Nov. 17, 1953

L. C. ERICKSON

MINE SKIP

2,659,502

Filed May 2, 1951

8 Sheets-Sheet 1

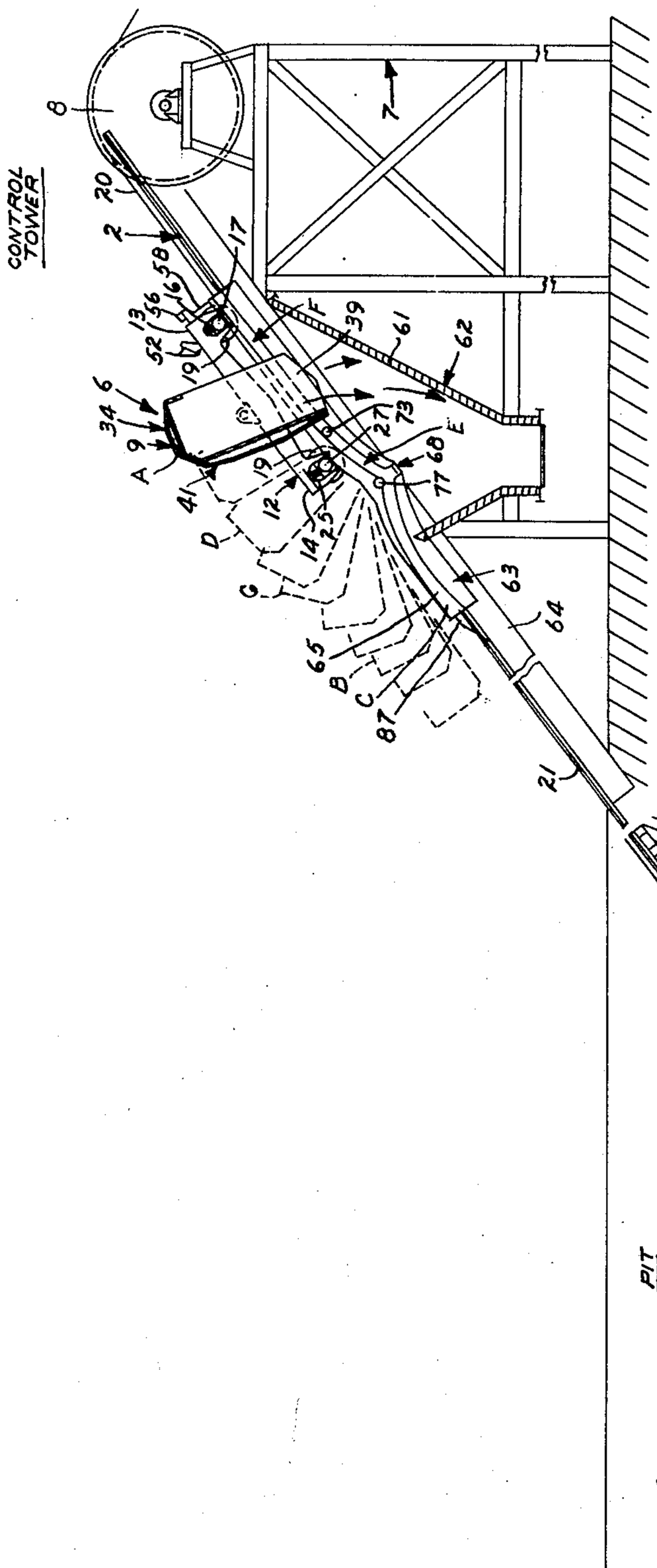

FIG. 1.

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8 Sheets-Sheet 2

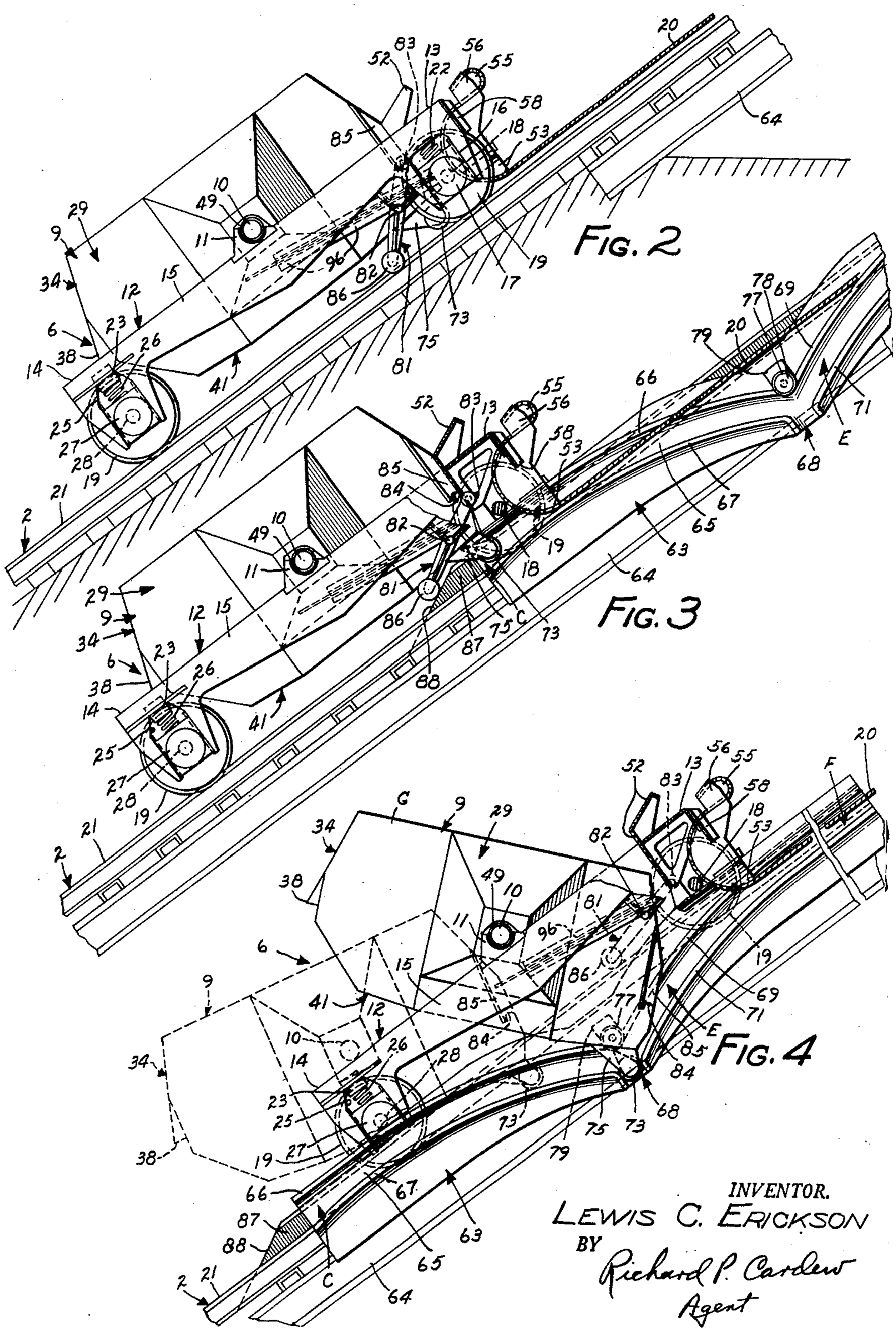

FIG. 2

FIG. 3

FIG. 4

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MINE SKIP

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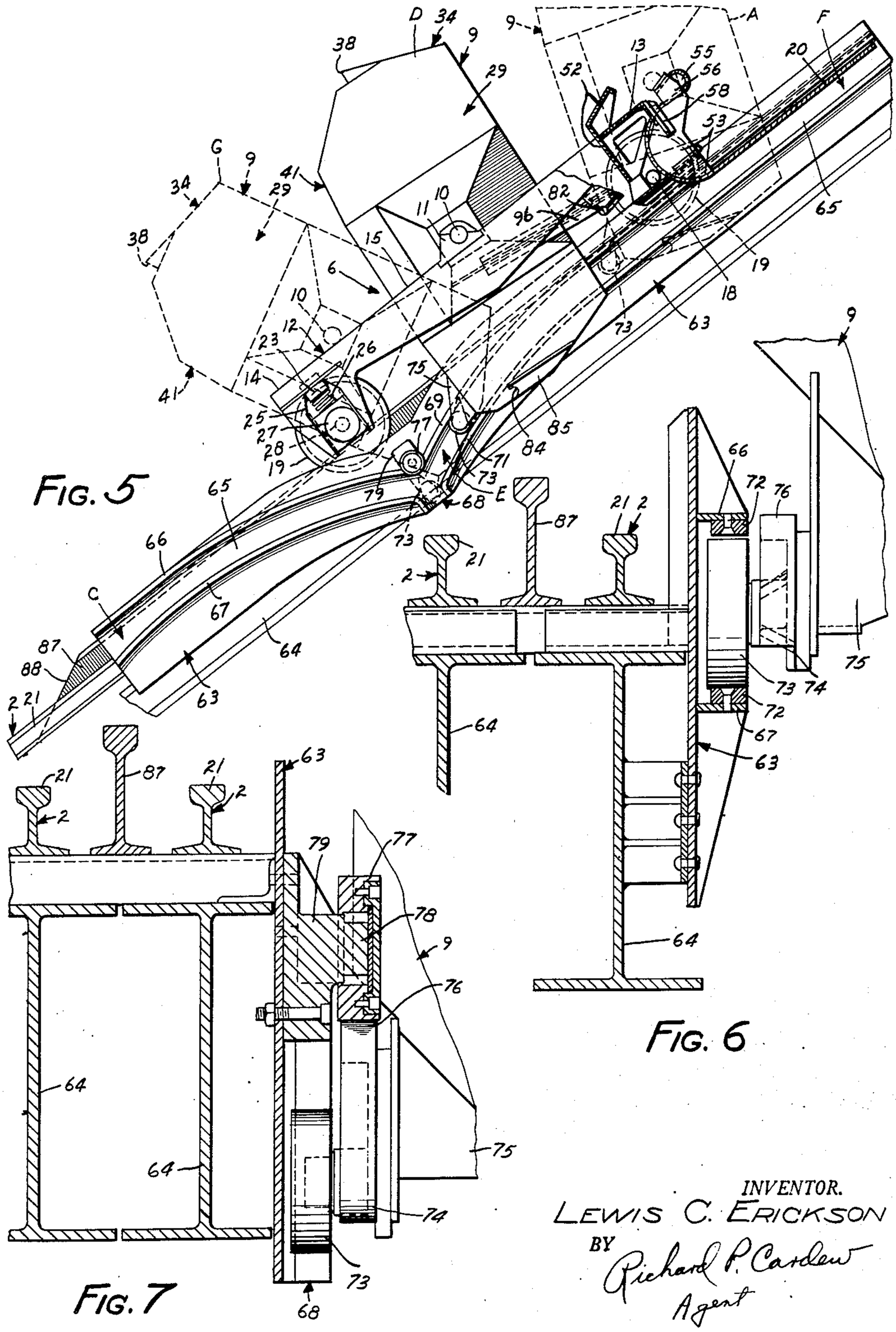

FIG. 5

FIG. 6

FIG. 7

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MINE SKIP

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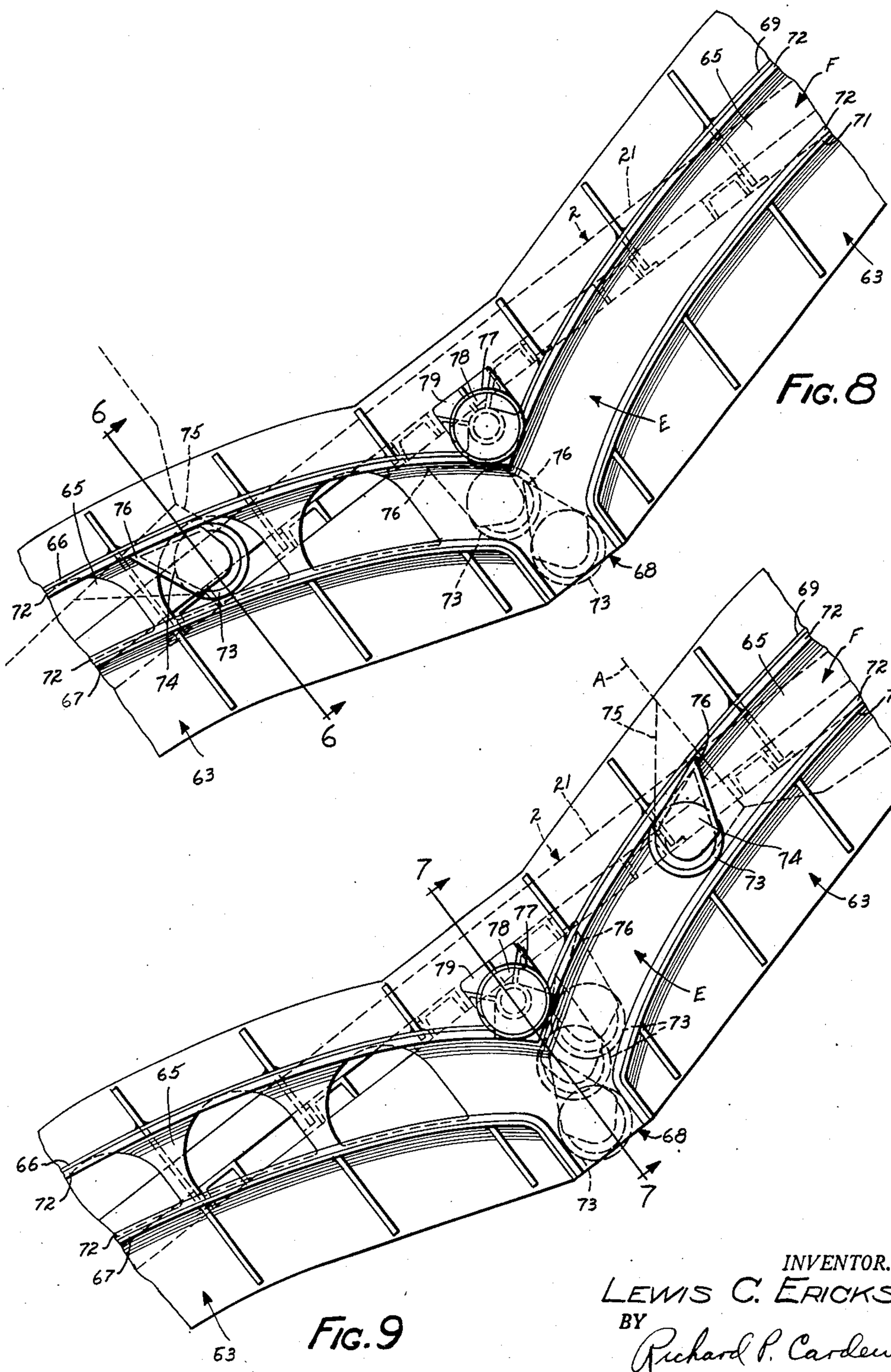

FIG. 8

FIG. 9

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MINE SKIP

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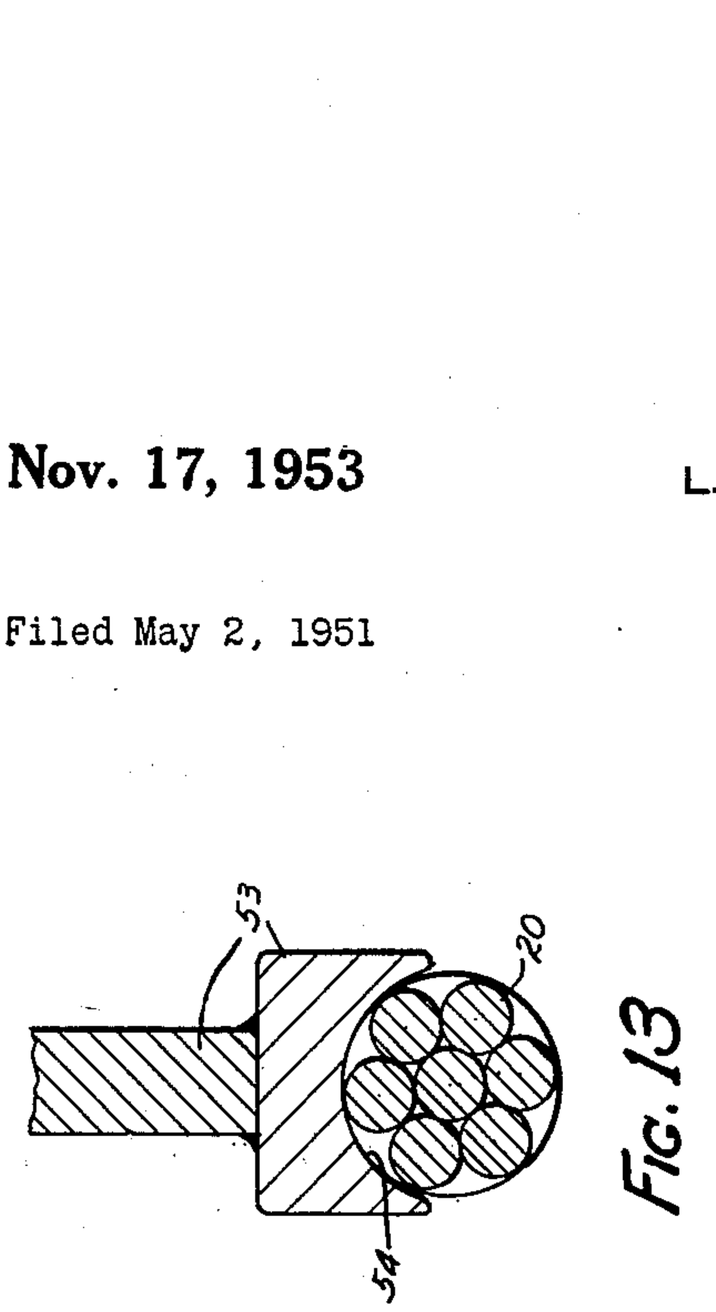

FIG. 13

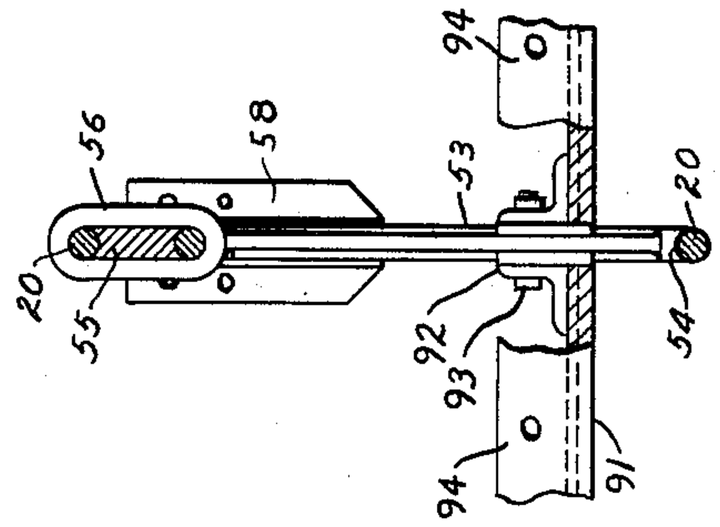

FIG. 12

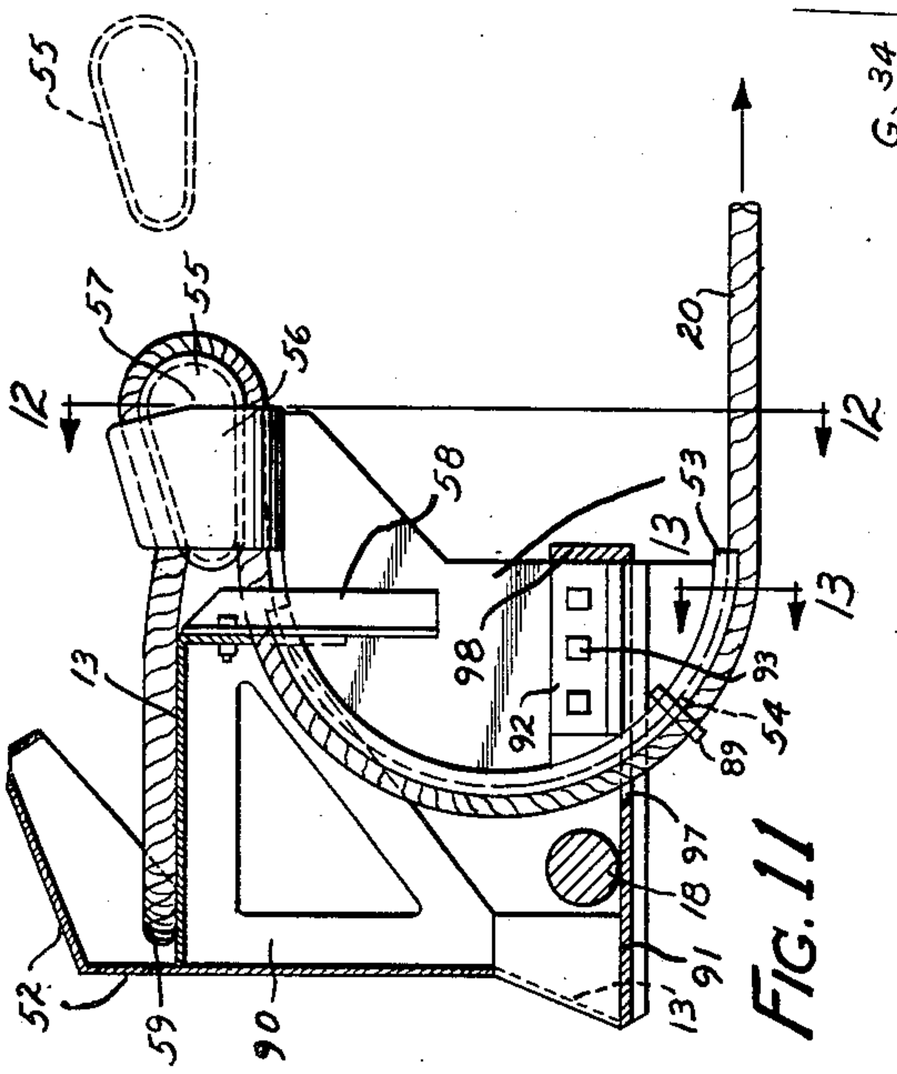

FIG. 11

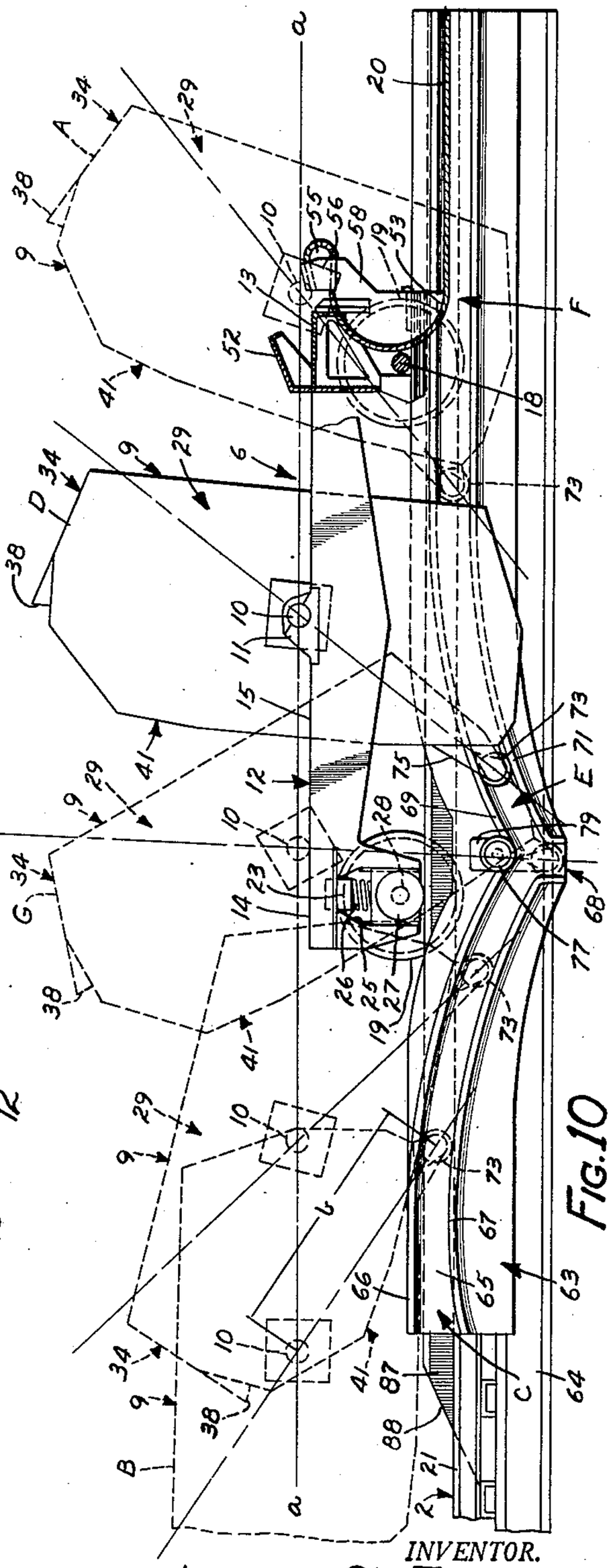

FIG. 10

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MINE SKIP

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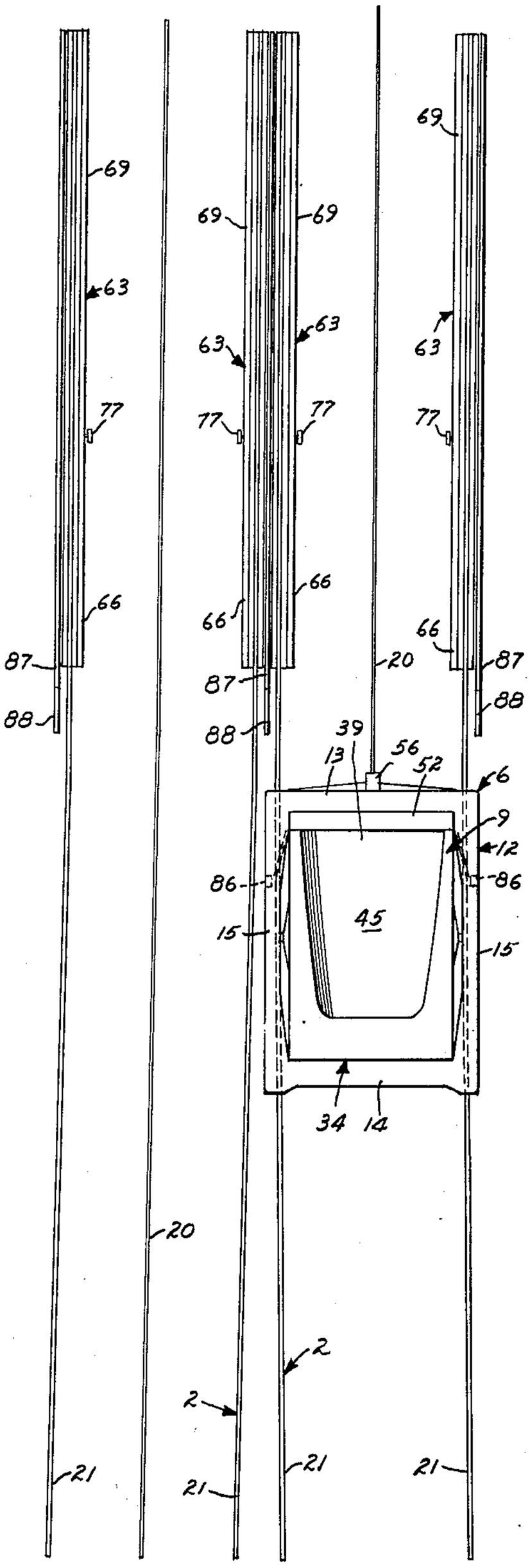

FIG. 14

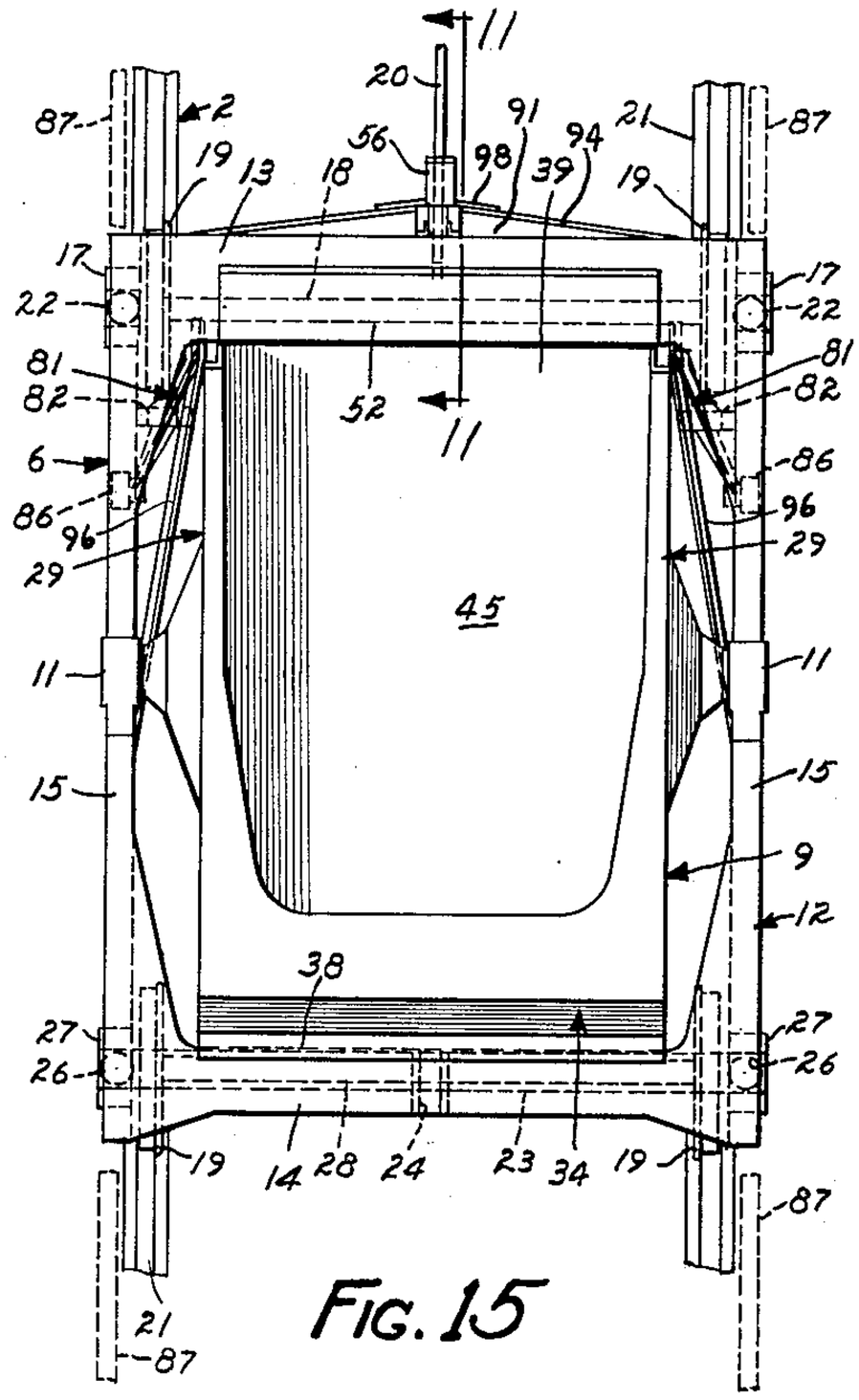

FIG. 15

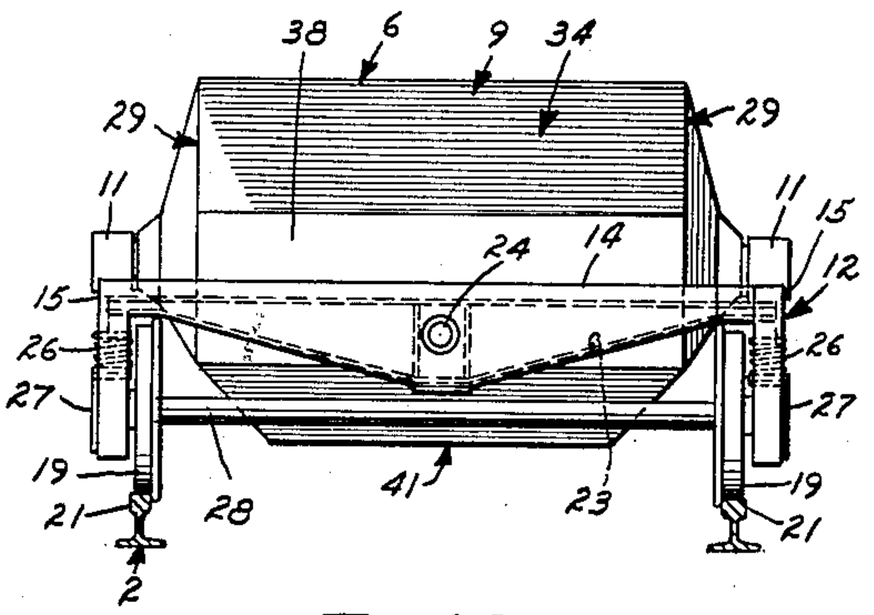

FIG. 16

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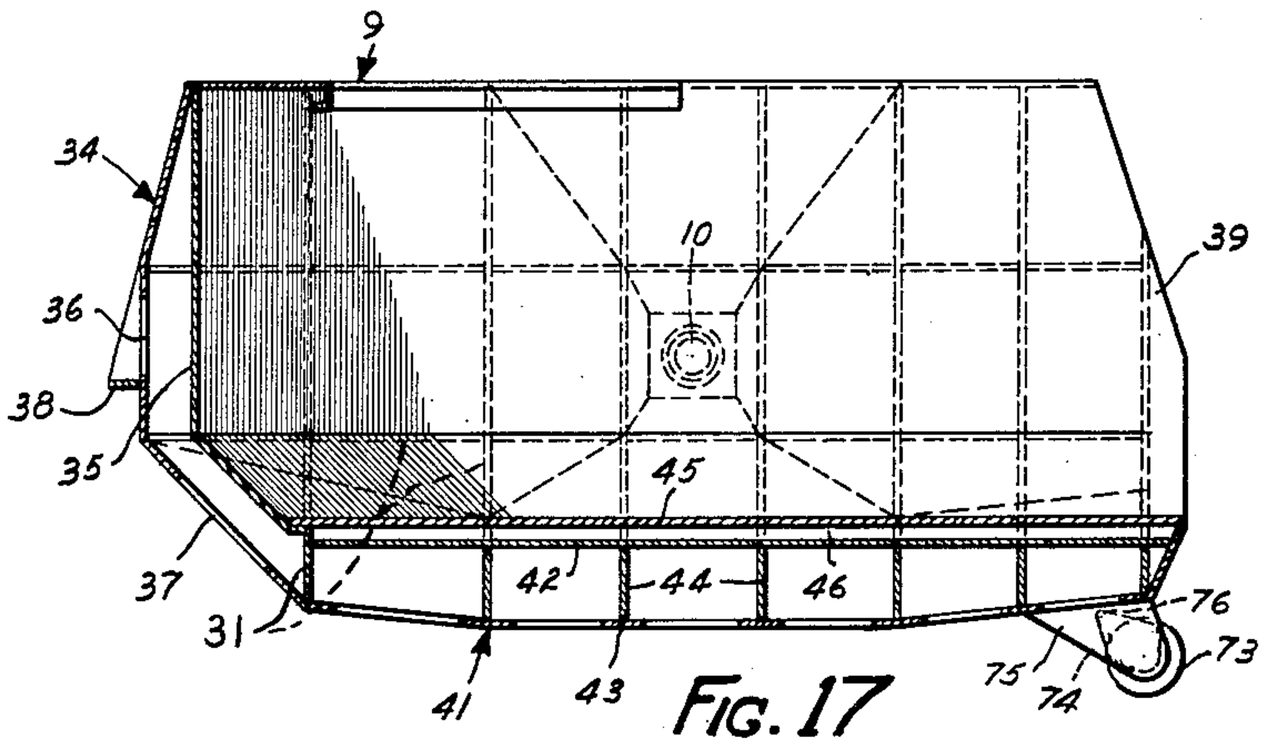

FIG. 17

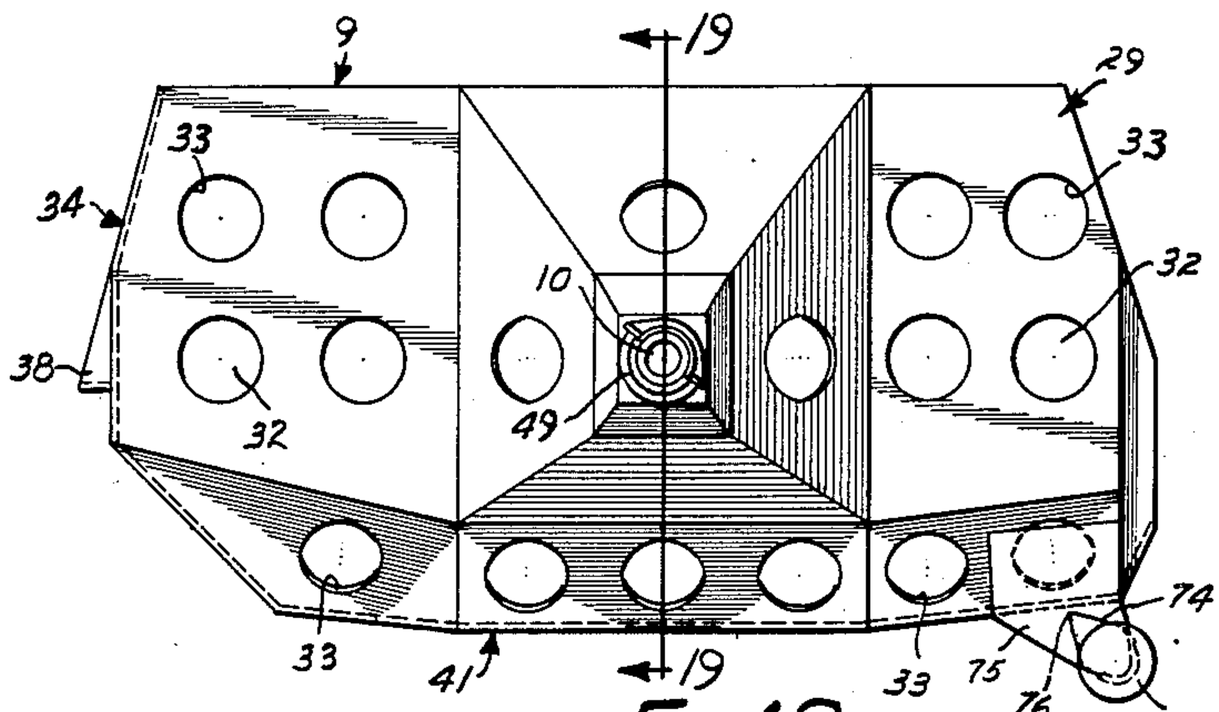

FIG. 18

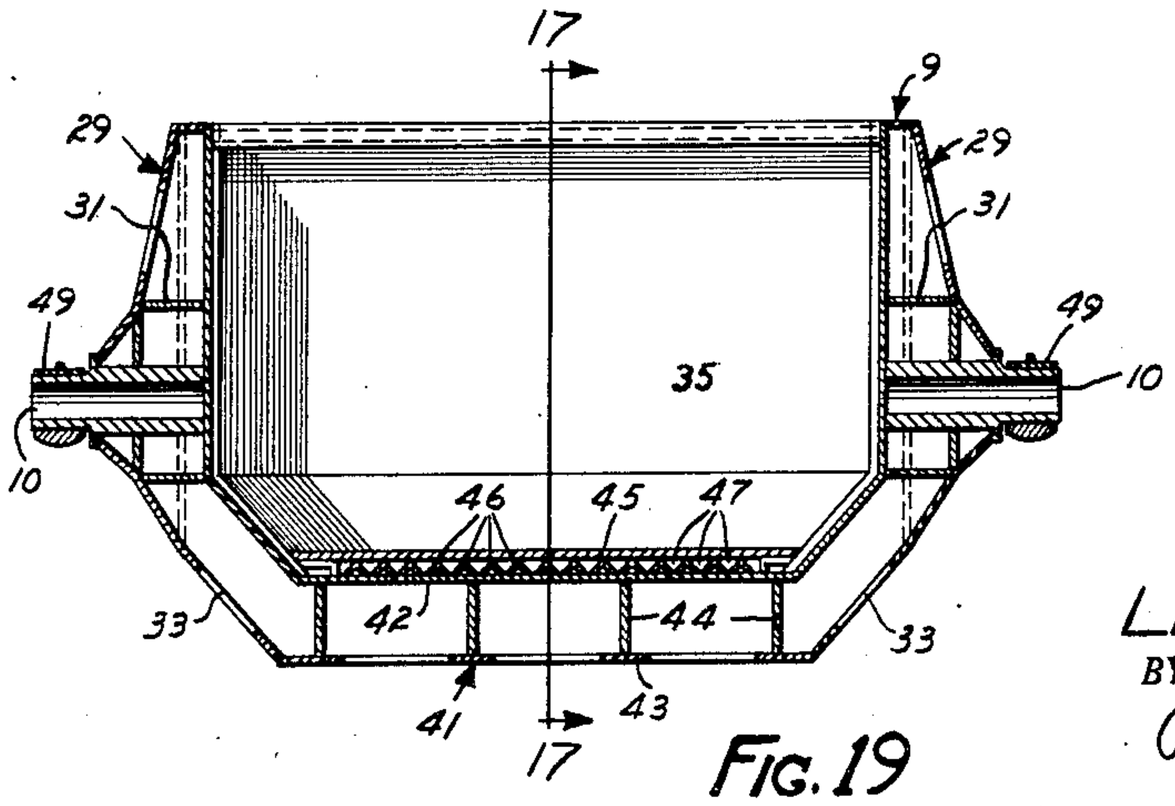

FIG. 19

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MINE SKIP

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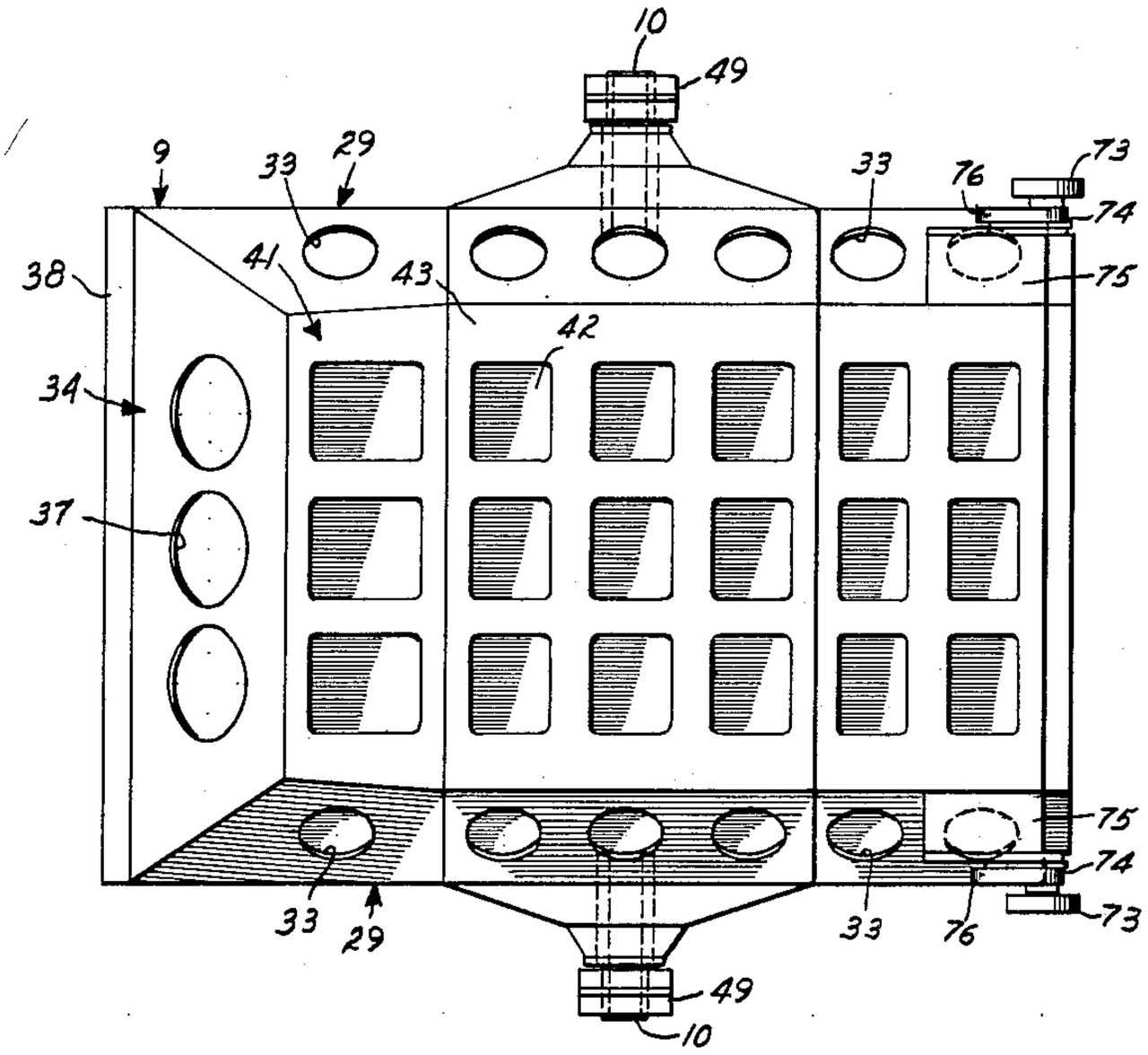

FIG. 20

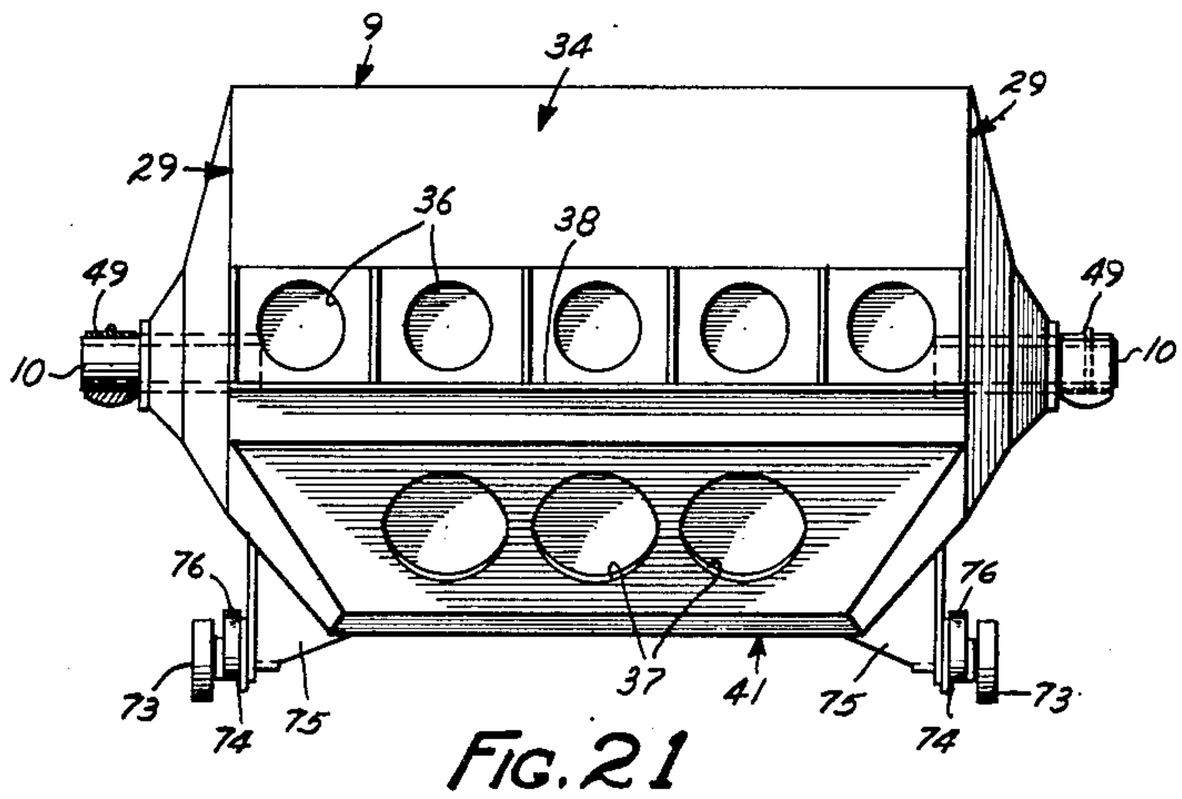

FIG. 21

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Patented Nov. 17, 1953 2,659,502

UNITED STATES PATENT OFFICE

2,659,502

MINE SKIP

Lewis C. Erickson, Duluth, Minn., assignor to National Iron Company, Duluth, Minn., a corporation of Delaware

Application May 2, 1951, Serial No. 224,226

6 Claims. (Cl. 214—103)

1

This invention relates to new and useful improvements in mine skips, generally, and particularly to a novel mechanism for automatically imparting a positive load-dumping action to the skip body when it reaches a predetermined location in its travel, as, for example, over a receiving hopper.

Various types of equipment have in the past been used for transporting material out of open pits or mines, including motorized trucks, and trains of dump cars, usually propelled by locomotives. The use of such equipment for removing strippings, ore, and other bulk materials from deep pits or mines is fast losing favor with many mine operators for various reasons, for example, because of the inability of such equipment to negotiate relatively steep inclines or grades, thereby requiring long, winding road-beds which comprise benches left around the pit walls, thus making less ore available for excavation from a given area, and also because of the continual expense incurred in the maintenance of adequate roadways and trackage for such rolling equipment. In addition, the cost of maintaining a fleet of vehicles, such as motorized trucks, and other equipment necessary in the operation thereof, usually runs extremely high. The use of other forms of material handling equipment have therefore been resorted to, such as cable-operated skips, but to the best of my knowledge from wide experience in the field, none of these have proven entirely satisfactory.

The present invention is directed to the latter type of apparatus, and preferably comprises two skips mounted for alternate up-and-down traveling movement between a loading station, which may be located at the bottom of an open pit or mine, and an unloading station, usually located exteriorly of the pit or mine.

An object of the present invention, therefore, is to provide an improved mine skip adapted for traveling movement between a loading point at the bottom of an open pit or mine, and an unloading station located at a higher elevation and laterally spaced from the loading point, usually exteriorly of the pit or mine, and means being provided at the unloading station for automatically imparting a positive load-dumping or rocking movement to the skip body upon its supporting chassis, whereby the load dumping movement of the skip body is progressive and constant throughout the cycle, including the return movement of the skip to load-receiving position, thereby greatly minimizing shocks and severe strains in the cables and other equipment, and

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thus protecting them against damage from such shocks and vibration, even when handling material which may contain large heavy chunks or particles, which frequently have a damaging effect upon equipment when a load is suddenly dumped into a hopper or other receiving means.

A further object is to provide a skip comprising a suitable frame or chassis provided at its front and rear ends with suitable carrying wheels adapted for traveling movement upon suitable rails, a skip body pivotally carried by said frame, and a cam mechanism located at the upper end of the track adapted to be engaged by means carried on the skip body, thereby to impart a rocking motion to the skip body to dump its contents into a suitable receiving means when the skip reaches a predetermined position in its upward travel.

A further object is to provide an apparatus comprising a pair of skips each including a wheeled frame having a load-carrying body mounted thereon for pivotal movement about horizontal axes disposed transversely of the skip, and the forward ends of the wheeled frames of said skips being operatively connected to the ends of a pull-cable which has an operating connection with a power device, not shown in the drawings, and which, when operated, will cause the skips to alternately move up and down on their respective supporting tracks between a skip-loading station at the bottom of a pit, and a receiving station such as a hopper which may be located above the pit.

A further object is to provide an improved operating mechanism for a tiltable skip body, comprising a pair of cam plates located at opposite sides of the skip supporting rails at the point of material discharge, and each of said cam plates comprising a longitudinally extending cam groove adapted to receive a cam roller carried by the forward end of the skip body, said cams being fashioned to impart a uniform rocking motion to the skip body on its supporting chassis as the skip approaches a position over the receiving hopper, and whereby the rocking or load-dumping motion imparted to the skip body is progressive and uniform throughout its travel, when dumping its load, and when returning to load-receiving position, whereby the dumping of the load into the receiving hopper may be accurately controlled, regardless of the nature of the material being handled, and regardless of the location of the center of gravity of the load.

A further object resides in the novel construction of the skip, per se, which includes a sup-

porting frame or chassis provided at its forward end with suitable guides for movably and resiliently supporting a pair of journals which rotatably support an axle having a pair of flanged wheels secured thereto for traveling movement upon suitable rails, and a rocker or evener being pivotally mounted in the rear end of the supporting frame of the skip adapted for rocking movement about an axis disposed lengthwise of said frame, the opposed ends of said rocker engaging a pair of spring elements having their lower ends seated on journals mounted for vertical movement in suitable guides provided in the rear end portion of the skip frame, and an axle being mounted in said rear journals and having similar flanged wheels secured thereto, said rocker cooperating with the carrying wheels at the front end of the frame to provide a three-point suspension for the skip frame on its supporting rails, and the resilient mounting of the axle supporting journals functioning to assist in absorbing load shocks and cooperating with the evener to compensate for irregularities in the rails of the track over which the skip travels.

Other objects of the invention reside in the unique mounting and construction of the load-carrying body of the skip, the walls of which may be of box-like cross-section, whereby they may be made of boiler plate intimately welded together to provide, in effect, an integral structure having great strength and ruggedness, with a minimum of weight, and whereby said walls provide a certain degree of resiliency which cooperates with the spring mounting of the skip body upon its supporting chassis to absorb severe load impacts and shocks; in the unique construction of the bottom wall of the skip body whereby a plurality of closely spaced ducts are provided therebeneath through which a suitable heating medium may be circulated, if desired, to permit operation of the apparatus in freezing temperatures; in the novel construction of the cable attaching means for detachably securing the ends of the pull-cables to the wheeled frames of the skips, whereby the cable ends may readily and quickly be secured thereto without damaging the cable, and also whereby cable slack may readily be taken up in a comparatively short space of time, if necessary, and whereby the ends of the pull-cables are attached to their respective skips at an elevation close to the rails, thereby to minimize whip in the cables, and also whereby should the operating mechanism for the pull-cables fail when a skip reaches its load-dumping position, the skip may pass completely over the head sheaves without seriously damaging said sheaves or the supporting structure.

A further object of my invention is to provide, as a safety factor, means to lock the skip body in its load-carrying position during its loading and load-carrying periods, and to unlock same immediately before the dumping operation begins.

These and other objects of the invention and the means for their attainment will be more apparent from the following description taken in connection with the accompanying drawings.

In the accompanying drawings there has been disclosed a structure designed to carry out the various objects of the invention, but it is to be understood that the invention is not confined to the exact features shown, as various changes may be made within the scope of the claims which follow.

In the drawings:

Figure 1 is a diagrammatic view illustrating a typical installation such as utilized in open pit mines, wherein one of the skips is shown in load-receiving position at the bottom of the pit, while the other skip is in load-dumping position above the pit;

Figure 2 is a view showing a loaded skip approaching the unloading station above the ground level;

Figure 3 is a view partly in section showing the cam rollers on the skip body entering the cam grooves of the skip body operating mechanism;

Figure 4 is a view similar to Figure 3, but showing the body of the skip partially tilted to load-dumping position;

Figure 5 is a view similar to Figure 4 showing in full lines the skip body in its full load-dumping position;

Figure 6 is an enlarged detail sectional view on the line 6—6 of Figure 8, showing one of the cam engaging rollers on the skip body engaged in a cam groove;

Figure 7 is an enlarged detail sectional view on the line 7—7 of Figure 9, showing one of the control cams of the skip engaged with its respective guide roller;

Figure 8 is a fragmentary view showing in full lines the position of one of the cam rollers when the skip body initially begins its tilting or load-dumping movement, and showing in dotted lines the position of the cam roller on the skip when entering the depression or gap in the bottom of the cam plate, with the triangular cam element thereof about to enter the upwardly and forwardly extending portion of the cam groove;

Figure 9 is a view similar to Figure 8, but showing the cam roller of the skip in the position assumed when the skip approaches its full dumping position, illustrated in Figure 5;

Figure 10 is a diagrammatic view illustrating in full and dotted lines various positions assumed by the skip car during its load-dumping movement;

Figure 11 is an enlarged detail sectional view substantially on the line 11—11 of Figure 15;

Figure 12 is a detail sectional view on the line 12—12 of Figure 11;

Figure 13 is an enlarged detail sectional view on the line 13—13 of Figure 11;

Figure 14 is a diagrammatic plan view showing the preferred arrangement of the two sets of tracks adjacent to the unloading station, and also showing the location of the cam plates relative to the rails of the tracks;

Figure 15 is an enlarged plan view of a skip with its load-dumping body in normal load-carrying position;

Figure 16 is a rear end view of a skip with its load-carrying body in the position shown in Figure 15;

Figure 17 is a longitudinal sectional view on the line 17—17 of Figure 19, showing the box-like construction of the walls of the skip body;

Figure 18 is a side elevation of Figure 17;

Figure 19 is a cross-sectional view on the line 19—19 of Figure 18, showing the trunnions at the opposite sides of the skip body;

Figure 20 is a bottom view of Figure 18; and

Figure 21 is a rear view of the skip body.

Loading station and unloading station

In the selected embodiment of the invention herein disclosed, there is diagrammatically il-

lustrated in Figure 1 a mine skip installation comprising a pair of inclined tracks 2 which extend downwardly into an open pit or mine 3 to a loading platform 4, onto which a conventional dump truck 5 may be driven to dump its load into a skip 6, shown positioned adjacent thereto. The loading platform 4 is of simple inexpensive construction, whereby it may readily be moved as the loading point follows operations to deeper levels. The tracks 2 continue upwardly above the ground level and are herein shown terminating in a head frame 7, which supports the operating mechanisms for actuating the skips, including supporting sheaves 8 which have running connections with the pull-cables of the two skips. The power means for operating the cables is of conventional construction, and therefore need not be illustrated in the drawings.

An important feature of the invention resides in the relationship between the upper ends of the rails 2 and the sheaves 8, whereby should one of the skips accidentally excessively overrun its unloading position, shown in full lines in Figure 1, it could, without causing serious damage to the sheaves 8 and the control tower, pass completely over the sheaves 8 onto the ground below the tower. Such an incident could rarely occur because the trackage is extended a considerable distance beyond the receiving station 62 to take care of most abnormal over-runs, as illustrated in Figure 1.

Skip and supporting chassis

Another important feature of the invention resides in the specific construction of the skip which, as best illustrated in Figures 2 to 4, inclusive, and 15 and 16, comprises a load-carrying body 9 having oppositely disposed trunnions 10 secured thereto and mounted for rocking or tilting movement in suitable bearings or journals 11 provided on the side beams or members of a carrying frame or chassis 12, whereby the skip body 9 is mounted for pivotal movement on an axis disposed transversely of the chassis 12, as will be understood by reference to the drawings. Journals 11 are provided with split sleeves or bushings 49, the lower halves of which are spherical in configuration whereby when supported in the journal boxes 11, shown in Figures 2 and 3, the bushings are made self-aligning to compensate for variations or irregularities in the mounting of the body on the chassis frame, and also whereby any mis-alignment or distortion of the chassis frame will have no effect upon the pivotal action of the skip body thereon. The upper faces of journal boxes 11 are preferably disposed at an angle to the upper edges of the side members of the chassis frame, and are open to form saddle-like supports adapted to detachably receive the split bushings 49 which rotatably support the skip trunnions 10 in the journal boxes 11. By this arrangement, should the skip body accidentally become damaged, another one may readily be substituted therefor by simply lifting the damaged skip body from its supporting chassis with a suitable crane.

The frame or chassis 12 comprises front and rear cross members 13 and 14, respectively, and side members 15, all of which are shown constructed of high-tensile steel plate, whereby said frame members are box-shaped in construction, cross-sectionally, thereby to provide the utmost in strength and ruggedness with minimum weight. Light weight is an important factor in

an apparatus of this general type, as it makes it possible to relatively increase the pay load carried on the skips.

The forward end of chassis 12 is provided at each side with vertically disposed guides 16 adapted to slidably receive a pair of journal blocks 17 which rotatably carry an axle 18 to which are secured a pair of flanged wheels 19 adapted to travel on the rails 21 of the tracks 2, as will be understood by reference to Figures 2, 3, 15 and 16. Suitable means not shown is provided for retaining the journals 17 in the guides 16. Spring elements 22 are shown interposed between the upper ends of journals 17 and the bottoms of the inverted guides 16 to resiliently support the forward end of the chassis frame upon the front axle 18, as will be understood.

Three point suspension

Another important feature of the invention resides in the means provided at the rear end portion of the chassis frame to provide a three-point suspension for the chassis frame on its supporting wheels. Such means is shown comprising a rocker or evener 23, mounted for rocking movement upon a pivot pin 24 preferably having its ends fixed in the walls of the rear cross member 14 of the chassis. The opposed ends of the rocker 23 are received in the bottoms of vertical guides 25 provided at the rear corners of the chassis frame, and engage the upper ends of suitable spring elements 26, similar to springs 22 at the forward end of the frame. The lower ends of springs 26 are seated on the upper ends of a pair of journal blocks 27, movably supported in the guides 25, and which cooperate to rotatably support a rear axle 28 in a manner similar to the journal blocks 17 at the forward end of the chassis, as will be understood by reference to Figure 16.

The above construction, as hereinbefore stated, is important in that the rocker cooperates with the front wheels to provide a three-point suspension for the chassis frame on its supporting wheels, whereby irregularities or variations in the rails 21 will not have any ill effects upon the operation of the skips as they travel back and forth on the rails 21 of the tracks 2. The provision of the spring elements 22 and 26 at the front and rear of the chassis is also extremely important in that they sufficiently cushion the impact of loads dumped into the skip body at the loading station to greatly minimize damage to the skips.

In a skip installation such as herein disclosed, each skip is usually designed to carry a load which, in actual practice, is substantially equal to the load of a truck body, whereby an entire truck load may be dumped into an empty skip body stationed at the loading station, as shown in Figure 1. Such dumping of the material into the skip body results in extremely heavy load impacts on the skip which, in the present instance, the spring elements 22 and 26 of the skip chassis assist in absorbing. The severe load impacts imposed on the skips when being loaded, will be more fully realized when it is understood that the tail end of a loaded truck stationed on the loading platform in the bottom of the pit may be between fifteen and twenty or more feet above the bottom of the empty skip body, and the skips herein disclosed have theretofore been carefully designed and constructed to readily withstand such severe load impacts over long periods without damage.

Another feature of the invention, therefore, resides in the novel construction of the skip body, per se, which, as best shown in Figures 17 to 21, inclusive, is constructed entirely of metal, such as high-tensile steel plate, welded together to form box-like side walls, the outer walls **29** thereof being here shown as having openings **33** therein to provide means whereby the vertical and horizontal members **31** which space the inner walls **32** from the walls **29** may be securely welded in place to form the box-like double wall construction here shown. The rear wall of the skip body is similarly constructed to provide an outer wall **34** having openings **36** and **37** therein and similar members **31** welded between the wall **34** and the inner wall **35**. The box-like, double wall construction of the skip body provides for extreme strength because of the intimately welded association of the inner and outer walls with the spacer members **31—31** secured between same at substantially right angles to provide a plurality of adjacent relatively small box elements which provide great strength and reinforcement with least possible weight.

The bottom **41** of the skip body is similarly of box-like construction, as best illustrated in Figure 19, and comprises inner and outer plate elements **42** and **43** spaced apart by upright metallic spacer and strengthening elements **44**, all of which are intimately welded together to provide the required strength in the same manner as the side and rear walls.

The skip body is also provided with strength and reinforcement in its general construction; that is, the skip body is so formed as to have substantially U-shaped yokes to support and sustain its loads and stresses. These yokes are clearly illustrated in Figures 15 and 19. In Figure 15, it can be readily seen that the skip body is open in front, as at **39**, and has a U-shaped side and rear wall contour, with the trunnion **10** extending from the yoke's side walls **29—29**. This longitudinal yoke embraces the load of the skip body as the cables pull the skip upwardly, of course.

In addition, there is a yoke transversely of the skip body. As seen in Figure 19, the cross section of the skip is of U-shape and the trunnions **10** are secured to the side walls **29—29** thereof whereby the weight of the load is adequately supported between the trunnions **10**.

An abutment member **38** is provided on the rear wall **34** of the skip and is adapted to engage the upper surface of the rear cross member **14** of the chassis frame when the skip body is in its normal load-carrying position, as seen in Figure 2, to support the rear end of the skip body and prevent its being tipped rearwardly on its pivotal mountings **10**. The position of the trunnions **10** relative to the skip body is preferably slightly forwardly of the normal center of gravity of the skip body, both when loaded and empty. This positioning of the trunnions is to insure that the skip body is biased rearwardly and remains in its normal load-carrying position during its operation except when it is intentionally caused to be tipped at the unloading station, as will become apparent. It is deemed apparent that the load of the skip body is supported between the trunnions **10—10** and the abutment member **38** which rests on the rear transverse frame member, and that these parts, and their relation to each other, serve as means to hold the skip body against pivotal movement when traveling, especially when carrying a load, thus preventing loss

of material at undesired points along the skip-travel-path.

A wear plate **45** constitutes the effective bottom surface of the skip body, and is shown supported upon a plurality of inverted angle irons **46**, whereby a plurality of closely spaced fluid-circulating passages **47** are provided in the bottom wall of the skip body. The angle irons are disposed adjacent each other lengthwise of the skip body, as shown in Figure 19. Should it be found necessary to operate the apparatus in freezing temperatures, a heating medium may be circulated through the passages **47** in the skip bottom, and, of course, the heating medium may be directed into the spaces between the side and back walls as well to keep material from stocking or freezing to the inner walls of the body.

A guard plate **52** is provided at the front end of the chassis frame, as best shown in Figure 4, and provides a partial front wall for the skip body when the latter is in its normal load-carrying position, shown in Figures 2 and 3. The guard plate **52** also extends forwardly and upwardly over the front cross member **13** of the chassis frame to prevent material from spilling forwardly into contact with the cable attaching means.

Cable attaching means

Another important feature resides in the means provided for attaching the ends of the pull cable **20** to the chassis frames of the two skip cars, it being understood that the two skip cars are preferably utilized in the installation which are so arranged that when a loaded skip is ascending from the mine pit, an empty skip is descending to the loading station to receive another load.

The cable-attaching means is best illustrated in Figures 10 to 13, inclusive, and comprises a semi-circular member **53** having a peripheral groove **54** for receiving the pull-cable **20**. The free end portion of the cable is wrapped around a wedge-like element **55**, indicated in dotted lines in Figure 11, with the bight in the cable around the larger end of the member **55** and facing the direction of pull on the cable. Said wedge-like element with the cable thus wrapped about it is then inserted into a socket member **56** provided on the upper portion of member **53**, as shown at **57**, the socket member being disposed above the member **53** and preferably forwardly of the vertically center line of the member **53**. The angles of the opposed sides of wedge element **55** are such that when said element is forced into the socket member **56**, as shown in Figure 12, and the cable **20** is placed under tension, a force is constantly exerted on the wedge element **55** to firmly secure it and the cable in the socket member **56** without damaging the cable, and positively preventing the cable from accidentally becoming detached from the skip chassis.

The cable-attaching means includes the upright semi-circular member **53** which is a flat plate-like piece having its cable receiving, peripheral groove therein, as shown, and the socket member **56** attached thereto, as by welding, for example. The member **53** is removably secured to the front end of the skip frame, whereby the member **53** may be very conveniently removed and mounted on the cable with comparative ease once the mounting point has been established, as there will be no difficult maneuvering of the unwieldy cable through slots or other small openings in confined spaces. It is desirable that a cable clamp, suggested at **89**, be installed adjacent the lower end of the cable anchor plate **53**,

as shown, to hold the cable securely in its mounting. With the plate **53** thus mounted on the cable, the plate and cable can be conveniently remounted on the skip frame, as shown.

The member **53** is secured to the frame of the skip by means of angle brackets **58** adjacent the upper end thereof, which are welded to the opposed vertical faces of the member **53**, the brackets being bolted to the outer face of the downwardly projecting portion of the frame member **13**, as seen in Figure 11, it being noted that the said outer portion of the member **13** is amply supported and braced by brackets **90** to carry the member **53**. In addition, the member **53** is fastened to the transversely disposed anchor tie plate **91** as by angle members **92** disposed on each side of the member **53**, the tie plate having a slot **97** therein to receive the member **53** and the members **92** being, preferably, welded to the tie plate on each side of the slot and having bolts **93** extending through the upwardly facing flange of the members **92** and the plate **53**, as shown, whereby the cable anchorage is secure.

The tie plate **91** has an upwardly turned flange **94** on its outer edge, as shown, and has its inner edge welded to the lower edge of the skip body closure portion **52** of the member **13**, whereby the tie plate has a girder effect and reinforces the frame of the skip as well as serving as a portion of the cable anchorage. Obviously, the cutting of the slot **97** into the plate **91** weakens same; however, I have provided a heavy bar of metal **98** to extend across the slot and to be bolted to the flange **94** of the tie plate on each side of the slot, thereby restoring the girder effect of the tie plate and further securing the cable anchorage.

To further provide adequate cable anchorage and to distribute the pulling stress as equally as possible to the skip frame, one end of a girder or stress distributing member **96** is firmly fixed to each end of the portion **52** of the member **13** adjacent the lower end thereof where the plate **91** meets the member **13**. The opposite end of each of the girders **96** is secured to the side members **15** of the skip frame, preferably adjacent the trunnions **10**, as shown in Figure 15. Thus it may be seen that there is a U-shaped yoke (girders **96—96** and tie plate **91**), which carries the cable pull on the skip, making for more even distribution of stresses.

By attaching the cable to the chassis frame as above described, and as shown in the drawings, the cable is located close to the surface plane of rails **21**, whereby whipping of the cable is reduced to a minimum. Such construction also makes it possible to readily vary the length of the cable at any time if necessary and also whereby excessive slack which may develop in the cable may readily be taken up without damaging the cable. If desired, the excess cable **59** may be supported upon the upper front frame member **13** beneath the forwardly extending guard member **52**, said frame member **13** serving as a deck upon which to place the excess cable.

Skip body operating mechanism

Another important feature of the present invention resides in the novel means provided for operating or tilting the skip body from its normal load-carrying position, shown in Figure 2, to its full load-dumping position, indicated at A in Figure 10, and back to its horizontal load-carrying position, indicated at B. This operation is extremely important in the operation of the skip body, as it assures a smooth rocking motion without any abrupt changes of direction, and the unloading of the material may be targeted to a restricted area, such as the wall **61** of the receiving hopper **62** in the control tower. Such controlled discharging of the load from the skip is accomplished regardless of skip speed, and minimizes spilling of material from the skip and damage to the equipment.

Cam plates

The operating mechanism is best illustrated in Figures 2 to 9, inclusive, and comprises a pair of cam plates **63**, shown secured to supporting beams **64** which may constitute a portion of the supporting structure of the receiving station, as shown in Figure 1. The beams also provide the main support for the upper ends of the tracks **2** and the operating mechanism for the skips.

In Figure 14 is will be noted the installation herein disclosed comprises two tracks **2—2**. The cam plates **63** are best illustrated in Figure 5. Two such cam plates are utilized for each skip, and are located adjacent to each pair of rails **21**, at the inner sides thereof, as clearly illustrated in Figures 14 and 15. Each cam plate **63** has a longitudinally extending cam groove **65**, which may be formed by welding to one side surface of the plate a pair of spaced bars **66** and **67**, which extend forwardly and downwardly to a recess or gap **68**.

Similar cam bars **69** and **71** are secured to the other end portion of each cam plate **63** and cooperate with the bars **66** and **67** to complete the formation of the longitudinal cam groove **65**, as will be understood by reference to Figure 5. The adjacent faces of cam bars **66** and **67** and cam bars **69** and **71** are provided with high carbon steel facings **72** which cooperate to provide wearing surfaces for a pair of cam rollers **73**, mounted on brackets **74** secured to depending portions or structural brackets **75** provided at the lower front corners of each skip car, as best illustrated in Figures 3, 5, 17, 18, 20 and 21.

The cam grooves **65** and rollers **73** of the skips constitute a very important feature of the present invention in that this mechanism positively controls the dumping actions of the skip bodies, as each skip passes over the receiving hopper **61**. As hereinbefore stated, the dumping movement of each skip body is progressive and gradual from the time the skip body initiates it dumping movement until it has completely discharged its load and is returned to its normal load-receiving position, preparatory to returning to the pit for reloading. Such movement is important because it assures a gradual discharge of the material from the skip body as it is tilted to its full dumping position, clearly indicated in Figures 1 and 10, which greatly minimizes shocks and vibration.

The positive but gradual dumping or tilting action of the skip body is, of course, controlled by the relative formation or contour of the cam grooves **65** with respect to the line of travel of the trunnions **10**, and the location of the cam or dump rollers **73** with respect to the trunnions. By referring to Figure 10 of the drawing, it will be seen that the gradual dumping of the skip body results because of the progressively varying distances between the cam grooves and the line of travel *a—a* of the skip trunnions **10**, it being understood that the distance between the skip trunnions **10** and the cam rollers **73** always

remains constant. Therefore, for each forward increment of travel of the skip body, the degree of tilt or dump of the skip body can be accurately predetermined and controlled by the formation of the cam grooves. In the instant disclosure, the initial tilt per increment of travel is but slight so that there will be least possible stress to the cable and other mechanism required to overcome the inherent inertia of the skip body which resists tilting. Once this inertia is overcome, however, the degree of tilt per increment of travel may be gradually increased without undue stresses to the equipment.

In the same manner, the dumping of the skip can be targeted to a particular point of discharge irrespective of which of the said increments of travel the skip happens to be in at a given time. This is a very desirable feature, as different types of material handled by the skips dumps in different manners; in other words, some leaves the skip body relatively earlier than others, yet all materials engage substantially the same target point in the hopper **62**. This makes it possible to design receiving stations in a manner to sustain the load-dumping shocks most efficiently, of course.

Because the skip frame travels in a continuously straight line, and only the skip body tilts, the cam grooves cannot, of course, be designed to extend farther from the trunnions **10** than the cam rollers **73** extend. Therefore, I have provided means for making it possible to use relatively flat cam grooves to tilt the skip body more than 90°, as shown, to insure complete emptying of the skip each time it is dumped. This means includes V-shaped cam elements **76** fixed to the roller supporting brackets **74** inwardly of the cam rollers **73**, the elements **76** being adapted to engage a pair of rollers **77**, rotatably mounted on trunnions **78** of a pair of brackets **79**, shown secured to the cam plates **63** at a point intermediate the cam bars **66** and **69**. See Figures 6 and 7. The rollers **77** are spaced inwardly from the cam plates **63**, and are aligned with the cam elements **76** of the skip body so that said cam elements engage the rollers **77** when the cam rollers **73** approach the downwardly open gap **68** in the bottom of the cam grooves between the cam bars **67** and **71**, as shown in Figure 3.

As is deemed apparent from the drawings, especially Figures 7, 8, and 9, the V-shaped cam elements take over from the cam rollers **73** as the latter move into the point where cam bars **66** and **69** meet; that is, the upper side of the cam elements **76** engage the rollers **77** and guide the cam rollers **73** downwardly into the gap **68** and the said upper side of the cam passes beyond the roller, as shown, as the skip moves forward. As the skip continues forward, the front corners of the skip are restrained from forward movement momentarily until the trunnions **10** pass over the center of the gap **67** to the position shown at G in Figures 5 and 10. As the skip frame continues forward, the skip body moves therewith, of course, causing the rollers **73** and cam elements **76** to move upwardly out of the gap **68**. Now, because of the V-shape of the cam elements **76**, the other side thereof engages the rollers **77** and they guide the dump or cam rollers **73** into the cam groove area E defined by the bars **69** and **71** and the skip body moves into the position D, as shown, until the skip reaches its full load-dumping position A, attained when the cam rollers **73** enter the straight portions F of the cam grooves. Of course, this action takes place relatively fast and the travel of the skip frame and body is uniformly smooth so that no jarring or jolting takes place.

This cam-dumping arrangement, as described, serves to make the dumping operation less critical in speed of dump and in the final stopping place of the skip when dumped, whereby cable length does not have to be critically adjusted to permit loading of the down-skip.

Safety latch for securing skip body in load-carrying position

As a safety factor, means is provided for locking the skip body against tilting or rocking movement upon its trunnions during the traveling movement thereof between the receiving station and the bottom of the pit, thereby to prevent any possibility of the skip body tilting forwardly and interrupting its travel should the center of gravity of its load be located forwardly of its trunnions **10**. Because of the construction heretofore described, this is not likely to occur; however, in the construction and operation of heavy equipment, it is good practice to include safety features. To lock the skip body against tilting movement, a pair of latches, generally designated by the numeral **81**, are pivotally mounted on the forward end of the chassis frame, as shown at **82** in Figures 2, 3, 4, and 15.

Each latch is provided at its upper end with a pin **83** adapted to engage in seats or notches **84** provided in the lower ends of a pair of latch-engaging members **85** secured to the forward end of the skip body in laterally spaced relation, as clearly illustrated in Figures 3 and 15. Rollers **86** are also mounted on the lower ends of the latch arms and are laterally offset in an outward direction from the upper rollers **83**, as illustrated in Figure 15. Rollers **86** are adapted to engage stationary cam bars **87** disposed in spaced parallel relation to the rails **21** of track **2**, when the skip approaches its load-dumping position in the control tower. Cam bars **87** extend from the lower ends of the cam plates **63** to a point well beyond the upper ends of the cam plates, whereby the latches are retained in unlatching position throughout the full dumping travel of the skip.

In other words, latch members **81** may be actuated to release the skip body for its load-dumping operation at or about the time the cam rollers **73** of the skip body enter the cam grooves **65**, as shown in Figure 3. The cam grooves are slightly outwardly flared at their lower ends to permit free entry thereinto of the cam rollers **73** when the skip approaches its load-dumping position. As soon as cam rollers **73** have fully entered cam grooves **65**, the cam grooves take over complete control of the dumping action of the skip body and provide a positive action whereby the skip body is progressively tilted in a forward direction from its load-carrying position, shown in Figure 2, to its full load-dumping position, shown in full lines in Figure 1, assisted, as stated, by the V-shaped cam elements **76** and rollers **77**. The return movement of the skip body from the full lines position, shown in Figure 1, to its load-receiving position, is controlled by the cams in a manner similar to the action imparted thereto when dumping its load.

In Figure 14, it will be noted that only three latch-operating cams **87** are utilized, whereas each skip car comprises two latches. The center latch cam **87** thus serves the two skips, and to

avoid interference between the adjacent latches of the two skips, the tracks 2 gradually diverge from the receiving station in an outward direction sufficiently to permit ample clearance between the two skip bodies at the point in their travel where they pass each other in their up and down movements on the tracks 2. The converging of the tracks at the receiving station permits the receiving station to be of less width, and obviously, reduces the bulk and cost of the receiving station proportionately.

Operation

In the operation of the novel skip car installation herein disclosed, the skips, after having been operatively secured to the pull cable 20, may be set into motion by an hoist operator located in any convenient location. The operator's station, however, is preferably, and may well be, arranged so that the operator may clearly view the loading operation at the bottom of the pit and the unloading operation in the tower. A suitable communication system may be provided between the operator in his control station, not shown, and the observer at the loading station, whereby the loading observer may signal or apprize the control operator each time a skip has been loaded and is ready to ascend to the receiving station. The apparatus is then set into motion whereby the loaded skip ascends to the unloading station, over the hopper 61, and simultaneously the empty skip descends to the loading station.

When the loaded skip approaches the control mechanism over the hopper 61, the cam rollers 73 of the skip enter the cam grooves 65 at C in Figure 10, and simultaneously or immediately thereafter the latch rollers 86 engage the inclined surfaces 88 of the fixed cams 87, whereby the upper rollers 83 of the latches are moved out of locking engagement with the elements 85 to thereby release the skip body so that it may proceed with its load-dumping movement. As the skip passes between cam plates 63, its cam rollers 73 enter and follow said cam grooves. The V-shaped cam elements 76 prevent cam rollers 73 from passing over cam recesses 68 and into the lower portion E of the upper portions of cam grooves 63 before the skip is properly tilted, because the upper surface of the cam elements 76 remain in engagement with the peripheries of rollers 77 until rollers 73 have entered cam recesses or gaps 68, as will be understood by reference to Figure 4. As the advancing skip body tilts from position G to position D in Figure 10, the opposite face of the V-cams engages the rollers 77 to guide the cam rollers 73 upwardly into cam section E, is indicated.

This action, as hereinbefore stated, is extremely important in that it imparts to each skip car a positive dumping action which is gradual and uniform throughout its full cycle, and is not dependent upon nor can it be affected by gravity. The cam mechanism also compensates for any variation in the distance between the path of travel *a*—*a* of the skip trunnions 10 and the supporting rails 21 of the tracks 2 as a result of the resilient mounting of the skip body upon its supporting chassis. In actual practice, the novel cam mechanism herein disclosed has been found to function positively and efficiently, and with the assurance that each load as it is gradually discharged from a skip body is directed onto a predetermined area substantially without shock to the skip mechanism, which is an extremely important factor in apparatus of this general type where the load particles may greatly vary in size and weight.

The unique mounting of the skip body on its supporting chassis is also important in that it makes it possible to quickly remove a damaged skip body from its supporting chassis and substitute another therefor without requiring the removal of any bolts or other fastening elements.

Apparatus of this general type is usually subjected to extremely rough treatment because of the nature of the material to be handled thereby. It frequently contains large, heavy chunks which may be extremely heavy, whereby they may contact the skip bottoms with severe impacts when dumped thereinto at the loading station. The particular construction of the skip body, the resilient mounting of the skip bodies upon their supporting chassis, and the inclination at which the skip is normally carried when loading and running protect the skips against damage from such severe load shocks. The three-point suspension of the chassis upon the rails is also instrumental in minimizing excessive strains which may be imparted to the skips as a result of irregularities in the rails.

It is to be noted that one of the features of my invention is that it is designed for use in open pit mining wherein the tracks lie on the wall of the pit, the walls of the pit, of course, being at an inclination which the material being mined inherently maintains. That is, the walls of the pit assume the natural angle of repose of the material being mined and the tracks are laid at this inclination.

The upper edge of the skip body and the skip bottom lie substantially parallel with the track, as is readily apparent from the drawings; thereby, when the skip is loaded from a truck or the like, the material assumes its natural angle of repose and the skip cannot be overloaded to the point that spillage will occur along the track as the skips ascend, as all spillage will occur at the loading station. In this manner also, the skip load can be accurately predetermined, and it cannot be overloaded to put excess strains on the equipment, thereby providing for longer life and durability of the entire assembly.

The foregoing detailed description has been given for clearness of understanding only and no unnecessary limitations should be understood therefrom, but the appended claims should be construed as broadly as permissible in view of the prior art.

Having thus described my invention, what I claim is:

1. A skip installation for use in an open pit mine comprising, a track mounted on the walls of said pit at substantially the same inclination as said walls, a wheeled frame adapted for traveling movement on said inclined track between a loading station and an unloading station, a load carrying body mounted for pivotal movement on said wheeled frame, means for propelling the loaded skip from the loading to the unloading station, a longitudinally extending cam groove at the unloading station, said groove being divided into two shallowly curved segments which have their lowest extremities at the division point between said segments, a guide roller mounted intermediate said segments in laterally spaced relation to said groove, a skip roller mounted on the forward end of the skip body and engageable with said cam to gradually tilt the skip body on said wheeled frame to its maximum load-dumping position as the skip passes

over the unloading station, said cam groove being fashioned to gradually tilt the skip body from load-carrying to its maximum load-dumping position to cause the material to gradually discharge therefrom, and cam means adjacent said skip roller for engaging said guide roller for causing said skip roller to follow in a predetermined path through the segments of said cam to cause the skip to assume maximum dumping position with a minimum of cam width and permitting said skip to overrun its maximum dumping position without damage to it or to adjacent structures.

2. In a skip installation for an open pit mine, an inclined track lying against the walls of said pit and having one end terminating adjacent the bottom of said pit, a loading station at the lower end of said track, a control tower above the pit for supporting the upper end of the track, a receiving hopper in the control tower, a skip comprising a rectangularly shaped open frame, wheels on each corner of said frame adapted for traveling movement on said track, a load-carrying body, said skip body being substantially rectangularly shaped and having a bottom, rear, and two opposed side walls and an open front and top, said body being pivotally mounted within said frame with its pivotal axis on said side walls and extending transversely of said frame and track, a stop carried by the skip body at the rear end thereof engageable with a portion of said wheeled frame to hold the skip body in normal load-carrying position at the same inclination as said track, a pair of cam plates adjacent to the receiving hopper providing elongated cam surfaces, cam engaging elements mounted on the forward lower corners of the skip body engageable with said cam surfaces when the skip approaches the unloading station, said cam surfaces being elongated and shallow whereby said elements remain in engagement therewith during all of the period when said body is out of normal load-carrying position and whereby said cam elements and cam surfaces will effect a gradual and positive load-dumping action to the skip body as it passes over the receiving hopper.

3. In an apparatus of the class described, an inclined track having one end terminating in the bottom of a pit or open mine, a loading station at the lower end of said track, a control tower above the pit for supporting the upper end of the track, a receiving hopper in the control tower, a skip comprising a rectangular frame, said frame having a pair of transverse axles, one at the forward and one at the rear end thereof, a wheel at each end of each of said axles adapted for traveling movement on said track, a load-carrying body pivotally mounted on said frame with its pivotal axis extending transversely of said body between said axles, means carried by the skip body engageable with means on the wheeled frame to hold the skip body in load-carrying position substantially parallel with said track, a pair of cam plates mounted adjacent said tracks and to the receiving hopper providing inwardly facing longitudinally extending cam grooves which are elongated longitudinally of said track but are relatively shallow in their curvature, means forming a recess or gap in the lower wall of each cam groove and dividing said grooves into two opposed similarly disposed parts, cam rollers mounted on the forward lower corner of the skip body receivable in said cam grooves when the skip approaches the unloading station, a cam element on the skip body adjacent to each cam roller engageable with a pair of rollers mounted above the recesses or gap in the bottom of said longitudinally extending cam grooves thereby to guide the cam rollers into said depression to impart a positive and uninterrupted tilting movement to the skip body which is constant as it passes from one part into the other of said grooves whereby its load is discharged from the skip with minimum impact.

4. A skip installation according to claim 3, wherein dual skips are utilized for operation on spaced tracks, and power means is provided for alternately moving said skips up and down on said tracks, whereby the weight of the empty descending skip counter-balances a portion of the weight of the ascending loaded skip.

5. In a skip installation for running on the inclined walls of an open pit mine; a substantially uniformly inclined track mounted on said walls; a loading station at the lower end of said track; a tower at the upper end of said track for supporting the upper end of said track; a receiving hopper in said tower providing an unloading station; a skip comprising a rectangular open frame; wheels mounted at each corner of said frame to carry said frame along said track and maintain same at all times at the same inclination as said track; means for propelling said skip along said track; a substantially rectangular skip body having a bottom, rear, and two opposed side walls; pivotal mounting means on each of said side walls for pivotally supporting said body within said open frame; means on said body engaging said frame to normally hold said bottom wall in substantially parallel relation to said inclined track except when said body is being dumped; and means adjacent said track at said unloading station for tipping said body to unload same through its open forward end.

6. The structure as set forth in claim 5 and said tipping means comprising a pair of cam plates mounted adjacent said tracks providing elongated cam grooves extending longitudinally of said track; said grooves being in two segments, said segments being in end to end relationship and curved upwardly and away from each other from their meeting point; cam rollers mounted on the forward lower corners of said skip body and receivable in said cam grooves; and means to guide said cam rollers from one of said segments into the other whereby movement of said frame along said track over said cam plates will cause said body to tilt and discharge its load.

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