May 4, 1954 F. CARTLIDGE 2,677,537

MINING MACHINE HAVING DIGGING ARMS WITH IMPACT MEANS

Filed June 1, 1950 9 Sheets-Sheet 1

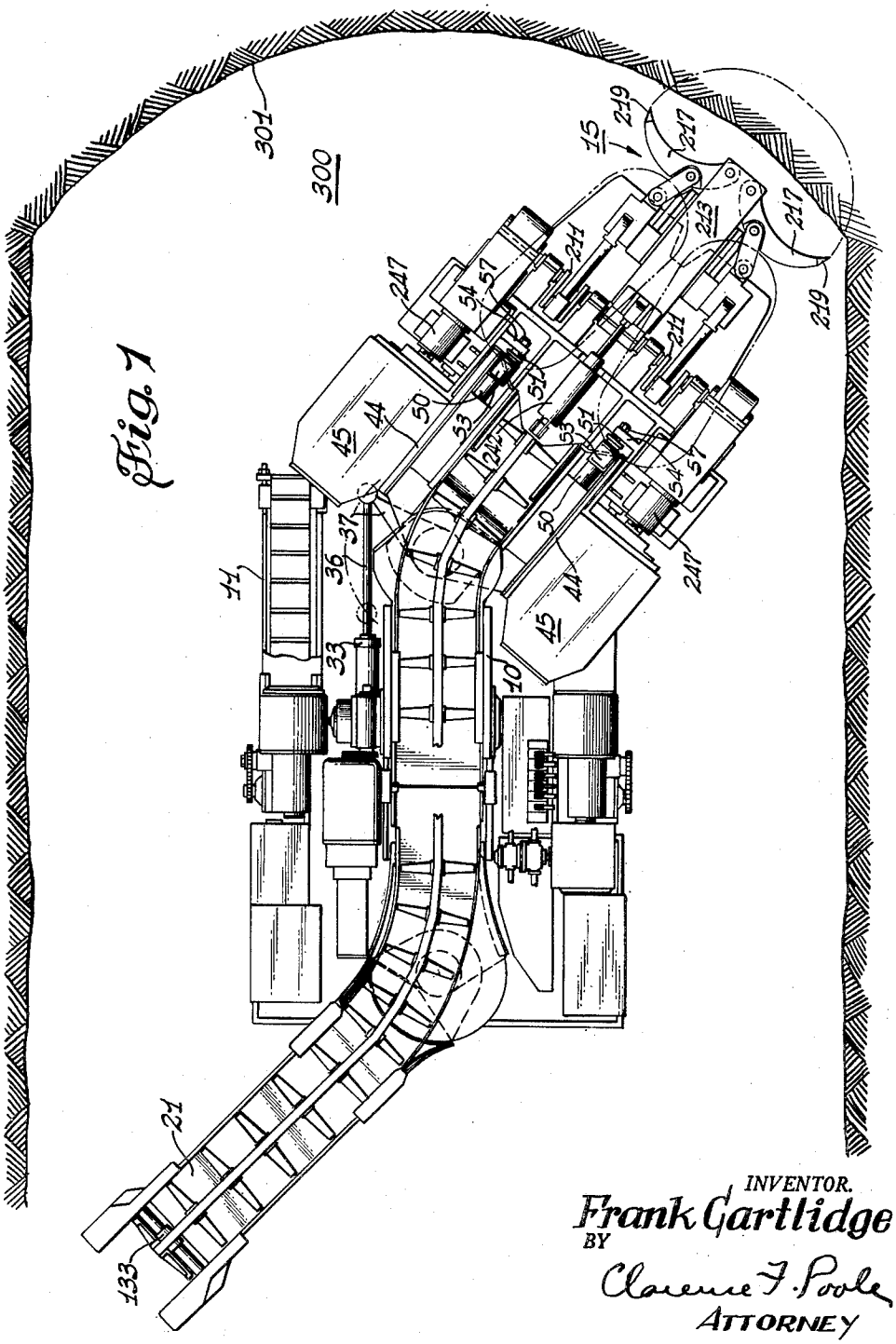


Fig. 1

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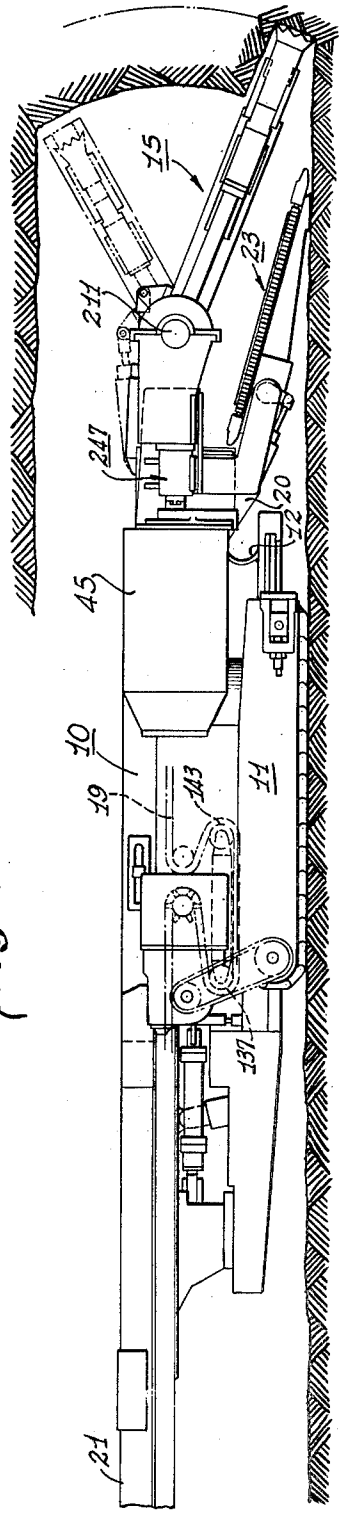


Fig. 2

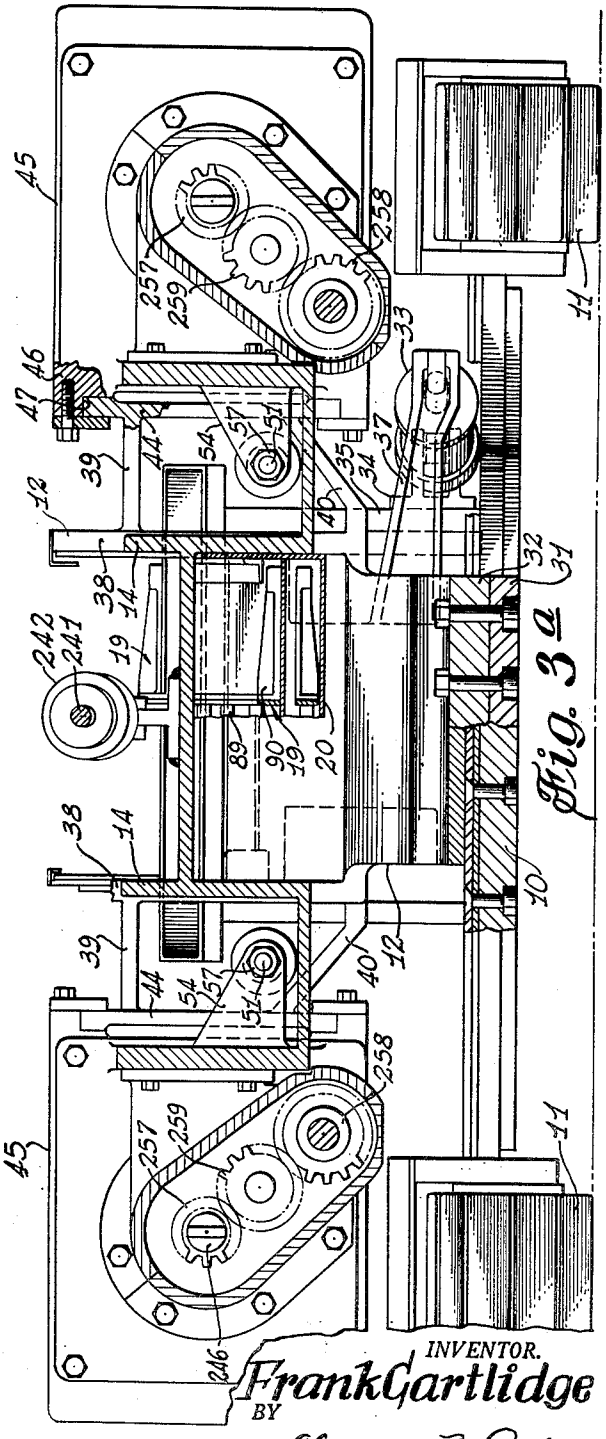


Fig. 3a

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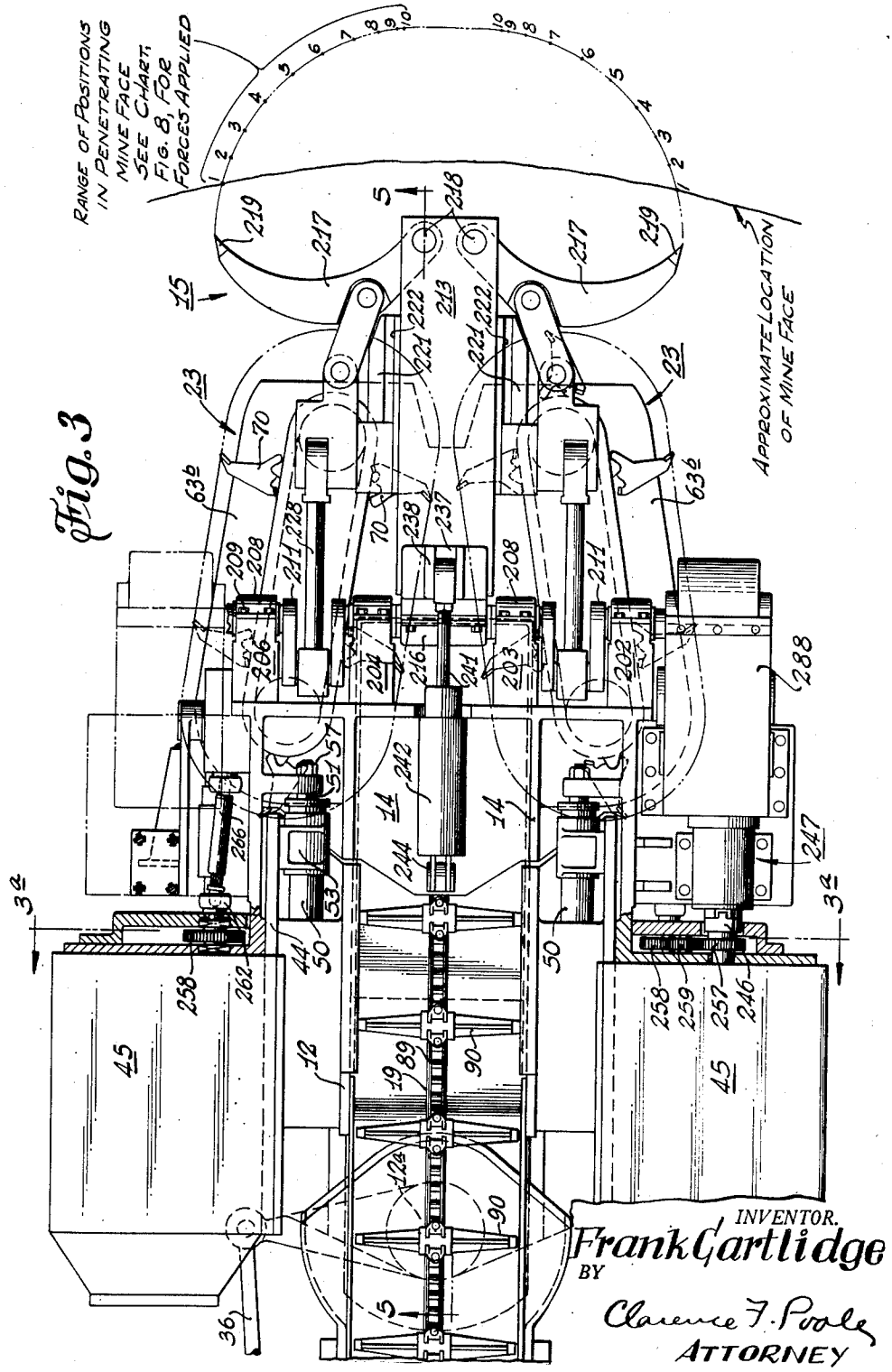


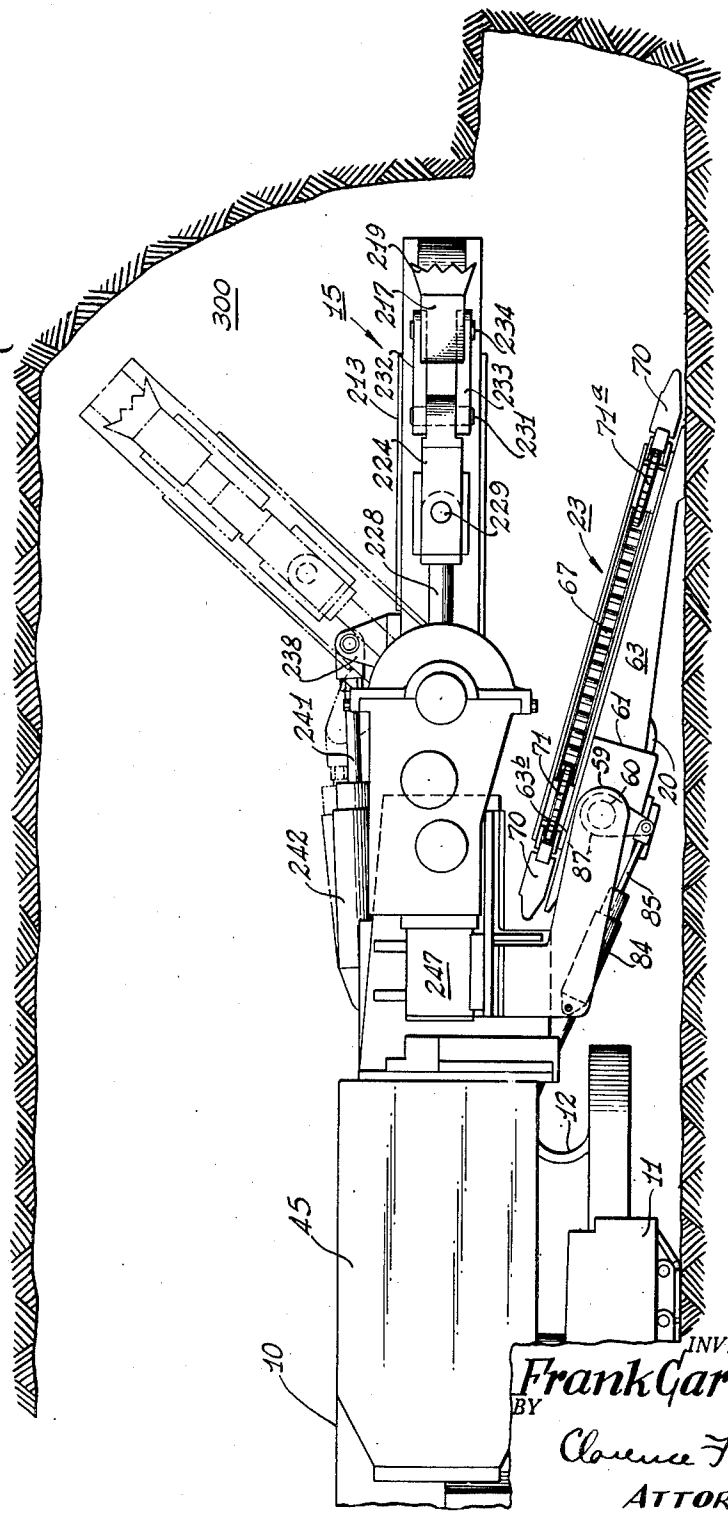
Fig. 3

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MINING MACHINE HAVING DIGGING ARMS WITH IMPACT MEANS

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Fig. 4



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Fig. 5

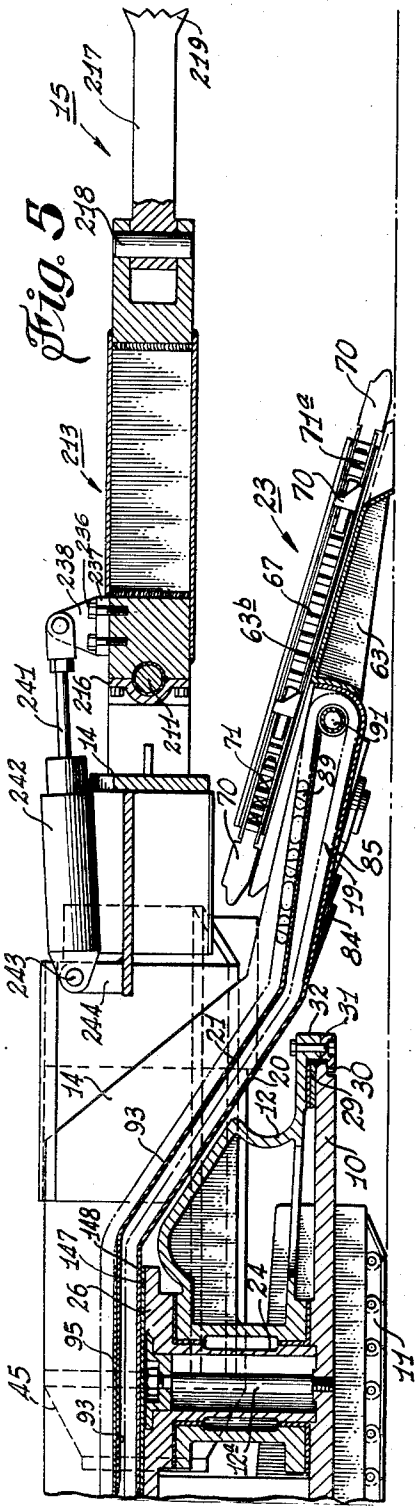
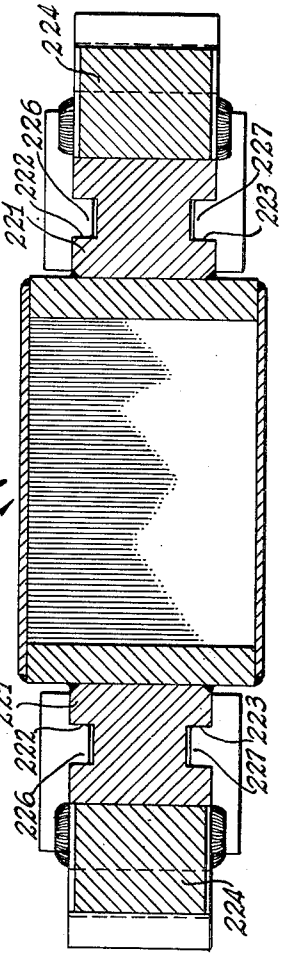


Fig. 6a



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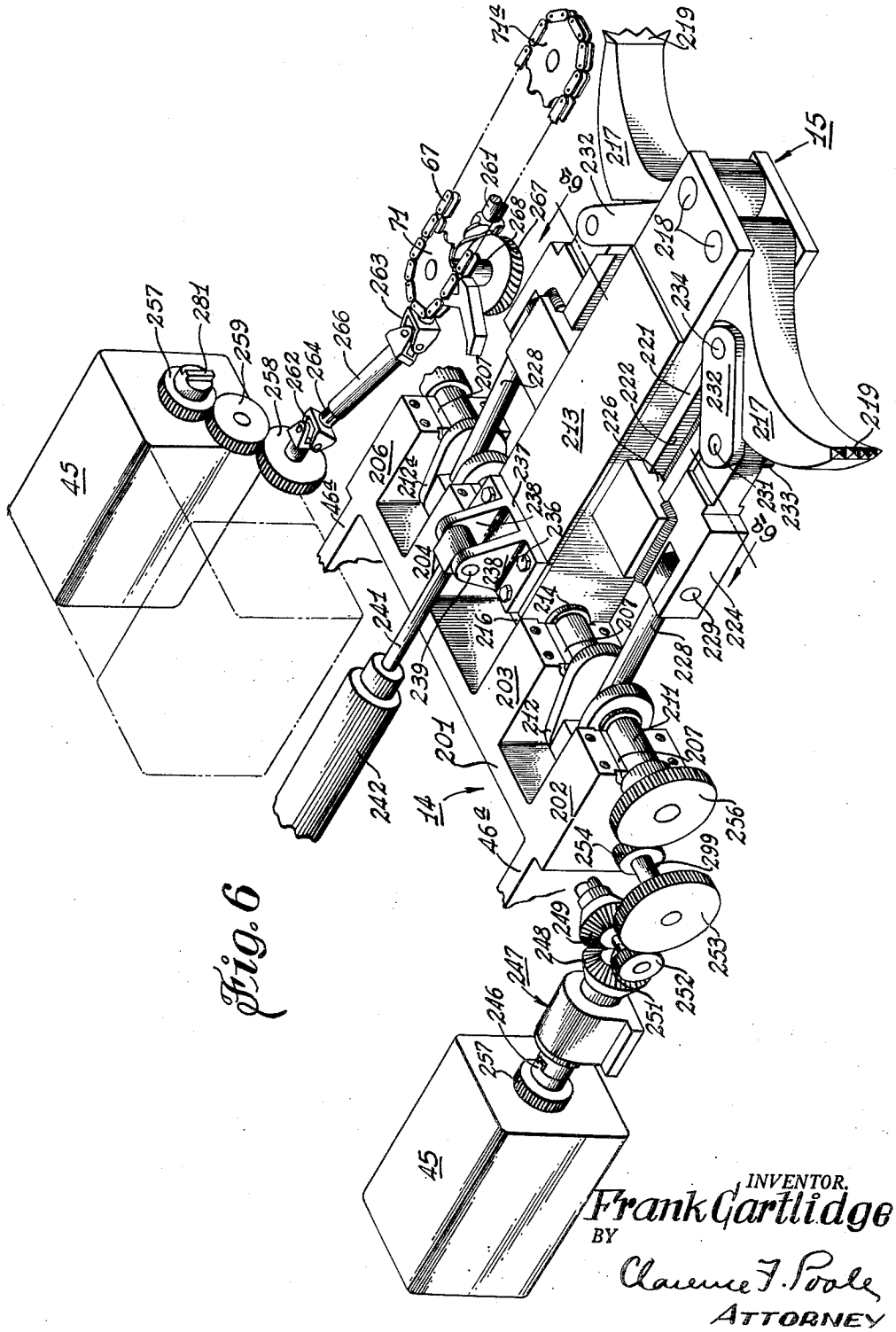


Fig. 6

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MINING MACHINE HAVING DIGGING ARMS WITH IMPACT MEANS

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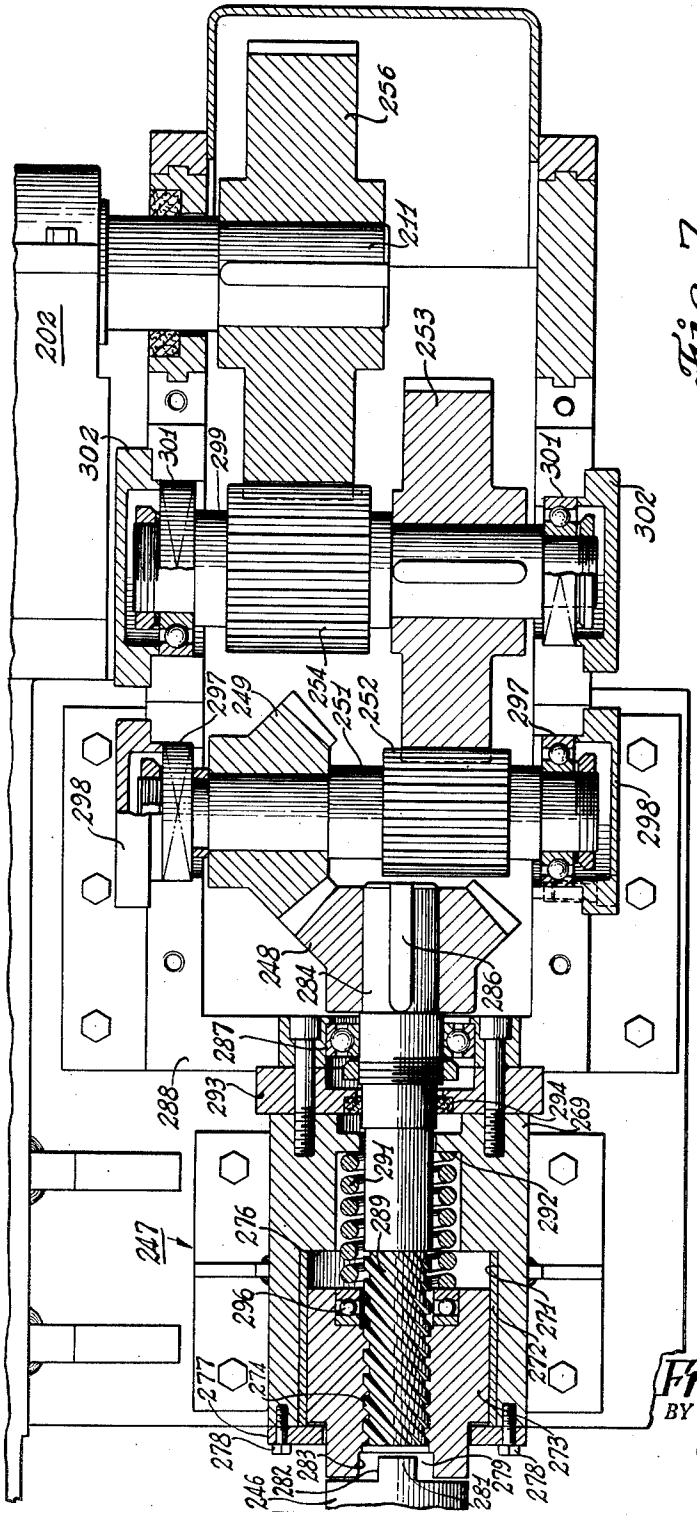


Fig. 7

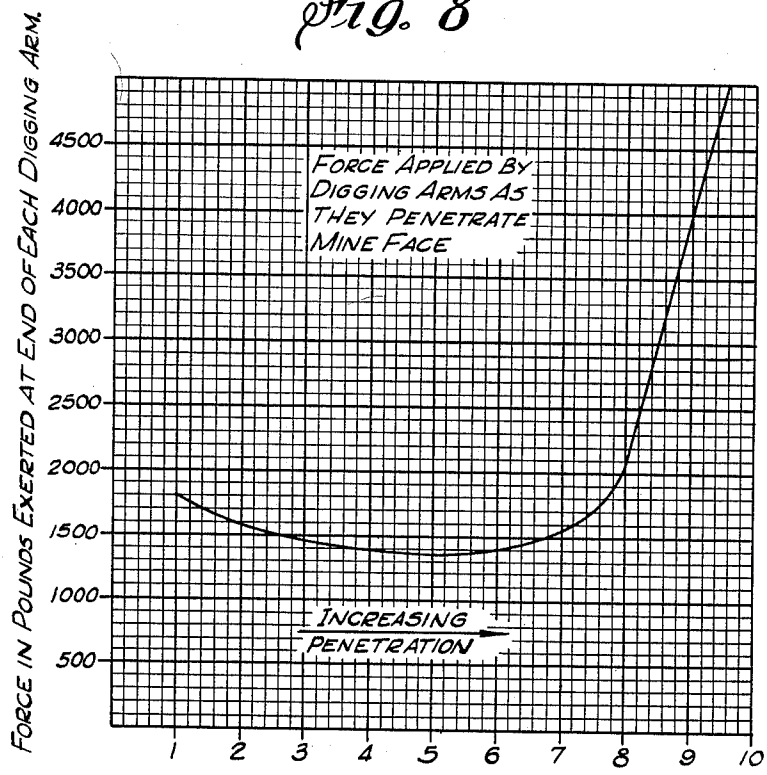
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Fig. 8



POSITIONS OF DIGGING ARMS THROUGHOUT RANGE SHOWN IN FIG. 3

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MINING MACHINE HAVING DIGGING ARMS WITH IMPACT MEANS

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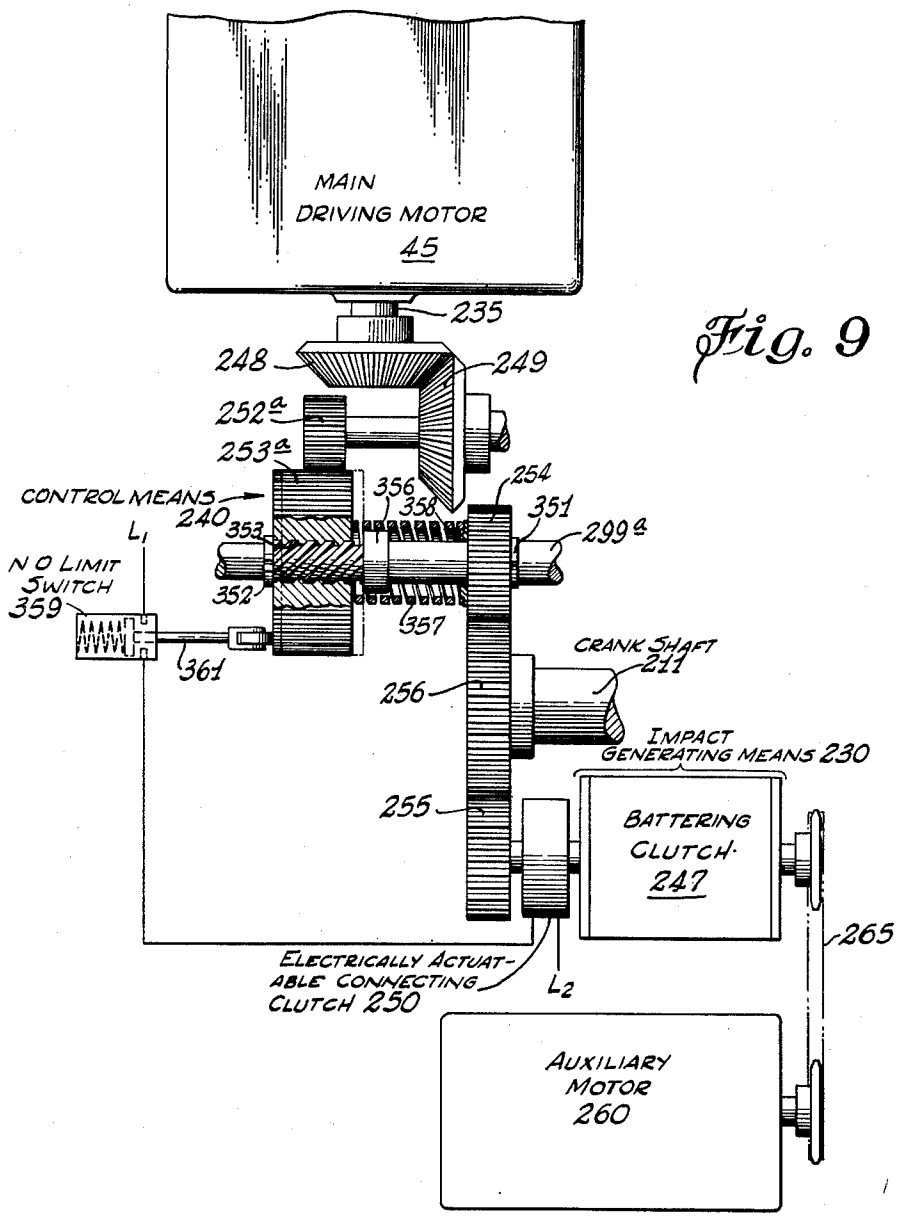


Fig. 9

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2,677,537

UNITED STATES PATENT OFFICE

2,677,537

MINING MACHINE HAVING DIGGING ARMS WITH IMPACT MEANS

Frank Cartlidge, Chicago, Ill., assignor to Goodman Manufacturing Company, Chicago, Ill., a corporation of Illinois

Application June 1, 1950, Serial No. 165,506

18 Claims. (Cl. 262—13)

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This invention relates to an improved mining machine for the continuous cutting and dislodging of coal, salt, ore and the like directly from a soild mine face without the usual undercutting, shooting and loading operations.

A principal object of this invention is to provide a new and improved form of combined mining and loading machine capable of producing more lump material and utilizing less power for the amount of material mined than with former mining and loading machines. In this connection the improved machine comprises a pair of cooperating digging elements which are pivotally mounted on a mobile frame for simultaneous swinging movement toward the mine face to remove material in a manner which might be compared with the operation of a pair of tongs or pincers driven into the mine face, thereby cutting and dislodging material in large lump sizes and with a minimum of fines or dust.

Previous attempts to carry out direct mining operations by tong- or pincer-like arrangements have met with failure when applied to mining of hard materials such as coal, ore and salt because of failure to appreciate the proper method of applying power to the digging elements.

In the present invention, as graphically portrayed in Figure 3, power is utilized most effectively by application through eccentric means such as a crank or cam shaft which applies an increasing force to the digging elements as they are driven into the mine face. An ancillary feature includes the provision of impact mechanism which goes into operation automatically to apply a series of hammer blows to the digging elements whenever they are stalled, or about to be stalled, by resistance in the mine face.

A specific object is the provision of batter clutch means in the drive for the digging elements which is normally inoperative but goes into operation automatically responsive to a predetermined abnormal reaction between the mine face and the digging elements to store driving energy and release it in a series of sharp impacts to overcome the abnormal resistance met in the face.

Another object, broadly, is the provision of driving means for the digging element or elements which will apply a series of hammer blows to the digging element(s) whenever resistance to digging exceeds a predetermined value.

Another object is the provision of driving means so arranged that the hammer blows will be applied to the digging elements in simultaneous timed sequence to facilitate straight-line advance of the digging elements into the

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mine face. Without this arrangement, if the hammer blows were permitted to be struck first on one element and then on the other, power would be wasted in slewing the head of the machine ineffectively in one direction or the other.

A further object is the provision of driving means for the digging elements in which a single driving member, herein specifically disclosed as a crank shaft or cam, is utilized to actuate both digging elements so they will swing forward and backward in positively simultaneous, timed sequence whereby the machine will dig straight ahead and not slew off toward one side or the other.

A still further object is the provision of a mining machine of the character described in which the tong-like digging elements are mounted on an auxiliary frame which itself is mounted for extensible and retractible movement with respect to the main frame so the digging elements may be fed into the mine face while the main frame is stationary—this being distinctly advantageous in that it provides a fixed platform, stable irrespective of roughness in the floor surface, for driving the digging elements into the face.

Another object is the provision of a combined mining and loading machine having concurrently swingable digging arms mounted on a portable main frame for universal movement, including forward and backward movement, up and down movement, and side to side movement, whereby an entire mine face may be mined out without tramming the machine forward or sidewise.

Other objects and advantages of the present invention will appear in the following description taken in connection with the drawings in which:

Figure 1 is a plan view of a continuous cutting and loading machine employing one embodiment of the present invention;

Fig. 2 is a side view of the machine shown in Fig. 1;

Fig. 3 is a fragmentary enlarged view of Fig. 1 showing more particularly the forward part of the machine constructed in accordance with the present invention;

Fig. 3*a* is a cross-sectional view of Fig. 3, taken along line 3*a*—3*a*;

Fig. 4 is a side view of Fig. 3;

Fig. 5 is a longitudinal sectional view of the loading end of the machine, as seen along the line 5—5 of Fig. 3;

Fig. 6 is a fragmentary perspective view of the loading machine showing the drives for the digging arms and for the components of the gathering mechanism;

Fig. 6a is a cross-sectional view of Fig. 6, taken along line 6a—6a;

Fig. 7 is an enlarged fragmentary plan view of the arrangement for driving the digging arms and shows the details of the battering clutch means employed to overcome abnormal resistance met by the digging arms;

Fig. 8 is a graphical representation of the increasing force applied by the digging arms as they penetrate the mine face; and

Fig. 9 is a diagrammatic view of another driving arrangement wherein auxiliary motor means is employed for applying a series of hammer blows to the digging elements responsive to a predetermined abnormal reaction between the mining face and one or both of the digging elements; this embodiment differs from that covered by the previous figures in that separate motor means is employed to apply the hammer blows.

General arrangement

Referring now more particularly to the drawings, the general arrangement illustrating the present invention is best shown in Figs. 3, 4, 5 and 6, the remainder of the machine, particularly the rear end, being similar to that disclosed in applicant's prior application, Serial No. 116,684, filed September 20, 1949, which is herein included merely for the sake of disclosing a complete machine serving as an environment for the present invention.

A portable or mobile main frame 10 (Figs. 3 and 4) is suitably mounted on and propelled about the mine by a pair of laterally spaced, continuous tread devices 11. A horizontally swingable intermediate frame 12 is mounted on the forward end of the main frame for pivotal movement about a vertical axis 12a—12a of sleeve 24 (Fig. 5). The intermediate frame 12 has an extensible frame 14 supported and guided thereon for forward and backward movement relative thereto and has the cutting and dislodging arrangement of the present invention, generally designated 15, projecting forwardly therefrom. The arrangement 15 will be described in detail subsequently.

The lower reach of an endless, center-strand chain conveyor 19 is mounted on the machine and runs forwardly in a forwardly and downwardly disposed section 20 (Fig. 5) of the extensible frame 14 and the upper reach runs upwardly and rearwardly from the forward end of that section, then runs backward beyond the main frame 10 over a horizontally and vertically swingable rear discharge end 21 for discharging the mined material into a suitable receptacle, such as a mine car, a rubber-tire-mounted shuttle car or any of the well known forms of conveyors of the type used underground in mines. A gathering mechanism, generally designated 23, is provided at the forward end of the frame section 20 to pick up the mine material from the ground and discharge it onto the receiving end of the conveyor.

For horizontally swinging the front end of the machine, the intermediate frame 12, which carries the extensible frame 14, is pivotally mounted on the upright sleeve 24 which depends from and is herein shown as being formed integrally with an upper plate 26 of the main frame 10, and is recessed within the lower plate of the main frame, all as shown in Fig. 5. The intermediate frame 12 extends forwardly beyond the sleeve 24 along the top of the main frame 10 and is slideably supported for horizontal swinging movement on an arcuate segmental bearing 29 which is carried at the front of the main frame. An arcuate shouldered-under forward end portion 30 of the main frame 10 is slideably engaged by a segmental retaining guide 31 secured to the bottom of an arcuate flange 32, which latter depends from the forward end of the intermediate frame 12 and functions to hold the intermediate frame against vertical displacement during operation of the machine.

The intermediate frame 12 is swingable about the axis 12a—12a of sleeve 24 and fixed in any desired position by means of a double-acting cylinder 33, the latter being suitably pivoted at its head end to a bracket 34 extending laterally from a side frame member 35 of the main frame 10. A piston rod 36, extensible from cylinder 33, is pivotally connected at its forward end to an arm 37 extending laterally from and herein shown as being formed integrally with the intermediate frame 12.

The intermediate frame 12 acts as a slideable support for the extensible frame 14. As shown in Fig. 3a, the intermediate frame 12 has two longitudinally extending upstanding wall portions 38 defining a central channel through which the conveyor 19 passes. Upper and lower supporting arms 39 and 40, respectively, extend outward from the wall portions 38 and have longitudinally extending vertical support and guide plates 44 at the outer ends thereof. The plates 44 extend beyond the forward and rear of the arms 39 and 40. The upper and lower edge portions of the plates 44 function as slideable supports for the extensible frame 14 which has, at the rear and on each side thereof, a motor 45. The motors 45 are herein shown as being well known forms of electric motors and serve to drive the cutting and dislodging arrangement 15 and the gathering mechanism 23 in a manner to be described in detail. As shown in Fig. 3a, the motor housings 46 have shouldered guides 47 extending inwardly from and along the upper and lower edges thereof and opening toward each other for slideably engaging the upper and lower edges of the guide plates 44.

As shown in Fig. 1, double-acting cylinders 50, having piston rods 51 extensible therefrom, are provided on each side to extend or retract the extensible frame 14 relative to the intermediate frame 12 along the support and guide plates 44 for moving the cutting and dislodging arrangement 15 toward and away from the mine face while the main frame 10 is stationary on the treads 11. The cylinders 50 are clamped to the inside of the guide plates 44 by longitudinally spaced clamps 53 and they extend beyond the forward ends of plates 44. As shown in Fig. 3a, the piston rods 51 extend through and are secured, as by nuts 57, to ears 54 which extend inwardly from the housing structures 46 of the extensible frame.

Gathering mechanism

As best shown in Figs. 3, 4 and 5, the gathering mechanism 23 is mounted on the extensible frame 14 for forward and backward movement therewith, and is pivotal thereon for movement between a "down" position to gather dislodged material directly from the floor and an "up" position to clear the floor during tramming. As shown, particularly in Fig. 4, the gathering mechanism 23 includes an apron-like frame structure 63 having a flat upper surface 63b with laterally extending trunnions 60 pivotably journaled with-

in support arms 59 which extend angularly downwardly from the housing structures 46 of the extensible frame 14.

The gathering mechanism 23 is pivotable for up and down movement about the axis of the trunnions 60 by means of a pair of double acting fluid pressure cylinders 64 (Fig. 4) each having a piston rod 65 extensible therefrom. Each of these cylinders extends along, and inside of, one of the angular support arms 59, which carry the gathering mechanism. Each is pivoted at its rear end to its corresponding support arm 59 and its piston rod is pivotally connected at the forward end to lever arm 67 formed integrally with and depending from gear housing 61. The gathering mechanism 23 may be of any well known form, but is herein shown as being an endless chain type, including two laterally spaced, substantially coplanar, endless chains 67 guided in orbital paths about upper, driving sprockets 71 and lower idler sprockets 71*a* for movement along the top surface 63*b* of the inclined apron 63. Each of the endless chains carries a plurality of spaced gathering arms 70 pivotally connected thereto and extending laterally therefrom and beyond the forward end of the apron 63 at their forward limit of travel to pick up loose material from the ground, convey it upward and discharge it onto the receiving end of the conveyor 19.

Conveyor

The conveyor 19 is herein shown as being of the laterally flexible, center-strand, endless chain and flight type, including an endless chain 89 formed from a plurality of aligned lengths of chain vertically and horizontally pivoted at their opposite ends to opposite sides of material-carrying flights 90. As shown in Fig. 5, the endless chain 89 passes forward from the main frame 10 along the horizontal section of plate 143, downward along the inclined section of plate 143, around a direction-changing idler sprocket 91 which is journaled adjacent the forward end of the extensible frame 14 and upwardly along inclined and horizontal sections of plate 93. As shown in Fig. 5, the horizontal sections of plates 93 and 143 (which are part of extensible frame 14) are interposed between, and in lapping relation with, chain-carrying plates 95 and 147 respectively of the main frame to provide for extension and retraction of the chain with corresponding movements of the extensible frame 14. To permit the forward portion of the chain to extend and retract in this manner while the rear end is guided about a relatively fixed idler 133 on the rear section, chain tightening means, such as disclosed in the above-mentioned co-pending application, may be utilized. For a description of the details of that chain tightening means, reference should be made to the prior application—briefly, it comprises a structure in which the lower reach of the chain is looped about a pair of idlers 137 and 143 (Fig. 2) which are urged apart by suitable hydraulic means.

Other details relating to the parts of the machine behind the intermediate frame 12 are described in detail in the above-mentioned co-pending application and it is considered unnecessary to repeat them here.

Cutting and dislodging arrangement

The description will now be directed primarily to the parts illustrating the present invention.

Referring now to Fig. 6, the spaced side plates 46*a* of the extensible frame 14 are joined at their forward ends by a cross-piece 201 which, itself, is formed with forwardly extending, spaced members 202, 203, 204 and 206, which carry main bearings 207, each held in place by a retainer 208 (Fig. 3). The latter are held in place by bolts 209.

Rotatable eccentric means, in this case a crank or cam shaft 211 is journaled within the bearings 207, with crank arms 212 and 212*a* being disposed for rotation between sections 202—203 204—206, respectively, of the extensible frame 14.

A vertically pivotable boom 213 is mounted on the forward end of the extensible frame 14, between sections 203 and 204.

The rear end of the boom carries a bearing 214, held in place by a bolted retainer 216. At the forward end of the boom is a pair of coplanar arcuate digging arms or elements 217 pivotally mounted on transverse pins 218 for swinging movement toward and away from the mine face. The end of each digging arm is provided with a sharpened multiple-pick-like formation 219 to facilitate penetration of the mine face.

The digging arms are interconnected for simultaneous swinging movement toward and away from the mine face, being coincidentally driven by the crank means 211, as will now be described. Referring to Figs. 6 and 6*a*, along each side of the boom is a gibbed formation 221 having upper and lower, longitudinally extending guide slots 222 and 223. A reciprocable slide member 224 having upper and lower longitudinally extending tongues 226 and 227, respectively, engaged with slots 222 and 223, is mounted on each side of the boom for forward and backward movement responsive to rotation of the crank means 221, as will be seen. Each of the crank arms 212 and 212*a* is connected to a corresponding one of the members 224 by means of a connecting rod 228, each of the latter being pivoted to its corresponding member 224 by a wrist pin 229. The forward end of each member 224 is provided with a vertical pin 231 forming a pivotal mounting for upper and lower links 232 and 233. The latter are pivotally mounted at their opposite ends on a similar vertical pin 234 extending through the corresponding digging arm. Each of the members 224 is herein shown as built up, by welding, from a main central section and upper and lower tongue-carrying sections. If desired, however, each member 224 may be formed as an initial, unitary part. As shown in the drawings, particularly in Fig. 6, the crank arms 212 and 212*a* will be off-set from the axis of rotation of the crank in the same direction. Thus, it will be seen that rotation of the crank results in simultaneous forward and backward movement of the connecting rods 228. This will, in turn, reciprocate the members 224 in unison to result in simultaneous forward and backward swinging movement of the digging arms 217 through linkage means 232—233.

Atop the rear end portion of the boom 213, and held by bolts 236, is a pad 237 having a pair of upstanding spaced ears 238. Connected between the tips of the ears is a pin 239 engaging the end of a piston rod 241 which runs in and out of a double acting cylinder 242, the latter being pivotally mounted by a pin 243 (Fig. 5) to a bracket 244 connected to the extensible frame 14. Thus, the cylinder-piston arrangement 242—241 will be effective through suitable hydraulic controls (not shown) to pivot the boom up or down about

the axis of the crank and maintain it at any particular pivotal position when desired.

Impact-generating means

Attention will now be directed to the novel means for rotatably driving the crank shaft 211 and for applying a series of hammer blows to it when necessary to overcome an abnormal resistance encountered by the digging arms in the mine face.

In Fig. 6 the driving arrangement between the two motors 45 and the crank shaft and gathering means is shown. For simplification, to expose the parts of the gathering means, the motor on the far side of that figure is shown shifted beyond its normal position which is indicated in broken lines. To further clarify the figure, only the connections for driving the crank shaft are shown on the near motor and only those for driving the gathering mechanism are shown on the far motor. It will be understood, however, that each motor is connected to drive its corresponding end of the crank shaft and one of the gathering mechanism driving sprockets 71.

Referring now, first, to the driving arrangement whereby each motor drives one end of the crank shaft, each rotor shaft 246 operates through a hammer blow mechanism 247 (to be described in detail) to turn a bevel gear 248. The latter meshes with and drives a bevel gear 249 which, in turn, rotates shaft 251 and turns pinion 252. The latter is connected, through speed reducing gears 253 and 254, to drive the main gear 256 on one end of the crank shaft. This arrangement is duplicated on both sides of the machine.

Referring now to the arrangement for driving the gathering mechanism, reference is made to the far motor in Fig. 6 where the rotor pinion 257 is shown driving gear 258 through a reach gear 259. Gear 258 is connected to rotatably drive worm 261 through universal joints 262 and 263 and intersplined shafts 264—266. The worm 261 meshes with worm gear 267 and drives shaft 268 supporting the driving sprocket 71. This arrangement, as pointed out above, is also duplicated on each side of the gathering apron 63. The intersplined connection between members 264 and 266 compensates for the variation in distance between each motor 45 and its corresponding worm 261 as the gathering mechanism is tilted up and down about the axis of its trunnions 60.

The hammer blow means, generally designated 247, comprises in this instance a battering clutch, best shown in Fig. 7. The battering clutch has a housing 269 and a bore 271 lined with a bearing or bushing 272. Journaled within said bushing, for rotatable and reciprocable movement, is a battering member 273, threaded internally at a steep angle as shown at 274. Reciprocable movement in one direction is limited by an inturned stop shoulder 276 and in the opposite direction by an annular retainer 277 held in place by bolts 278. One end portion of the internally threaded member 273 is provided with a slot 279 which engages a similarly formed flat-sided projection or extension 281 provided on the end of the rotor shaft 246. In the present instance, the opposite sides or edges of the projection 281 comprise spaced parallel surfaces 282, and the mating surfaces 283 in the member 273 are of like configuration. The projection 281, however, is considerably narrower than the slot 279 in order to provide sufficient clearance for the battering member 273 to move into and out of engagement with the projection when hammer blow action is required, as will be described.

The bevel pinion 248 is keyed to a shaft 284 by a feather 286, the shaft being rotatably supported in a bearing 287 mounted in one end of the gear housing 268. The opposite end of shaft 284 is formed with steep, external threads 289 which are engaged with the internal threads 274 in the battering member 273. The latter is normally urged to the left (Fig. 7) against stop plate 277 by a coil spring 291 which is footed against an inturned shoulder 292 formed within the housing 269. Under the condition shown in Fig. 7, which may be considered normal, the battering member 273 will engage the projection 281 within slot 279 for transmitting rotational force steadily from the motors 45 to their corresponding gears 256 through the respective gear trains. An annular spacer flange 293, interposed between the housing 269 and 288, carries a grease retainer 294. Between the reciprocable member 273 and the spring 291 is interposed a ball bearing member 296 to provide for rotation of the member 273 with respect to the spring.

In operation each of the impact generating arrangements, generally designated 247, functions, independently of the other, as follows:

Normally, torque will be transmitted from rotor shaft 246 to the battering member 273 through interengagement of the projection 281 and the slot 279. The driving torque between member 273 and the shaft 284 will tend to cause the member 273 to rotate relative to the shaft and climb, to the right, up the threads 289. Under normal load conditions, however, this tendency will be completely off-set by the spring 291 which will maintain the member 273 at its left-hand limit, as shown in Fig. 7. Under abnormal load conditions, as where the digging arms 217 are stalled in the mining face, or about to be stalled, the battering member 273 will "climb" to the right (Fig. 7) upon the shaft 284 to disengage the slot 279 from the projection 281. The rotor 246 will then "race" for approximately one-half a revolution and re-engage the battering member 273 with a hammer blow as the slot of the latter is pressed back onto the extension 281. Thus, kinetic energy will be permitted to build up in the rotor for approximately half a turn and applied suddenly to the digging arm drive to permit the arms to overcome the abnormal resistance met in the face. These hammer blows will be repeated until the digging arms are again moving smoothly into the face. The torque between the shaft 284 and the rotor 246 will be proportional to the resistance met by the arms in the mine face and the torque at which hammer blow action begins to occur will be predetermined by the strength of spring 291.

The hammer blow means may be incorporated at any desired position between the motors and the digging arms. In the present instance it is considered advantageous to drive the two hammer blow units directly from the two motors, so as to be on the high speed side of the crank 211 and, therefore, impart hammer blows to the digging arms at a high frequency. With this arrangement it is recognized that, under some conditions, the effectiveness of the hammer blows may be somewhat reduced by energy absorption in the gears and other parts of the drive; hence, in certain service conditions, it may be preferable to place the hammer blow generating means closer to the digging arms.

With the present arrangement, it will be noted that the two hammer blow units 247 provide for advantageous, independent and flexible operation. If one should fail for any reason, the other would still operate so as to avoid a possible shutdown which might result if both went out of use. Furthermore, while both units operate independently, nevertheless they do cooperate in applying the above-mentioned battering action to the two opposite ends of the crank shaft.

The motors 45 will not necessarily be synchronized so that, in operation, they need not run at identical, synchronous speeds. On the contrary, there are certain practical advantages of permitting the motors to run independently over a range of conditions whereby, at times, the battering clutches 247 will be in phase to support one another as to magnitude, at other times completely out of phase so as to double the frequency of impacts applied and, at still other times, at intermediate phase conditions, thereby providing an automatically variable battering arrangement to apply hammer blows to the mine face over a wide range of variations both as to magnitude and frequency, so as to automatically seek out the conditions under which the coal, salt or ore breaks down most easily. Under some conditions of mining, it may be found advantageous to deliberately run the two motors 45 at different speeds, or to run one at a fixed speed and the other at a varying speed, so as to introduce a fixed or variable "beat" in the action of the impact means on the digging arms.

While one specific hammer blow means 247 has been described, any other arrangement capable of generating blows responsive to a predetermined torque or resistance in the mine face may be employed.

Referring now to Fig. 7, the housing and bearing arrangement for certain of the driving gears, not previously mentioned, will be described. The shaft 251 is held at its ends by bearings 297, maintained in place by retainer caps 298. The shaft 299, carrying gears 253 and 254, is similarly mounted in bearings 301, maintained in place by retainer caps 302.

As pointed out above, previous arrangements for driving swingable digging arms have been unsatisfactory in that the load applied to the digging arms decreased as they penetrated the mine face. In contrast to this idea, attention is directed to Fig. 8 which is a graphical representation showing that, in the present miner, the digging force actually increases as the arms penetrate the mine face. Fig. 8 is to be considered in connection with Fig. 3, where, at the front end of the machine, a line is drawn indicating the approximate location of the mine face as, in practice, it would be, a few inches ahead of the boom before digging begins. Starting at the mine face are a number of positions indicated "1," "2," "3," etc., these positions being the location of the tips of the digging arms throughout their range of penetration within the mine face. These positions comprise the abscissa of the curve in Fig. 8. A representative range of forces, exertable at the end of each digging arm by use of a practical size motor, comprises the ordinate of the curve. For example, from Fig. 8, if the force applied by each arm at position "1" is 1800 pounds, then, at position "5," it will be in the same order of magnitude, about 1400 pounds, and from then on it will rise to 4000 pounds at position "9" and something higher at position "10."

Operation

In operation, the miner will be advanced into a room 300 (Fig. 1) and centrally located with its endless treads 11 parallel to the sides of the room. After completing a cut to define a spherically shaped face 301, the extensible frame will be retracted to the limit of its travel by applying pressure through suitable hydraulic means (not shown) to cylinders 50. The machine will then be trammed forward on the treads 11 by suitable driving and control means (not specifically shown) until the tips 219 of digging arms 217 are within a few inches of the face, it being understood that the digging arms will have previously been moved to their extreme retracted position, as shown in Fig. 6. The rear end section of the conveyor 19 will be swung to discharge onto a suitable receptacle such as a shuttle car (not shown). Then, by application of hydraulic pressure to cylinder 33, the intermediate frame 12 will be swung to align the digging elements with one side of the mine face. The boom 213 will be lowered by application of pressure to, or release from, cylinder 242 to lower the digging elements to the floor. The motors 45 will then be energized by suitable means (not shown) to swing the digging arms 217 into the mine face, the battering clutches 247 going into operation automatically when needed to overcome abnormal resistance in the face. After advancing through positions 1–10 (as shown in Fig. 3) with increasing force (as shown in Fig. 8) the arms will be swung back to their retracted position for a new bite at a higher level as the boom is swung upwardly by pressure admitted to cylinder 242 to traverse the face from floor to roof. As the material is dislodged, it will be transferred by the gathering mechanism to the conveyor 19, which then moves it to the back of the machine for discharge onto a suitable receptacle.

In one construction of the miner, provision is made for extending the extensible frame 14 about 24 inches. In mining very hard materials, the extensible frame may be set to dig, say, 6 inches into the face. Then, after the head has traversed all the way from the floor to ceiling, the extensible frame 14 will be advanced another 6 inches or so, with respect to the main frame, for the return pass to the floor level. By making repeated up and down passes, following extensions of the frame 14, the face may be mined in to the full extent allowed by the extensibility of frame 14 without changing the position of the main frame.

Following mining out one side of the face, for the full depth permitted by the extensibility of frame 14, the latter will be retracted and swung about axis 12*a*—12*a* until the digging arms are aligned with the adjacent uncut portion of the face. This portion will then be mined out to the extent permitted by the extensibility of frame 14 and these operations will be repeated until the entire face is mined from top to bottom, and from side to side to the maximum depth permitted by the machine. This entire series of operations will have been performed without changing the position of the main frame. When it is completed the frame 14 and the arms 217 will once more be retracted to their limits and the machine trammed forward to repeat the series of operations in the new face.

By tieing the movement of the two digging elements 217 together with the common member 211, the hammer blows must necessarily be

applied to the digging elements, through the member 221, in simultaneous timed sequence. This facilitates straight-line advance of the pair of digging elements into the mine face. If the hammer blows were permitted to be applied first to one element and then to the other, much of the effectiveness of the impacts would be dissipated by uselessly slewing the head one way and then the other. By applying the hammer blows to the two digging elements in simultaneous timed sequence, the pair will advance straight into the face.

It will thus be seen that the present invention provides a mining and loading machine which drives the digging elements 217 into the mine face, with forces which increase with the amount of penetration, to rapidly dislodge material, directly from a solid mine face in relatively large pieces and with a minimum of power consumption.

Modification employing separate power source for impact-generating means

Fig. 9 shows a modified form of drive for one end of the crank shaft 211. It will be understood that the same arrangement might be duplicated for the opposite end of the crank shaft. In this arrangement, the battery elements 247 (Fig. 6) will be operably connected through the crank shaft to one of the main driving motors 45 and an auxiliary motor 260. Control means 240 is connected in the drive between the main motor and the digging elements. Impact generating means, in this case including a battering clutch already described under the designation of numeral 247, is connected in the drive between the auxiliary motor and the digging elements. The impact generating means is controlled by the control means 240 for superimposing a battering or vibratory load on the relatively continuous load applied by the main driving motor 45 whenever the resistance encountered by the digging elements in the mine face rises above a predetermined point, as will now be described in detail.

As shown in Fig. 9, the main drive gearing between the motor 45 and the crank shaft 211 is identical to that described for the previous embodiment except that a straight shaft 235 replaces the battering clutch 247, the latter now being connected to drive the gear 256 directly through pinion 255; and the control means 240 takes the place of gear 253 and shaft 299.

The control means 240 is mounted on a shaft 299*a*. On the right end portion of shaft 299*a* is keyed the pinion 254, the latter being held against longitudinal movement a C-ring 351. Held on the opposite end portion by a C-ring 352 is a relatively wide gear 253*a*. Adjacent the C-ring 352 the shaft is formed with steep threads 353 engaged with mating internal threads 354 in gear 253*a*. At the end of the threaded section is a collar 356. Between the gear 253*a* and pinion 254 is a compression spring 357, seated at its right end on an annular bearing member 358 which is mounted for limited rotatable movement with respect to the pinion 254. While the particular torque-responsive control means described may be utilized, it will be apparent that any other means capable of responding to the reaction between the digging arms and the mine face may be utilized to control the application of the battering clutch 247 to the crankshaft.

A normally open limit switch 359, mounted adjacent the gear 253*a*, has a roller-carrying extension 361 engageable with the end face of the gear. When the gear moves to the right, the element 361 follows, permitting switch 359 to close.

Referring now to the auxiliary motor portion of the circuit arrangement shown in Fig. 9, the battering clutch 247 is driven by the motor 260 through a chain 265. An electrically actuatable connecting clutch 250, being shown only diagrammatically, is actuatable to connect the battering clutch to a pinion 255. With this arrangement the auxiliary motor 260 and the battering clutch may, if desired, be run continuously while the mining machine is operating, so as to be up to speed when needed, and the connecting clutch 250 will operate instantaneously to transmit impact loads to the crankshaft through pinion 255 whenever the limit switch 359 is closed.

In operation, the main driving motor 45 and the auxiliary motor 260 will normally both be running. However, unless the resistance met in the mine face rises above an abnormal amount as predetermined by the strength of spring 357, only the main driving motor 45 will actually carry any load. This load will be transmitted through pinion 252*a* and gear 253*a*, and, because the spring 357 resists climbing movement of the gear 253*a* up the threads 353, the pinion 254 will be driven as a unit with the gear 253*a* to transmit power to the crank shaft. During this time, the auxiliary motor 260 is rotating freely by reason of the face that clutch 250 remains energized.

Whenever the digging elements encounter an abnormal resistance in the face, the reaction will be transmitted backward through the gearing to cause control gear 253*a* to be shifted to its right hand limit, against collar 356, where it will be held so long as the abnormal resistance in the face prevails. This will energize clutch 250 through switch 359 causing the battering clutch 247 to go into effect instantaneously to superimpose a battering load upon that applied by the main motor 45 to the crank shaft.

Under some conditions of operation it may be preferable to run the auxiliary motor 260 only when vibratory load is called for. The arrangement in Fig. 9 may be revised for such operation merely by eliminating the clutch 250 and connecting the switch 259 to energize the auxiliary motor directly.

While a preferred embodiment of the present invention has been illustrated and described in detail, it should be understood that the invention is not limited to the specific apparatus or arrangement of parts disclosed.

I claim:

1. In a combined mining and loading machine for dislodging material directly from a mine face, mobile frame means; a pair of cooperating digging elements pivotally mounted on said frame means for simultaneous swinging movement toward and away from the mine face; drive means for said digging elements including crank means, linkage means connecting said crank means with said digging elements for swinging the latter toward and away from the mine face upon rotation of the crank means, motor means for rotatably driving said crank means, and battering clutch means between the motor means and the crank means effective to impart a series of hammer blows through the crank means to the digging elements responsive to a predetermined torque exerted on said clutch means by said motor means.

2. In a combined mining and loading machine for dislodging material directly from a mine face,

mobile frame means; a pair of cooperating digging elements pivotally mounted on said frame means for simultaneous swinging movement toward and away from the mine face; drive means for said digging elements including a rotatable crank having a pair of crank arms thereon, linkage means connecting each of said crank arms with one of said digging elements for swinging the two digging elements simultaneously toward and away from the mine face upon rotation of the crank, a pair of motor units each having a driving connection with said crank to rotatably drive the latter, each of said driving connections including a battering clutch operable responsive to a predetermined torque applied thereto to impart a series of hammer blows to the digging elements through the crank, each of said battering clutches being operable independent of the other to apply a series of hammer blows to both of said digging arms.

3. In a combined mining and loading machine for dislodging material directly from a mine face, mobile frame means; a pair of cooperating digging elements pivotally mounted on said frame means for simultaneous swinging movement toward and away from the mine face; drive means for said digging elements including a rotatable crank having a pair of eccentric crank arms thereon, linkage means connecting each crank arm to one of said digging elements at a position intermediate the pivot point and the digging end of said element for swinging the digging elements about their respective pivots toward and away from the mine face responsive to rotation of the crank; motor means for rotatably driving the crank; and impact-generating means between said motor means and said digging elements effective to apply a series of hammer blows to said digging elements responsive to a predetermined reaction between the digging elements and the face.

4. In a combined mining and loading machine for dislodging material directly from a mine face, a pair of cooperating pointed digging arms pivotally mounted on mobile frame means for simultaneous swinging movement toward the mine face; motor means; a movable member connected intermediate said motor means and said arms for swingably driving the latter simultaneously toward the mine face upon movement in one direction by said motor means; and impact-generating means between said motor means and said intermediate member effective to apply a series of hammer blows, in simultaneous timed sequence, to said digging arms through said movable member; whereby to facilitate advance of the pair of digging arms into the mine face.

5. In a combined mining and loading machine for dislodging material directly from a mine face, mobile frame means; a pair of cooperating digging elements pivotally mounted on said frame means for simultaneous swinging movement toward and away from the mine face; drive means for said digging elements including rotatable crank means having a crank arm for each of the digging elements and linkage means connecting each crank arm to its corresponding digging element for swinging said elements simultaneously toward and away from the mine face responsive to rotation of the crank means, motor means for driving said crank means; and impact-generating means between said motor means and said digging elements effective to apply a series of hammer blows to said digging elements while the latter are being swung forward against the faces.

6. In a combined mining and loading machine for dislodging material directly from a mine face; mobile frame means; a pair of cooperating digging elements pivotally mounted on said frame means for simultaneous swinging movement toward and away from the mine face; drive means for said digging elements including crank means, linkage means connecting said crank means with said digging elements for swinging the latter toward and away from the mine face upon rotation of the crank means, a pair of motor means for rotatably driving said crank means; and individual impact-generating means between each of said motor means and said crank means being individually effective to apply a series of hammer blows to said digging elements through said crank means.

7. In a combined mining and loading machine for dislodging material directly from a mine face; mobile frame means including a main frame having an extensible frame reciprocably mounted thereon; a pair of cooperating digging elements pivotally mounted on said extensible frame for simultaneous swinging movement toward and away from the mine face; drive means for said digging elements including rotatable eccentric means, linkage means pivotally connected between said eccentric means and said digging elements for swinging the latter toward and away from the mine face responsive to rotation of said eccentric means, motor means for rotating said eccentric means; and impact-generating means between said motor means and said digging elements being effective to apply a series of hammer blows to said digging elements responsive to a predetermined abnormal resistance exerted against said elements by said mine face.

8. In a combined mining and loading machine for dislodging material directly from a mine face; mobile frame means; a pair of cooperating digging elements pivotally mounted on said frame means for simultaneous swinging movement toward and away from the mine face; drive means for said digging elements including rotatable eccentric means, linkage means between said eccentric means and digging elements for swinging the latter toward and away from the mine face responsive to rotation of said eccentric means, a pair of motor means for rotating said eccentric means; and individual battering clutch means between each of said motor means and said eccentric means said battering clutch means being effective to impart a series of hammer blows, at different frequencies, through the eccentric means to the digging elements responsive to a predetermined torque exerted on each clutch means by its corresponding motor means.

9. In a combined mining and loading machine for dislodging material directly from a mine face, a pair of cooperating digging elements pivotally mounted on mobile frame means for simultaneous swinging movement toward and away from the mine face; drive means for swinging said digging elements toward said face including a motor, a driving connection between said motor and said elements, said connection including means automatically operable in response to a predetermined abnormal resistance exerted against said elements by said mine face for storing energy from said motor and releasing it repetitively in hammer blows applied to said elements to overcome said abnormal resistance.

10. In a combined mining and loading machine for dislodging material directly from a mine face, a pair of pointed cooperating pincer-like digging elements pivotally mounted on mobile frame means for simultaneous swinging movement thereof to move their points in an arcuate path toward and away from one another and the mine face; drive means for swinging said elements simultaneously toward one another while entering said face including means for applying, in simultaneous timed sequence, a series of hammer-blows to said digging elements to facilitate straight-line advance of the mobile frame means into the mine face.

11. In a combined mining and loading machine for dislodging material directly from a mine face, a pair of pointed cooperating pincer-like digging elements pivotally mounted on mobile frame means for simultaneous swinging movement thereof to move their points in an arcuate path toward and away from one another and the mine face; drive means for swinging said elements simultaneously toward one another while entering said face including means automatically operable responsive to a predetermined reaction between said elements and said face to apply a series of hammer blows to said elements for overcoming abnormal resistance to digging.

12. In a combined mining and loading machine for dislodging material directly from a mine face, a pair of pointed pincer-like digging elements pivotally mounted for simultaneous swinging movement to move their pointed portions in co-planar arcuate paths toward and away from one another and the mine face, main and auxiliary motor means connected to drive said elements simultaneously toward one another and into said face, impact generating means associated with said auxiliary motor means effective at times to apply the power from said auxiliary motor means to said digging elements in a series of hammer blows, control means between said main motor means and said elements actuatable to one condition responsive to increase of reaction between said elements and said face above a predetermined abnormal value, said control means being operably associated with said impact generating means to actuate the latter responsive to change of said control means to its said one condition, whereby said digging elements are normally driven by said main motor means and whereby further, upon rise of said reaction to its said predetermined value, said auxiliary motor means will be operable through said impact generating means to superimpose a vibratory load on both of said digging elements to overcome said abnormal reaction.

13. In a combined mining and loading machine for dislodging material directly from a mine face, a pair of pointed pincer-like digging elements pivotally mounted for simultaneous swinging movement to move their pointed portions in co-planar arcuate paths toward and away from one another and the mine face, a first power means operably connected to said digging elements to concurrently drive the latter toward one another and into the face under conditions of normal reaction between the elements and the face, a second power means including impact generating means associated with both of said digging elements for driving the latter into the face under conditions of abnormal reaction between the elements and the face, and control means associated with said digging elements and said second power means and being effective to actuate said impact generating means responsive to an abnormally high reaction between the elements and face for driving the digging elements in a vibratory manner to overcome said abnormal reaction.

14. In a combined mining and loading machine for dislodging material directly from a mine face, a pair of pointed pincer-like digging elements pivotally mounted for simultaneous swinging movement to move their pointed portions in co-planar arcuate paths toward and away from one another and the mine face, power means operably associated with said digging elements for driving the latter toward one another and into the face, control means operably associated with said digging elements and operable to an abnormal condition responsive to rise of reaction between said face and said elements above a predetermined value, and means for modifying the operation of said driving means, responsive to change of said control means to its said abnormal condition, to apply a series of hammer blows to said face through said digging elements.

15. In a combined mining and loading machine for dislodging material directly from a mine face, digging means including a pair of pointed pincer-like digging elements pivotally mounted for simultaneous swinging movement to move their pointed portions in co-planar arcuate paths toward and away from one another and the mine face, drive means effective to exert digging pressure against both of said elements, and control means for said drive means operable responsive to a predetermined reaction between said elements and said face to modify the operation of said drive means to cause the latter to apply a series of hammer blows to said elements for overcoming abnormal resistance to digging.

16. In a combined mining and loading machine for dislodging material directly from a mine face, mobile frame means; a pair of cooperating digging elements pivotally mounted on said frame means for simultaneous swinging movement toward and away from the mine face; drive means for said digging elements including eccentric means, linkage means connecting said eccentric means with said digging elements for swinging the latter toward and away from the mine face upon rotation of the eccentric means, motor means for rotatably driving said eccentric means, and battering clutch means between the motor means and the eccentric means effective to impart a series of hammer blows through the eccentric means to the digging elements responsive to a predetermined torque exerted on said clutch means by said motor means.

17. In a combined mining and loading machine for dislodging material directly from a mine face, a pair of pointed cooperating pincer-like digging elements pivotally mounted on mobile frame means for swinging movement toward and away from one another and the mine face; and drive means for swinging said elements toward one another while entering said face including means for applying a pulsating force to each of said elements in a direction to press it into the face.

18. In a combined mining and loading machine for dislodging material directly from a mine face, a pair of pointed cooperating pincer-like digging elements pivotally mounted on mobile frame means for swinging movement toward and away from one another and the mine face; means interconnecting said arms for simultaneous forward and backward movement relative to the face; and

drive means for swinging said elements toward one another while entering said face including means for applying a pulsating force to each of said elements in a direction to press it into the face.

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