ABSTRACT: Emergency lighting system for escape slides for vehicles, primarily aircraft, comprising lighting harnesses with a plurality of electric lighting units, a battery pack, switch mechanism automatically operated to energize lights upon deployment of slide, the lighting harnesses being prefabricated in one standard size adaptable for application to slides of widely varying sizes and configurations and a testing device for determining operative condition of switch, lights and batteries without deploying slide. Slide is normally carried in aircraft in tightly folded condition with battery pack and lighting units inaccessible. Testing device includes jack extended to accessible position and testing instrument with cooperating plug. Instrument may be carried to any folded slide on an aircraft or a fleet of aircraft for periodic checking. Instrument indicates by deviation from a predetermined standard reading when defects exist in batteries, wiring, bulbs or switch.
LIGHTING SYSTEM FOR FOLDED INFLATABLE ESCAPE SLIDES WITH MEANS FOR TESTING SYSTEM WITH SLIDE IN FOLDED CONDITION

BACKGROUND OF THE INVENTION

Escape slides, stairs or other equivalent devices are employed with substantially all of the larger aircraft in commercial service. They are normally folded into extremely compact form and mounted in position for convenient use in association with the regular as well as emergency exits. Recent governmental regulations require the fitting of such slides with emergency lighting equipment which will unfailingly function independently of electrical power systems of the aircraft if and when such slides are deployed for emergency use. Thus, there is a present need for lighting systems which may be retrofitted to existing escape slides with a minimum of difficulty and expense and which also may be fitted to new escape devices as they are manufactured for replacement or original equipment use.

A high degree of reliability is required and provision must be made for regularly scheduled maintenance checking of the condition of the components of the lighting system on each of the slides so equipped. Since the unfolding and refolding of a typical escape slide involves several hours of work by a team of two expert operators it is apparent that the checking of the lighting system should be possible without deployment or other disarrangement of the folded slide or detachment thereof from the aircraft in which it is installed.

BRIEF DESCRIPTION OF THE INVENTION

It is a major objective of the present invention to provide an emergency lighting system which is capable of being readily attached to substantially any form or size of slide currently in use or reasonably expected to be adopted in the future. Irrespective of variation in size and specific design there are fundamental requirements common to all of these slides which the present invention meets. At the same time the system must also be provided with lighting harnesses with lighting units spaced at fixed distances along flat ribbonlike wires of adequate length to provide a string of lights down each longitudinal side of the slide and extending across the bottom edge of the slide, the latter extending slightly to illuminate the area of the ground or water upon which an escaping occupant will land when he reaches the bottom of the slide. The lighting system is arranged to be adapted to slides of different lengths by the simple procedure of folding the wires upon themselves to space the individual light units more closely together on shorter slides and farther apart on longer ones.

Another fundamental requirement which must be met is that the lighting harnesses and all apparatus may be attached to existing slides in a retrofitting operation or may be attached to new slides at the time of manufacture thereof in a firm and secure manner without any risk whatever of interference with the gas tight integrity of the slide structure. This is accomplished in the present invention by using the flat wires mentioned above with rugged bulb assemblies of essentially flat configuration whereby the harnesses may be readily attached to a deployed slide by the use of adhesive or pressure sensitive adhesive tape or other suitable means.

Another fundamental requirement that is met by the present invention is that the lighting system be rugged and entirely flexible so that it may be folded up with the slide when the latter is deflated for packing in ready condition without adding any or at least any substantial bulk to the folded package.

Another fundamental requirement is the provision of facilities for testing the batteries and other components of the lighting system on a periodic basis during the time that the folded slide is stored in the aircraft for emergency use. As will be evident the slides usually are never deployed for actual use and will remain stored ready for use for periods of several years. While periodic test deployment is performed on a schedule related to other maintenance procedures for a particular aircraft such tests are very infrequent and testing of the lighting systems should be performed much more frequently since the best of batteries, wires and sockets may fail during long periods of nonuse and bulbs of best quality may develop cracks or other defects. The present invention provides test facilities whereby the lighting system may be rapidly checked at intervals as frequent as may be desired without deployment or any other disarrangement of the folded slide.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a simplified fragmentary perspective view of an escape slide deployed for use in evacuation of an aircraft with an illustrative, preferred embodiment of the lighting system of the present invention attached hereto;

FIG. 2 is a view similar to FIG. 1 showing the underside of the deployed escape slide including certain elements of the lighting system;

FIG. 3 is a simplified perspective view of an escape slide in folded condition in which it is stored in ready condition within an aircraft and showing the manner in which the testing device for the lighting system is used;

FIG. 4 is a wiring diagram of the complete lighting and testing system of the present invention;

FIG. 5 is an elevational view with parts broken away of the battery pack and associated switch;

FIGS. 6 and 7 are elevational views, respectively of the opposite ends of the structure shown in FIG. 5;

FIG. 8 is a plan view with parts broken away and parts omitted of one of the lighting harnesses provided by the present invention; and

FIG. 9 is a vertical sectional view taken along the line 9—9 in FIG. 8.

Referring now to the drawings:

In FIGS. 1 and 2 an escape slide 10 is shown in deployed condition ready for use in which occupants of an aircraft 12 escape through an opening 14. The details of construction of the slide 10 or the manner in which it is secured to the aircraft for emergency use with the opening 14 and the associated door or window (not shown) form no part of the present invention. Therefore the escape slide 10 as shown in FIG. 1 is illustrated in simplified and diagrammatic fashion and it is intended only to suggest a construction typical of the many types of slides, stair lighting harnesses and other to which the emergency lighting system of the present invention may be secured. Such typical escape slide may be made up of four generally tubular inflatable bolsters of gas tight material, such as rubber or plastic coated fabric, mitered together at the corners to form a generally rectangular structure when inflated. In FIG. 2, which is a view of the underside of the slide, longitudinal bolsters 16 and 18 are mitered to transverse bolsters 20 and 22 at corners indicated generally at 24. Referring back to FIG. 1 the upper surface of the slide comprises a sheet of fabric 26 which is firmly secured to the four bolsters. The fabric 26 thus serves as the surface upon which persons slide when evacuating an aircraft. Usually the surface fabric 26 is provided with grounding strips 28 of electrically conductive material which, as shown in FIG. 2 extend around the lower edges of the slide so as to come into contact with the ground upon deployment of the slide. A scuff strip 30 also rests upon the ground to protect the deployed slide from damage. Static electrical charges built up on the body of the slide 10 or the bodies of the users of the slide will be discharged to the ground through the grounding strips 28 reducing the discomfort of electrical shock and also reducing the risk of ignition of any ambient flammable liquids or gases.

As shown in FIG. 2 the lower surfaces of the longitudinal bolsters 16 also may be cross-connected by web strips 32 spaced along the length of the slide to further stabilize it when deployed in conditioned. The uppermost web strap 34 as shown
3,621,383

herein is secured to an apron 36 which in turn is secured to a girt bar 37 for attachment to the aircraft. The apron 36 is made of flexible material and frequently serves the dual purpose of attachment to the aircraft and of providing a surface which gives a reassuring continuity to the surface of the slide and the interior of the aircraft.

It will be understood that the length and width of the slides will vary greatly depending upon the aircraft for which they are designed and also depending upon the particular exit with which they are to cooperate. In a general sense, for use with commercial aircraft in use, as of the time of filing of this application, the slides are normally length from a minimum of about 140" to a maximum of about 270". Obviously, at larger aircraft or aircraft of different configurations are brought into use the range of lengths of the slides may be extended at both ends.

Slides of the types here involved are normally carried in the aircraft or other vehicle in deflated, tightly folded condition adjacent the door or other opening with which they are intended for use in an emergency. A typical configuration of a folded slide is shown in FIG. 3. To be placed in such folded condition the slide must be free of enclosed air and it is folded up by trained personnel in a specific manner usually with the aid of thin paddles and mallets, an operation which, as noted above, takes a large number of man-hours to complete. The folded slide is held in such a manner by various types of breakaway fastening devices including, in some cases a plurality of separable fasteners 38. A lanyard (not shown) is usually provided for initiation of inflation and deployment of the slide when desired.

In FIG. 3 the slide 10 is so folded that a cylinder 40 of highly compressed gas is enveloped in the upper portions of the folds with a pressure regulator-assembly 42 in exposed position. The latter assembly also includes a pressure gauge 44 in visible position for routine checking by inspectors. The assembly 42 is connected by a flexible tube 46 and a fitting 48 to the interior of the slide, in this example it is connected (FIG. 2) with the longitudinal bolster 18. An aspirator 50 is so associated with the gas supply tube 46 as to admit air by injection when the highly compressed gas from cylinder 40 enters the fitting 48 and expands into the slide. In a typical installation the cylinder 40 may contain nitrogen and under a pressure of about 2,500 p.s.i. and because of the operation of the aspirator system, including aspirator 50, the fully inflated, deployed slide will contain about 95 percent air, by volume, and only about 5 percent nitrogen. Suitable relief valves are usually provided, not shown herein, to protect the structure from overinflation. During inflation the various breakaway devices mentioned above will release in proper sequence to ensure inflation of all internal regions of the slide and thus the assumption of proper deployed shape as shown in FIGS. 1 and 2.

In view of the exacting requirements for proper folding and deployment of the slide and in view of the demand for minimum space occupancy when the slide is folded in FIG. 3 it will be apparent that an emergency lighting system must be so designed and installed as not to interfere with or completely the folding and deploying operations and it must not increase, or at least not greatly increase, the size of the folded slide.

The bulkliest part of the lighting system of the present invention is the battery pack and switch assembly. As shown in FIG. 3 such assembly 52 is cylindrical and it is positioned just below the gas cylinder 40. When the slide is folded this particular portion of the folded assembly includes a plurality of reverse folds of the fabric and it has been found that the battery pack 52 may be squeezed in during the folding operation between adjacent folds without noticeably increasing the size of the folded slide. In this connection it should be pointed out that the battery pack and switch assembly 52 is about the same size as the battery-containing portion of a standard five-cell flashlight.

Referring now to FIG. 2 the battery pack and switch assembly 52 is firmly secured to the gas cylinder 40 which, in turn is secured to one of the web straps 32. Preferably the assembly 52 is thus secured to cylinder 40 by several turns of pressure-sensitive tape. Such firm securing is essential inasmuch, as will become apparent, the reliable operation of the switch mechanism during deployment of the slide is dependent upon relative movement between the assembly 52 and a lanyard 54 secured elsewhere to the slide body.

Referring back to FIG. 3 the only visible portion of the lighting system of the present invention is a test jack 56 which is connected by an electric cord 58 to the assembly 52. The jack 56 preferably is secured, as by pressure sensitive tape, to the pressure gauge 44 thus to be readily visible and to serve as a reminder that the lighting system must be checked at least whenever the gauge 44 is checked by an inspector. For testing the lighting system the inspector is provided with an instrument 60 having an electrical cord 62 and a plug 64 to fit jack 56. To make a test the plug 64 is inserted into jack 56 and the condition of the various components of the lighting system will be registered, as by a needle 66 on instrument 60.

Referring now to FIG. 4 the battery pack and switch unit 52 and the test instrument 60 are shown in a wiring diagram. In the pack 52 a plurality of batteries 68 is shown in series with a switch 70. The switch 70, which will be described in greater detail below, is spring biased toward closed position but is held in open position, by means including the lanyard 54, when the slide is in the folded condition. A two-conductor connecting element 72 mates with a similar element 74 to connect a lighting harness 76 consisting of a double conductor 78 with a plurality of bulbs 80 connected in parallel therewith. Another two-conductor connector element 82 mates with a similar element 84 to connect a second lighting harness 86 consisting of a double conductor 88 with a plurality of bulbs 90 connected in parallel therewith. The connector elements 72 and 82 are connected in parallel with one another and across the series circuit including batteries 68 and switch 70 whereby when switch 70 is closed the bulbs 80 and 90 in the harnesses 76 and 86 will be energized.

Also, in FIG. 4, the test instrument 60 is shown as comprising an ammeter 92 connected across the two conductors of test cord 62 and thus with the two contact elements of the plug 64. The mating contact elements of jack 56 are connected through the two conductors of cord 58 to the terminals 94 and 96 of switch 70. As will be seen from FIG. 4 when the plug 64 is inserted in jack 56 the ammeter 92 of test instrument 60 will be connected in parallel with the open switch 70. The ammeter 92 preferably is a low-resistance type which includes a low-resistance shunt whereby when it is connected across the switch 70 for testing purposes it will cause the bulbs 80 and 90 in both lighting harnesses 76 and 86 to be energized by batteries 68 much as if the switch 70 had been closed. The ammeter 92 thus will indicate the amount of current which the batteries 68 are supplying to the lighted bulbs. The ammeter 92 is provided with a scale or other markings whereby a normal reading may be predetermined for the amount of current which the full complement of operative bulbs will draw from a fresh set of batteries with all wiring and connecting components in proper conductive condition. When a test is made a meter reading which is lower or higher by a predetermined amount than the standard will indicate that the lighting system needs servicing. For example a low reading, but well above zero, will result when one or more of the battery cells has partially deteriorated, when electrical connection between battery cells or other components have developed unduly high resistance or when more than an acceptable number of the bulbs 80 and 90 have failed or become disconnected. A reading at or near zero will result when one or more battery cells are very weak or dead, when switch 70 has closed or become short circuited or when an open or highly resistive break has occurred between the batteries and both of the lighting harnesses 76 and 86. A reading substantially higher than the predetermined standard will result when a full or partial short circuit exists anywhere in the circuit from the terminal 96 of switch 70 to the positive terminal of the series-connected battery cells 68. The condi-
tions just given as examples are merely typical and it will be recognized that any sort of electrical failure or malfunction of the system will produce an abnormal reading on the ammeter 92. A normal reading on the ammeter 92 will substantially un

When, upon making a routine test of the lighting system as described above, an abnormal condition is indicated by the test instrument 60 the folded slide 10 ordinarily will be removed from the aircraft and replaced by a slide with properly operating lighting and other systems. The defective condition will then be corrected on the removed slide. Depen

dent upon the particular configuration and method of folding of the slide in which the defect was detected the slide usually will have to be at least partially unfolded even to replace the battery cells in the battery pack 52. If replacement of the battery cells results in a normal reading on instrument 60 the partially unfolded slide may be refolded and put back into ser

A salient feature of the present invention is the incorporation in a lighting system of the specialized type here involved of means for testing the system under operating condition, that is, with the lighting units or bulbs 89 and 90 energized by the battery cells 68 and with the emergency switch 70 biased open in a ready condition. By carefully selecting each of the components of the system on a basis or ruggedness and long life under nonuse conditions, and preferably with 100 percent inspection of such components when the system is assembled, the incidence of failures may be reduced to a practical minimum. A preferred combination of components will now be described which can be relied upon in a very large percent

As shown in FIG. 5 a length of ball chain 118 of familiar construction including a series of balls 120 pivotally connected by links 122 is secured to an end of lanyard 54. Preferably lanyard 54 is a flexible, nonstretchable cord of synthetic material such as nylon, or suitable polyester or polyvinyl filmteens, for example. The lanyard cord 54 may be attached to the ball chain 118 by any suitable and appropriately temporary permanent means. For example a tube 123 of shrinkable plastic material may be fitted over the overlapping ends of the cord 54 and chain 118 respectively and then shrunk by heat or other technique appropriate for the particular shrinkable plastic material used for the tube 124. This procedure affords a reliable and essentially smooth and flexible joint between the cord 54 and chain 118 which is substantially devoid of any tendency to become fouled with moving parts of the slide 10 upon deployment thereof.

The ball chain 118 is similar in appearance to the familiar pull chain used with electric lighting fixtures but preferably is made of stainless steel, plastic or other noncorrosive material having very high tensile strength. A high quality ball chain of the type frequently used in fishing tackle is suitable and is available in various effective diameters with specified tensile test characteristics. For use in the present invention the chain 118 is chosen with an effective diameter so related to the eff

dicate in FIG. 4. The outlet cords emerge from the end closure 100 and include the cord 58 which extends through a double connector 106 to the test jack 56 (FIGS. 3 and 4). As indicated in FIG. 4 the two conductors within cord 58 are connected respectively with the contacts 94 and 96 of switch 70.

Outlet cords 108 and 110 of the two conductor type emerge from end closure 100 and terminate respectively in the pairs of connectors 72 and 82 to which the two lighting harnesses 76 and 86 are connected (see FIG. 4) when the lighting system is installed on a slide. As will be understood the cords 108 and 110 are connected, internally of the pack 52, in parallel with one another and in series with the battery cells 68 and switch 70. The connectors 72, 82 and 106 are shown diagrammatically but it will be understood that they can be of any commercial type approved for this particular use in the aircraft or other vehicle in which the emergency slide 10 is to be used.

The switch 70 is illustrated in FIG. 5 in simplified diagrammatic form. Preferably it is an aircraft quality microswitch having an actuating plunger 112 for moving the contact 96 away from contact 94 when the plunger 112 is pressed inwardly. The contact 96 is constantly spring biased towards contact 94 so that, to maintain switch 70 in open condition it is necessary to hold the plunger 112 in depressed position as illustrated in FIG. 5.

In the illustrated, preferred form of the present invention the switch 70 is held in open condition by a simple and reliable means especially adapted to be unfallingly operated automatically by movement of the lanyard 54 (see FIGS. 2 and 3) when the slide is deployed. Thus, as shown in FIGS. 5 and 7 the end closure 102 has fixed therein a generally semicircular filler block 114 of rigid material such as metal or plastic which lies above the body of switch 70. The block 114 is provided with a generally semicylindrical bore 116 extending parallel with the axis of the pack 52 and closed at the inner end by the bulkhead 104 of closure 102. As shown particularly in FIG. 7 the bore 116 is arranged to receive the plunger 112 of switch 70 and to permit the plunger to move outwardly of switch 70 to close the contacts 94 and 96 when the bore 116 is empty. However when some object of proper size which will serve a purpose similar to an arming pin is inserted into the bore 116 that object will depress the plunger 112 of switch 70 to hold it in open position. While a rigid metal or plastic pin would serve such a purpose in this device it is preferred to use a length of ball chain of suitable effective diameter for several reasons as will now be explained.

As shown in FIG. 5 a length of ball chain 118 of familiar construction including a series of balls 120 pivotally connected by links 122 is secured to an end of lanyard 54. Preferably lanyard 54 is a flexible, nonstretchable cord of synthetic material such as nylon, or suitable polyester or polyvinyl filmteens, for example. The lanyard cord 54 may be attached to the ball chain 118 by any suitable and appropriately permanent means. For example a tube 123 of shrinkable plastic material may be fitted over the overlapping ends of the cord 54 and chain 118 respectively and then shrunk by heat or other technique appropriate for the particular shrinkable plastic material used for the tube 124. This procedure affords a reliable and essentially smooth and flexible joint between the cord 54 and chain 118 which is substantially devoid of any tendency to become fouled with moving parts of the slide 10 upon deployment thereof.

The ball chain 118 is similar in appearance to the familiar pull chain used with electric lighting fixtures but preferably is made of stainless steel, plastic or other noncorrosive material having very high tensile strength. A high quality ball chain of the type frequently used in fishing tackle is suitable and is available in various effective diameters with specified tensile test characteristics. For use in the present invention the chain 118 is chosen with an effective diameter so related to the eff
fitting 124 provides a smooth curved path for movement of the chain 118 when the latter is pulled from any direction. As will be apparent, although the chain 118 is yieldingly retained in the position shown in FIG. 5 by action of the spring-pressed plate 112, a relatively light force will be effective to withdraw the chain 118 bodily from the bore 116 whereupon the switch 70 will close to energize the lighting harnesses 76 and 86. Preferably the sizes of the chain 118 and bore 116 are so selected with regard to the strength of the spring which urges plunger 112 outwardly that insertion of the chain into the bore may be readily effected by manual pushing of the chain into the confined space and that a pull of about one pound will be effective to withdraw the chain from the bore when required.

The force required for withdrawing the chain 118 from bore 116 may be further modified to a desired normal level by fitting small rubber or other elastomeric discs, not shown, onto the wire links 122 between the several bulbs 120 of chain 118 which, in the position shown in FIG. 5, extend to the right from plunger 112 through the flared fitting 124. Such discs also serve to seal the opening of fitting 124 so that the switch assembly may be rated as "explosion proof" when required.

As shown in FIGS. 2 and 3 the opposite end of lanyard 54 is secured as by a pressure sensitive adhesive tape or patch 126 to a portion of the slide which is certain to move far enough relative to the battery pack and switch assembly 52 when the slide is deployed by inflation to withdraw chain 118 from the bore 116 to energize the lighting system. Preferably the point of attachment of the far end of lanyard 54 is so chosen that the lights will be energized early in the cycle of inflation of the slide to assist the aircraft crew at night in determining that inflation is proceeding properly and to make it evident when inflation is sufficiently advanced to permit use of the slide for escape purposes.

A preferred form of lighting harness is shown in FIGS. 8 and 9 wherein harness 76 is illustrated, it being understood that the harness 86 may be identical therewith. A primary feature of the harness 76 is that the conductor used for the major portion of the harness is a very thin plastic tape enclosing two spaced parallel flat metal ribbons which serve as electrical conductors. Such tape is available as a "computer-type" conductor and the tape selected is 0.006" thick. It is extremely rugged and will take repeated sharp bending without breaking as a result of fatigue or work-hardening of its components. Such tape conductor is shown at 128 in FIGS. 8 and 9 and the electrical conducting elements thereof are shown at 130 and 132 in said FIGS. At the left-hand end as viewed in FIG. 8 the conductors 130 and 132 are electrically connected with the wires within a two-conductor cord 134 having the connectors 74 at the opposite end for connection with connectors 72 (see FIG. 4) of the battery and switch pack 52. The electrical connection between the cord 134 and tape 128 may be effected by soldering (not shown) and the soldered connections may be reinforced mechanically and insulated electrically by a length of shrink-plastic tubing 136 shrunk into position over the joint.

Typical lighting units 138 are shown in plan and section respectively in FIGS. 8 and 9, although as will be evident certain parts have been broken away in FIG. 8 for clarity of disclosure. For each such lighting unit 138 a stiff fiber board rectangle 140 is positioned beneath the tape 128 and a rectangular sheet 142 of reflective material such as metal or metal-coated polyester film for example, is positioned above the tape 128. A bulb 80 is placed on the reflective material 142. Each bulb 80 is a subminiature tubular filament type lamp of great illuminating power. The particular tubular lamps chosen for use in this invention are about 0.125" in diameter and less than 2 inches in length, excluding pigtails. They are almost indestructible by crushing because of the relatively great thickness of the tubular wall. Wire pigtails 144 and 146 are soldered to opposite ends of the tube and are connected by ruggedized connections with opposite ends of the filament 148 (see FIG. 9).

As shown in FIGS. 8 and 9 the pigtails 144 and 146 of each bulb 80 are connected respectively by soldering to the conducting ribbons 130 and 132 of tape 128. Soldering may be effected by removing a small portion of the plastic body of tape 128 at requisite spots. A soldered connection between pigtails 144 and conductor ribbon 130 is shown at 150 in FIG. 9.

To avoid short circuits it is preferable that the reflective material 142 have a length only slightly exceeding the length of the tubular body of the bulb 80 and that it be carefully centered beneath the tube as shown in FIG. 8. Preferably the reflective material 142 is crinkled or otherwise textured in a regular pattern (squares or ribs for example) to enhance wide and even distribution of the light reflected by such material.

When soldering of a bulb 80 is completed a transparent shrink-plastic tube 152 of appropriate cross-sectional diameter is slipped over the assembly and is shrunk by heat or otherwise so as to contract circumferentially upon the assembly to hold it firmly and permanently in assembled condition. As shown in FIG. 8, the shrunk tube 152 is of such length as to extend well beyond the exposed portions of pigtails 144 and 146, thus to insulate them electrically from contact with external objects. The stiff fiber board rectangle 140 which is positioned beneath the tape 128 at each bulb position serves to hold the conductor tape 128 and reflector assembly flat in resistance to the considerable force exerted by the shrinking of the plastic tubes 152 in the final step of assembly as described above. It also serves as a protection against bending forces which might be placed upon the tubular bodies of the bulbs 80.

Preferably the opposite end portions 154 (see FIG. 8) of the shrink-plastic tube 152 are flattened and cramped during the heat or other shrinking step so as to form a very firm, slip and leak proof seal between such flattened portions 154 and the plastic body of the tape 128. The lighting unit 138 near the right-hand end of FIG. 8 shows these flattened ends 154 in plan. Preferably, as shown in the lighting unit 138 shown near the left-hand end of FIG. 8, the opposite ends of the fiberboard rectangle 140 extend only part-way into the flattened and cramped portions 154 so as to be firmly gripped to the shrunk tube 152 while, at the same time, permitting intimate sealing contact between the portions 154 and the plastic body of tape 128 in regions beyond the ends of the fiberboard rectangle 140.

It will be understood that one complete lighting harness such as the harness 76 shown in FIG. 8 will include a desired number of lighting units 138, spaced as may be desired along the length thereof. While the harness may be custom designed for a particular slide it is preferred, particularly when a large number of retrofitting installations are selected to select a uniform length of harness and a generally uniform spacing of lighting units 138 thereon, which is adequate for the longest slide which may be encountered. Purely by way of example, appropriate for the time at which this application is filed, each harness may be so constructed as to be about three hundred inches long.

A typical installation of the lighting system of the present invention is shown in FIGS. 1 and 2. For the purposes of installation the slide 10 preferably is deployed into fully inflated condition. The lighting harnesses 76 and 86 are now strung along the top surfaces of the longitudinal bolsters 16 and 18 or the fabric top 26 which may extend over such top surfaces. For slides 10 which are shorter than the maximum length for which the harnesses 76 and 86 are designed a suitable spacing is selected which will result in approximately even spacing of the units 138 along such top surfaces. Also, to provide lighting of the ground or other surface on which the deployed slide will rest in use, one or two lighting units 138 of each harness will be attached, as shown in FIG. 8, to the lower transverse bolster 22 in appropriate positions for that purpose.

Securing of the harnesses 76 and 86 in the desired positions is readily effected by the use of a high quality pressure sensitive adhesive tape. Thus, as shown in FIG. 1 lengths 156 of such tape having a width considerably greater than the width of the conductor tapes 128 are applied over each of those por-
tions of the tape conductor 128 which extend between ad-

djacent lighting units 138. In each case the ends of each length 156 of adhesive tape are brought up close to the lighting units to hold them securely while leaving them uncovered for radia-

tion of light. While a transparent adhesive tape may be used in

each case length thereof could be continued over all of the

ing lighting units it usually is preferred to use an opaque adhesive

tape of some high-visibility or fluorescent color in which event the

individual lengths 156 shown herein should be used. The adhe-

sive tape selected for use must have an adhesive layer which is

compatible with and will form a firm bond with the rubber or rubberlike coating or bodies of the fabrics normally

used for construction of the inflatable slides. By using adhe-

sive tape for securing of the lighting harnesses 76 and 86 to the

slide 10 there will be no danger of puncturing or otherwise

disturbing the gaslight structure of the slide 10.

Any excess length of tape conductor 128 which may extend

between lighting units 138 in a particular installation are

merely folded transversely to form one or more pleats or ac-

cordion folds which then are secured in flattened condition

beneath a length 156 of adhesive tape. At the lower end of

slide 10 the conductor tapes 128 of the harnesses 76 and 86

have been diagonally folded and transversely pleated so as to

turn through about 90° thus to facilitate the securing of one or

more lighting units 138 of each harness to the lower bolster 22

as described above.

At the upper end of the slide 10 as shown in FIG. 1 the

lighting harnesses extend circumferentially around and are

folded down upon the upper bolster 20. Turning now to FIG. 2 the

harnesses 76 and 86 and the connecting cords 134 for each

harness are secured on the under side of the slide struc-

ture by additional lengths 156 of adhesive tape. The joints

between the tape conductors 128 and cords 134 may be posi-

tioned wherever desired and are not specifically located in

FIG. 2. The connecting cords 134 are connected with the bat-

tery and switch pack 52 by the connecting devices 72, 74 and

82, 84 as described above.

The battery and switch pack 52 with the ball chain 118 of

lanyard 54 inserted in the bore 116 to maintain switch 70 open is

now secured, as by suitable adhesive tape, not shown, to the

gas bottle 40.

Under these circumstances the slide is deflated and the fold-

ing operation is initiated. As an incident to the folding opera-

tion the free end of the lanyard 54 is secured in an appropriate

position to a convenient surface of the slide, for example, it

may be secured to longitudinal bolster 18 by an adhesive

member 126 such as a piece of the adhesive tape used el-

sewhere or a patch or the like of adhesive material having

adequate holding power when applied to the selected surface

of the slide. As stated above the point of attachment of the

free end of the lanyard 54 is so selected that the lanyard will

be certain to be pulled out of the pack 52 to light the lighting

units as the slide is next deployed by inflation. Obviously the

sequence of attachment of the lanyard 54 may be reversed if

so desired in which event the ball chain 118 is not inserted into

the bore 116 and the free end of the lanyard 54 is first secured

by adhesive member 126 to the fully inflated slide. After defla-

tion and partial folding of the slide the ball chain 118 may then

be inserted into the bore 116 and the battery cells 68 may be

inserted into the pack 52. After testing the lighting system by

pulling the lanyard 54 out and reinserting the ball chain end

thereof the folding of the slide 10 may be completed and the

slide in the folded condition shown in FIG. 3 may be put into

service.

Maximum benefit from the lighting system incorporating

the preferred components described above or components of

equivalent or, when developed, of superior quality, and the

custom test provisions herein disclosed will be realized when

battery cells having long "shelf-life" are used. At the time of

filling this application there are available on the market

battery cells based on magnesium-carbon chemistry which have

a guaranteed shelf life of five years. These cells are of the

"self-passivating" type, that is, when the cells are not in use

(in storage or between periods of use) the active metallic mag-

nesium electrode becomes plated with another metal from

the electrolyte and internal chemical action is almost completely

stopped. Each time the external circuit is closed the passivat-

ing coating passes into the electrolyte and power is delivered

in normal fashion. Replacing follows each termination of use.

As will be apparent battery cells of this type are particu-

larly well-suit for use in the present invention wherein the

lighting system is to be tested at relatively frequent intervals

by placing the full operative load on the batteries for a brief

period sufficient to determine by reading the instrument 60

that the batteries and other components are in acceptable

operating condition. The five year shelflife of batteries of this

type makes it possible, in the absence of unexpected damage,

deterioration or failures of the various components which

would be detected by use of the testing instrument 60, to leave

the slides equipped with such systems in service in packed

and tightly folded condition for five year periods throughout the

service lives of the slides. Since it is customary in many in-

stances at the present time to test all slides by deployment and

repacking at five year intervals the installation of the preferred

lighting system of the present invention ordinarily will not

make deployment and repacking necessary at intervals more

frequent that those already established.

The system described above operates at a low voltage. For

example tubular bulbs of the type herein disclosed are availa-

ble for operation at 9 volts. Thus only six or seven battery cells

68a, 69b etc., depending on the design voltage of particular

type of cells, need be provided in the battery and switch pack

52 and the total weight of the entire system including tape

used to install it may be kept well below about 2 pounds.

The foregoing description of a preferred system embodying

the present invention has been presented in compliance with

requirements of the Patent Statutes. It will be apparent that

modifications and variations in many details may be made by

those skilled in the art within the purview of the invention. For

example the flat ribonkle wire 128 may be cemeted
directly to the body of the slide 10 thus avoiding the use of

pressure-sensitive tape which may be desirable and wires

in forms other than the flat ribbons shown herein may be used

where appropriate. Also, the harnesses 76 and 86 may be

custom made to fit a particular escape slide, inflatable stair-

way or the like if desired. The shape and location of the bat-

tery pack 52 and the mechanical relationship thereof with the

switch 70 as well as the specific design of the switch 70 may be

varied to meet specific desires or requirements as, for exam-

ple, when the folding pattern for a particular escape device

makes it preferable to locate a separate battery pack of suitable shape

other than in close proximity with the inflating devices pro-

vided in such escape device. Similarly, it is convenient in the

typical example chosen for illustration herein to attach the test

jack 56 to the pressure gauge 44 but in other configurations

of folded escape devices such a test jack may be attached el-

sewhere, the important requirement being only that it be so

located as to be readily accessible when the folded escape
device is in its normal position of storage in the aircraft or

other vehicle in which it is carried.

What is claimed is:

1. In an emergency lighting system for an escape slide for

use in vehicles such as aircraft wherein said escape slide is

made of flexible gaslight material, is prepared for positioning

within a vehicle by being placed in tightly folded deflated con-

dition, and is provided with inflating means to deploy said

slide into inflated condition for use; said emergency lighting

system comprising electrical components including a plurality

of light bulbs, wires secured to said slide and connected with

said bulbs, a battery pack, and a switch connected in series

with said battery pack and said wires, said switch being open

when said slide is in said folded condition; and said emergency

lighting system including means for closing said switch, when

said slide is deployed, to energize said light bulbs; and at least

some of said electrical components being enclosed in inac-

cessible position when said slide is in said tightly folded
deflated condition; wherein the improvement comprises: testing means for testing the operative condition of the electrical components of said emergency lighting system while said slide is in said tightly folded deflated condition, said testing means comprising a pair of electrical conductors connected across the terminals of said open switch and having portions accessible from the exterior of said slide when said slide is in said tightly folded deflated condition, a test instrument comprising a current-sensitive device giving predetermined displays of the absence of or the relative amounts of current flowing through said device, means for connecting said device across said accessible portions of said pair of electrical conductors thus to shunt said device across the terminals of said open switch, said test instrument having an effective electrical resistance which is sufficiently low that when said device is shunted across said open switch said light bulbs and said wires are connected with said battery pack through said device under conditions which approximate those conditions which would exist were said open switch to be closed, whereby the absence of current flow or the relative amount of current flow to said light bulbs displayed by said device when shunted across said open switch is a useful indication respectively of inoperativeness or of the relative state of operativeness of said electrical components of said emergency lighting system.

* * * *