

July 22, 1969

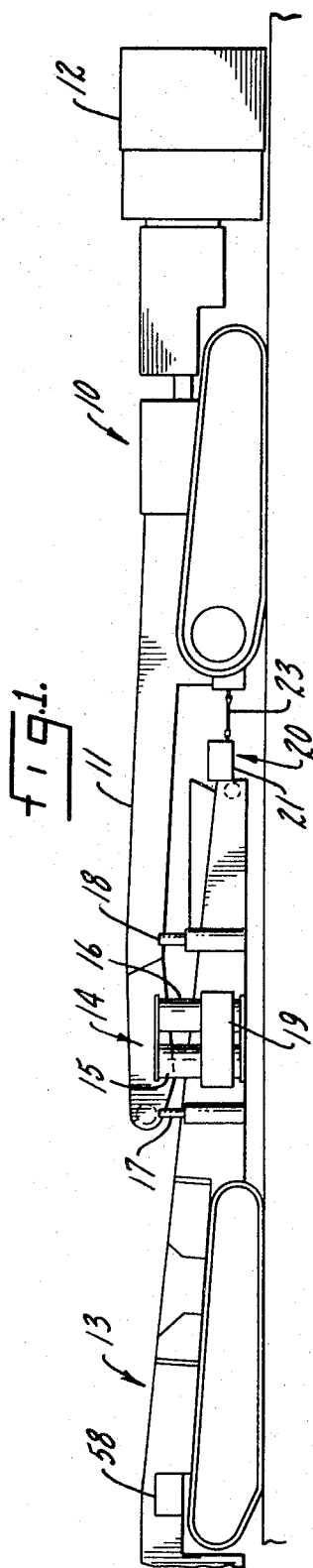
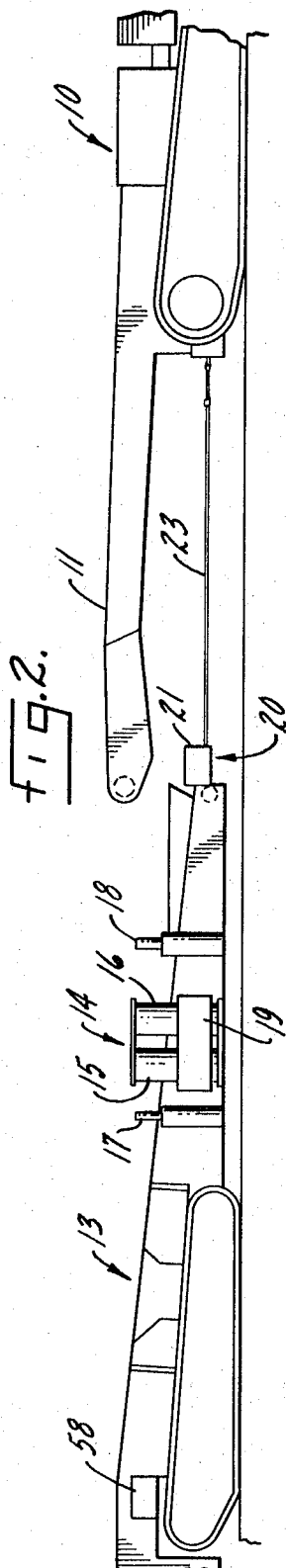
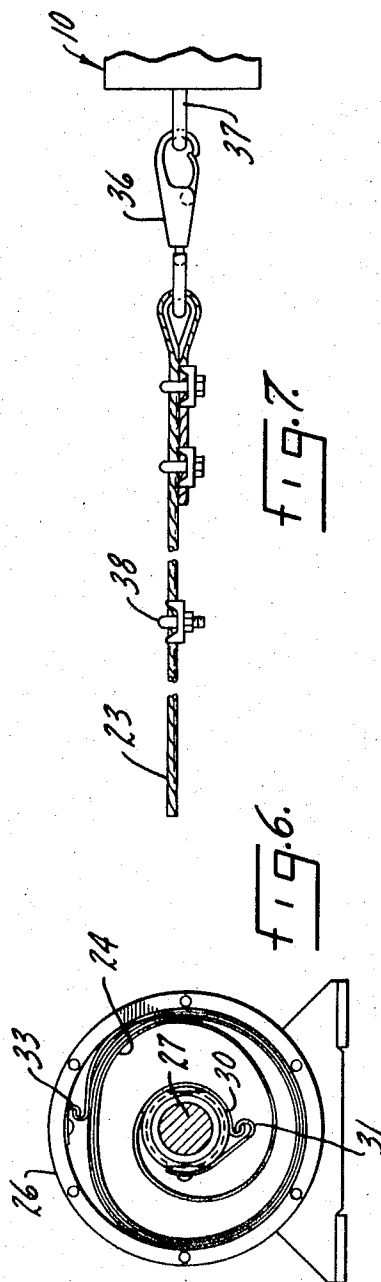
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3,456,982

AUTOMATIC INTERNAL TRAM CONTROL

Filed July 24, 1967

2 Sheets-Sheet 1



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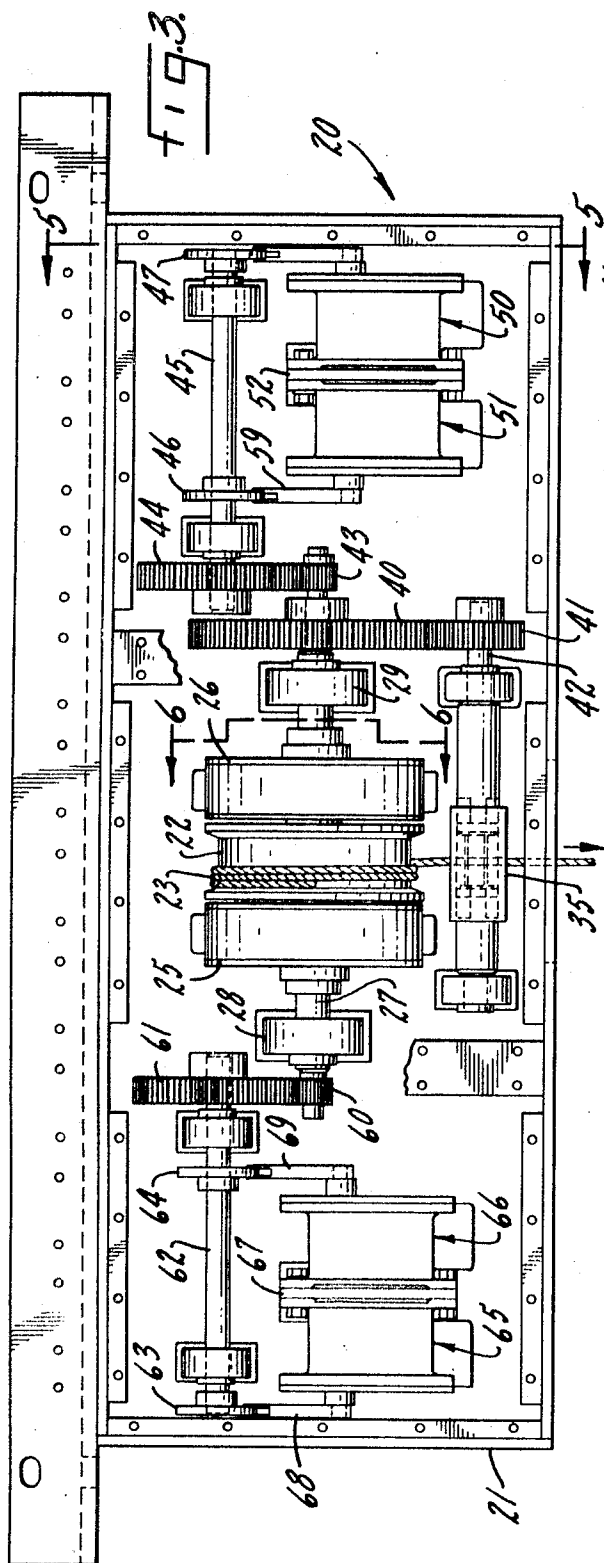
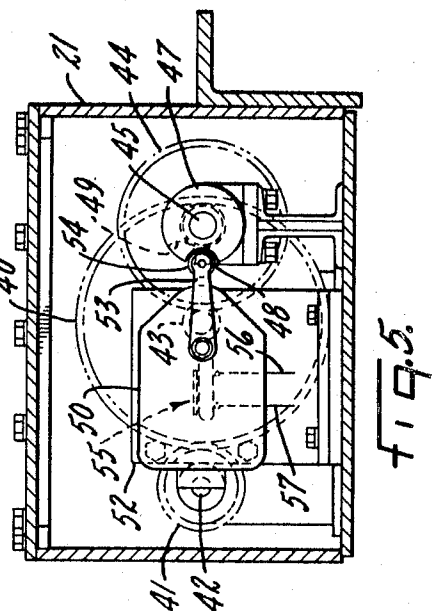
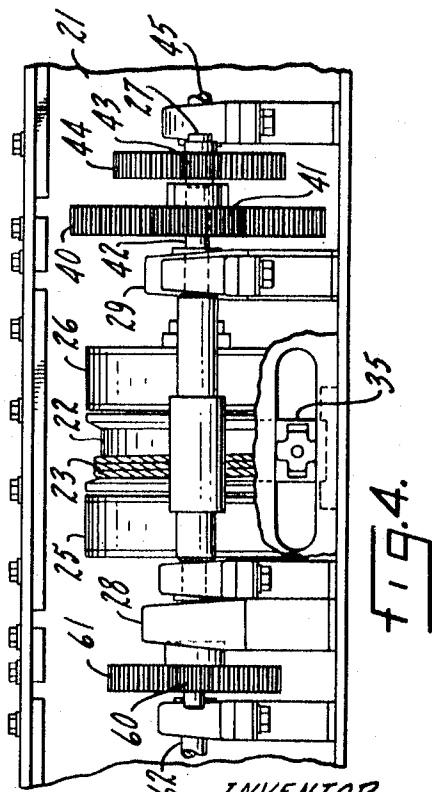
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2 Sheets-Sheet 2



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AUTOMATIC INTERNAL TRAM CONTROL

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14 Claims

ABSTRACT OF THE DISCLOSURE

A system and method for maintaining a stop and go type trailing unit, such as a conveyor which carries roof bolting equipment and receives cuttings from a lead unit, such as a borer, in operative relationship to the lead unit which may continuously advance. A short line or "dog leash" is payed out from the trailing unit as the lead unit advances until switch means are operated to cause the trailing unit to catch up to the lead unit.

The invention relates to a method of automatically advancing, in substantially equal increments, a stop-and-go trailing unit which trails a continuously advancing lead unit so as to maintain the stop-and-go unit within a predetermined maximum distance limit of the lead unit at all times, and apparatus therefor.

Although the invention may be applicable, with appropriate modification, to many systems in which a stop-and-go type trailing unit is required to stay within a predetermined maximum traveling distance from an advancing lead unit, it will be described as applied to a coal mining system in which a roof bolting operation occurs immediately behind a continuously advancing mining operation. In the specific embodiment described, the roof bolting equipment is carried by a movable conveyor unit which receives coal from a continuously advancing coal borer and conveys it away from the face. Since the roof bolting equipment must be stationary during drilling, the conveyor unit must likewise be stationary. After bolting, the conveyor unit and roof bolting equipment must catch up with the borer before the borer moves beyond the conveyor and discharges onto the floor of the entry. The invention is intended during normal operation of the above mentioned system to advance the roof bolting equipment a fixed distance during each increment of movement so that a desired, uniform spacing may be maintained between roof bolts. Furthermore, the incremental advancement of the roof bolting equipment occurs automatically so that the roof bolt drill operator need not be concerned with run controls during the limited time available.

Accordingly, a primary object of the invention is to provide a method of automatically maintaining a stop-and-go type trailing unit within a pre-determined maximum trailing distance of a continuously advancing lead unit.

Another object is to provide a method of accomplishing the aforesaid object, in which the trailing unit is advanced in substantially equal increments of distance so long as the lead unit is advancing during the advance period of the trailing unit.

A further object is to provide a method of maintaining a stop-and-go type trailing unit within a predetermined maximum trailing distance of an advancing lead unit even if the speed of the lead unit varies, or ceases between increments of advance of the trailing unit.

Yet a further object is to provide apparatus for accomplishing the above objects.

The invention is illustrated more or less diagrammatically in the accompanying drawings wherein:

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FIGURE 1 is a side view of a coal borer and the advancing end of a self-propelled combination roof bolting and conveyor unit, the two machines being at their condition of minimum spacing;

FIGURE 2 is a side elevation similar to FIGURE 1 showing the two machines in the position of maximum spacing;

FIGURE 3 is a top plan view, with the cover removed, of the cable mechanism which regulates the automatic tram control on the trailing unit;

FIGURE 4 is a front view, with the cover omitted, of the mid portion of FIGURE 3;

FIGURE 5 is a view taken substantially along the line 5—5 of FIGURE 3;

FIGURE 6 is a view taken substantially along the line 6—6 of FIGURE 3; and

FIGURE 7 is a view, to an enlarged scale, of the portion of the leash or cable which connects the lead unit to the trailing unit.

Like reference numerals will be used to designate like parts throughout the following description of the invention.

A boring machine suitable for underground mining is indicated generally at 10 in FIGURE 1. It may have a conventional construction and is shown in this instance as including a rearwardly extending boom 11 which carries a conveyor to remove cuttings resulting from the operation of the head 12. The exact construction of the borer is not particularly essential to an understanding of the invention, except for the fact that one purpose of the invention is to provide a system in which the coal conveying units are always maintained in close receiving relationship with the borer.

As used in this specification and the claims the term "forward" will be used to refer to a direction of advance toward the face and the term "reverse" to movement in the opposite direction.

A conveyor unit is indicated generally at 13 in FIGURES 1 and 2. Again, the construction of the conveyor is not particularly critical to the invention.

In the illustrated system, the borer advances continuously along the entry. It is not feasible, however, for the conveyor unit to advance continuously because provision must be made for roof bolting as required by state laws. Accordingly, a roof bolting station is indicated generally at 14, the roof bolting station being carried by the conveyor unit. It will be understood that two such stations may be provided, located opposite one another, but since the stations are identical, a discussion of one will suffice for both.

The roof bolting station includes a pair of jacks 15, 16 which are operated to steady the station during drilling of the roof bolt hole. A pair of drills are indicated at 17, 18, the drills being controlled by an operator located at the operator station 19. It may be assumed for the purposes of discussion that the drills 17, 18 are spaced five feet from one another, which is a common spacing since many state laws require roof bolting every five feet.

Since the conveyor unit 13 which carries the roof bolting stations must be stationary during roof bolting operations, yet the borer is continuously advancing into the entry, it is highly desirable that some automatic means be provided for tramping the roof bolting equipment forward the necessary distance in readiness for a succeeding roof bolting operation.

A system for advancing a stop and go type trailing unit, such as conveyor unit 13, equal increments of travel behind a continuously advancing lead unit, such as borer 10, is indicated generally at 20. The system permits the lead unit to advance an initial distance ahead of the stationary trailing unit, then actuates the trailing unit for advancing movement at a faster rate of speed than the

rate of speed of the lead unit, and finally terminates movement of the trailing unit after it has traversed a desired distance which, in the illustrated embodiment may be of the order of ten feet.

The system includes a housing 21 having a wire rope spool 22 upon which is coiled a wire rope 23. The wire rope is payed out and payed in under tension provided by a pair of torsion springs 24 located in the housings 25, 26 at the ends of the spool. From FIGURES 3 and 6 it will be noted that the spool rotates about a shaft 27 which is journaled in a pair of pillow blocks 28, 29, the shaft being connected to one end 30 of each clock spring 24 as at 31 and at the other end to casing 26 as at 33. Thus, as the wire rope is pulled outwardly off the spool in the direction of the arrow in FIGURE 3, the clock springs will guide the rope. Preferably, the wire rope passes through a wire rope guide 35.

As best illustrated in FIGURE 7, the forward end of the rope 23 is removably secured, as by a swivel eye snap 36 to a hook or other securing member 37 carried by the lead unit 10. If desired, a wire rope clip 38 may be provided near the forward end of the rope or leash so that when the rope is disconnected from the lead unit, it will not be completely coiled on the rope spool 22. That is, the clip 38 stops recoiling of the rope at a point which leaves a short length available for easy accessibility. It should be noted, however, that clip 38 must be placed on the rope at a point where it is beyond the actuating point on the rope, as will be explained in detail hereinafter.

A large gear 40 carried by the shaft 27 meshes with a pinion 41 carried by the shaft 42. Rotation of shaft 42 facilitates even placement of the wire rope on the spool.

A small pinion 43 is secured to the outer end of shaft 27 and meshes with a large gear 44. Gear 44 rotates cam shaft 45 which carries a pair of cams 46, 47. Cam 47 includes an indentation 48, as best seen in FIGURE 5, and cam 46 carries a small indentation which is indicated at 49.

A pair of limit switches are indicated at 50 and 51. The limit switches are supported from switch bracket 52. Actuator arm 53 extends outwardly from switch 50 and carries a follower 54 which engages cam depression 48 on cam 47 when the parts are in the relative position shown in FIGURE 5. It will be understood that actuator arm 53 is connected by any conventional means to a switch indicated generally at 55 which, when closed, completes a circuit through lines 56 and 57 in the motor 58 which powers conveyor unit 13. Switch 51 includes actuator arm 59 having a cam follower which is received in cam depression 49 of cam 46.

The opposite end of shaft 27 carries a pinion 60 which drives a gear 61 carried by cam shaft 62. A pair of cams are indicated at 63, 64. A second pair of limit switches are indicated at 65, 66, these switches being supported from switch bracket 67. Cam actuator 68 includes a cam follower which is received in a suitable cam depression in cam 63. Likewise, cam actuator 69 includes a cam follower which is received in a cam depression in cam 64.

The gearing system is designed in such a fashion that pay out and pay in of wire rope 23 at its extreme limits will not result in more than one complete revolution of either of cam shafts 45 or 62.

The use and operation of the invention are as follows.

Assume that borer 10 is advancing in a forward direction at the rate of three feet per minute in FIGURE 1 and that conveyor unit 13 is at rest in its position of closest approach to the borer during normal operation.

The operator, at this time, activates the jacks 15, 16 to steady the bolting station and then drills a pair of roof bolt holes with drills 17 and 18. Following retraction of the drills, roof bolts are inserted and seated.

While the operator has been roof bolting, the borer 10 has been moving away from conveyor unit 13. Assume now that the roof bolting operation has been completed

and the borer has moved almost ten feet away from conveyor 13.

When the position of FIGURE 2 is reached, cam follower 54 drops into cam depression 48 in cam 47. Actuation of the cam closes switch 55 which completes the circuit through motor 58 which is the power source for tramming conveyor unit 13 forward. Conveyor unit 13 therefore begins to move forward at a faster rate of speed than the speed of borer 10. Assume, for example, that conveyor unit 13 moves at approximately twenty-five feet per minute.

When conveyor unit 13 approaches borer 10 at the point where it is the same distance from the borer as indicated in FIGURE 1, the cam carried by cam actuator 59 drops into cam depression 49 on cam 46 and the motor circuit is open. It should be understood, of course, that while conveyor unit 13 was overtaking borer 10, cam 46 was rotated and cam 47 moved out of the illustrated seating position of FIGURE 5. During this period of time however, a conventional holding circuit functions to maintain the motor in operation.

By the time conveyor unit 13 has re-established the same relative position to borer 10 it occupied in FIGURE 1, it will have traveled forwardly approximately ten feet. It will be readily understood by those skilled in the art that by a suitable cam design, conveyor unit 13 can be caused to move any desired distance, it being only necessary to take into account known factors such as the speeds of the borer and the conveying unit and the net effect of the gear system.

As soon as the relative position of FIGURE 1 has been re-established, the cycle previously described is repeated by the operator and the borer again begins to move forwardly with respect to the stationary conveyor unit.

Limit switches 65 and 66 are provided for safety.

The function of limit switch 66 is to cut off power to the borer in the event of a malfunction associated with switch 50. That is, if for some reason motor 58 of conveyor unit 13 did not operate to tram conveyor unit 13 forward when the position of FIGURE 2 was reached, switch 66 opens the motor circuit in borer 10 to prevent the borer from pulling leash 23 off drum 22.

The function switch 65 is to prevent a collision between the borer 10 and the conveyor unit 13. That is, in the event borer 10 approaches conveyor unit 13 at a point closer than the relative position shown in FIGURE 1, as might occur when the borer trams in a reverse direction for some reason while connected to conveyor unit 13, switch 65 will operate to either signal conveyor unit 13 to tram in a reverse direction or cut off power to the borer.

It will be understood, of course, that the primary working switches are 50 and 51 and so long as the system operates in the intended normal fashion, switches 65 and 66 will not be activated.

In essence, switch 50 may be considered a trailing unit activating means, and switch 51 a trailing unit deactivating means, whereas both of switches 65 and 66 function as protective switches.

I claim:

1. A method of advancing a stop-and-go type trailing unit substantially equal increments of travel behind a continuously advancing lead unit, said method including the steps of

advancing the lead unit ahead of the trailing unit while the trailing unit remains stationary, producing a first control signal when the lead unit reaches a first position which establishes a pre-determined maximum distance between the units, starting advancing movement of the trailing unit responsive to the control signal, advancing the trailing unit at a faster rate than the lead unit until a pre-determined distance of travel has been traveled by the trailing unit, at which time the distance between the units is at a minimum,

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producing a second control signal when the trailing unit reaches a second position which defines the aforesaid pre-determined minimum distance between the units,

stopping the trailing unit responsive to the second control signal,

maintaining the trailing unit in the stopped position until the continuously advancing lead unit reaches a new first position which re-establishes the pre-determined maximum distance between the units, and repeating the foregoing sequence of steps whereby to advance the trailing unit substantially equal increments of travel.

2. The method of claim 1 further characterized in that the lead unit is advanced at a substantially constant rate of speed.

3. The method of claim 1 further characterized in that the lead unit is a mining machine and the trailing unit includes roof bolting equipment, and further including the step of

performing roof bolting operations at the trailing unit during the dwell periods when the trailing unit is stationary.

4. The method of claim 1 further characterized in that start up and stoppage of the trailing unit is initiated mechanically.

5. A system for initiating start up and stoppage of the trailing unit in a system having a continuously advancing lead unit and a stop-and-go type trailing unit which moves substantially equal increments of distance as it trails the lead unit, said system including

an elongated member attached to the two units having means to pay out and pay in under tension as the relative distance between the two units varies, trailing unit actuating means operable when an initial distance of separation between the lead unit and the trailing unit is reached to initiate movement of the trailing unit in a direction to close the distance between the units, and

trailing unit deactivating means operable when the trailing unit has traversed a predetermined distance to stop movement of the trailing unit.

6. The system of claim 5 further characterized in that firstly, the trailing unit actuating means includes cam means which is actuated in response to pay out of the elongated member to a point which corresponds to an initial distance of separation of the units from one another, and a power source operable, in response to actuation of the first cam means to advance the trailing unit at a faster rate of speed than the speed of the lead unit, and

secondly, in that the trailing unit deactivating means includes second cam means which is actuated in response to pay in of the elongated member to a point which corresponds to the point at which pay out of the elongated member began, said second cam means being operable to stop operation of the power source and thereby terminate movement of the trailing unit.

7. The system of claim 6 further characterized in that the elongated member is coiled about a drum as it is paid out and paid in, and further including

a gear system operatively connected between the drum and the first and second cam means for translating axial lengthening and shortening of the elongated member into accurate motion in the first and second cam means.

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8. The system of claim 6 further including first emergency lead unit shut down means effective, in the event of failure of the trailing unit activating means, to stop movement of the lead unit.

9. The system of claim 8 further characterized in that said emergency shut down means includes

third cam means which is activated by pay out of the elongated member to a point which corresponds to a distance between the units greater than the distance at which the first cam means is actuated.

10. The system of claim 6 further including second emergency lead unit shut down means effective, in the event the lead unit reaches a position in which the units are spaced from one another a distance which is less than the minimum operating distance, to prevent collision of the units.

11. The system of claim 10 further characterized in that said second emergency lead unit shut down means includes

fourth cam means which is activated to pay in of the elongated member to a point which corresponds to a distance between the units shorter than the distance which is established when the second cam means is activated.

12. A method of advancing a stop-and-go type trailing unit discrete increments of travel behind a lead unit which may advance during periods in which the trailing unit is at rest, said method including the steps of

advancing the lead unit to a point at which the distance between the units is at a maximum, automatically sensing the attainment of said maximum distance,

generating a control signal in response to the sensed condition,

thereafter automatically advancing the trailing unit in response to reception of the sensed control signal to a point at which the distance between the units is at a minimum,

terminating the advance of the trailing unit, and repeating the aforesaid steps in the above sequence.

13. The method of claim 12 further characterized in that

the trailing unit is stationary while the lead unit is advanced to the point at which the distance between the units is at a maximum.

14. The method of claim 12 further characterized in that

the lead unit moves in an advancing direction while the trailing unit is advancing to the point at which the distance between the units is at a minimum.

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ERNEST R. PURSER, Primary Examiner

U.S. Cl. X.R.

61—45; 180—77; 198—92; 299—18

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3456982 Dated July 22, 1969

Inventor(s) Donald C. Reilly

It is certified that error appears in the above-identified patent
and that said Letters Patent are hereby corrected as shown below:

Column 1, line 71, "Th" should read - - The - -, claim 11, line
4, "to" should read - -by - -.

SIGNED AND
SEALED

NOV 4 1969

(SEAL)

Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents