

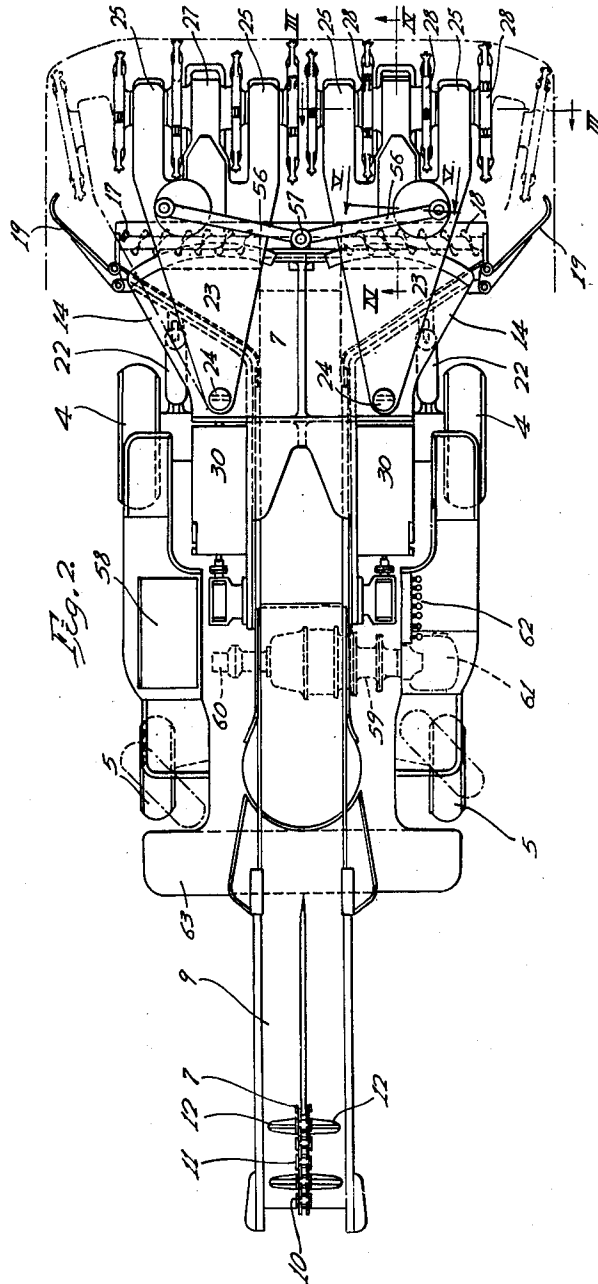
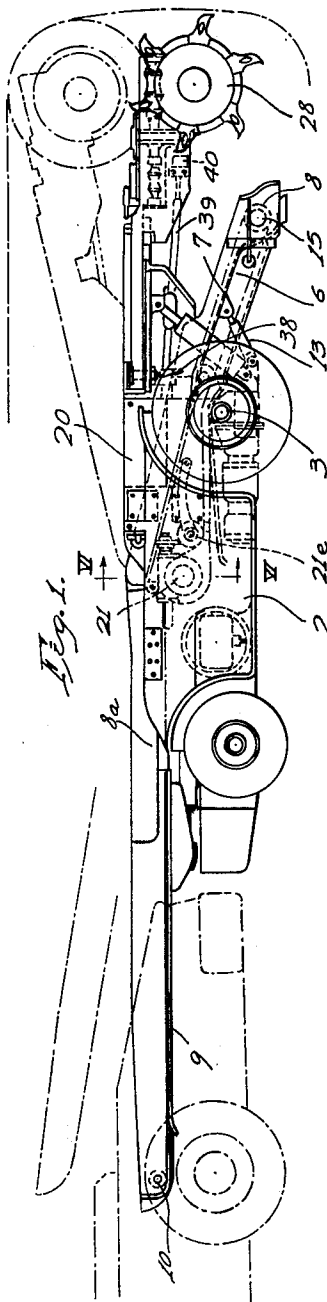
Nov. 23, 1954

E. M. ARENTZEN
CONTINUOUS MINING MACHINE WITH OSCILLATING
GROUPS OF ROTARY CUTTERS

2,695,164

Filed May 3, 1950

7 Sheets-Sheet 1



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BY

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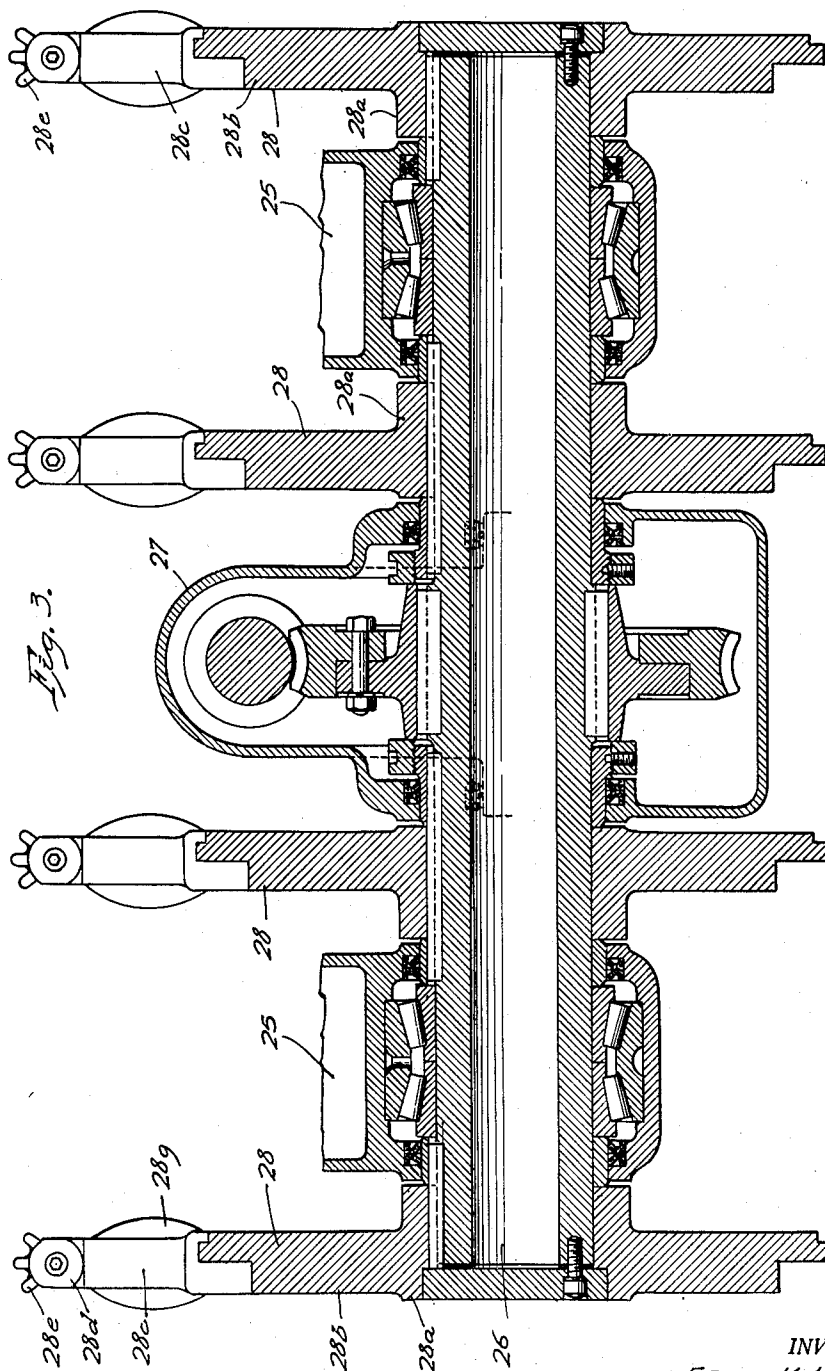
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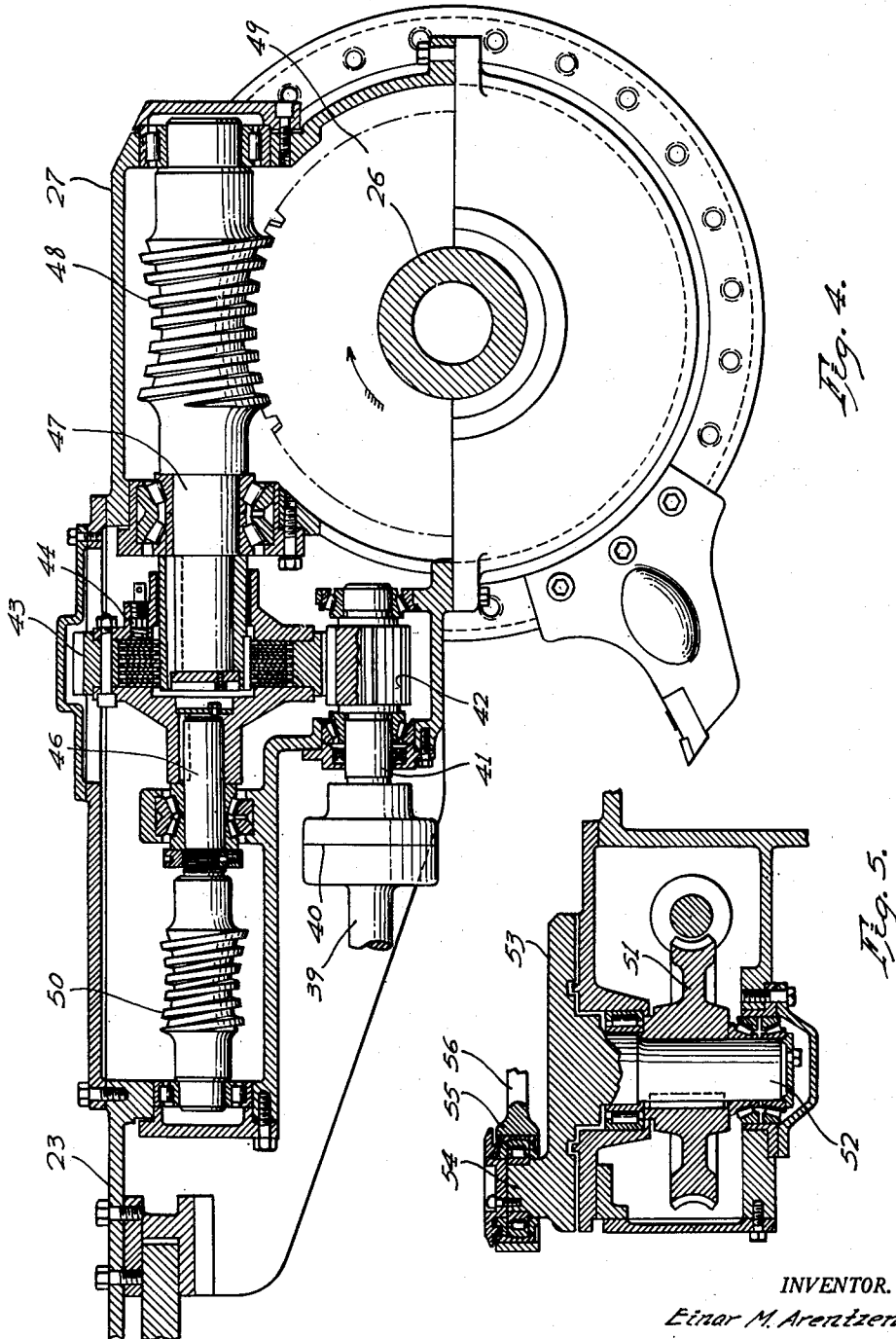
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7 Sheets-Sheet 3



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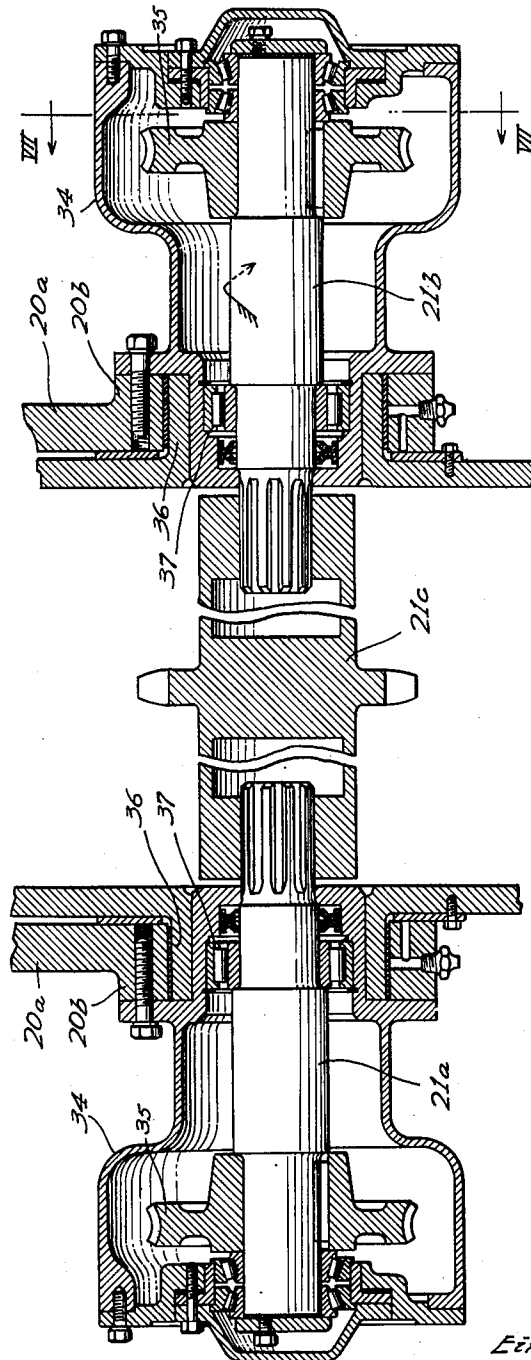
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2,695,164

Filed May 3, 1950

7 Sheets-Sheet 4

Fig. 6.



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2,695,164

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7 Sheets-Sheet 5

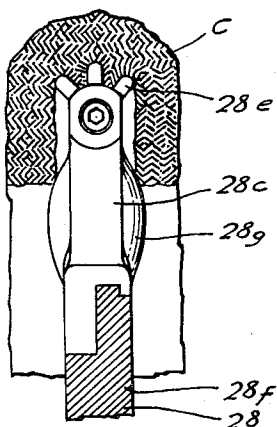
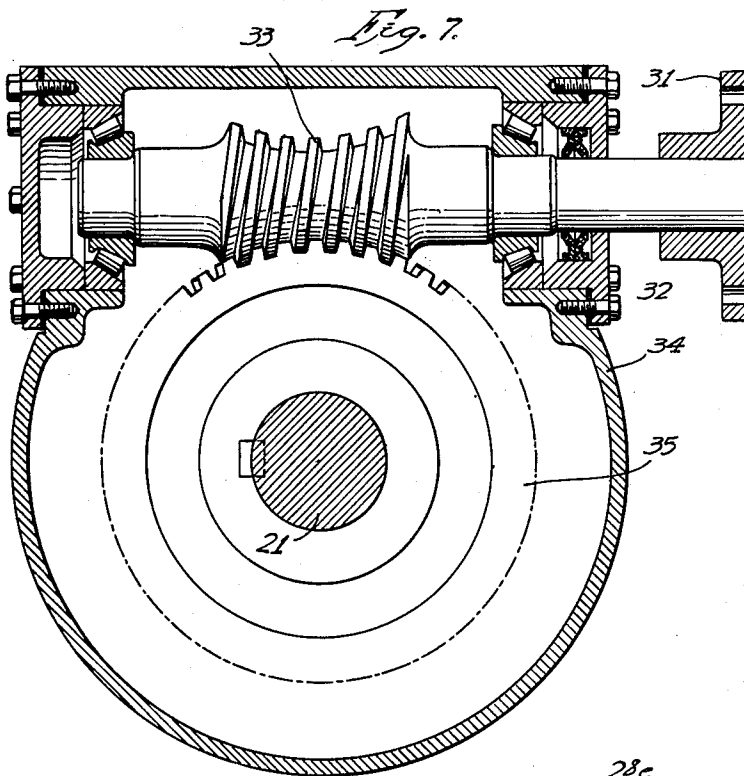


Fig. 8.

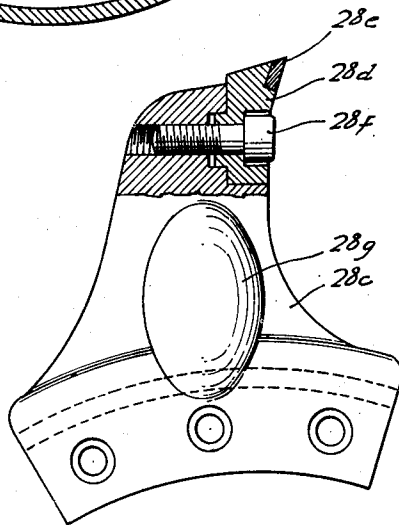


Fig. 9.

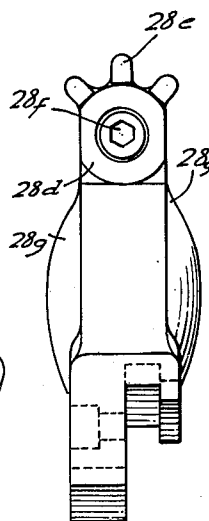


Fig. 10.

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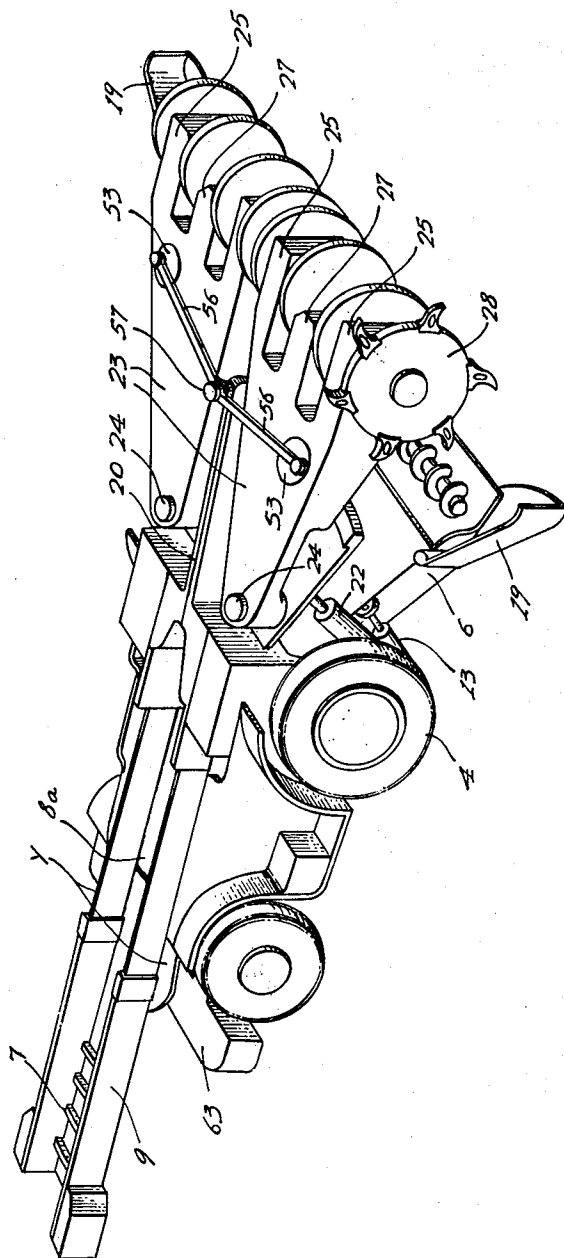
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2,695,164

Filed May 3, 1950

7 Sheets-Sheet 6

Fig. 11.



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E. M. ARENTZEN
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2,695,164

Filed May 3, 1950

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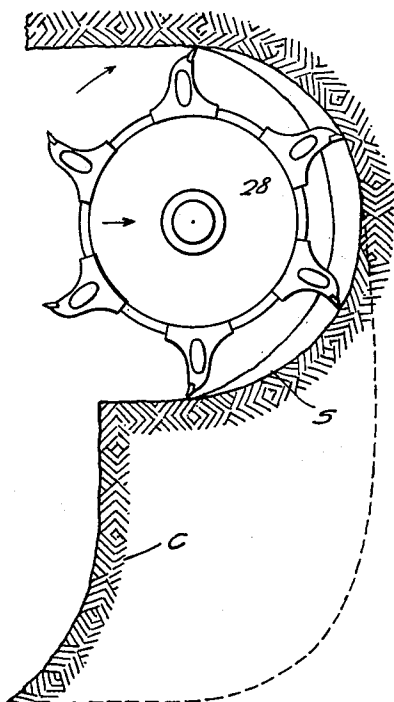


Fig. 12.

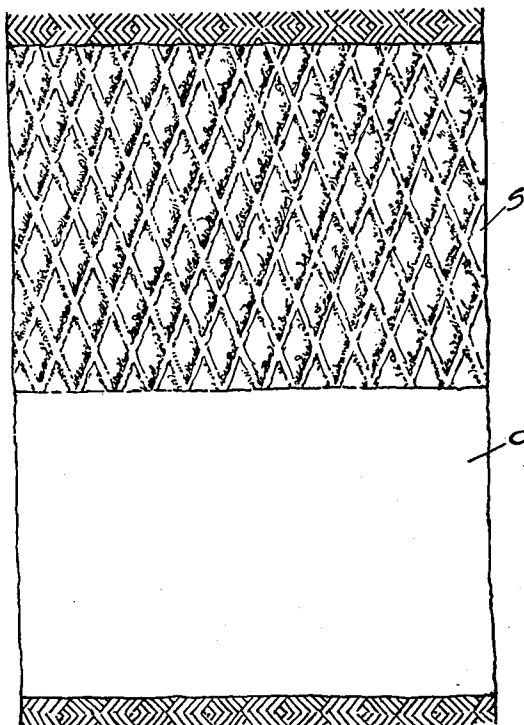
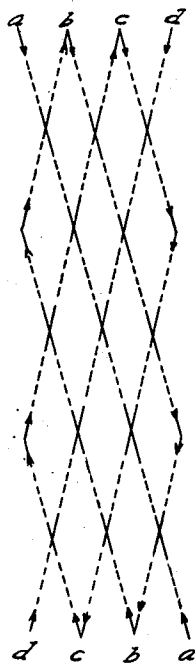


Fig. 13.

Fig. 14.



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1

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CONTINUOUS MINING MACHINE WITH OSCILLATING GROUPS OF ROTARY CUTTERS

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Application May 3, 1950, Serial No. 159,851

10 Claims. (Cl. 262—20)

This invention relates to mining machines and is for a machine of novel construction especially useful for continuous operation, as distinguished from intermittent operation.

The invention is designed primarily for the mining of coal, but it is applicable to the mining of other materials. By way of illustration, however, it will be described specifically in connection with the mining of coal.

The conventional method of mining coal most commonly used in the United States involves undercutting the coal by a chain cutter to a depth of from about six to ten feet, drilling the coal which is so undercut, and placing a blasting charge in the drill holes, after which the blasting charge is exploded, breaking the coal loose, and it falls to the mine floor. Then a loading machine is brought in to gather up the coal and load it into cars or onto a conveyor. Self-propelled shuttle cars have been used more recently to carry the coal from the loader to mine cars.

It has long been recognized that coal is most effectively mined by combined cutting and breaking operation. In such combined operation, part of the coal of course is removed by cutting elements, and then pressure is applied to the coal to break it loose. Various types of machines have been designed, wherein continuously operating cutters, as for example a group of traveling chain cutters, are used to cut parallel grooves into the coal; and other machines have been proposed using various auger arrangements which continuously drill into the coal and break it out. These machines have certain definite limitations. In some of them, a high percentage of the coal is removed directly by cutting, increasing the power requirements of the machine, and in most of such machines there is a problem of having adequate working clearance alongside the machine, not to mention mechanical difficulties, and their expensive construction. Such machines also increase undesirably the amount of "fine coal," i. e., particles from $\frac{3}{16}$ " mesh down, resulting also in considerable coal dust. One type of such mining machine involves the use of large augers that bore straight into the coal.

It has also heretofore been proposed to mine coal through the use of machines that cut parallel horizontal kerfs into the coal, after which the machine is backed away and the cutter cutting head is changed to then cut vertical kerfs into the working face of the coal so that a pattern of intersecting kerfs are cut to enable the intervening areas of coal to be broken out. The difficulty with such machines is that they are not continuous because the cutters must first be operated in one position and then the other, and much of the advantage to be gained from such a machine is lost in the time required to change the cutting head from one position to the other. The design and construction of such machines becomes very difficult and complicated.

According to the present invention there is provided a machine which continuously cuts intersecting kerfs in the working face of the coal and breaks away the solid coal between the intersecting kerfs. Thus it can continuously cut and break away the coal as it advances into the mine. The coal which is cut and broken away is gathered up and discharged at the rear of the machine. The machine will operate in coal seams of different heights, and it is so constructed that it will cut an areaway as it is advanced, substantially wider than the projected front area of the machine, whereby there is a working clearance in the mine at each side of the machine back from the cut-

2

ting head, giving adequate room for operating and maneuvering the machine and for the operator to work around the machine, and where necessary, posts can be set alongside the machine close to the working face, and adjustments and repairs can be made.

My machine is characterized essentially by the provision of a cutter head carried on a forwardly-projecting boom so that it may be moved up and down in a vertical arc over the working face. The cutter head itself comprises a series of cutters, preferably rotary cutters, with means for traversing the cutters back and forth in a horizontal direction as the cutters rotate, whereby a series of intersecting kerfs is cut into the working face with substantially "diamond-shaped" lands or areas between the intersecting kerfs, and as the operation progresses, these lands break out. Part of the coal is therefore removed by cutting, while a high percentage of it is removed by breaking. The machine operates continuously because the cutting of the intersecting grooves is effected automatically by the back and forth movement of the cutters as the cutters are rotating. Because the cutters move sidewise as they rotate, the total area over which the cutters operate is substantially wider than the projected area of the cutting head itself, whereby the additional clearance at each side of the machine is gained.

The principal objects of my invention therefore are to provide a mining machine designed to continuously cut intersecting kerfs or grooves in the working face of the coal, and thereby effect removal of the coal, and to provide a machine in which the area over which it is effective, is substantially wider than the projected area of the cutting head itself to provide adequate clearance at each side of the machine. The invention has various other objects and advantages which will hereinafter more fully appear.

My invention may be more fully understood by reference to the accompanying drawings, which illustrate a present preferred embodiment of my invention, and in which:

Fig. 1 is a side elevation of a machine constructed in accordance with my invention, and the broken lines at the right-hand end of the figure indicate the manner in which the cutter works in the coal seam;

Fig. 2 is a top plan view of Fig. 1;

Fig. 3 is a transverse section taken on the line III—III of Fig. 2 through a part of the cutter head, showing the cutters and the drive for the cutter shaft on a somewhat larger scale;

Fig. 4 is a longitudinal section in substantially the plane of line IV—IV of Fig. 3, but on a larger scale, showing the cutter drive;

Fig. 5 is a transverse section in the plane of line V—V of Fig. 2, showing the mechanism by which an oscillating or back and forth movement is imparted to the cutters;

Fig. 6 is a detail view of the drive mechanism at the rear end of the boom;

Fig. 7 is a transverse section in the plane of line VII—VII of Fig. 6;

Fig. 8 is a fragmentary view showing the front of a single cutter, the view indicating the cutter in the process of cutting the coal;

Fig. 9 is a side view of one of the cutters;

Fig. 10 is a front view thereof on a larger scale than Fig. 8;

Fig. 11 is a more or less schematic perspective view of the entire machine, certain parts of the machine being omitted and other parts being conventionally illustrated, in order to more fully shown the overall aspects of the machine;

Fig. 12 is a more or less schematic view showing the manner in which the cutting disks move first into the upper part of the coal seam and then work down, pulling and tearing the coal as the downward movement progresses;

Fig. 13 is a more or less schematic view looking at the face of the coal, showing the manner in which the cutters operate to form diagonally intersecting kerfs in the face of the coal; and

Fig. 14 is a schematic view tracing the movement of the cutters.

The general organization and assembly of the machine

may be best seen by reference to Figs. 1, 2 and 11. The machine as thus illustrated has a chassis designated generally as 2, with a front axle 3 having wheels 4 thereon, this axle being a power-driven fixed axle. At the rear end of the chassis there are swiveled wheels 5 which, as indicated in Fig. 2, can be turned for steering and maneuvering the machine. Rubber tired wheels are preferably used for the reasons hereinafter noted.

At the front of the machine there is a forwardly and downwardly-inclined apron 6 along the center of which is a conveyor chain 7 that passes around a sprocket 8 at the forward tip of the apron. This conveyor extends upwardly and rearwardly and travels along a horizontal trough 8a. At the rear of the horizontal trough 8a there is a swiveled extension 9 that can be raised and lowered, or moved from side to side, the conveyor being of a known construction, and forms no part of the present invention per se. The sides of the conveyor trough are made flexible adjacent the hinge point of the conveyor so as to permit the required movement, as is well understood in the art. There is a sprocket 10 at the end of the extension 9 around which the conveyor chain passes. The conveyor as shown in Fig. 2, where a fragment of the chain is illustrated, preferably comprises a single central chain 11 having laterally-extending flights 12, these flights moving the coal along the surface over which they travel.

The inclined apron 6 is provided with a hydraulic jack 13 by means of which it can be raised and lowered within limits. The apron itself has flared side portions 14. The sprocket 8 is on a shaft 15 that extends across the nose of the apron, and it has reversely arranged screw conveyors 17 and 18 thereon, the function of which is to move coal at each side of the central conveyor inwardly toward and onto the conveyor. Foldable auxiliary gathering elements are indicated at 19 at each side of the apron (see Fig. 2).

According to the present invention, there is provided a boom structure designated generally as 20 that projects forwardly over and beyond the apron, and which pivots about the axis of a shaft 21. This boom, which is formed of a casting, or of metal plates, is arranged to be raised and lowered by means of hydraulic jacks 22 located at each side of the boom forwardly of the front axle of the machine. Mounted on the boom and projecting forwardly therefrom are two like structures or carriers 23, which are of generally triangular shape with the apex of each triangle at the rear of the structure, the apex of each structure being pivotally engaged with a fixed pivot pin 24 on the top surface of the boom, whereby they may be oscillated from side to side over the top face of the boom. At the forward end of each of the structures 23 are forwardly-projecting arms 25 forming a support for a shaft 26. Each member 23 also has a housing 27 intermediate the two arms 25 for enclosing the drive gear for the shaft 26 as hereinafter more fully described. The shaft 26 has a series of spaced cutter disks 28 thereon, which disks will be hereinafter more fully described. I have shown four cutters on each shaft, but this may be varied, a plurality, however, being desired.

According to the general plan of operation of the machine, the two shafts 26 are simultaneously rotated to rotate the cutter disks 28. At the same time the carriers 23 are oscillated in a generally horizontal direction so that the cutter teeth have a compound motion in the face of the coal as will be hereinafter more fully explained, and by reason of such compound movement, criss-cross diagonal kerfs are formed in the face of the coal. As the cutting progresses, the coal breaks out, falls to the ground where it is gathered by the apron and conveyor, and carried back over the machine and dumped into a car or other receptacle. In the preferred method of operating the machine, the boom 20 is tilted upwardly in the manner indicated in the dotted lines in Fig. 1, and as the cutter disks rotate and are moved sideways back and forth, the machine is moved slowly forward on its rubber-tired wheels into the coal seam, at the top as shown in Fig. 12, this being what I term the "sumping cut." This cut is continued to a depth preferably roughly approximating the diameter of the cutting disks. In Fig. 12, C designates the coal and S the sumping cut. When the forward cutting has progressed to the depth above indicated, the forward travel is stopped and the cutter head is caused to move down, cutting into the bottom of the

sumping cut and ripping and digging the coal out. The coal falls toward the front of the machine as it is ripped and broken out. When the cutters reach the floor level, the machine is backed away, the cutter head raised, and the cycle repeated.

With this general description of the machine and its manner of operation, the details of one present preferred construction may be more fully explained and more easily followed.

The main drive for the cutters and the conveyors is provided by two motors located on the boom, one at each side of the center line. It is contemplated that each of these motors may be of 60 H. P. although this may be changed from time to time. The motors are more or less schematically illustrated, and they are designated 30. The rear end of each motor shaft is connected through a flanged coupling 31 with a shaft 32 on which is a worm gear 33, the details of which are shown in Fig. 7. The worm gear 33 at each side of the machine is located in a housing 34 and each worm gear engages a worm wheel 35 at the end of a transverse shaft 21. In this way the two worms are connected together and operate in synchronism. As shown in Fig. 7, the shaft 32 is supported in conical bearings to take both the end thrust and the radial thrust on the shaft 32. The shaft 21, as best shown in Fig. 6 is not a continuous shaft, but is comprised of three sections designated 21a, 21b and 21c, the shafts 21a and 21b having the worm wheels 35 thereon, and having splined ends that engage in the mid-section 21c. The midsection 21c has a sprocket wheel 21d thereon over which the bottom reach of the conveyor chain passes so that the motors 30 are not only connected to each other through the shaft assembly 21, but power is transmitted to the conveyor chain through this arrangement. A chain tensioning sprocket 21e is shown in Fig. 1 forwardly of the sprocket 21d.

The boom 20 has vertical side plates 20a thereon (see Fig. 6), which side plates have bearing elements 20b that are concentric with the shaft 21, and as shown in Fig. 6, the gear housings 34 are bolted to these hub sections 20b. The bearing portions 20b surround bearing retaining hubs or housings 36 on a part of the machine frame, these housings 36 having bearings 37 therein for the shaft sections 21a and 21b respectively. It is through this structure that the boom is rigidly mounted on the frame of the machine and arranged to swing up and down about the axis of the shaft 21, as hereinbefore mentioned. In operation, the cutters are held against the working face of the coal with great pressure, and this bearing arrangement provides a mounting designed to resist the thrust, and at the same time it enables the motors which drive the cutters, as hereinafter explained, to be mounted on the boom, and also to drive the conveyor chain on the chassis of the machine.

The forward end of each motor 30 is connected by a universal coupling 38 with a connecting shaft 39, and the shaft 39 has a universal joint or coupling 40 at its forward end through which it is connected to a short shaft 41 (see Fig. 4). The shaft 41 has a spur gear 42 thereon which in turn meshes with a spur gear 43 (forming part of a friction clutch assembly designated generally as 44) through which motion is transmitted to a shaft 46 extending rearwardly from the clutch, and shaft 47 extending forwardly from the clutch, the spur gear being effective to drive the shaft 46 continuously. The clutch provides a yielding connection or safety friction in the drive which absorbs sudden shock or heavy strains which might otherwise injure the mechanism, although overload controls on the motors are also provided to protect the machine. The clutch per se forms no part of the present invention. The shaft 47 at each side of the machine has a worm 48 thereon meshing with a worm wheel 49 on the transverse cutter shaft 26. The shaft 41, the spur gear 42, the gear 43, and the shafts 46 and 47 are all enclosed within a housing on the oscillating member 23, with which these parts are associated.

The shaft 46 has a worm 50 thereon. This worm meshes with a worm wheel 51 (see Fig. 5) which is horizontal and which is on a short vertical shaft 52. At the top of the shaft 52 is a disk 53 that carries an eccentric pin 54. One end 55 of a link 56 engages the pin 54, and the other end of the link 56 is secured to a fixed pin 57 at the center of the boom. There is of course a duplication of this mechanism on each side of the

machine so that there are two of the links 56 connected with the single pin 57 as may be clearly seen in Fig. 2.

When the motors 30 are operated, they drive the cross shaft 21 in the manner previously indicated to operate the conveyor chain. Also each motor drives its shaft 39 which transmits motion through universal joint 40 to the shaft 41 to drive the spur gear 42. This in turn drives the shafts 46 and 47. The motion of shaft 47 is transmitted through the gearing described to revolve the group of cutters forming the cutting head of one side of the machine. The shaft 46, driving the disk 53 with its eccentric pin 54 at the same time causes the frame member to be oscillated in a generally horizontal plane, or from side to side about its pivot 24. Thus as the motors are operated, the cutting disks 28 which operate in a vertical plane are simultaneously caused to travel sideways. The universal joints 40 and couplings 38 allow the arcuate movement of the units 23 relative to the driving motors, while transmitting power from the driving motors to the respective mechanisms on the oscillating frames.

In the preferred embodiment of the machine as I have described it, the cutting head is formed of two series of cutters, one on one of the members 23, and one on the other of these members. The operating mechanism just described causes these two members to move simultaneously in opposite directions, so that the sidewise thrust on the machine is equalized. If the two heads moved simultaneously in the same direction, or if there were a single head instead of a divided one, it is apparent that while the machine would operate satisfactorily, there would be a reaction tending to move the chassis one way or the other opposite to the direction in which the cutters were moving. As above stated, by having two heads moving simultaneously in opposite directions, such side thrust is equalized.

Since the motors 30 drive the conveyor chain 7, and since the conveyor passes around the sprocket wheel 8, the motors 30 thus also serve to operate the gathering screws 17 and 18 at each side of the apron.

In the drawings, the controller for the motors 30 is schematically indicated at 58. For propelling the machine forwardly, there is a smaller motor 59 under the conveyor which operates a pair of hydraulic pumps at opposite ends of the motor shafts; one of which pumps is designated 60 and creates pressure for operating the various hydraulic jacks, while the other, designated 61, operates to drive the wheels 4 through a hydraulic transmission (not shown). A series of control levers is schematically indicated at 62 for controlling the various hydraulic functions of the machine. An oil tank, located at the rear of the machine and schematically indicated at 63, contains the necessary oil for the hydraulic system of the machine.

The various hydraulic mechanisms and transmissions are well known in the art, and form no part of the present invention, per se, and for such reason have been only schematically illustrated, and only to the extent necessary to enable the general organization of the machine to be understood.

The cutting disk 28 may be of any preferred construction, but as shown in Fig. 3 these cutting disks preferably have a hub 28^a which is keyed to the shaft 26. Extending out from the hub is a web 28^b, the periphery of which is preferably rabbeted as shown, for interfitting engagement with the cutter teeth carriers 28^c which are secured thereto at regular intervals by bolts that pass transversely through the base of the carriers and the periphery of the disk. At the outer end of each carrier 28^c on the forward or leading edge thereof is a recess into which is fitted a bit holder 28^d from which project the cutter bits 28^e. A bolt 28^f is employed to secure the cutter block in the recess. The cutter itself may be of any desired shape, but as shown in Figs. 8 and 10, it may have three diverging prongs so that the overall width of the cut is somewhat wider than the width of the outer end of the carrier 28^c. The carrier is preferably formed with bulges 28^g at each side thereof, the purpose of which is to exert a pressure laterally on the coal at each side of the cut as indicated in Fig. 8. Since parallel cuts are being formed in the face of the coal, the unsupported areas of the coal between adjacent cutters is thus subjected to pressure tending to break this part of the coal away. In Fig. 8, C designates the coal, and the manner in which the cutting and breaking takes place is clearly illustrated.

There may be any desired number of cutting bits, depending upon the diameter of the disks and upon other factors including the character of the coal or other material that is being cut, and the amplitude of the sidewise sweep or oscillation of the cutter heads. In the operation of the machine, it is brought into the mine in position against the working face of the coal or other material to be mined. At the start of the operation, the boom 20 is elevated so that the periphery of the cutters will move in a circle, the top of which is substantially tangent to the top of the coal seam. With the motors 30 operating, the cutters dig into the coal, and as they dig in, the frames 23 oscillate so that each cutter moves through a diagonal path at the working face of the coal. If the machine is so geared that the frame 23 makes one complete oscillation for each rotation of the cutter shaft, half of the cutters on a given disk will cut a kerf which is inclined in one direction, while the other half will cut a kerf which is inclined in the reverse direction, thereby cutting intersecting kerfs with diamond-shaped lands in between. The action of the cutters can be seen by reference to Fig. 13 showing the wall at the face of the sumping cut where there are intersecting kerfs with diamond-shaped lands between. In Fig. 14, the pattern formed by a single cutter disk having six teeth is diagrammed. Line *a-a* is the path traversed by one tooth which may be designated No. 1, and line *d-d* is traced by the No. 4 tooth. Line *b-b* is traced by tooth No. 2 and line *c-c* is traced by tooth No. 3, it being understood that the teeth are numbered in a counter-clockwise direction.

The movement of the cutters may perhaps be better visualized if we assume first that each disk has only a single cutter thereon, and that its carrier 23 makes one complete oscillation for one complete rotation of the cutter disk. Starting at the top of the cut, the single tooth would move downwardly through a vertical arc and at the same time it would be carried sidewise so that it would trace a single diagonal line over the face of the coal. When the cutter had been carried through an arc of 180° and was at the bottom of its travel, it would then travel upwardly in a vertical arc entirely out of contact with the coal. At this time the carrier would be shifting horizontally in the opposite direction, and when the cutting tooth was around to its starting position at the top of the face of the coal, it would register exactly with its position at the beginning of the cycle. However if there be two cutters 180° apart, and the same gear ratio remains, one tooth will form a diagonal cut in one direction. When the second tooth comes into position to operate, the frame 23 will have reached the limit of its travel and start to reverse, therefore the second bit will travel a line which is a diagonal that crosses the first one, and the two teeth will describe a kind of an X-shaped mark on the face of the coal. With six teeth the pattern shown in Fig. 14 results.

It will be noted first that as the cutting head moves down after completing the sumping cut, the cutters are working not only against the face of the coal but on the coal at the bottom of the sumping cut, tearing and ripping it out.

As before stated, the operation is commenced by starting with the boom elevated. Then as the cutting proceeds, the boom is lowered so that the cutting head or heads eventually sweep down one below another in the manner described. The coal that is dug out by the cutters, and the coal that is broken out in this way, all falls to the floor of the mine. The teeth on the cutting disk, when the boom is dropped to its lowest position, aids in pushing the coal which has thus fallen down back onto the gathering apron and conveyors, and other coal is picked up by this apron and the conveyors as the machine shoves forward over the bottom of the mine. As previously indicated, the coal is carried up and discharged into a suitable receiving device at the rear of the continuous mining machine.

It will be seen that since the cutters move laterally as they cut into the coal, the swath or width of the tunnel formed by the machine and penetrating the coal will be substantially wider than the projected width of the machine itself. If each head swings through a maximum distance of 15 inches at the cutting face, the tunnel will be 30 inches wider than the machine. This gives plenty of room for a workman to get up to the cutting head if necessary, and gives room to maneuver the machine.

While other types of cutters, as for example short-chain cutters, might be used in place of disks at the forward end of the boom, I prefer to use the disk cutters illustrated, because they are simple in construction, they are solid, and they can be forced with pressure against the coal. It has heretofore been noted that each of the wheels of the machine is rubber tired, the tires preferably being pneumatic tires. Rubber tired wheels are preferable to solid wheels or Caterpillars because they will allow for some yield or give of the machine and cutting head when it is operating, and this is of assistance in breaking out the coal.

Various coals break better under different conditions of operation, and the present invention provides a machine which is easily adjusted to different types of coals or other material. For example, the speed of oscillation or amplitude of oscillation of the carriers 23 can be changed by replacing disk 53 with a disk having the eccentric pin 54 closer to, or further away, from the center. Adjustment for different conditions can be provided by changing the number of teeth on the cutting disks themselves, and depending upon where the machine is to be used, the designer can change the ratio of the worm gears 50 and 51 to the ratio of the worm gears 48 and 49, so as to change the rate of oscillation of each head with respect to the speed of rotation of the cutters. In other words, the same machine can be arranged by very simple modification of the gearing, so that each frame 23 will oscillate through one full cycle for each revolution of the cutter shaft 26, or there may be several revolutions of the cutter shaft 26 before a full cycle of oscillation of each frame 23 has been effected. My invention therefore provides a continuous mining machine which, as long as it is operating, continuously cuts and breaks out the coal. It provides a machine in which the working face of the coal is cut by intersecting diagonal kerfs creating a condition favorable to the easy breaking out of the coal. It provides a machine of a simple, durable and rugged construction, which can be readily changed to meet the conditions encountered in any particular kind of coal or other material to be mined, and which digs an entry or tunnel substantially greater than the projected area of the machine, so that working clearance is always available, and the machine can be maneuvered around corners and can dig its way around corners, which is an important advantage.

While I have illustrated and described one particular embodiment of my invention, it will be understood that this is by way of illustration, and that various changes and modifications may be made in the invention, and that the invention is not restricted to the specific construction and arrangement of parts illustrated, but the same manipulation of the cutters can be secured by other mechanisms which are fully equivalent for the purpose, and which will be apparent to those skilled in the art.

I claim:

1. A continuous mining machine having two cutting heads at the forward end thereof for making a section cut in a mine vein substantially wider than the combined width of the two cutter heads, comprising a group of horizontally spaced vertical rotary cutting disks in each head with the heads connected for simultaneous sidewise oscillation, means for rotating the cutting disks, means geared to the cutter rotating means for simultaneously oscillating the two groups of rotary cutters in opposite sidewise directions with an amplitude to cut criss-crossing kerfs in the face of a mineral vein during a complete oscillation of a cutter head.

2. A mining machine having a chassis, a vertically movable boom projecting forwardly from the chassis, a pair of cutting heads mounted on the boom each comprising a carrier with a group of horizontally spaced vertical cutting disks connected for simultaneous sidewise oscillation, means for rotating the cutting disks, means geared to the cutter rotating means for simultaneously oscillating the groups of cutting disks in opposite sidewise directions with an amplitude to cut criss-crossing kerfs in the face of a mine vein during a complete oscillation of a cutter head, and means for raising and lowering the boom to carry the cutters through a vertical movement while they simultaneously make the sidewise cuts.

3. A continuous mining machine comprising a chassis,

a boom structure at the forward end of the chassis movable through a vertical arc, a pair of carriers mounted on the boom projecting forwardly therefrom and interconnected for simultaneous sidewise oscillating movement, a group of horizontally spaced vertical cutting disks on each carrier, means for oscillating the carriers simultaneously back and forth opposite to each other, means for raising and lowering the boom independently of the carrier-operating mechanism, and means geared to the carrier-oscillating means for rotating the cutting disks on the carriers to make a complete revolution while the carriers make a complete oscillation.

4. A mining machine comprising a chassis, a vertically movable boom projecting forwardly from the chassis, a pair of cutter carriers pivotally mounted to extend over the front end of the boom, a group of horizontally spaced vertical cutters rotatably mounted in each carrier, connections between the carriers for simultaneously oscillating the carriers in opposite sidewise directions, a common driving means for rotating the cutting disks and for oscillating the carriers with an amplitude to cut criss-crossing kerfs in the face of a mine vein during a complete oscillation of a carrier.

5. A mining machine as defined in claim 1 wherein each disk has a series of spaced cutter holders thereon on which are mounted cutter bits, the cutter bits each having rounded thickened portions inwardly from the outer ends thereof for exerting lateral impact pressure against coal through which the cutters are moving.

6. A mining machine comprising a chassis, a boom projecting forwardly from the chassis and mounted thereon for movement in a vertical arc, said boom having a supporting structure at its projecting forward end, and a carrier pivotally supported on the supporting structure for movement in a horizontal plane, said carrier having a shaft at the outer end thereof remote from the pivotal mounting of the carrier and beyond the end of the supporting structure, said shaft having a series of wheel-like cutters with teeth on the periphery thereof, means for moving the boom up and down, means for rotating the shaft, including a motor, drive shaft and gearing, an eccentric on the carrier driven by said driving means, a thrust link engaging the eccentric at one end and fixed at its other end to the boom whereby the driving of the cutters effects an oscillating movement of the carrier.

7. A mining machine as defined in claim 6 wherein the motor is on the chassis, the last-named shaft has a universal joint to enable it to flex with the movement of the boom up and down and with the movement of the carrier back and forth, and the gearing and eccentric are housed in the carrier.

8. A mining machine comprising a chassis, a boom projecting forwardly from the chassis, means for moving the boom up and down in a vertical arc, a pair of generally triangular carriers pivoted at their apices to the boom and having their ends projecting beyond the end of the boom, one of said carriers being at each side of the longitudinal center of the boom, a shaft at the outer end of each carrier having a plurality of spaced cutter disks thereon, a driving means for rotating both cutter shafts, an eccentric crank on each carrier rotated by said driving means, and a fixed link attached to each crank and having its one end fixed to the boom whereby the carriers are caused to oscillate when the cutters are rotated and in predetermined relation thereto.

9. A mining machine as defined in claim 8 in which the cranks on the two carriers are 180° out of phase so that said carriers are operated in opposite directions.

10. A mining machine comprising a chassis, a boom projecting forwardly from the chassis, means for moving the boom up and down in a vertical arc, a pair of cutter carriers pivoted to the boom and having their ends projecting forwardly from the boom, one of said carriers being at each side of the longitudinal center of the boom, an eccentric mounted on each carrier having a link connected therefrom to a fixed pivot on the boom, a shaft at the outer end of each carrier having a plurality of horizontally spaced cutter disks thereon, and a common driving means for rotating said shafts and eccentrics for oscillating said carriers about their pivots in a predetermined relation to the rotation of the cutters.

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9

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