Oct. 29, 1957 C. A. BLACKBURN 2,811,334

EXPLOSIVE CHARGE HANDLING DEVICE

Filed May 4, 1955 6 Sheets-Sheet 1

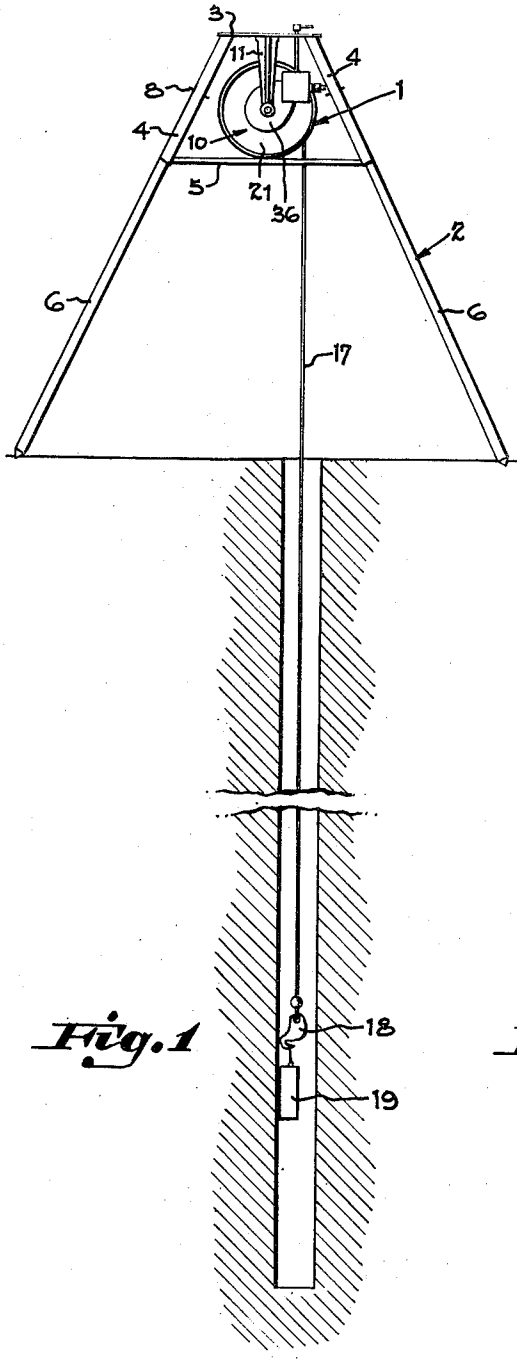

Fig. 1

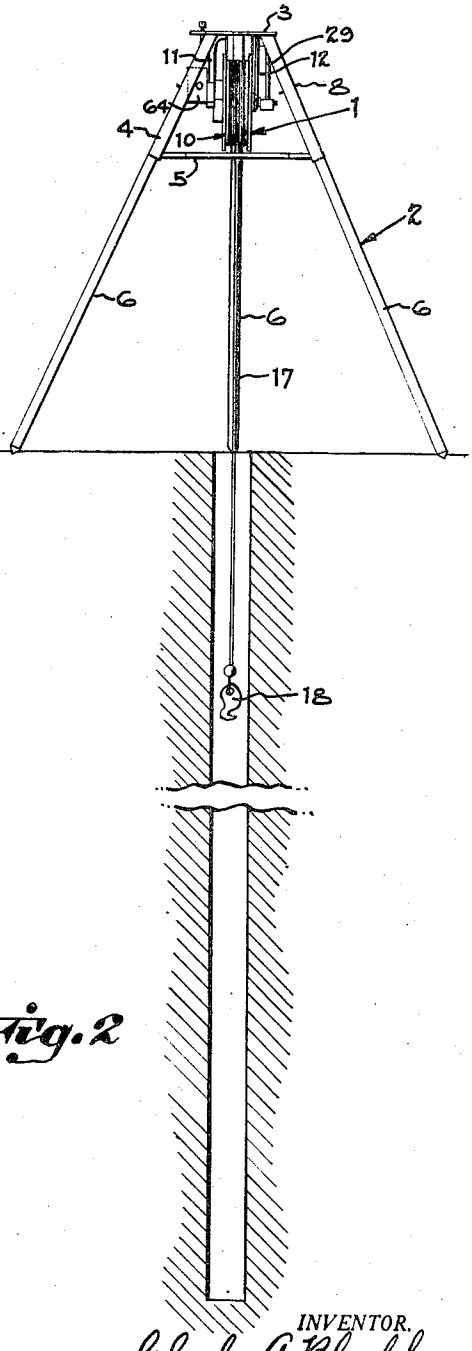

Fig. 2

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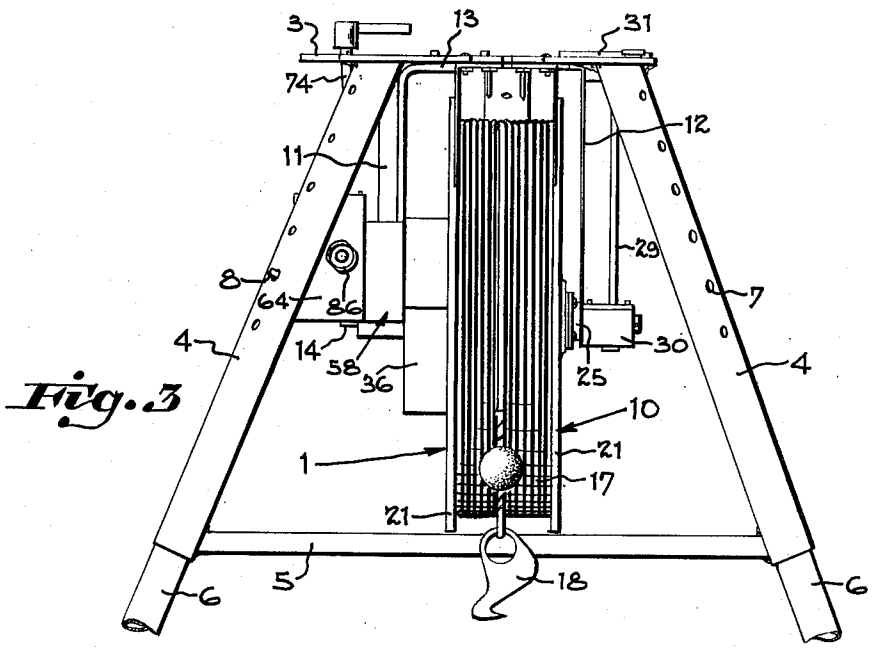

Fig. 3

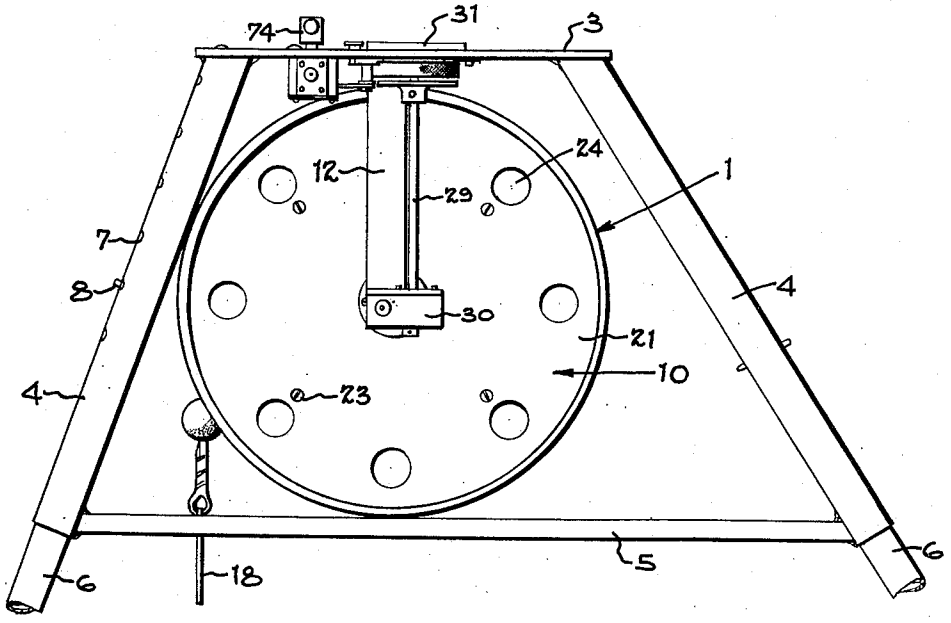

Fig. 4

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EXPLOSIVE CHARGE HANDLING DEVICE

Filed May 4, 1955 6 Sheets-Sheet 3

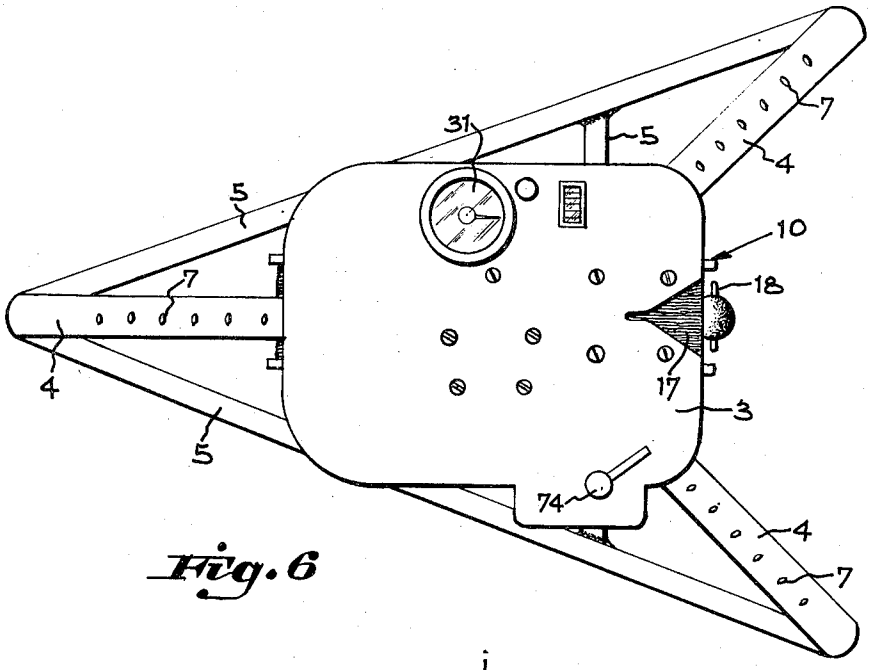

Fig. 6

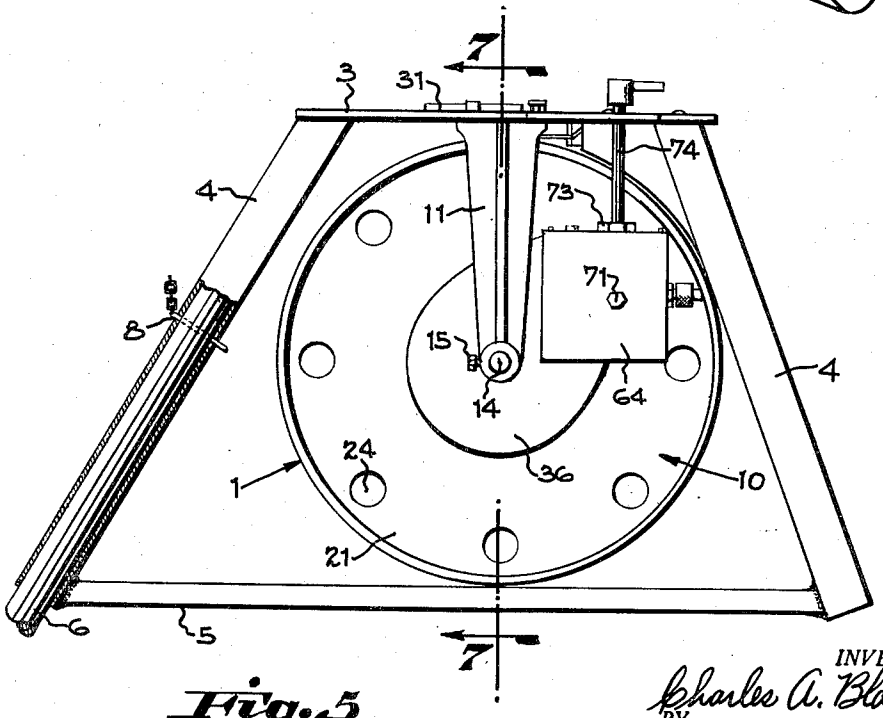

Fig. 5

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EXPLOSIVE CHARGE HANDLING DEVICE

Filed May 4, 1955 6 Sheets-Sheet 4

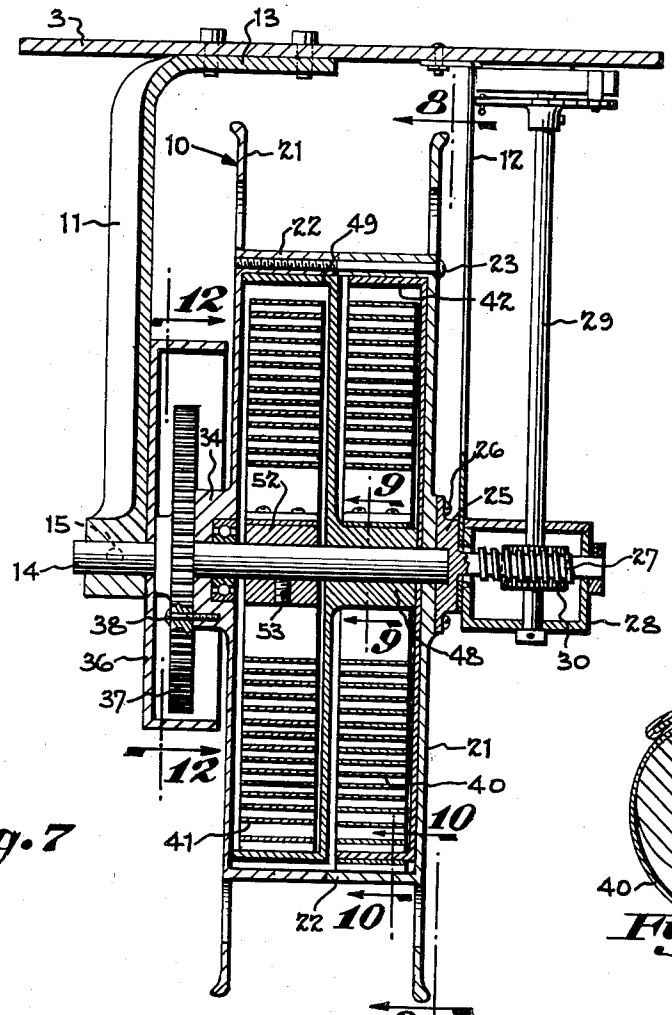

Fig. 7

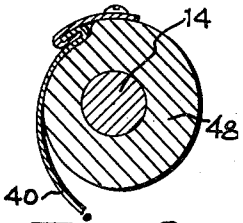

Fig. 9

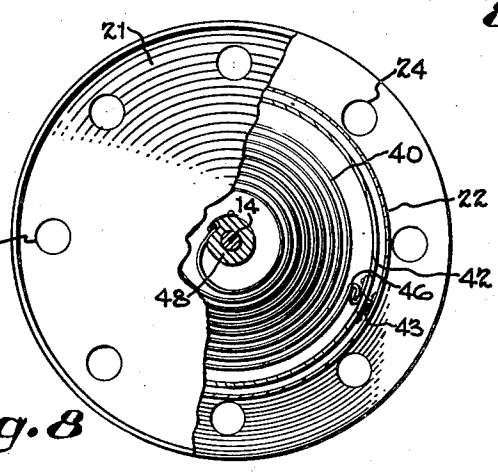

Fig. 8

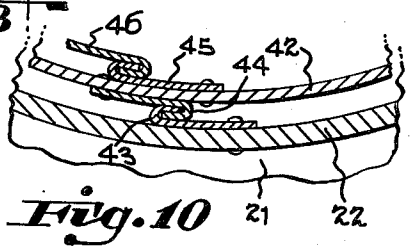

Fig. 10

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Filed May 4, 1955 6 Sheets-Sheet 5

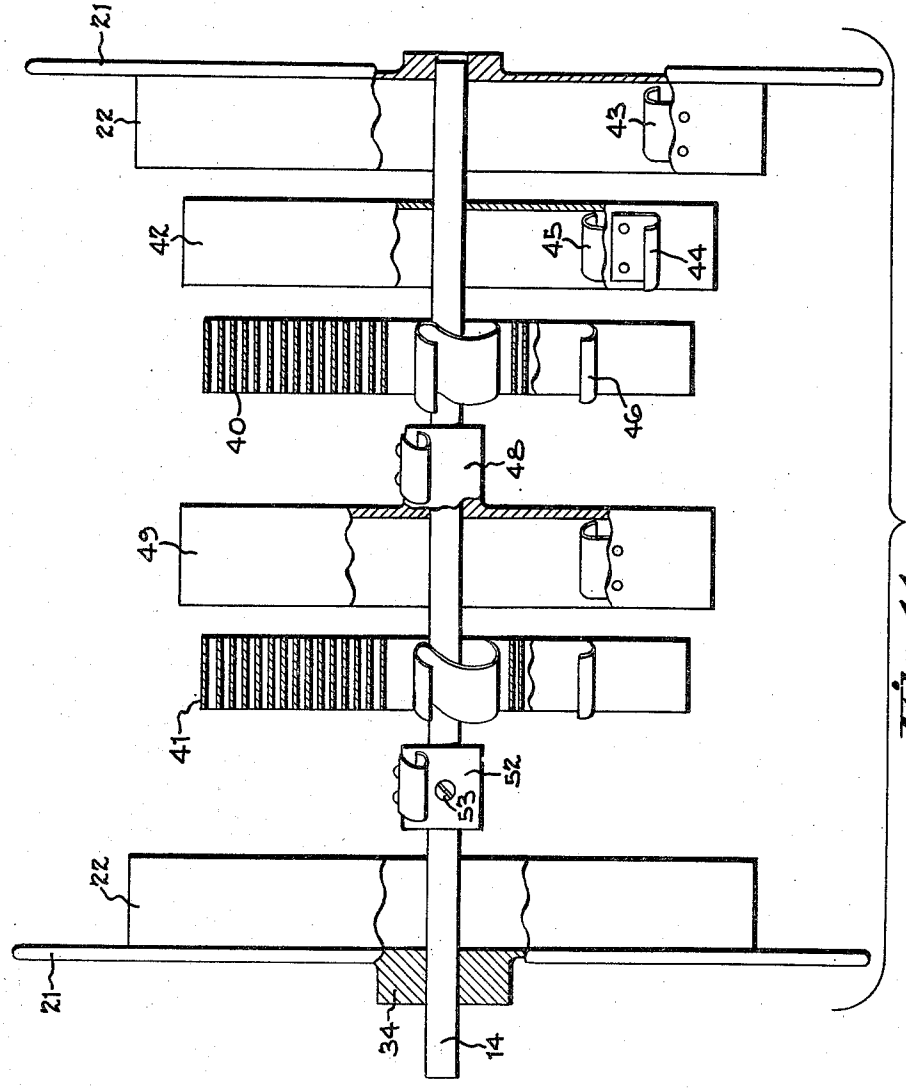

Fig. 11

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EXPLOSIVE CHARGE HANDLING DEVICE

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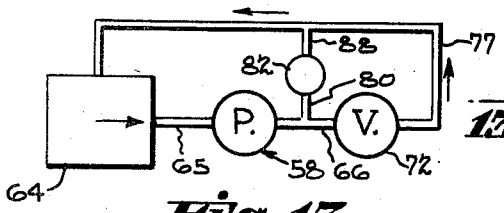

Fig. 17

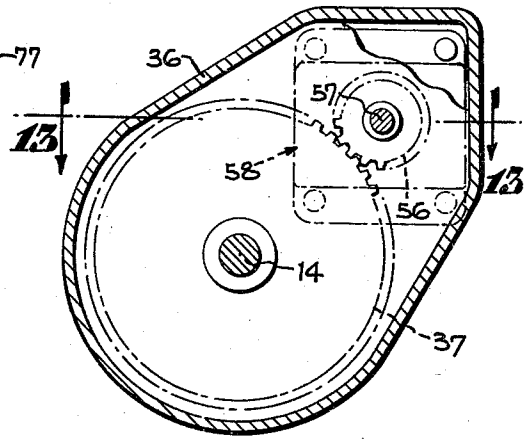

Fig. 12

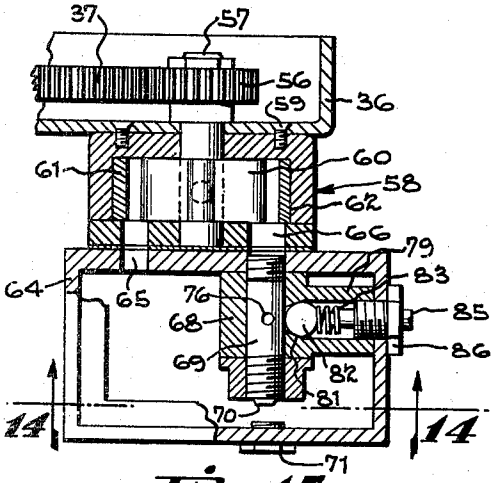

Fig. 13

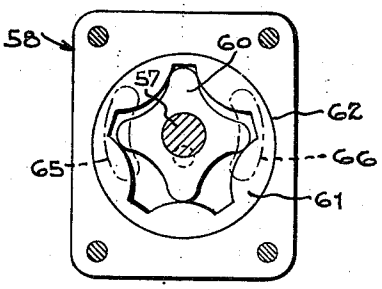

Fig. 16

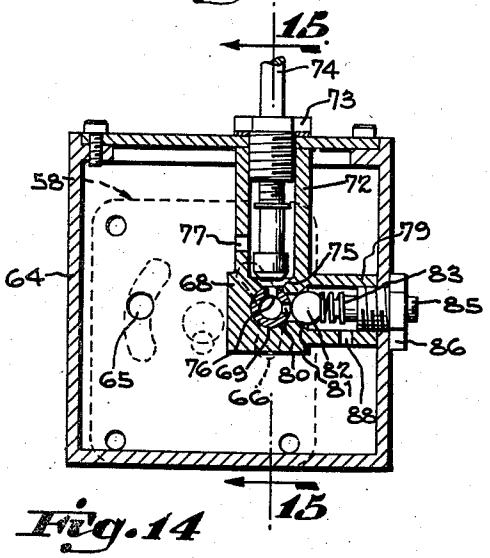

Fig. 14

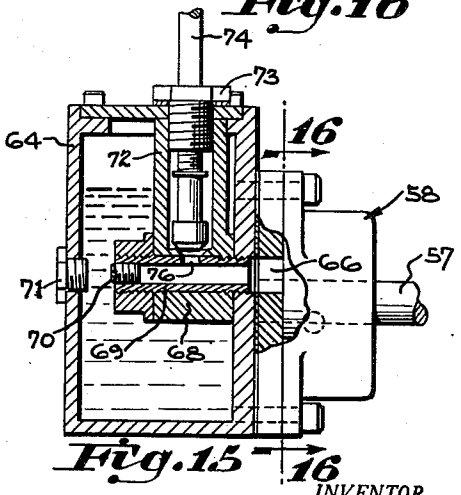

Fig. 15

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United States Patent Office 2,811,334 Patented Oct. 29, 1957

2,811,334

EXPLOSIVE CHARGE HANDLING DEVICE

Charles Arthur Blackburn, Chattanooga, Tenn., assignor to The King Powder Company, Inc., Cincinnati, Ohio, a corporation of Ohio

Application May 4, 1955, Serial No. 505,969

6 Claims. (Cl. 254—152)

This invention relates to apparatus for lowering charges of explosive into a blast hole by means of a rope having an automatic release hook, and for retrieving the rope and hook from the blast hole in a rapid and convenient manner.

In primary blasting, for the dislodgment of stone in a quarry for example, it is conventional practice to drill a blast hole to some predetermined depth, lower one or more cartridges of explosive into the hole, and then detonate the explosive. The cartridges of explosive are lowered into the hole by means of a rope having a self-releasing hook at the end of it which automatically becomes disconnected from the cartridge when the cartridge hits the bottom of the hole, or hits the top of a cartridge that was previously lowered. Primary blast holes vary in depth from 25 to 200 feet, or more, depending upon the nature of the quarrying operation, and it is conventional practice at the present time to lower an explosive charge manually, the operator simply paying out the rope, hand-over-hand, to allow the charge to descend; the rope is retrieved manually in similar manner by hauling it upwardly. In many primary blasting operations, a number of cartridges of explosive are required to be lowered into the blast hole, one after another, to provide the required total charge. It is obvious that the loading of a blast hole manually in this manner is tedious and time-consuming, especially if the blast hole is of substantial depth and a multiplicity of cartridges is required to make up the necessary charge.

The primary objective of this invention has been to provide a simple apparatus adapted mechanically to lower charges of explosive into a well at a controlled rate of descent, but also capable of retrieving the rope and hook automatically thereafter in a rapid and convenient manner. A further objective has been to provide a simple apparatus for this purpose which is also of light weight and portable so as to be moved readily from one blast hole location to another.

A still further objective has been to provide an apparatus of the type described which embodies a measuring indicator for denoting the exact position of the charge of explosive during its descent, as well as a control system for governing the rate of descent of the charge, such that a relatively high rate of descent may be employed in the initial stages of the lowering operation, and such that the rate of descent may be reduced to a safe speed when the charge approaches the bottom of the hole or the top of a charge of explosive which has previously been placed therein.

Apparatus typically constructed in accordance with the present invention is illustrated in the accompanying drawings in which:

Fig. 1 is a side view of the apparatus of this invention, in position of use over a blast hole;

Fig. 2 is a similar view showing the apparatus in end elevation;

Fig. 3 is a fragmentary elevation similar to Fig. 2, but on an enlarged scale to illustrate the head mechanism;

Figs. 4 and 5 are elevations of the respective sides of the head of the apparatus;

Fig. 6 is a top plan view;

Fig. 7 is a sectional elevation taken on the line 7—7 of Fig. 5;

Fig. 8 is a sectional elevation taken on the line 8—8 of Fig. 7;

Fig. 9 is a sectional elevation taken on the line 9—9 of Fig. 7;

Fig. 10 is a view taken on the line 10—10 of Fig. 7;

Fig. 11 is an exploded view illustrating lateral details of construction of the head;

Fig. 12 is a sectional elevation taken on the line 12—12 of Fig. 7;

Fig. 13 is a sectional view taken on the line 13—13 of Fig. 12;

Fig. 14 is a sectional elevation taken on the line 14—14 of Fig. 13;

Fig. 15 is a sectional view taken on the line 15—15 of Fig. 14;

Fig. 16 is a sectional view taken on the line 16—16 of Fig. 15; and

Fig. 17 is a diagrammatical view illustrating the hydraulic rate of descent circuit.

As shown in Figs. 1–6, the apparatus of the present invention comprises a head mechanism indicated generally at 1 and a support having splayed legs adapted to straddle a blast hole indicated generally at 2. In the device illustrated, the support 2 includes a rigid top plate 3 at the underneath face of which tubular legs 4 are fastened, as by welding. These legs are cross-braced by struts 5 which engage them at their lower extremities. Each tubular leg 4 has a plurality of longitudinally spaced cross bores 7 into any one of which a cross pin 8 is insertable, while each extension leg 6 has a cross bore near its upper extremity adapted to receive the pin 8. Thereby the extension legs 6 may be adjusted telescopically to suit the terrain upon which the tripod is to be mounted such that a rigid support will be provided for the head mechanism of the apparatus.

A reel indicated generally at 10 is suspended beneath the top plate 3 by bracket numbers 11 and 12, as shown in Fig. 3. Bracket member 11 has a foot portion 13 at its one end which is fastened rigidly to the bottom surface of the top plate 3, while the opposite end is bored to receive an axle 14 which is fixed against rotation by a cross pin 15. The other bracket, 12, may be in the form of a metal strap, suitably arranged to carry the weight load of the reel.

The rope 17 normally is coiled about the outer periphery of the reel 10, being payed out as the reel is caused to rotate in one direction under the weight of the cartridge, and being rewound onto the reel when the reel is rotated in the opposite direction; however, the reel is of the spring-return type, embodying spirally coiled springs in which energy is stored during the descent of the rope and its associated cartridge weight load 19 so as to rewind the reel and retrieve the rope after the load of explosive has been discharged at the bottom of the blast hole. To enable most effective utilization of the apparatus under various conditions encountered in lowering explosive charges of different weights, in holes of widely differing depths, the invention additionally contemplates a speed governor system through which the rate of reel rotation may be controlled, and a rotation counter device through which the height position of the rope within the hole is indicated.

Primary blast holes vary greatly as to depth, and explosive charges vary greatly as to weight. Now a simple rewind spring strong enough to permit a cartridge of a given weight to descend into a blast hole of given depth at an appropriate rate of speed will not satisfactorily serve the purpose if the cartridge load is appreciably greater, or if the blast hole is appre-

ciably deeper, or both. For example, if the spring were to be sufficiently light to allow a cartridge of given weight to descend at a safe speed to the bottom of a blast hole of certain depth, it would allow a heavier cartridge to descend so rapidly into a hole of the same depth that the cartridge would be damaged in hitting the bottom of the blast hole, with the resultant possibility that the explosive would subsequently fail to detonate. Also, an accelerating effect is encountered because of the progressively increasing weight of the rope acting on the reel as it is payed out. Conversely, a spring sufficiently strong or heavy to allow cartridges of given weight to descend at an appropriate rate of speed into blast holes of one depth would not permit proper operation to be obtained in the blast holes much deeper. The spring strength necessarily is related to the load which it must serve, while the degree to which the spring can be wound up governs the maximum depth of blast hole which the apparatus can serve.

In accordance with this invention, a hydraulic mechanism in the form of a speed governor system is utilized in conjunction with a reel having two or more serially energizable, spirally wound rewind springs. The governor mechanism, controllable manually, permits the operator to allow a cartridge to descend rapidly under a relatively light spring force as the cartridge is descending throughout the major portion of its fall, and the serial interconnection of the springs provides sufficient reel capacity to serve deep blast holes. However, when the cartridge nears the bottom of a hole, whatever its depth, then adjustment of the control mechanism brakes the reel, thereby decelerating the descent speed to a safe figure. In this manner, the optimum rate of descent is obtained in conjunction with optimum safety and maximum depth capacity.

To enable the operator to exercise speed control as the cartridge approaches the bottom of a blast hole (or approaches the top of a previously lowered explosive charge), an indicator is provided which designates the amount of rope which has been payed out.

The reel is made up of spaced circular disks or end plates **21—21** between which a ring **22** of smaller diameter is concentrically fastened by means of cross screws **23** (Fig. 7). The end of the rope may be fastened to the reel through any one of the holes **24** in either one of the end plates **21**.

One of the end plates **21** has a hub **25** fastened to it, as by screws **26**. This hub resides inwardly adjacent the bracket **12**, and terminates in a worm shaft **27** which projects through bracket **12** wherein it is rotatably supported. A housing **28**, fastened to the outer face of bracket **12**, surrounds the worm, and the housing is bored vertically to rotatably support a shaft **29**. Within the housing, shaft **29** carries a worm wheel **30** which is meshed with the worm **27**. The upper end of shaft **29** drives an indicator **31** which may be of any type, suitably calibrated in relation to the reel diameter. The indicator, as shown in Figs. 6 and 7, is mounted in the top plate **3**, and therefore, is readily visible to the operator.

At the opposite end of the reel **10**, end plate **21** is provided with a hub **34**. The axle **14** extends through this hub, one end of the axle being fixed in bracket **11** as previously described, while its opposite end is carried in a recess in the hub **25**. Between the hub portion **34** of the reel and the inner face of the bracket **11** a box **36** is located surrounding gear **37** which is fastened to the hub **34** by screws **38**. This gear drives the hydraulic speed governor, as described at a later point in the specification.

Within the reel are two spirally wound coil-type rewind springs **40** and **41** arranged in side-by-side relationship. In the construction illustrated, these coil springs are connected serially for energization by reel rotation as follows. Spring **40** is contained within a cup member **42**. The bottom of the cup resides adjacent the inner face of end plate **21** and the peripheral wall of the cup resides adjacent the drum ring **22**. As shown best in Fig. 11, the ring **22** is provided with an inwardly extending hook **43**. This engages a hook **44** extending outwardly from the outer surface of the wall of cup **42**. An inwardly extending hook **45** projects from the interior of the peripheral wall of cup **42** for engagement with a hook **46** at the outer extremity of coil spring **40**. The inner extremity of coil spring **40** is provided with a hook which extends outwardly from a hub **48** of a second cup member **49**, which is otherwise similar in shape to the cup **42**, and which resides facially adjacent the cup **42** in the other half of the reel interior. Cup **49** carries an inwardly projecting hook, which is not specifically shown but which is similar to hook **45**. This engages a mating hook portion at the outer periphery of spring **41**. The inner end of the latter spring is connected, by hooks similar to those shown in Fig. 9, to a fixed hub **52** which is fastened to the stationary axle **14**, by means of a set screw **53**. All of the hooks are faced in such direction that rotation of the reel in one direction, as during lowering of the rope, tensionally winds the springs, the motion progressing from reel spring **40** through hub **48** to cup **49**, thence through spring **41** to the fixed hub **52** where the rewind force is sustained by the fixed axle **14**. Because of this construction, the reel may be rotated through a substantial number of revolutions before both springs are completely wound up, and therefore, the reel is able to serve blast holes of substantial depth, and afterwards retrieve the bail therefrom by rewind. Yet each spring is sufficiently light in strength as to permit the reel to rotate relatively freely under a nominal weight load of explosive.

For speed control, gear **37**, which rotates with the reel within the housing **36**, drives a pinion **56** which is fixed to a shaft **57** of a gear-type hydraulic pump indicated generally at **58**. The hydraulic pump is fastened to the exterior of the housing **36** by screw **59**. Impeller **60** of the pump is fixed to the shaft **57**, as shown in Figs. 12, 13, and 16, and is of the star-wheel type. This impeller operates within a member **61** which is configurated at its interior generally to complement the contour of the pump impeller, but it is offset eccentrically with respect to the impeller axis of rotation, and its exterior is rotatable in a suitable cavity **62** provided within the pump housing. By virtue of the eccentric mounting of the cooperating pump members, the space of volume between the two members **60** and **61** progressively becomes greater at one side of center, thereby creating a suction for admission of hydraulic fluid, and then progressively becomes smaller so that pressure is exerted on the fluid trapped between the two.

Pump **58** is operated in conjunction with a reservoir and valve device **64** which is mounted to the outer face of the pump housing. The reservoir communicates with the pump cavity through an inlet opening **65**, while the pump directs pressure fluid through an outlet opening **66**. Within the reservoir **64** is a fixed boss **68** supporting a nipple **69** having its one end in communication with the outlet **66**, while the outer end of the nipple is closed by screw **70**. For clean-out purposes, the outer wall of the housing **64** is provided with a hole for access to the screw **70**, and this hole is closed by a plug **71**.

Boss **68** has a lateral tubular portion providing a passageway **72** which has its upper end closed by a plug **73**. The latter threadedly carries a valve stem **74**. The bottom of the passageway **72** terminates in a seat **75** which cooperates with the suitably configurated endwise portion of the valve stem **74** just above a port **76** which extends through the valve seat into the passageway of member **69**. Above the valve seat, passageway **72** communicates with the reservoir through a port **77**. Therefore, it will be seen that during reel rotation, the impeller of the pump **60** is driven to withdraw hydraulic fluid from the reservoir into the pump cavity through inlet **65** and to deliver fluid under pressure through the

outlet opening **66** into nipple **69**, thence through port **76**, past the valve seat and outlet **77** back into the reservoir. However, the adjustability of the valve stem **74** permits construction of the flow of fluid through the port **76**, thereby causing the pump to work against a back pressure through which a braking action is exerted on the reel.

A pressure relief system is also provided in the hydraulic circuit to prevent pump damage in the event the reel forcibly is rotated when the port **76** is closed. This system comprises a second laterally extending passageway **79** which communicates with a port **80** provided in the nipple **69**. Just outside the port **80**, seat **81** is provided which receives a ball **82**, the ball being held against the seat by a compression spring **83**. The opposite end of spring **83** is engaged by a screw member **85** which is threaded into a screw plug **86** which is threaded into the wall of the reservoir **64**. Outlet port **88** extends through the wall of the member **79** into communication with the reservoir. Therefore, as is shown in Fig. 17, if or when the pump pressure becomes excessive, ball **82** will be unseated and the pressure will be relieved by the passage of oil through the ports **80** and **88** back into the reservoir whether or not port **75** is closed. The spring **83**, of course, is of sufficient strength normally to seat the ball and thereby close the port **80** during normal usage of the apparatus.

The apparatus of the present invention is particularly advantageous in use because it prevents inadvertent release of the explosive cartridge during descent if it momentarily encounters any obstruction. Some bore holes have rough or jagged walls; others become partly filled with water or mud, and sometimes sticky mud is on the walls of the hole. Automatic release hooks of the type in common operation become self-releasing when slack appears in the rope, that is, when the movement of the load stops, but movement of the rope does not. For this reason, if a cartridge, while being lowered manually, hangs momentarily upon an obstruction in the bore hole or sticks to mud, or hits water or mud which has accumulated in the bore above the bottom while the operator unknowingly continues to pay out the rope hand-over-hand, it is probable that the hooks will become disengaged unintentionally from the cartridge load and special steps will then have to be taken to retrieve the cartridge.

In the use of the apparatus of the present invention, the return tension which is always maintained upon the rope during lowering of the cartridge prevents unintentional accumulation of slack and thereby the hook does not become disengaged through momentary stopping or deceleration of the load, since the reel rotates only in respect to the actual weight load. In this manner, the cartridge is released only when it reaches its resting position and can go no farther. Therefore, the present invention eliminates the costly nuisance which occurs in hand lowering operations when the cartridge is released inadvertently.

Having described my invention, I claim:

1. A device for lowering explosive charges into a blast hole and thereafter automatically retrieving the rope and hook, which device comprises, a support having splayed legs adapted to straddle a blast hole, a reel located between said legs, a stationary axle carried by said support rotatably supporting said reel, coiled spring members arranged in side-by-side relationship within said reel, means interconnecting said springs serially to one another and respectively to said stationary axle and said reel such that the springs are energized upon rotation of the reel in one direction and are effective to rotate the reel by spring power in the opposite direction, a fluid pump in driven connection with said reel and having inlet and outlet passageways, a reservoir in closed circuit interconnection with the inlet and outlet passageways of said pump, and a manually adjustable metering valve in said outlet passageway, said pump forcing hydraulic fluid through the metering valve in response to rotation of the reel in lowering and raising directions, the metering valve governing the rate of reel rotation as the explosive charge is lowered into the blast hole, the valve thereafter governing the rate of reel rotation in the opposite direction under spring power as the rope is retrieved after releasing the explosive charge.

2. A device for lowering explosive charges into a blast hole and thereafter automatically retrieving the rope and hook, which device comprises a support including splayed legs adapted to straddle a blast hole, an axle rigidly carried by said support between said legs, a reel rotatably mounted on the said axle, the said reel being adapted to carry a rope and hook at its periphery, spirally coiled springs arranged in side-by-side relationship within said reel, means interconnecting respective ends of the coiled springs serially with one another and to the said axle and the said reel whereby rotation of the reel in one direction is effective to energize the springs and rotation of the reel in the opposite direction is effected by the release of the coiled spring energy, a driving gear connected to said reel at one side thereof, a fluid pump in driven connection with said driving gear and having inlet and outlet passageways, a closed hydraulic circuit including a reservoir for hydraulic fluid and said inlet and outlet passageways, and an adjustable flow-constricting valve in said hydraulic circuit, said pump forcing hydraulic fluid through said flow-constricting valve in response to rotation of the reel in either direction and governing the rate of reel rotation as the charge is lowered into the blast hole, said valve providing a reel braking action upon adjustment of the valve as the charge approaches the bottom of the blast hole, said valve governing the rate of reel rotation in the opposite direction under spring energy upon adjustment thereof as the rope is retrieved after release of the explosive at the bottom of the blast hole.

3. A device for lowering explosive charges into a blast hole and thereafter automatically retrieving the rope and hook, which device comprises, a support including splayed legs adapted to straddle a blast hole, an axle rigidly carried by said support between said legs, a reel rotatably mounted on the said axle, the said reel being adapted to carry a rope and hook at its periphery, spirally coiled springs arranged in side-by-side relationship within said reel, means interconnecting respective ends of the coiled springs serially with one another and to the said axle and the said reel whereby rotation of the reel in one direction is effective to energize the springs and rotation of the reel in the opposite direction is effected by the release of the coiled spring energy, a driving gear connected to said reel at one side thereof, a worm gear connected to said reel at the other side thereof, a fluid pump in driven connection with said driving gear and having inlet and outlet passageways, a closed hydraulic circuit including a reservoir for hydraulic fluid and said inlet and outlet passageways, and an adjustable flow-constricting valve in said hydraulic circuit, the said worm gear having a worm wheel in driven interconnection therewith, and a revolution counter driven by said worm wheel to denote the extent of reel rotation in either direction, said revolution counter indicating the depth of the charge in response to reel rotation as the charge is lowered into the blast hole, said fluid pump forcing hydraulic fluid through the flow-constricting valve in response to rotation of the reel in either direction, said valve governing the rate of reel rotation as the charge is lowered, said revolution counter indicating that the charge is approaching the bottom of the blast hole, said valve, upon adjustment, providing a braking action upon the reel as the charge approaches said bottom.

4. A device including a rope and hook element for lowering explosive charges into a blast hole and thereafter rewinding the rope, comprising, a support including a plurality of splayed legs adapted to straddle a blast hole, a support member mounted in a horizontal plane

at the top of said legs, a bracket attached to said support member and depending downwardly therefrom within said splayed legs, a horizontal axle having an end portion rigidly mounted in the lower portion of said bracket, a reel rotatably mounted upon said axle between said legs and below said support member, a pair of spirally coiled springs on said axle within said reel residing in side-by-side relationship, said springs connected together in series, one of said springs having an end anchored to said axle, the companion spring having an opposite end anchored to the reel, whereby said springs are wound up in series upon rotation of said reel in lowering direction and are effective thereafter to rotate said reel in raising direction to retrieve said rope and hook element, a driving gear connected to said reel at one side thereof, a fluid pump mounted on said bracket and in driven connection with said driving gear, said pump having inlet and outlet circuit, and a manually adjustable metering valve in said circuit, said fluid pump forcing fluid through the metering valve in response to rotation of the reel in either direction, the valve governing the rate of reel rotation as the charge is lowered and being adjustable to govern the rate of reel rotation in the raising direction under energy stored in said springs, the turning force of said pump acting through said bracket to the support member at the top of said splayed legs.

5. In a device for lowering explosive charges into a blast hole, a support including splayed legs adapted to straddle a blast hole, an axle rigidly carried by said support between said legs, a hollow cylindrical reel rotatably mounted on said axle, a rope having one end anchored to the periphery of the wheel and having a self-releasing hook anchored upon the opposite end thereof, a first and second spirally coiled spring arranged in side-by-side relationship within said reel, a cup enclosing the first of said coiled springs, said cup residing within the reel and concentric therewith, said cup rotatably journalled on said axle, said first spring having its outer end anchored to said cup, a driving element projecting outwardly from the external periphery of said cup, a mating driving element projecting inwardly from the internal periphery of the reel and engageable with said first mentioned driving element, said mating driving elements adapting the reel and cup to be slipped upon said axle and into driving connection with one another, a second cup enclosing said second spring, said second cup having a hub loosely journalled upon said axle and projecting laterally within said first spring, said first spring having its inner end anchored upon said hub, said second spring having its inner end anchored upon said axle and its outer end anchored to the periphery of the second cup, whereby said reel rotates the first cup upon rotation in lowering direction to wind up the first spring and the first spring

rotates the second cup, and thereby winds up said second spring in a series with the first spring, said springs being effective to rotate the reel in raising direction to retrieve said rope and hook after said explosive charge is lowered, and released by the self-releasing hook.

6. In a device for lowering explosive charges into a blast hole, a support including a plurality of splayed legs adapted to straddle a blast hole, a support member mounted in a horizontal plane at the top of said legs, a bracket having its upper end attached to said support member and depending downwardly therefrom within said splayed legs, a horizontal axle having an end portion rigidly mounted in the lower portion of said bracket, a hollow cylindrical reel rotatably mounted upon said axle between said legs and below said support member, a rope having one end anchored to the periphery of the reel and having a self-releasing hook anchored upon the opposite end thereof, a first and second spirally coiled spring arranged in side-by-side relationship within said reel, a cup enclosing the first of said coiled springs, said cup residing within the reel and concentric therewith, said cup rotatably journalled on said axle, said first spring having its outer end anchored to said cup, a driving element projecting outwardly from the external periphery of said cup, a mating driving element projecting inwardly from the internal periphery of the reel and engageable with said first mentioned driving element, said mating driving element adapting the reel and cup to be slipped upon said axle and into driving connection with one another, a second cup enclosing said second spring, said second cup having a hub loosely journalled upon said shaft and projecting laterally within said first spring, said first spring having its inner end anchored upon said hub, said second spring having its inner end anchored upon said axle and its outer end anchored to the periphery of the second cup, whereby said reel rotates the first cup upon rotation in lowering direction and winds up the first spring and the first spring rotates the second cup upon being wound up and thereby winds up said second spring in a series with the first spring, said springs being effective to rotate the reel in raising direction to retrieve said rope and hook after said explosive is lowered and released by the self-releasing hook, the turning force of said springs reacting through said axle and bracket to the support member at the top of the splayed legs.

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