Langley

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: GP

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for
Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No. : 3,546,552

Government or
Corporate Employee : U.S. Government

Supplementary Corporate
Source (if applicable) : N/A

NASA Patent Case No. : XLA-07473

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes ☐ No ☒

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of . . . "

Elizabeth A. Carter

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Enclosure
Copy of Patent cited above

VELOCITY LIMITING SAFETY SYSTEM

Filed July 8, 1969 2 Sheets-Sheet 1

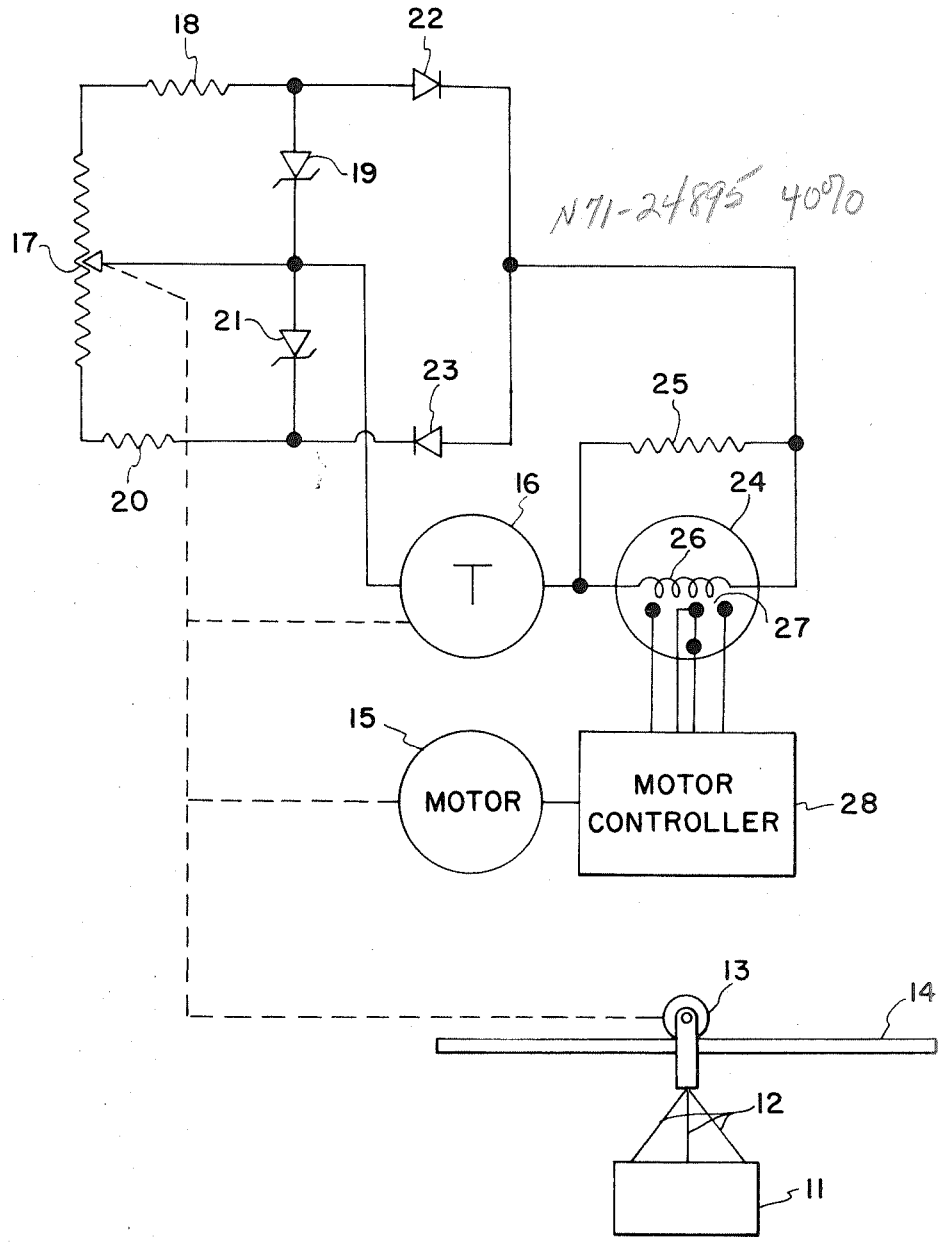

FIG. 1

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VELOCITY LIMITING SAFETY SYSTEM

Filed July 8, 1969 2 Sheets-Sheet 2

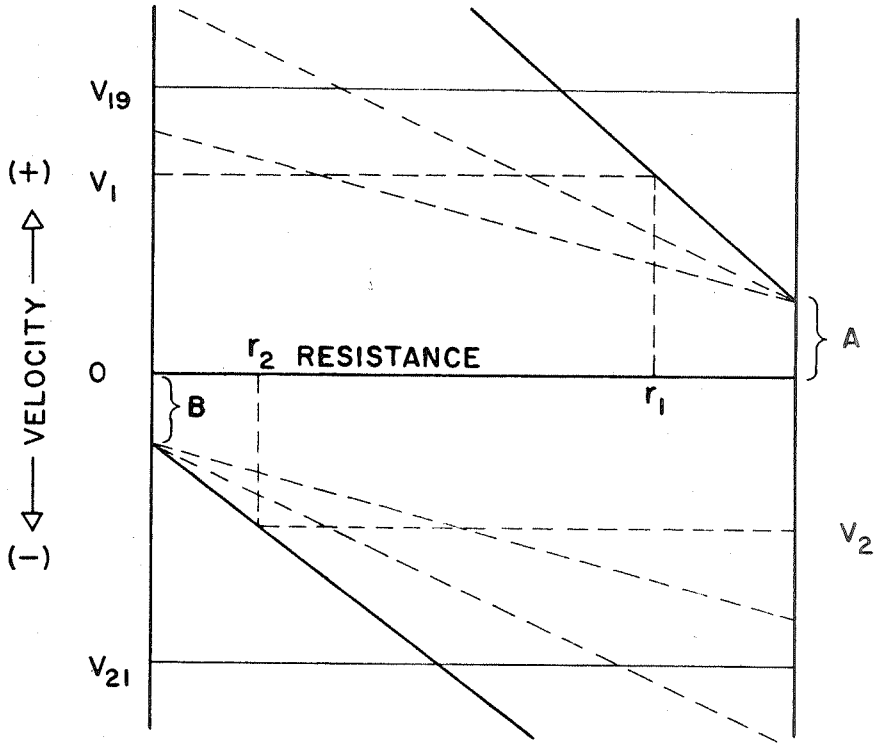

FIG. 2

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United States Patent Office

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VELOCITY LIMITING SAFETY SYSTEM

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Int. Cl. H02p 5/00
U.S. Cl. 318—265 7 Claims

ABSTRACT OF THE DISCLOSURE

A safety system that limits the velocity of a vehicle that is moved by a motor. The limiting velocity is determined by the position of the moving vehicle. The motor in addition to being connected to the vehicle is coupled to a generator and to the slider of a potentiometer. The generator and the potentiometer are connected in an electrical circuit with two switching diodes and a meter relay such that the current through the coil of the meter is dependent on both the position and velocity of the vehicle. Whenever the current through the coil exceeds a predetermined value, a switch is actuated causing the power to the motor to be cut off.

ORIGIN OF THE INVENTION

The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The invention relates generally to a velocity limiting safety system and more specifically concerns a safety system that limits the velocity of a vehicle with the limiting velocity being determined by the position of the vehicle.

A research vehicle with a standup pilot's compartment is used to study the handling qualities of lunar landing vehicles by the National Aeronautics and Space Administration's Langley Research Center, Hampton, Va. The Lunar Landing Research Facility, 250 feet high and 400 feet long, provides a controlled laboratory in which NASA scientists work with research pilots to explore and develop techniques for landing the Apollo Lunar Module on the moon's surface. The vehicle is operated within the confines of the overhead structure which provides travel of 360 feet down range, 50 feet cross range, and 180 feet vertically. The travel of the vehicle in six directions is controlled by three reversible motors. For safety purposes, it is necessary that when the velocity of the vehicle exceeds a predetermined value in either of the six directions the associated motor is cut off. The limiting velocity of the vehicle changes with the position of the position of the vehicle. That is, when the vehicle is close to the end of its possible travel in a direction the limiting velocity must be less than the limiting velocity when the vehicle is not close to the end of its possible travel. It is therefore the primary purpose of this invention to provide an improved system which senses instantaneous velocity and position of the vehicle and automatically initiates shutdown action should preset conditions in a function of the two variables be exceeded.

Prior systems for performing similar functions consists mainly of limit switches to sense the absolute position limit or time delay through a series of limit switches to sense velocity as a function of position over some time period. The disadvantages of the prior system are: they are not continuous or instantaneous in their operation,

they are not bi-directional without duplication of the system and they are complicated to set up and maintain.

SUMMARY OF THE INVENTION

In this invention a reversible motor that moves the vehicle along a particular axis has its shaft coupled to a D.C. tachometer generator and to the slider of a potentiometer. The tachometer generates a voltage indicative of the magnitude and direction of the velocity of the vehicle and the position of the slider of the potentiometer is indicative of the position of the vehicle. The tachometer and the potentiometer are connected in a circuit with a meter relay such that the current through the meer coil is a function of both position and velocity. Whenever this current exceeds some predetermined value the meter relay is actuated thereby initiating shutdown action. Zener diodes are used to initiate shutdown action when the velocity exceeds a predetermined value regardless of position. If the vehicle is controlled in six directions three embodiments of the invention are required.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic drawing of the preferred embodiment of the invention; and

FIG. 2 is a graph of velocity versus position for the purpose of describing the operation of the preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The number **11** in FIG. 1 designates the vehicle whose velocity is to be limited. Vehicle **11** is supported by cables **12** from a wheel **13** which is free to move on a rail **14**. A motor **15** is coupled to wheel **13** to move it back and forth on rail **14**. Motor **15** is also coupled to a D.C. tachometer generator **16** and to the slider of a potentiometer **17**. Tachometer **16** produces a voltage proportional to the velocity of wheel **13**. When wheel **14** moves to the right long rail **14**, the left terminal of tachometer **16** is positive and the slider of potentiometer **17** moves upward. When wheel **13** moves to the left along rail **14** the left terminal of tachometer **16** is negative and the slider of potentiometer **17** moves downward. The upper end of potentiometer **17** is connected through a resistor **18** and a Zener diode **19** to the slider of the potentiometer, and the lower end of the potentiometer is connected through a resistor **20** and a Zener diode **21** to the slider of the potentiometer. The junction of resistor **18** and Zener diode **19** is connected through high speed switching diodes **22** and **23** to the junction of resistor **20** and Zener diode **21**. The slider of potentiometer **17** is also connected through tachometer **16** and a meter coil **26** of a meter relay **24** to the junction of diodes **22** and **23**. A meter shunting resistor **25** is provided for the scaling of meter **24**. When the current flow through coil **26** of meter relay **24**, in one direction, exceeds a predetermined value relay contacts **27** close one way and when the current flow through coil **26**, in the other direction, exceeds said predetermined value relay contacts **27** close the other way. A motor controller **28** senses when contacts **27** close and disconnects the power supply to motor **15** to cut it off. Once activated, a manual reset capability can be provided as an option. Power controller **28** could merely be the contacts as shown connected between the motor and the power for the motor in which events the contacts as shown would connect the power the motor and when the contacts are actuated the power would be disconnected from the motor. Motor controller **28** could also be something more elaborate and could be utilized to apply brakes to wheel **13**.

In describing the operation of the invention the graph in FIG. 2 will be referred to. In this graph velocity is

proportional to the voltage generated across tachometer 16. If the left terminal of tachometer 16 is positive (wheel 13 is moving to the right along rail 14) the velocity shown on the graph is positive and if the the left terminal of tachometer 16 is negative the velocity is negative. The horizontal line V_{19} is the positive velocity corresponding to the breakdown voltage of Zener diode 19 and the horizontal line V_{21} is the negative velocity corresponding to the breakdown voltage of Zener diode 21. "Resistance" in this graph is the resistance of the lower portion of potentiometer 17. Hence, "resistance" is a function of the position of the slider of potentiometer 17. The graph in FIG. 2 shows three different curves. The only parameter that differs in these three curves is the value of shunt resistor 25. Hence, the slope of the curves is dependent on the value of resistor 25. The distance A is dependent on the value of resistor 18 and the distance B is dependent on the value of resistor 20. When the velocity of vehicle 11 is less than A or B the motor is not cut off regardless of the position of vehicle 11.

In the operation of this invention, assume that wheel 13 is moving to the right along rail 14 and assume that wheel 13 accelerates to a velocity V_{19}. Then Zener diode 19 will break down and a surge of current through coil 26 will activate contacts 27. This will happen regardless of the position of the slider of potentiometer 17 since when diode 19 breaks down potentiometer 17 and resistor 18 are bypassed and the voltage across tachometer 16 that exceeds V_{19} is applied across diode 22 and meter 24. Likewise if wheel 13 is moving to the left along rail 14 and accelerates to a velocity V_{21}, Zener diode 21 breaks down and the resulting current surge through coil 26 activates contacts 27.

Now assume that wheel 13 is moving to the right along rail 14 at a velocity V_1 less than V_{19} and assume that resistor 25 has a value such that the solid curve is valid. When the slider of the potentiometer moves along until the lower portion of the potentiometer has a resistance r_1 (upper portion has a resistance $R-r_1$ where R is the total resistance of potentiometer 17) there is adequate current through coil 26 to actuate contacts 27. That is, with tachometer 16 across the upper portion of potentiometer 17, resistor 18, diode 22 and meter coil 26, and with the slider at position r_1, there is adequate current through coil 26 to actuate contacts 27. Assume that wheel 13 is moving to the left along rail 14 at a negative velocity V_2 less than V_{21}. When the slider of the potentiometer moves along until the lower portion of the potentiometer has a resistance r_2 there is adequate current through coil 26 to activate contacts 27. That is with tachometer 16 across the lower portion of potentiometer 17, resistor 20, diode 23 and meter coil 26, and with the slider in position r_2, there is adequate current through coil 26 to actuate contacts 27. Whenever contacts 27 are actuated, motor controller 28 cuts off the power to motor 15 to stop it. Hence, as can be seen the point at which motor 15 is cut off while wheel 13 is traveling along rail 14 in either direction is dependent on both the velocity and position of wheel 13.

The advantages of this invention are numerous. It is simple and requires only a minimum number of components, it requires no power other than the signal; it is essentially passive in nature and therefore highly reliable; and it is continuously sensing.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred embodiment. Various changes may be made in the arrangement of parts. For example, equivalent elements may be substituted for those illustrated and described herein, parts may be reversed, and certain features of the invention may be utilized independently of the use of other features, all without departing from the spirit or scope of the invention as defined in the subjoined claims. Many other types of relays could be substituted for meter relay 24. Motor controller 28 in addition to cutting off

motor 15 could also control a braking system for wheel 13. If this invention is used for the vertical direction motor 15 would control a pulley instead of wheel 13 and only the lower or upper portion of the invention would be used. Even though this invention has been disclosed as being used in NASA's Lunar Landing Research Facility, it could obviously be used other places. For example, it could be used in any overhead crane system.

I claim:

1. A safety system that limits the velocity of a vehicle with the limiting velocity being dependent on the position of the vehicle comprising:

a reversible motor mechanically connected to said vehicle for moving it in either of two opposite directions;

a generator mechanically connected to said motor for generating a voltage whose amplitude is proportional to the velocity of said vehicle and whose polarity is indicative of which of said two directions said vehicle is moving;

a potentiometer having its slider mechanically connected to said motor such that the movement of said slider corresponds to the movement of said vehicle;

a first switching diode with its anode connected to one side of said potentiometer;

a second switching diode with its cathode connected to the other side of said potentiometer and with its anode connected to the cathode of said first switching diode;

a relay which actuates its contacts when the current through its coil exceeds some predetermined value connected in series with said generator between said slider and the junction between said first and second diodes; and

a controller for cutting off said motor when the contacts of said relay are actuated whereby the limiting velocity of said vehicle is dependent on both the velocity and position of said vehicle.

2. A safety system according to claim 1 including a first resistor connected between said one side of said potentiometer and the anode of said first switching diode and a second resistor connected between said other side of said potentiometer and the cathode of said second switching diode to insure that the velocity of said vehicle has to be above some minimum value before the contacts of said relay will be actuated.

3. A safety system according to claim 1 including a first Zener diode connected between the anode of said first switching diode and the slider of said potentiometer and a second Zener diode connected between the slider of said potentiometer and the cathode of said second switching diode to insure that the velocity of said vehicle cannot be above some predetermined value regardless of the position of said vehicle.

4. A safety system that limits the velocity of a vehicle with the limiting velocity being dependent on the position of the vehicle comprising:

a motor mechanically connected to said vehicle for moving it in one direction;

a generator mechanically connected to said motor for generating a voltage proportional to the velocity of said vehicle;

a variable resistor mechanically connected to said motor to lower the resistance of said variable resistor as said vehicle moves;

a relay which actuates its contacts when the current through its coil exceeds some predetermined value;

a switching diode connected in series with said variable resistor and said relay across said generator; and

a controller for cutting off said motor when the contacts and said relay are actuated whereby the limiting velocity of said vehicle is dependent on both the velocity and position of said vehicle.

5. A safety system according to claim 4 including a resistor connected in series with said diode, said variable

resistor and said relay to insure that the velocity of said vehicle has to be above some minimum value before the contacts of said relay will be actuated.

6. A safety system according to claim 4 including a Zener diode connected across said variable resistor to insure that the velocity of said vehicle cannot be above same predetermined value regardless of the position of said vehicle.

7. A safety system according to claim 2 including a first Zener diode connected between the anode of said first switching diode and the slider of said potentiometer and a second Zener diode connected between the slider of said potentiometer and the cathode of said second switching diode to insure that the velocity of said vehicle cannot be above some predetermined value regardless of the position of said vehicle.

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317—13, 19; 318—18, 326, 466