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[54] **PACING SYSTEM FOR CONVEYANCES**[76] Inventor: **Robert E. Proctor**, 11311 Stanwood Dr., Los Angeles, Calif. 90066[22] Filed: **Mar. 17, 1972**[21] Appl. No.: **235,757**[52] U.S. Cl. **340/22, 244/114 R, 340/26, 350/96 B**[51] Int. Cl. **G08g 1/09, G08g 5/00**[58] Field of Search..... **240/1.2; 244/114; 356/23; 340/22, 25, 31 R, 35, 36, 41, 26**[56] **References Cited****UNITED STATES PATENTS**

3,529,284	9/1970	Villemain.....	340/35
3,593,262	7/1971	Spencer	340/36
3,302,168	1/1967	Gray et al.	340/31 R

OTHER PUBLICATIONS

Popular Science, March 1932, page 26.

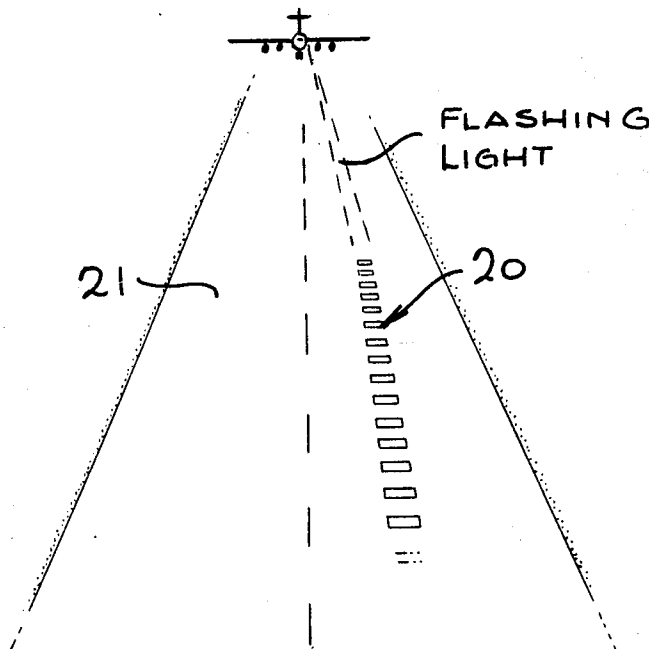
Popular Mechanics, August 1956, page 128.

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[57]

ABSTRACT

Systems for pacing the movement of conveyances are disclosed, each system being comprised of a stationary strip of equally spaced bars, the longitudinal axis of the bars being transverse to the direction of traffic (either erect on one side or horizontal in the path of the traffic, such as on an airport runway) and means for intermittently illuminating them simultaneously at a selected frequency, where the frequency is selected to produce a stroboscopic effect on an observer moving parallel to the strip of such bars, such that only at a predetermined velocity will the bars appear to be motionless, i.e., appear to have a velocity of zero relative to the moving observer.

7 Claims, 10 Drawing Figures

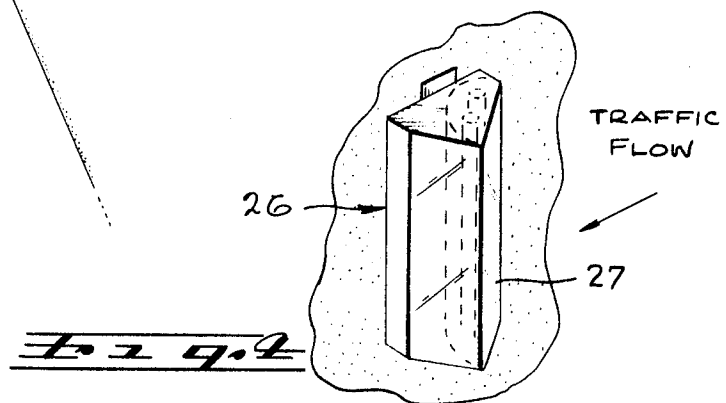
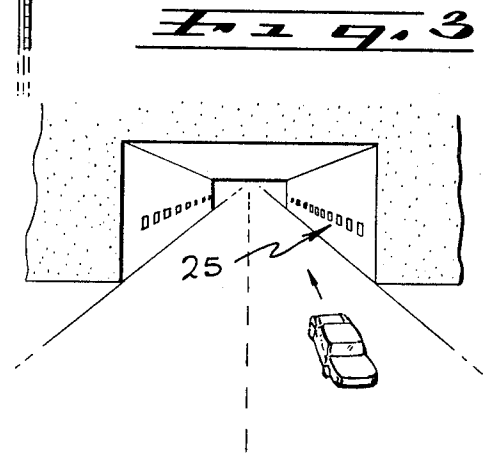
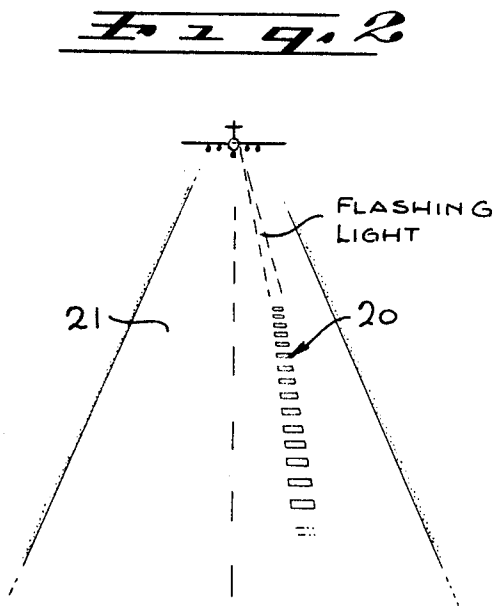
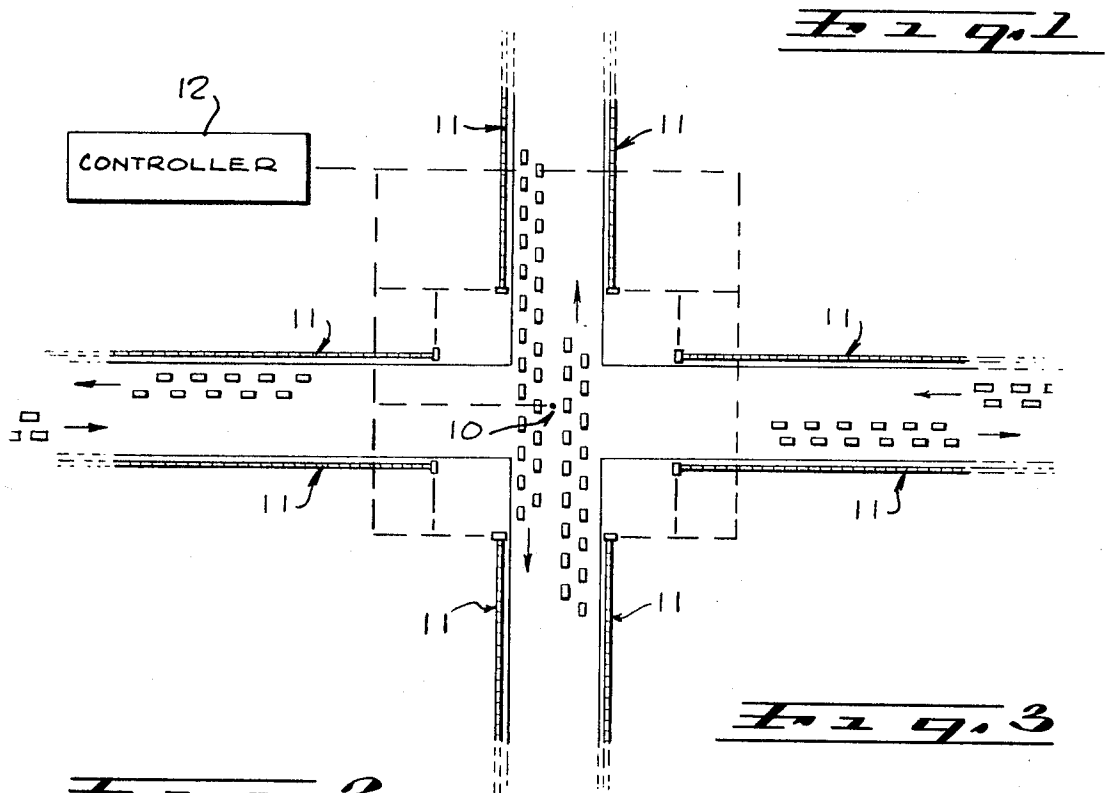


Fig. 5

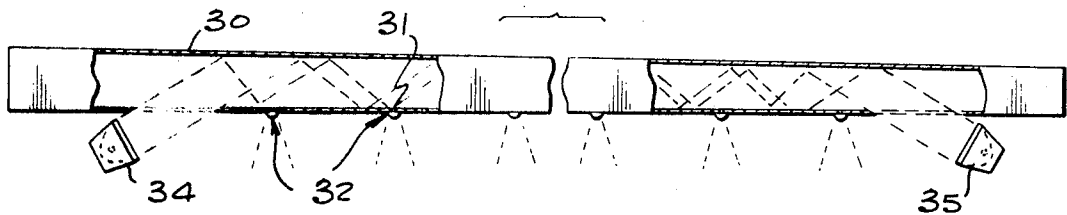


Fig. 6

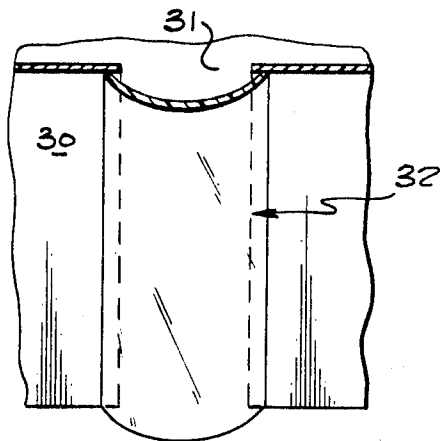


Fig. 7

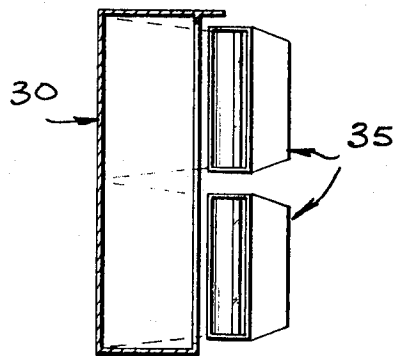


Fig. 8

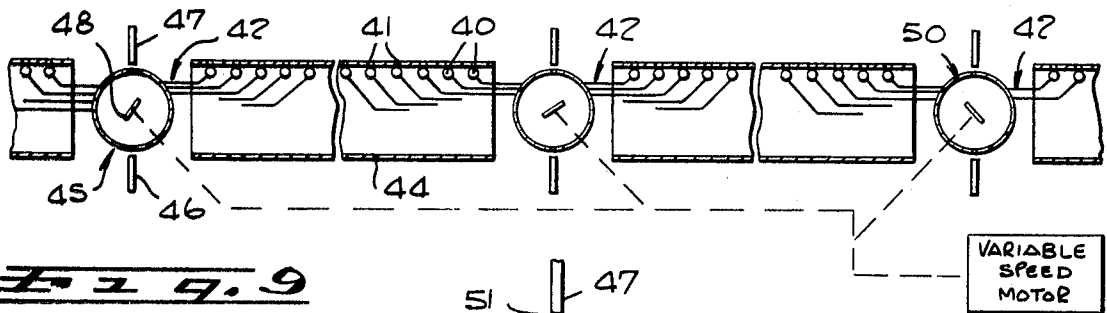


Fig. 9

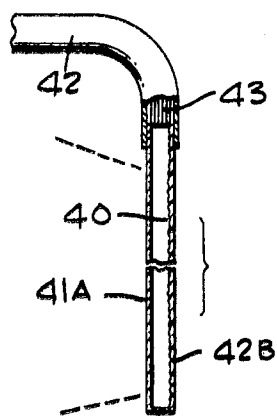
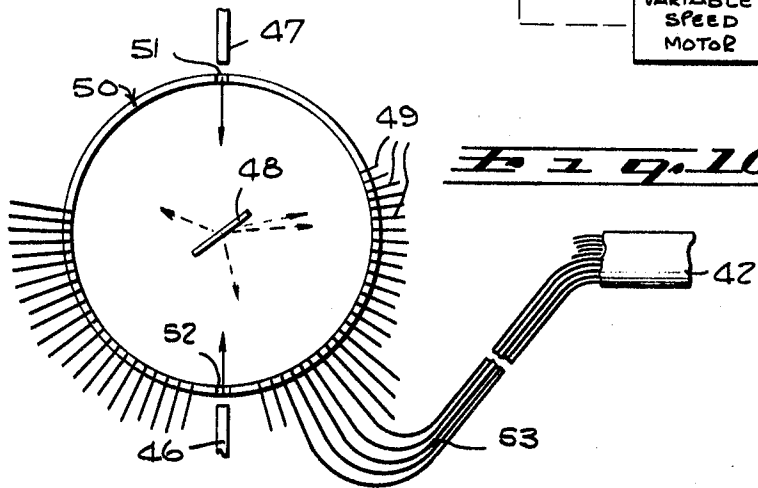


Fig. 10



PACING SYSTEM FOR CONVEYANCES

BACKGROUND OF THE INVENTION

This invention relates to a visual aid for pacing the movement of conveyances, and more particularly to an optical system employing a stroboscopic effect for pacing the movement of conveyances such as automobiles, trucks, buses, aircraft and watercraft.

Traffic congestion is one of the biggest problems of any large metropolitan area. Its relation to the problem of pollution, its drain on our major sources of energy, petroleum, and its rank as a major cause of fatalities and injuries accentuate the need for new methods to expedite the movement of conveyances, particularly private automobiles, which will continue to be the preferred means of transportation for a majority of the people. It is predicted that the total number of vehicles registered in the United States will increase 62 percent in the next 10 years over what it was 10 years ago, and 75 percent more vehicle miles will be traveled. Obviously, the traffic problems cannot be solved by constructing more roads, for the costs are too great and there is a growing resentment by the public to the condemnation of land and housing, and to the sprawl of surface transportation.

On arterial streets, freeways and highways during peak periods of traffic, the flow of traffic is seldom orderly; more often it is erratic, sometimes chaotic. The "stop-go" kinesis is familiar to almost everyone who drives a motor vehicle. The erratic movement of traffic, with its cyclic acceleration and deceleration of the internal combustion engine, not only forfeits time but also reduces the efficiency of the engine. The prime mover becomes a producer of an inordinate quantity of noxious fumes, especially during periods of deceleration. An engine running at constant speed is not feasible. Nor is it possible to eliminate all erratic traffic movement and the stop-go syndrome; however, the pacing of vehicular traffic is possible and promises a vast reduction in the frequency of occurrence of both.

The curtailment of stop-and-go driving in a network of city streets will require a system which organizes the vehicles into platoons and so paces them through most major intersections, at speeds predetermined for each direction of traffic, that the platoons move without interruption through a majority of the intersections. The cost of erratic traffic movement is not measurable in terms of gasoline consumption and wear on the vehicle; however, there can be little doubt that it is enormous. The relationship between erratic movement and accidents is a statistical record. The effect of erratic movement on the health of drivers is understood, even though imperfectly. In view of all these and other factors, the cost of installing a traffic pacing system can be readily justified.

The ultimate capacity of freeways, expressways and arterial streets is unknown because as the traffic increases so does the erratic movement of traffic until the movement degenerates into the "stop-go" kinesis. A maximum capacity can be achieved only by pacing, unless our present systems are to be replaced in the immediate future by the electronic highway, which removes control and decision making from the driver. This method of transportation, although technologically feasible, will be evolutionary, not revolutionary. A pacing system can, however, be revolutionary, thus affording

almost immediate relief from the problems of traffic congestion.

There is increasing emphasis on external means for imparting certain types of information to the pilots of aircraft. Visual aids such as touchdown zone lighting systems, threshold lights, approach slope indicators, taxiways and runway lighting systems now constitute a branch of illumination engineering. A visual aid which serves both as guidance and warning on landing and takeoff speeds would be beneficial, a precaution which could prevent an overrun on landing or a premature takeoff. One application of this invention is just such a visual aid, and because of its inherent flexibility it can be regulated to the performance characteristics of any aircraft and, above all, it can compensate for wind velocity.

Still other applications for a pacing system provided in accordance with this invention will be apparent. Accordingly, it is an object of this invention to provide a pacing system that is relatively inexpensive yet readily adjustable for use in a variety of different applications.

SUMMARY OF THE INVENTION

Briefly, the present invention is comprised of a stationary strip of equally spaced bars transverse to the direction of traffic (either erect on one side or horizontal in the path of the traffic, such as on an airport runway), and means for intermittently illuminating them simultaneously at a selected frequency, where the frequency is selected to produce a stroboscopic effect on an observer moving parallel to the strip of bars, referred to hereinafter as the strobstrip, such that only at a predetermined velocity will the bars appear to be motionless, i.e., appear to have a velocity of zero relative to the moving observer. At a velocity near but greater than the predetermined velocity, it will appear to the observer that he is overtaking the bars, and at a velocity near but less than the predetermined velocity, it will appear to the observer that the bars are moving away from him.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention will best be understood from the following description when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates one application of the present invention to control noninterfering flow of platooned vehicles through intersections.

FIG. 2 illustrates another application of the present invention to transmit speed information to an aircraft taking off or landing on a runway.

FIG. 3 illustrates still another application of the present invention to transmit speed information to vehicular traffic in a tunnel.

FIG. 4 illustrates an isometric view of a light source for the application of FIG. 3.

FIGS. 5 to 7 illustrate one embodiment of a strobstrip for the present invention.

FIGS. 8 to 10 illustrate another embodiment of a strobstrip for the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates schematically the use of a strobstrip for pacing automobiles on city streets through in-

tersections. For convenience, only one intersection is showing; it has a traffic signal 10. Traffic signals at other intersections in all four directions are synchronized with the traffic signal 10 to stop traffic periodically and thereby form platoons of vehicles which may move continuously without interfering with one another at the intersections if the platoons are properly paced, except as noted hereinafter.

The pacing system shown is comprised of a strobostrip 11 along at least a portion of each street on each side and viewed to the right of each driver. Each strobostrip is in turn comprised of a multiplicity of fixed, evenly spaced bars, as will be described more fully hereinafter. These bars of a given strobostrip are illuminated by flashes at a frequency regulated by a controller 12. The means for illumination is assumed to be a high intensity source at each end of each strobostrip, as will be more fully described with reference to FIG. 5, but other means may be employed. Regulation of the light sources, illustrated by dashed lines, is electronic in that it requires only electrical pulses to be transmitted by the controller to the light sources. The controller may then be simply an oscillator, preferably a voltage-controlled oscillator so that its frequency may be readily altered from a remote location to regulate the pacing speed of traffic. The controller also includes a timing system for the traffic signal 10 that is synchronized with controllers at all other intersections crossed by the two surface streets shown. The frequency of the oscillator in the controller is, of course, coordinated with the timing of the traffic signal.

All platoons approaching any one intersection can be paced to provide continuous movement through that intersection. Not all platoons can be paced through every controlled intersection in a network of streets but, the majority of them can because each strobostrip permits pacing at any reasonable speed, with possible variations of as little as 2 miles per hour.

It is not essential that the strobostrips be installed as continuous bands for block after block. Once a platoon has been organized and paced it can travel hundreds of feet without referring to the strobostrip by simply maintaining speed until another strobostrip is encountered to reconfirm speed or to adjust to a different desired speed.

In pacing traffic, the spacing of the bars, the frequency of the flashes and the speed of a vehicle are related, one to another, with the result that the bars present to the driver of the vehicle a stroboscopic effect of motion or no motion, depending on the speed of the vehicle. When the bars appear to be motionless, the vehicle is proceeding at the selected control speed. At a speed near but less than the control speed, the bars appear to be moving away from the driver of the vehicle in the direction of travel, whereas at a speed greater than the control speed the bars appear to be moving toward the driver. Thus the stroboscopic effect is used to continuously convey to the driver of each vehicle the information needed to regulate the speed of the platoon to that which has been determined to be the optimum for orderly movement of all of the traffic.

As noted hereinbefore, conventional traffic signals, incorporated into the pacing system, are timed to move the traffic progressively. The number of vehicles comprising a platoon will depend upon the duration of the "green" period of the traffic signal cycle at a given intersection. The "red" period will hold at the intersec-

tion those vehicles which have yet to become members of a continuously moving platoon. The frequency at which any strobostrip is flashed and the durations of the green and red periods of a traffic signal are capable of being regulated over an extensive range.

This pacing system does not require the use of a computer except for merging traffic from on-ramps with freeway traffic. However, computer control of the flashing rate in a specific speed range and of the traffic signals for a complex traffic situation can be accomplished with known computer programming techniques.

The stroboscopic relationship among velocity V , in terms of feet-per-second, the bar spacing B , in terms of bars-per-foot (horizontal) and flashing rate f , in terms of flashes-per-second, is given by:

$$(VB/f) = N$$

in which N is any integer, except zero, or any member of a set of fractions ($\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$. . .). This relationship will produce synchronism between the strobostrip and the vehicle at a desired velocity.

From this relationship, the values of B and f can be selected for the desired velocity such that, at the desired velocity the bars of the strobostrip will appear to be stationary relative to the driver of the moving vehicle. This then is the pacing speed, a speed at which traffic organized into platoons will travel with order on the city streets.

The real motion of a vehicle will always be toward the bars of the strobostrip, but the apparent motion of the bars will either be toward or away from the vehicle depending upon whether the vehicle's velocity is greater or less than V . This stroboscopic motion of the bars can best be understood by assigning a value of 2 to N in the above equation. When the repetition rate (VB) of the bars exceeds the flashing rate f , the strobic motion of the bars is toward the vehicle, i.e. in a direction opposite to the motion of the vehicle. At this repetition rate, the quantity VB/f is slightly greater than 2. When the repetition rate of the bars is less than the flashing rate, the strobic motion of the bars is away from the vehicle in the same direction as the actual motion of the vehicle. At this rate VB/f is slightly less than 2. Accordingly, if the velocity of the vehicle is greater than V , it will appear to an observer that he is overtaking the bars, and if less than V , it will appear to the observer that he is following behind the bars which have an apparent motion in the direction of the vehicle's motion.

The stroboscopic motion assumes that the flashing rate f has been chosen sufficiently high to be within the requirements of the persistence of vision.

The persistence of vision is approximately one-tenth second. Therefore, the flashing rate should be such that an observer on a moving vehicle will see bars illuminated by the flashes at a rate greater than 10 per second, such as 25 per second, at the desired velocity V . The values for the spacing B and the frequency f for the desired velocity V can be easily chosen. In practice the spacing B is chosen with practical consideration of physical space, and the frequency f is then selected. To increase, or decrease, the chosen velocity V within a reasonable range, the frequency f is simply increased, or decreased, proportionally to produce synchronism at a higher or lower velocity.

Synchronism can occur at a higher and a lower velocity than that desired, i.e., than that set by the frequency f selected for a predetermined number of bars/foot. However, the difference between the other velocities that will produce synchronism and the desired velocity will be so large that the driver of a vehicle being paced will not be confused or attempt to synchronize at those other velocities.

The velocities at which synchronism can occur above and below the desired velocity can be predetermined. There is then a given range of higher and lower velocities within which the desired stroboscopic effect will take place. Proper selection of bar spacing will assure that the range will be sufficient to avoid confusion for a given velocity. Although it will not be possible to segregate all traffic into noninterfering platoons at each major intersection, as noted hereinbefore, the majority of vehicles can be so ordered. The elimination of such a large volume of stop-go traffic will yield immeasurable benefits in the reduction of exhaust emissions, increased mileage per gallon of gasoline and increased engine life (or decreased repairs).

Another use of this invention is, as referred to hereinbefore, to merge the traffic on the on-ramp of a freeway smoothly into the flow of traffic on the freeway. The installation would be comprised of strobostrips mounted on the right side of the freeway and the on-ramp to be controlled, a conventional traffic signal to control traffic onto the on-ramp and a computer programmed to control the traffic signal and the flashing frequency f of the strobostrip to pace vehicles onto the freeway into gaps in the freeway traffic sensed by vehicle detectors on the freeway. By cyclically pacing the freeway traffic at high and low velocities, the necessary gaps in the freeway traffic are created. To pace vehicles on the on-ramp, vehicle detectors could track the progress of a platoon of vehicles and feed data into the computer to program acceleration of the platoon into the moving gap in the freeway traffic.

This invention may also be employed to communicate speed information and to regulate speed under a variety of conditions, and for types of vehicles other than automobiles, trucks and buses, such as: trains in and near congested communities, as well as in approaches to terminals; and aircraft on takeoff and landing. In the case of aircraft, the strobostrip may be placed adjacent to the centerline of an airport runway, as shown in FIG. 2 for a strobostrip 20 in a perspective view of an airport runway 21 which might be viewed by a pilot on an approach to a landing. The strobostrip thus serves as a guide as well as an indicator of optimum landing speed.

Similar landing strip lighting has been successfully employed in airports. It is therefore feasible to provide such lighting in the form of a strobostrip with the flashing rate controlled for the desired ground speed of an approaching aircraft taking into consideration the type of aircraft and the wind velocity at the time. In this, as in other types of applications of the invention, the bars of the strobostrip may be illuminated by a source carried by the vehicle, as shown in FIG. 2, such as a Xenon lamp repeatedly triggered at the desired rate or frequency.

For those applications using a flashing light source carried by the vehicle, the strobostrip bars may be comprised of microscopic prism-like particles or glass spheres embedded in a thermoplastic sheet, or simply

a plastic tape made brilliant by a suitable pigment. In some applications, it may be advantageous to shade the bars for good day and night visibility. Where the requisite high visibility is unobtainable during the hours of daylight, it may be necessary to limit the use of the strobostrip to only those hours between dusk and dawn. However, those are usually the most critical hours so that installation costs of such a vehicle-illuminated stroboscopic strip can still be justified, particularly if, in the daylight hours, the strip serves another useful purpose, such as a guideline on the runway of an airport.

FIG. 3 illustrates the application of the present invention to the task of pacing traffic through a long tunnel, using a plurality of light fixtures, such as a fixture 26 illustrated in FIG. 4. The fixture houses suitable lamps, such as fluorescent or Xenon lamp. It is preferably made of opaque material, such as sheet metal with a translucent panel 27. The panel may be colored with a suitable pigment, or may be simply white as in standard fluorescent light fixtures. The slope of the panel, relative to the direction of traffic flow, is selected to minimize visibility of the panel by traffic moving in the opposite direction in order that traffic in opposite directions can be paced at different speeds without confusing the drivers on one side by the stroboscopic effect of the flashing light on the opposite side of the tunnel. For a wide tunnel, or for controlling traffic in both directions at the same speed, a single lamp, housed in a diffuser would be adequate.

The foregoing illustrates the great utility and versatility of the present invention, and demonstrates that many techniques are feasible for implementing a strobostrip. All that is needed is a strip (rectilinear or curvilinear) of properly spaced bars, and means for illuminating them with light flashing at a frequency calculated from the general equation set forth hereinbefore. The illuminating means may be, for example, as shown in FIGS. 5 to 10, a flashing light source carried by the vehicle, as suggested hereinbefore with reference to FIG. 2, or individual flashed light sources mounted in suitable fixtures as shown in FIG. 4. Other techniques for implementing a strobostrip will suggest themselves with front lighting, edge lighting or back lighting, using in each case any suitable light source. A strobostrip may even be formed as a panel of light-emitting diodes. It is, therefore, intended that the claims be interpreted to cover all forms of strobostrips, and not simply those expressly suggested, or those of some particular interest to be described with reference to FIGS. 5 to 10. In FIG. 5, a top view of a strobostrip partially broken away is shown comprised of an opaque conduit 30 having apertures 31 covered by a translucent shield 32 to form a vertical bar as more clearly shown in FIG. 6. The shields may be smooth on the outside for ease in cleaning, and finished with prism-like facets on the inside for greater diffusion of light passing through apertures in the conduit. Other alternatives for the shield include lining the inside with optical glass spheres, or applying to it a suitable brilliant pigment.

Light flashes are introduced into the conduit from each end by floodlight units 34 and 35. Each unit includes two stacked floodlights, as shown in FIG. 6 for the unit 35, to provide a beam having a vertical dimension substantially equal to the height of the vertical bars. The inside of the conduit walls are reflective surfaces. Beams of light are repeatedly reflected from the

walls to virtually fill the entire conduit with light beams that illuminate the front apertured wall everywhere, including the apertures, thus forming spaced bars of light each time the floodlight units are flashed simultaneously.

A floodlight unit at each end of the conduit assures more uniform light intensity for the bars. At each aperture, some light escapes from the conduit, thereby diminishing the intensity of the light from one unit as the flashed light beams travel to the other end of the conduit; however, with light beams traveling from the floodlight unit at the other end, lumens at each aperture will be approximately the same. To ensure that there will be no "dead areas" in the conduit, the plane of the back wall may diverge slightly from a parallel position with the plane of the front wall, as shown in FIG. 5. The effect would be to progressively diverge the light from one end and converge the light from the other end.

FIG. 8 shows schematically a plan view of another strobostrip embodiment using fiber optics to distribute light flashes from a source to bars 40. Each of the bars, represented by circles, is positioned directly opposite an aperture 41 in a conduit 44 which encloses a bundle of parallel hollow tubes 42. One end of each tube 42 is connected to a different bar 40 by a bundle 43 of optical fibers as shown in FIG. 9. The bar is a hollow cylinder or square tube having a translucent viewing side 41A and a back 42B lined with high intensity reflective material of prismatic facets, microscopic optical glass spheres or brilliant pigment, any one of which is represented in FIG. 9 by the rough inside surface of the back 42B.

The other end of each tube is connected to a light distributor 45 comprised of two simultaneously flashed and opposing light sources 46 and 47 and a revolving mirror 48. As the mirror completes one revolution, light will be distributed to the tubes 42 twice, once from the source 46 and once from the source 47.

The distributor includes on each side of the opposing light sources, a plurality of short radial tube sections 49, one section for each tube 42. The sections are held in place by a hoop 50 having apertures 51 and 52 for the beams from the sources 46 and 47. The ideal sources will be continuous wave (CW) lasers with their pencil-thin beams. Other light sources would require appropriate reflectors and lenses to produce a beam which is very narrow in one plane. The illumination of more than one radial tube section at a time will not affect the performance of the distributor. In this instance, the more narrow the beam, the greater its intensity. Whatever their sources, these beams will have their center lines lying in the same plane as the center lines of all of the radial tube sections 49. Each radial tube section 49 is then connected to a parallel tube 42 by a bundle of optical fibers 53. In that manner, the revolving mirror distributes the light beams and controls the frequency of the flashes at the bars.

For each application, and each strobostrip arrangement, the control system for flashing the light source, or sources, may include a voltage controlled oscillator and a programmed digital computer to compute the correct control voltage for the oscillator to flash the

bars of the strobostrip at the right frequency f for a desired velocity V . The output of the computer could be converted to an analog signal through a basic digital-to-analog converter. Manual control or override can be provided at the digital-to-analog converter. Although particular embodiments of the invention have been described and illustrated herein; it is recognized that modifications and variations may readily occur to those skilled in the art. It is therefore intended that the claims be interpreted to cover such modifications and variations.

What is claimed is:

1. Apparatus for pacing the movement of conveyances in a given direction comprised of

15 a strip of equally spaced and stationary bars disposed parallel to said given direction, said bars being more visible to an observer in said conveyance when illuminated than the background surrounding said bars,

20 means for intermittently illuminating said bars simultaneously at a predetermined frequency to produce a stroboscopic effect on an observer moving in one of said conveyances such that when the velocity of said conveyance is greater than said predetermined velocity within a given range of higher velocities, it will appear to the observer that said bars are moving toward the observer, when the velocity of said conveyances is less than said predetermined velocity within a given range of lower velocities, it will appear to the observer that said bars are moving away from said conveyance in the direction of motion of said conveyance, and when the velocity of said conveyance is equal to said predetermined velocity, it will appear to the observer that said bars are stationary relative to said conveyance.

2. Apparatus as defined in claim 1, wherein said bars are spaced apart a distance B and said frequency is selected for said desired velocity V to satisfy a relationship

$$(VB/f) = N$$

where N is an integer, except zero, or any member of a set of fractions ($\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$...)

3. Apparatus as defined in claim 2, wherein said frequency is chosen sufficiently high to be within the requirements of the persistence of vision.

4. Apparatus as defined in claim 3, wherein said means is comprised of individual flashed light sources mounted in fixtures.

5. Apparatus as defined in claim 3, wherein said means is comprised of a flashing light source carried by said conveyance.

6. Apparatus as defined in claim 3, wherein said means is comprised of an opaque conduit having said bars formed as apertures in said conduit, each aperture being covered by a translucent shield, and floodlights for filling said conduit with flashes of light from each end of said conduit.

7. Apparatus as defined in claim 6 wherein said conduit has a planar back wall diverging slightly from a parallel position with a planar front wall having said apertures.

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