Jan. 7, 1969 T. BISLAND 3,420,572

AUTOMATIC HEADREST AND NECK PROTECTOR

Filed Jan. 20, 1964 Sheet 1 of 3

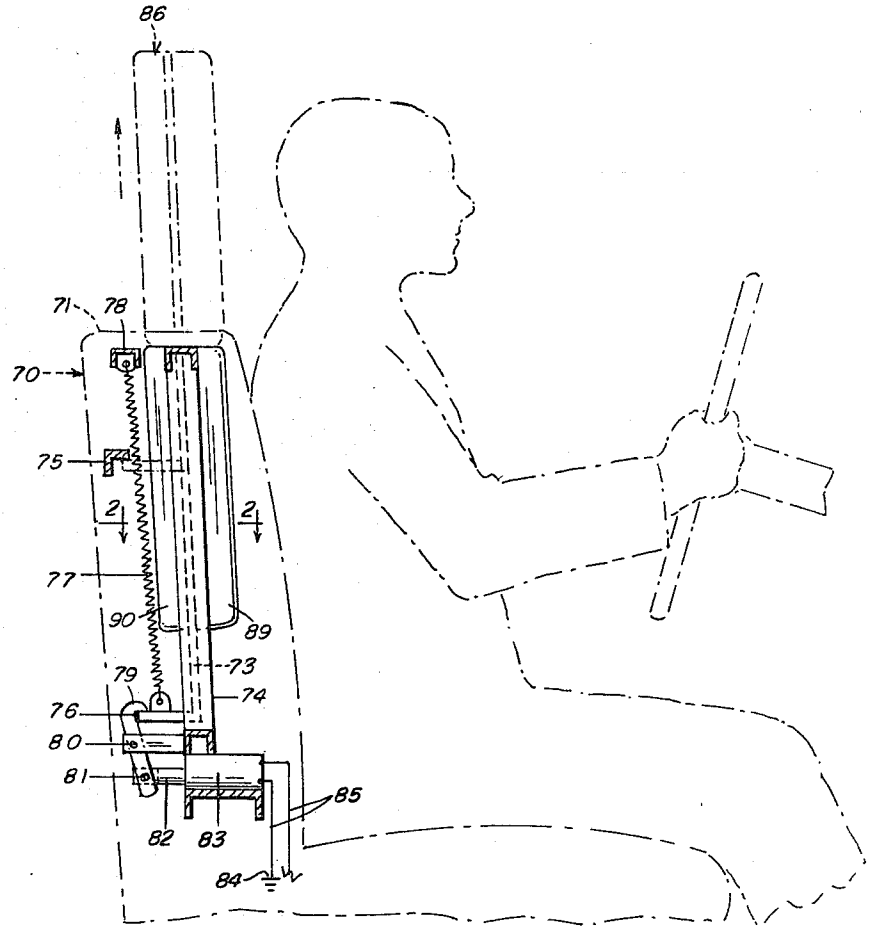

FIG. 1

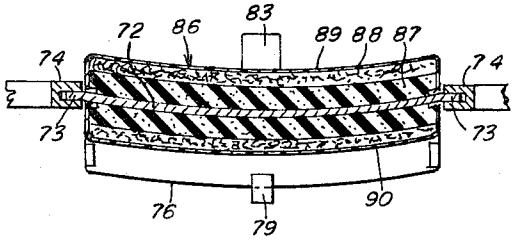

FIG. 2

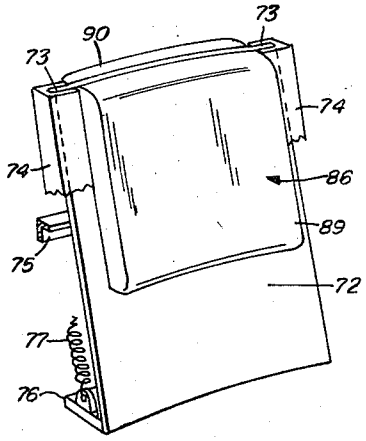

FIG. 3

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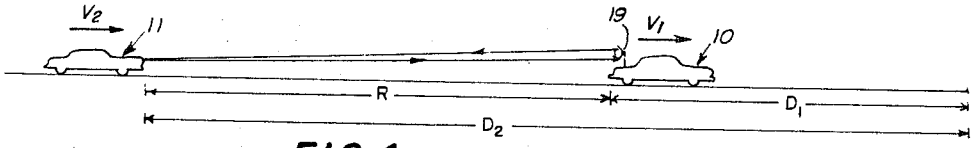

FIG. 4

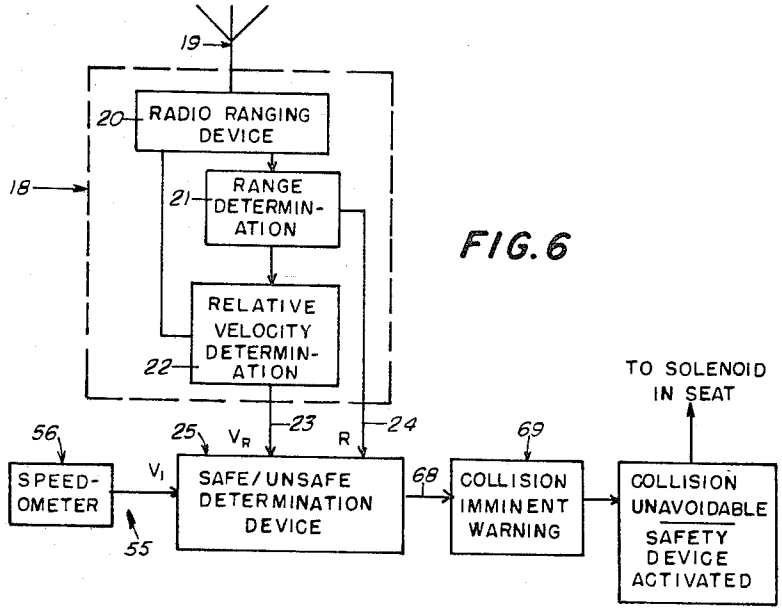

FIG. 6

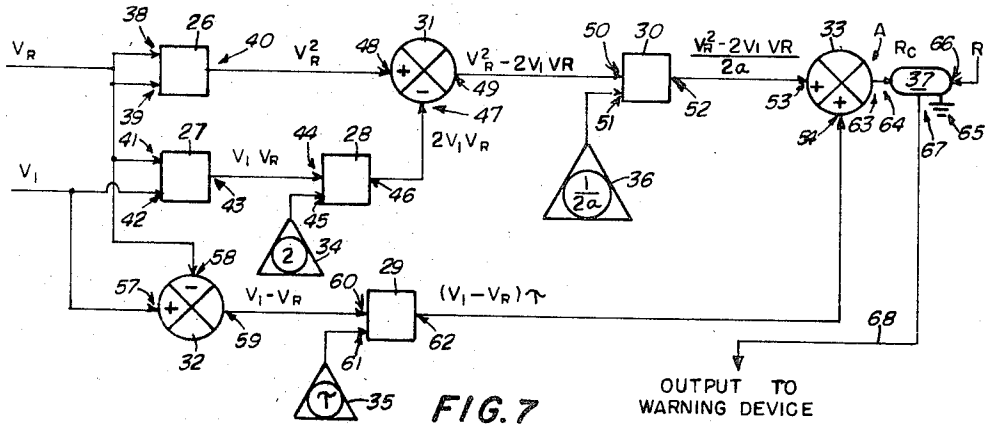

FIG. 7

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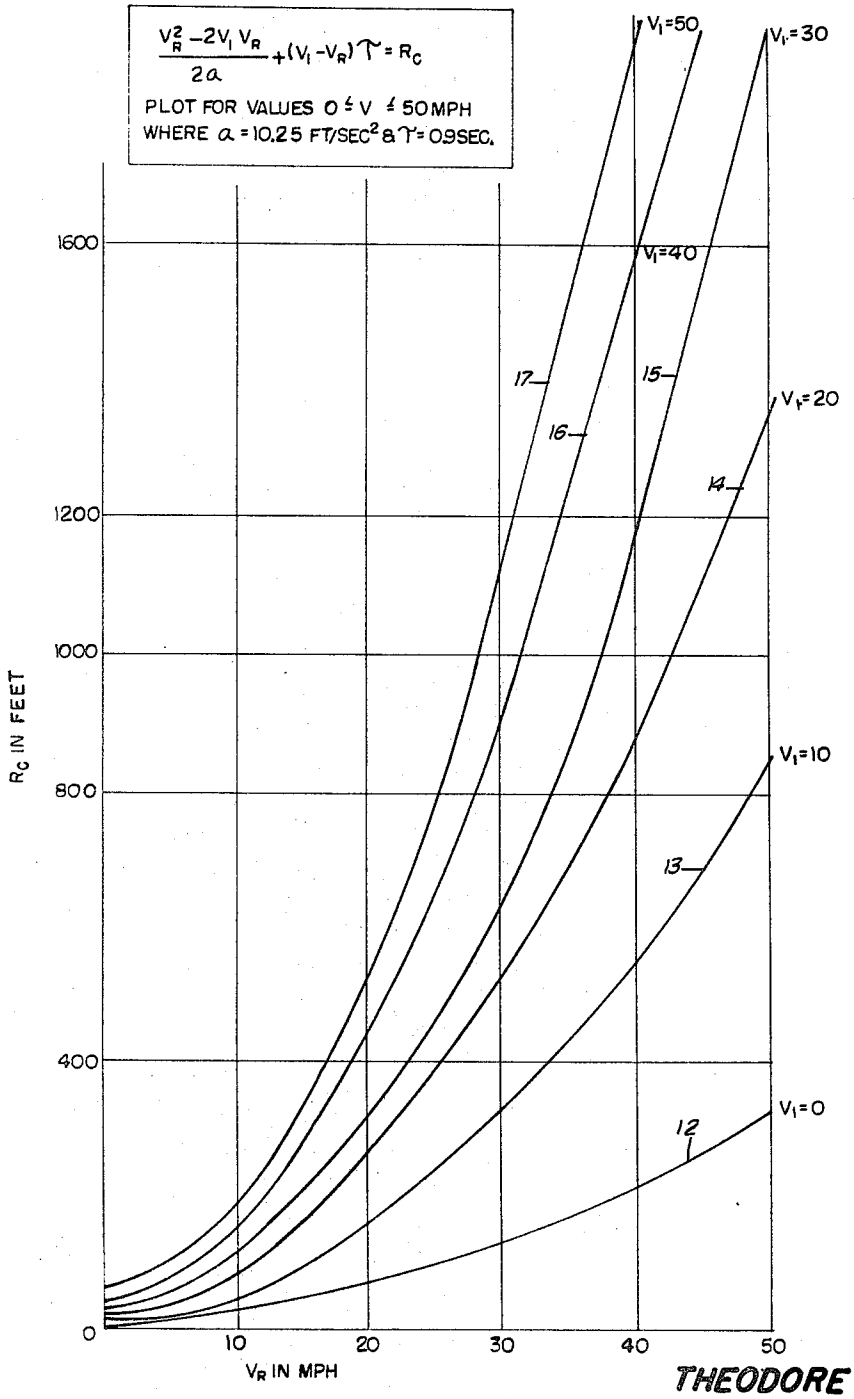

FIG. 5

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AUTOMATIC HEADREST AND NECK PROTECTOR

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Filed Jan. 20, 1964, Ser. No. 338,683
U.S. Cl. 297—216 5 Claims
Int. Cl. B60r 21/10

While a largely successful compaign has been waged in this country by public spirited, safety-conscious public and private organizations and individuals to arouse motor vehicle riders of the desirability of using seat belts, very little has been done to minimize a common injury which a seat belt cannot prevent.

This injury is caused by rear-end collisions which results when a following vehicle cannot avoid hitting a vehicle in front of it. Too often this is the result of poor judgment on the part of one or both drivers involved; rarely is it caused by mechanical failure.

The injury often resulting is known as "whiplash," because the sudden impact on the vehicle hit causes the unsuspecting occupant's head to be suddenly snapped backwardly; after which, it will be brought forwardly again by muscular reflex action.

The so-called "whiplash" syndrome results from the rapid to-and-fro movement of the unsupported head when the trunk is carried forward by the seat of the car. This rapid extension and flexion of the cervical spine can cause varying symptoms, depending upon the amount of damage done locally and the damage done at other parts of the body by virtue of damaged innervation or damaged blood supply.

The immediate damage may vary from a slight sensation of a "strained back of neck muscle" up to and including actual decapitation of the individual.

The delayed effects from whiplash injuries generally fall into the following categories:

Bone damage: This can be in the form of a traumatic arthritis of the cervical spine. Many times there are X-ray changes over a period of months which graphically demonstrate these changes. Ofttimes, these changes lead to involvement of the various openings where the spinal nerves make their exit from the spinal canal, and this leads, in turn, to:

Nerve damage: This can be seen in the paralysis of the brachial plexus that occurs following the whiplash injury. The brachial plexus supplies the motor nerves for the movements of the arm (upper and lower). The nerve damage is ofttimes intracranial (inside the skull). This type may be the result of actual damage to the nerve tissue by the initial trauma, or may be the indirect result of:

Blood vessel damage: By so-called "reflex vaso-spasm," the blood supply to the brain can be altered and markedly diminished. The two main arteries which supply blood to the brain are the common carotid, which gives off the internal carotidartery (which enters the skull from the anterior part of the neck under the angle of the jaw) and the vertebral artery which goes up the vertebrae and enters the brain from the area of the spine. The vertebral artery has been shown to be completely thrombosed (clotted off) in patients who had a relatively mild appearing initial whiplash injury which eventually ended in their death.

The decreased blood flow which can result in varying

degrees of cerebral hypoxia can give rise to many neurological symptoms. These include the following:

Diplopia (double vision), decreased accommodation (decreased focusing ability), decreased amplitude of binocular vision, headache, rapid fatigueability in previously "boundless energy individuals," decreased tolerance to stress situations, increased irritability, other mental and neurological symptoms up to and including well documented cases of rapid onset of mental illness in previously completely happy, well adjusted individuals. In at least one case, a patient progressed to the "vegetable stage" in a few months from what was apparently a moderately mild whiplash.

Therefore, it is one of the objects of this invention to prevent, or at least minimize the possibility of whiplash injuries to the occupant of a vehicle which has been struck from the rear, and to offer additional protection to the head and neck when an impending "head-on" collision appears to be imminent. In this event, the device can be actuated by a convenient switch on the dash or steering wheel, as well as by the electronic circuit.

For this purpose, a plate is provided for the seat of a vehicle, which plate may be concealed normally within the back thereof. Means is also provided whereby the plate may be raised behind the head and neck of the occupant to prevent any sudden backward movement of the head, which would be the normal result of an unexpected impact from the rear.

Electronic circuit means is associated with the plate-raising apparatus for continuously sensing the movement of any vehicle immediately to the rear. This circuit means also includes computing circuits for calculating the imminence of a rear-end collision and, when such a condition exists, for initiating action.

Other objects and advantages will be apparent to those skilled in the art after reading the attached specification in connection with the accompanying drawings, in which:

FIG. 1 is a cross-sectional elevation of one form of device for preventing injury to occupants of a vehicle constructed in accordance with the teachings of this invention;

FIG. 2 is a cross-section taken on the line 2—2 of FIG. 1;

FIG. 3 is a fragmentary perspective view of a portion of the mechanism shown in FIG. 1;

FIG. 4 is a diagram illustrating two vehicles traveling in the same direction, one behind the other, on a highway, and indicating the various factors involved in determining the imminence of a rear-end collision;

FIG. 5 is a graph illustrating relative rates of speed of the two vehicles shown in FIG. 4 and the distance between vehicles for safe and unsafe operating conditions at various rates of speed of the leading vehicle;

FIG. 6 is a block diagram of the electrical mechanisms associated in the operation of the device shown in FIG. 1; and

FIG. 7 is a schematic diagram of the components comprising the safe-unsafe determination device shown in FIG. 6.

In FIG. 1, the outline of a vehicle seat having a generally upright back portion **70** is indicated by the dotted lines. The top portion **71** customarily terminates at approximately the level of the shoulders of the occupant thereof.

In the preferred embodiment of this invention, a substantially rigid supporting plate **72** of generally semicylindrical configuration is normally concealed within the seat back. This plate is generally rectangular in vertical elevation having parallel side margins **73** which are slidably received in a pair of vertically disposed channel members **74** suitably mounted within the seat back.

As viewed in the side elevation (in FIG. 1) these channels are positioned so that when the plate is vertically raised, it will be moved almost vertically upwardly into close proximity with the back of the head of the occupant. However, upward movement of the plate is limited by a stop member **75** which engages with a rearwardly turned lower portion **76** of the plate.

The height of the plate and the position of the stop are such that while the plate may be completely concealed within the seat when not needed, it may be projected upwardly as shown in dotted lines in FIG. 1, a distance at least as high as the top of the head of the occupant of the seat. Furthermore, the plate should extend substantially across the entire width of the seat back so as to serve as protection regardless of the occupant's position.

Upward movement of the plate is effected by means of a spring means **77**, one end of which is attached to the rearwardly extending lower edge **76** of the plate, while the other end is attached to a suitable support **78** concealed within the framework of the seat adjacent the top thereof.

When not in use, the plate is held in its downwardly retracted position by means of a latch **79** supported on a pivot **80** and having a pivotal connection **81** with the armature **82** of an electrical solenoid **83**, all of these elements being concealed within the seat. The solenoid actuating coil is provided with the usual connections **84** and **85**, one of which may be grounded to the vehicle frame and the other connected with a mechanism, to be described later, capable of furnishing a voltage to actuate the solenoid to release the latch **79**, permitting the spring means to abruptly project the protecting plate **72** upwardly behind the occupant.

In order to cushion the impact between the protecting plate and the head of the occupant in the event of collision, the forward face of the plate is preferably covered with some form of cushioning means, indicated generally by the numeral **86**.

While this cushioning may comprise a fairly thick layer of yieldably elastic material, such as foam rubber, in the form shown, the cushioning means comprises a layer of a high elasticity material **87** with an outer layer **88** of a material which may be described as having low elastic qualities.

Materials such as foam rubber can be considered as high elasticity materials, because when deformed, they immediately and continuously tend to return to their normal shape. Thus, when an object strikes such a material, it usually rebounds quickly.

Materials such as goosedown, feathers, or granular Dacron, can be used and their characteristic is that while they are extremely yieldable to impact and therefore thus quickly adjust to the shape of the object received, they do not tend to return quickly to their original position, and therefore have a tendency to distribute the forces over a much larger area than do the high elasticity materials.

Of course, if the low elastic cushioning material comprises a loose packing of discreet particles, it would be held in place by a flexible sheet covering material **89**.

In addition, while it is considered desirable for all occupants of a vehicle to use seat belts, the possibility exists that the head of the person seated behind the seat shown in FIG. 1 might strike the back of plate **72** and therefore the rear surface should be provided with padding, as indicated at **90**.

FIG. 4 indicates diagrammatically the factors involved in determining the imminence of a rear-end collision between a leading vehicle and one following behind.

The leading vehicle, indicated generally by the numeral **10**, is moving with a velocity V_1, while the following vehicle, indicated generally by the numeral **11**, is proceeding at a speed V_2, the distance between the cars being represented as R.

If, at this point, car **10** begins decelerating at its maximum rate, indicated by α, it will come to a full stop within a distance indicated at D_1. The driver of the following car **11** will, upon observing the slowing down of the car in front of him, also immediately begin decelerating at its maximum rate of α, but the actions of the driver will be delayed by a time factor τ. While the actual reaction time in various individuals varies between individuals, for the purpose of this illustration, an average time will be used. This average value of τ, based on national studies, will be taken at 0.9 second. It will also be necessary to assume that all vehicles are capable of deceleration at the same rate and therefore, for this purpose, national studies indicate that an average value for the maximum deceleration rate α, is 10.26 ft./sec.^{2}.

Returning to FIG. 4, the distance which will be covered by car **11** before it comes to a standstill is indicated as D_2. In order that both cars may come to a stop without colliding, the distance between cars (R) at any given moment while they are moving, must be such that D_2 is equal to or less than D_1+R. Therefore, R must always be such that it is equal to or greater than D_2-D_1 and an equation may be derived which makes this determination possible.

In this equation, the following additional terms will be used:

$$V_R=V_1-V_2 \therefore V_2=V_1-V_R$$

$$d_1=\frac{V_1^2}{2\alpha} \qquad d_2=\frac{V_2^2}{2\alpha}+V_2\tau$$

$$R+d_1=d_2 \therefore R+\frac{V_1^2}{2\alpha}=\frac{V_2^2}{2\alpha}+V_2\tau$$

$$R=\frac{V_2^2-V_1^2}{2\alpha}+V_2\tau=\frac{(V_2-V_1)(V_2+V_1)}{2\alpha}$$

$$+V_2\tau=\frac{-V_R(V_1-V_R+V_1)}{2\alpha}$$

$$+(V_1-V_R)\tau \therefore R=\frac{V_R^2-2V_1V_R}{2\alpha}+(V_1-V_R)\tau$$

By definition, a collision is imminent only when V_R is negative.

It should be obvious that the safe distance between cars depends upon the speed at which they are traveling and, that this distance increases rapidly as the speed of the vehicles increases, and to illustrate this, the equation developed above has been graphically plotted in FIG. 5 in which the values for V_R are plotted as abscissa in miles per hour; while the distance R, in feet, is plotted as ordinates.

The various curves indicated by the numerals **12** through **17** inclusive have been obtained by substituting values V_1 for the rate of speed of the leading car **10** from zero (when it is at a standstill) to 10, 20, 30, 40 and 50 miles per hour, respectively. Each of these curves represents the dividing lines between safe and unsafe conditions at the respective rates of speed of the leading car.

Any combination of values for V_R and R which intersect to the left of the respective curves indicates that no collision will result; whereas, if the values for V_R and R are such that they intersect to the right of the respective curves, a collision is imminent. Thus, if the leading car

is traveling at 10 miles per hour and V_R and R are respectively 40 and 400, a collision is imminent, whereas if R is 400 feet and V_R is only 30 miles per hour, no danger exists.

Therefore, in order to actuate the protective means forming a part of the present invention, a detection and actuating means must be provided which will continually sense and calculate instantaneous values of R and V_R as well as the speed of the vehicle with which the detection system is associated.

On such form of detection and actuating system using conventional electronic circuits is disclosed in FIGS. 6 and 7. Since many types of circuits are known capable of providing signals proportionate to the values detected, no specific circuits are shown and it will be understood that the only criterion is that the various inputs and outputs throughout the system should be compatible.

In FIG. 6, the circuits included within the rectangular dotted lines comprise a conventional radio-sensing device for connection with an antenna **19** which is to be mounted on a vehicle **10** so as to be operative in a rearward direction. Many types of systems are known which include radio ranging sub-circuits **20**, range-determining circuits **21** and relative velocity determining circuits **22**, thereby providing output signals **23** and **24**, the signal **23** being proportional to the difference in speed between the two vehicles, or V_R, while the signal **24** is proportional to the distance between the vehicles or R. These two signals are continuously fed to a safe/unsafe determination circuit, indicated generally by the numeral **25**. The circuit **25** is shown in block diagram form in FIG. 7 and comprises an arrangement of well known electronic devices arranged to continuously compute the equation represented graphically in FIG. 5, and previously referred to.

The sub-components of the system include conventional electronic analogue multiplier circuits **26**, **27**, **28**, **29** and **30**, respectively, each of which receives two signals and is capable of furnishing an output signal which represents a value equivalent to the product of the values represented by the two input signals. Other components include adder and subtractor circuits **31**, **32** and **33**, which also receive two input signals and provide a single output signal. However, in the case of the adder and subtractor circuits, the single output signal represents either the sum or the difference between the values provided by the two input signals depending upon the mode of operation of each circuit.

Further, circuits represented by the numerals **34**, **35** and **36** are conventional signal sources, each of which is capable of supplying a signal representing constant values in the basic equation, while numeral **37** indicates a conventional electronic comparator circuit which receives two input signals and produces an output signal only when one input signal value is equal to or greater than the other input signal value.

Since the multiplier **26** is arranged to receive a signal corresponding to the value V_R at both of its inputs **38** and **39**, it continually supplies an output signal **40** representing the value of V_R^2. The multiplier **27**, however, receives at its input **41**, a signal equivalent to V_R and at its input **42**, a signal from speedometer **56** equivalent to V_1, therefore, it develops a signal at its output **43**, which represents a value V_1V_R. This signal is then fed to input **44** of the multiplier circuit **28**, while the signal source **34** feeds a signal equivalent to the numeral **2** to input **45**, with the result that this multiplier supplies at its output **46**, a continuous value equivalent to $2V_1V_R$, which, in turn, is fed to the input **47** of the adder and subtractor circuit **31** is receiving the signal from the output **40** of the multiplier **26**, the signal equivalent to V_R^2, and the circuit **31** being arranged to subtract the signal from input **47** from that of input **48**, the resultant signal produced at output **49** is $V_R^2-2V_1V_R$. This output signal is then fed to input **50** of the multiplier **30**, while the other input **51** receives the signal from the source **36** equivalent

to the value of the reciprocal of 2α to provide a signal at the output **52** representing a value of

$$\frac{V_R^2-2V_1V_R}{2\alpha}$$

which, in turn, is fed to the input **53** of the adder and subtractor **33**. The other input **54** of the adder and subtractor **33** receives another signal which will now be described.

This latter signal is also derived from the output **55** of the speedometer **56**. This output is not only fed to the multiplier **27**, but also to the input **57** of the adder and subtractor **32**. The other input **58** of this adder and subtractor circuit also receives a signal equivalent to the output signal **23** from the radar circuit **18**, and is arranged to produce an output at **59** equivalent to V_1-V_2, which, in turn, is fed to input **60** of the multiplier **29**.

The other input **61** of multiplier **29** receives the constant value from the signal source **35** equivalent to the value of τ, whereby it furnishes a signal at output **52** equivalent to $(V_1-V_R)\tau$; this signal being supplied at the input **54** of adder and subtractor circuit **33**; this latter circuit being arranged to furnish a signal at its output **63** equivalent to the sum of the two inputs, or

$$\frac{V_R^2-2V_2}{2\alpha}+(V_1-V_R)\tau$$

which value is the continuously computed value for the distance between the two vehicles **10** and **11** representing the boundary between safe and unsafe conditions at any instant, which value will be indicated as R_C.

In other words, if this computed value R_C is less than the actual distance R at that moment, conditions are determined as being safe, while if the computed value for R_C is greater than that of the actual distance, a collision is imminent.

This signal R_C is fed to one input **64** of an electronic comparator circuit **37**. The other input **66**, receives the signal **24** representing the actual distance R between the two vehicles, as measured by the radar. The comparator circuit is arranged in accordance with well known principles and is provided with two outputs **65** and **67**. The output **65** may be grounded to the frame of the vehicle in accordance with conventional use of "single wire" electric circuits, and the circuit is designed to produce a voltage at its output **67**, only when the two inputs receive simultaneous signals indicating that R_C is equal to or greater than R, or in other words, an indication that collision is imminent and transmits this signal as a voltage in line **68**.

This voltage can be fed directly to the connection **85** of the solenoid coil (see FIG. 1), or, as shown in FIG. 6, the comparator may be arranged so that the voltage in line **68** will be supplied when the value for R_C is slightly less than the value for R in order to actuate a visual or aduible signal device **69** to give the vehicle operator an indication that while an unsafe condition does not exist, such a condition is imminent.

Having disclosed one form of equipment for carrying out the purposes of this invention, it will be obvious that changes and improvements may be made by those skilled in the art which would be within the scope of the annexed claims.

I claim:

1. In an automatic head and neck protector for vehicle seats having a substantially vertical back portion, the combination including, a rigid plate having a curvature in the horizontally transverse direction corresponding generally to the curvature of the back of a human body, means for mounting said plate on a vehicle seat for vertical sliding movement, the top of said plate being nor-

mally positioned below the level of the occupant's neck, actuating means for raising said plate vertically behind the head and neck of the occupant, and electronic means for initiating operation of said actuator, said electronic means including means for sensing the movement of a vehicle toward the rear of a vehicle carrying the protector and for instantaneously and continuously calculating the imminence of a collision.

2. The invention as defined in claim 1, wherein said electronic means also includes means for sensing the speed of the vehicle carrying said protector.

3. The invention as defined in claim 1, wherein said electronic means also includes means for sensing the distance between said two vehicles.

4. The invention as defined in claim 3, wherein said electronic means also includes means for sensing the relative rate of change of said distance.

5. The invention as defined in claim 4, wherein said

electronic means includes means for sensing the speed of the vehicle carrying said protector.

References Cited

UNITED STATES PATENTS

365,248	6/1887	Fackrell	297—410
1,977,159	10/1934	Tursi	297—112
2,796,919	6/1959	Ginsberg	297—283
2,804,160	8/1957	Rashid.	
2,851,120	9/1958	Fogiel.	
2,943,866	7/1960	Witter	297—216
2,985,229	5/1961	Shamblin	297—410
3,088,539	5/1963	Mathues et al.	

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U.S. Cl. X.R.

343—7; 297—410, 217