen ist, wobei jeder Schwenkbolzen (68) vergrößerte und von den Kettenzahnrädern erfaßte Enden aufweist, wodurch der Scharnierbolzen während des Betriebs der Eimerkette in Umdrehungen versetzt wird.

Revendications

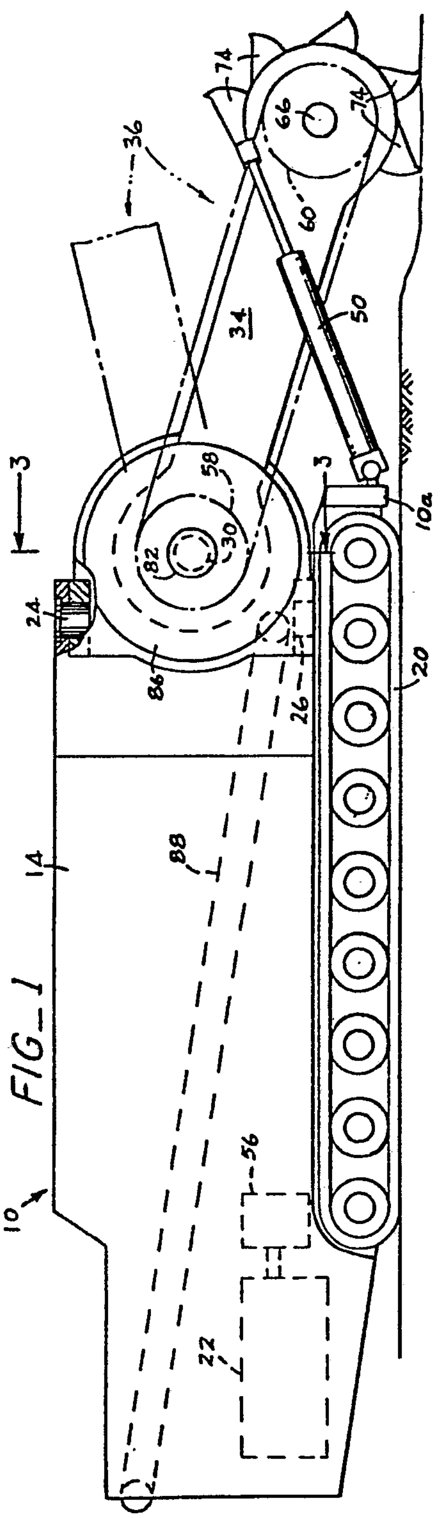
1. Appareil d'excavation et de transport en continu comportant un chassis (10) comprenant deux éléments de chassis (12, 14) rigidement réunis pour former une structure allongée en forme de caisson, deux chenilles sans fin entraînées (20) sur lesquelles est monté le chassis, un bras (36) portant une file sans fin de bennes piocheuses (74) et monté sur une suspension à la cardan de façon à osciller autour d'un axe horizontal (30), la suspension à la cardan étant supportée entre les éléments supérieur et inférieur du chassis de façon à faire osciller le bras autour d'un axe vertical (24, 26) et des moyens (48, 50) pour faire osciller le bras autour desdits axes horizontal et vertical, caractérisé par des plaques lourdes (12, 14), espacées et formant des côtés opposés du chassis de façon à agir comme des contrepoids contre les forces de cavage qui tendent à faire tourner le chassis autour de son axe longitudinal, les chenilles (20) étant placées pratiquement à l'intérieur de l'étendue latérale du chassis définie par les plaques latérales.

2. Appareil suivant la revendication 1, caractérisé en ce que les moyens pour faire osciller les bras comportent deux verins (48, 50) reliant les côtés du bras à des points espacés (52, 54) de l'extrémité avant du chassis principal au niveau des chenilles.

3. Appareil selon la revendication 1 ou 2 dans lequel les plaques latérales lourdes dépassent l'extrémité arrière des chenilles sans fin.

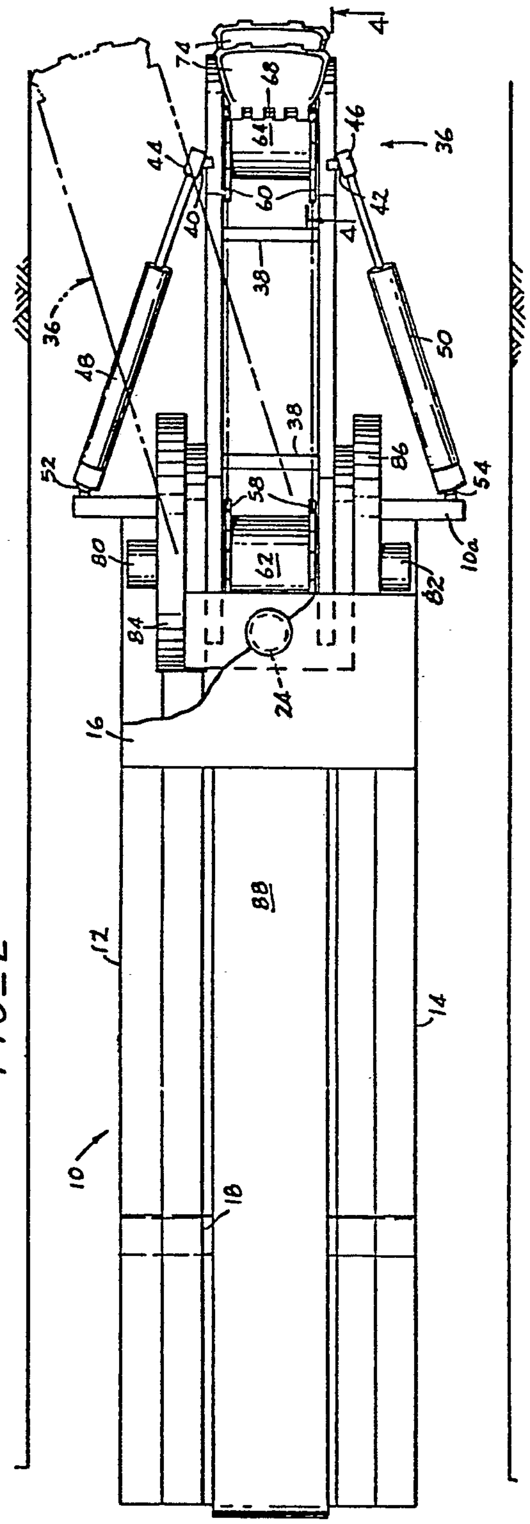
4. Appareil suivant les revendications 1, 2 ou 3, caractérisé par un transporteur (88) monté entre les plaques latérales (12, 14) pour enlever la matière extraite par la file de bennes piocheuses.

5. Appareil suivant l'une des revendications 1 à 4 caractérisé en ce que la file de bennes comprend des bennes (74) reliées de manière pivotante chacune à la suivante par un axe d'articulation commun qui est en prise avec deux roues à chaine (58, 60) chaque axe de charnière (68) ayant des extrémités élargies qui sont en prise avec les roues de sorte que l'axe est obligé de tourner lors du fonctionnement de la file de bennes piocheuses.



74
36
66
74
60
34
50
3
58
30
82
3
10a
24
86
26
20
14
88
56
22
10

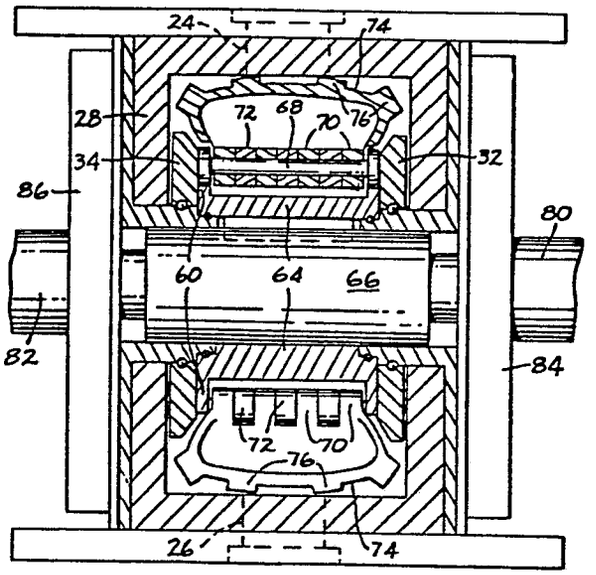
FIG_1



4
74
68
64
46
36
44
60
42
40
4
38
36
48
50
38
86
52
58
54
80
62
10a
82
84
24
16
88
12
14
10
18

FIG_2

FIG_3



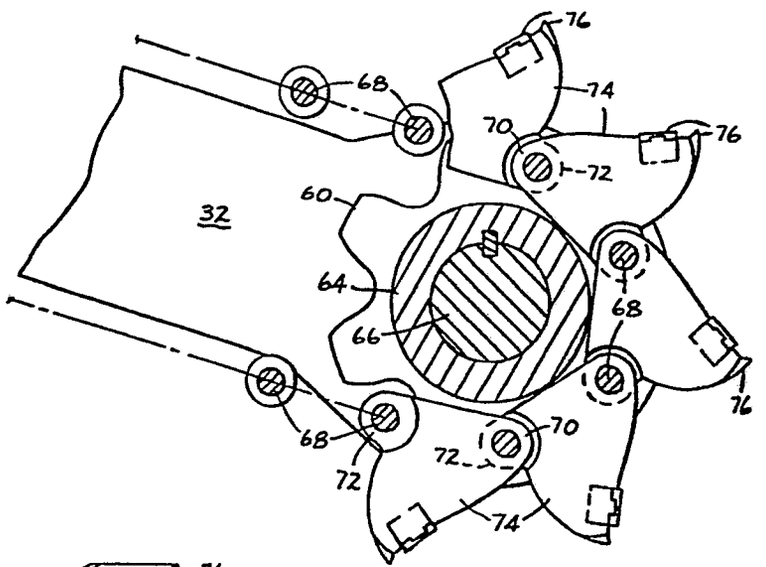


FIG_4

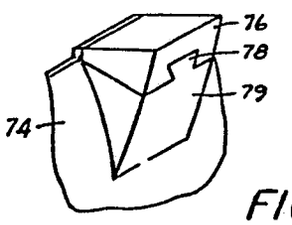


FIG_5