Feb. 16, 1965 E. W. GRAY 3,169,305

CABLE HARNESS ASSEMBLY APPARATUS

Filed Sept. 25, 1963

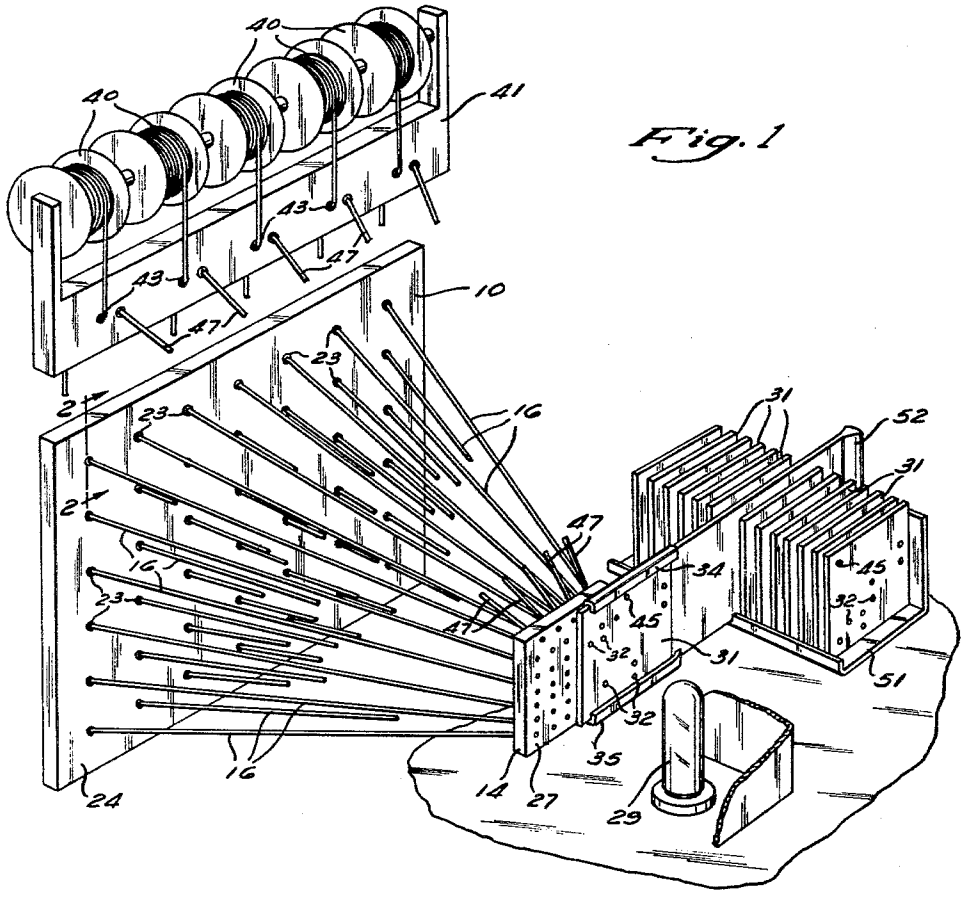


Fig. 1

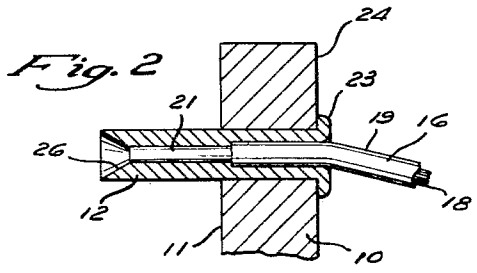


Fig. 2

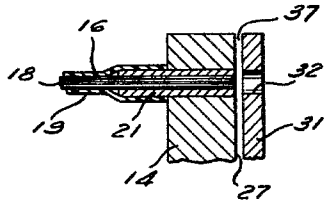


Fig. 3

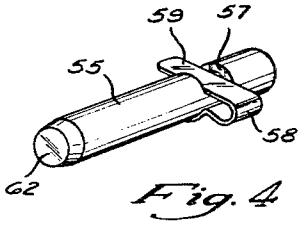


Fig. 4

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United States Patent Office 3,169,305 Patented Feb. 16, 1965

3,169,305
CABLE HARNESS ASSEMBLY APPARATUS

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Filed Sept. 25, 1963, Ser. No. 311,434
11 Claims. (Cl. 29—203)

This invention relates generally to the production of cable harnesses used in wired electrical systems and more particularly to apparatus used to guide and instruct the assemblers of such harnesses as to the manner in which the wires are to be arranged.

The principal object of this invention is to provide a novel cable harness assembly apparatus including a form board having wire supporting and positioning pins which are illuminable in a selective manner to display the various patterns according to which the wires are to be arranged.

Another object of this invention is to provide a novel cable harness assembly apparatus as set forth in the preceding object in which the pattern of lighted pins may be changed easily and rapidly so that the different patterns required for successive wires forming the harness may be assembled at a maximum rate of speed limited only by the ability of the operator to actually cut and position the wire in accordance with the pattern displayed.

Another object of this invention is to provide a novel cable harness assembly apparatus as set forth in the preceding objects which uses a single source of illumination for all of the lighted pins to insure that the pattern will always be correct and to avoid the possibility of displaying an incorrect pattern as could be possible if individual lights were used for each pin and one of them should become inoperative.

Another object of this invention is to provide a novel cable harness assembly apparatus as set forth in the preceding objects which uses a plurality of light conductors to conduct light from a single compact source to each of the pins to be illuminated on the form board.

Another object of this invention is to provide a novel cable harness assembly apparatus as set forth in the preceding objects in which the pattern of the illuminated pins is determined by the use of a relatively small mask placed between a single source of illumination and the input end of the light conductors to allow selective illumination of the light conductors.

Still another object of this invention is to provide a novel cable harness assembly apparatus in which a single mask provides all of the necessary information to the assembler for putting a wire in position in the harness by both illuminating the path of the wire is to follow and indicating the correct type or color code of wire to be used in a given position and to indicate the spool from which such wire is to be drawn.

Further objects and advantages of this invention relating to the simplicity of construction and relatively foolproof operation which provides the invention with a high degree of reliability to permit most efficient operation by the user at a minimum investment in the equipment. Such objects and advantages will readily become apparent to those skilled in the art upon a more complete understanding of the preferred embodiment of the invention as set forth in the following detailed description and shown in the drawings in which:

FIGURE 1 is a general schematic perspective view of a preferred embodiment of the apparatus according to this invention;

FIGURE 2 is an enlarged fragmentary sectional view taken on line 2—2 of FIGURE 1 showing details of the pin mounting on the form board;

FIGURE 3 is an enlarged fragmentary cross-sectional view showing details of the terminal board and mask; and

FIGURE 4 is a fragmentary perspective view of an alternative construction for the form board pin.

Referring now to the drawings in greater detail, the apparatus shown in FIGURE 1 includes a form board 10 which is preferably arranged to extend vertically and is mounted in a suitable framework to hold the board rigid during operations. The form board 10 may be made of any size necessary to accommodate the proper spacing and number of pins for the complete assembly of the harness. The form board 10 is provided with a plurality of pins 12 which project from the front face 11 of the board and are preferably arranged in hroizontal rows and vertical columns, although other arrays of pins may be used as required for specialized harnesses. Behind the form board 10 is the projecting apparatus for selectively illuminating the form board pins and which includes a terminal board 14 having holes therein corresponding to the pins on the form board. A plurality of light conductors 16 extend between the rear ends of the pins 12 in the form board and the openings in the terminal board 14 where they are secured so that the illumination falling on the end of the light conductor on the terminal board is transmitted through the light conductor to the pin 12.

These light conductors 16 are bundles of continuous glass filaments, each of the filaments being of a small enough diameter so as to be relatively flexible. The filaments are arranged to have square cut ends so as to admit the maximum amount of light into the interior of the fiber. These fibers have a central cylindrical core of glass having a relatively high index of refraction and are coated by a thin layer of glass having a lower index of refraction. Since light rays entering the square cut end of the fibers are refracted toward the axis of the fiber, they will strike the boundary between the core and the outer coating at a small angle of incidence and be totally reflected. Thus rays entering the fiber end at even a low angle of incidence will be reflected along the length of the fiber, and the only loss in intensity of the light is therefore from absorption. Since the high refraction glass used in the fiber cores has a relatively low absorption for light in the visible spectrum, the intensity of the entering rays drops to one half approximately every seven feet of fiber length. In addition to insuring total reflection of the rays within the inner core, the outer coating of low refraction glass also serves to protect the surface of the core and separates the individual fibers in the bundle from one another while allowing the necessary slippage to take place between the individual fibers when the entire bundle is flexed.

The fiber bundle 18 is covered with a protective layer 19 of an opaque abrasion resistant elastomeric material. At each end, the individual fibers are held together tightly by means of a metal ferrule 21 which extends flush with the end of the fiber bundle 18 and extends away from the end a distance under the cover 19, and indicated most clearly in FIGURE 3.

The mounting of the one end of the light conductor on the pin 12 on form board 10 is indicated most clearly in FIGURE 2. The pin 12 is provided with a flange 23 at the rear end which abuts against the rear face 24 of the form board. The pin extends through an opening in the form board within which the pin is suitably secured, such as by cementing, to project beyond the front face. These pins are arranged to be substantially rigid so that the individual wires being assembled together to form the cable harness may be wrapped around the pins to form loops to give the extra length for the wire necessary when it is to be connected to terminals on the devices of finished electrical apparatus for which the harness provides the wiring.

The pins 12 are tubular and have an axial bore which receives the end of the light conductor and the ferrule

which may be lightly pressed into place in the bore. The pins may be provided with a cup shaped recess 26 at the forward end extending back to the end of the metal ferrule 21 so that the fiber bundle 18 extends adjacent the inner end of recess 26. With this arrangement, the light being projected or radiated outward from the end of the fiber bundle will be reflected within the recess 26 which therefore serves as a reflector to diffuse the light so that it is more readily visible to the user of the apparatus. By using this reflecting recess 26, a relatively large area becomes illuminated and the rays have a greater degree of divergence than would be the case if the operator were to be required to merely view the light rays projected directly from the end of the fiber bundle. This is necessary because the bundle has such a small diameter that the light emerging from the end at the pin, even though it has high intensity, will be difficult to see because of the small size of the radiating area of the bundle end. Thus, the use of the reflector makes the illuminated pin much more readily visible than would be possible without the use of this reflector.

The terminal board 14 is arranged with a plurality of holes therein preferably arranged in the same array as the rows and columns of pins in the form board 10. Of course, the light conductors 16 need not be arranged in this manner, but having the same positional correspondence between the positions of the light conductors at both the form board and the terminal board aids in preparing the necessary masks for the selective illumination of the pins. As shown in FIGURE 3, the light conductors may be easily positioned in the terminal board 14 by merely pressing or cementing the metal ferrules 21 in the holes in the terminal board with the end of the ferrule and the fiber bundle flush with the rear face 27 of the terminal board 14.

In order to allow selective illumination of the light conductors 16, the terminal board 14 is mounted on a projector arrangement which allows the rear face 27 to be brightly illuminated by means of a suitable light source such as lamp 29. It will be understood that lamp 29 is arranged in the usual manner and provided with reflectors and/or lenses as required to insure a relatively high intensity of illumination of the rear face 27 of terminal board 14. To selectively illuminate the individual light conductors 16, masks 31 are provided to be placed across the rear face 27 of terminal board 14. These masks are provided with apertures or holes 32 which allow the light from the lamp 29 to pass through the apertures and enter the light conductors 16 immediately therebehind. These masks 31 may be arranged to be mounted in a suitable manner not unlike that used for photographic slides by being held within upper and lower channels 34 and 35. Thus, when a mask 31 is placed in the desired position adjacent the image plate 14, only those light conductors which correspond to the apertures 32 in the mask will be illuminated and thereby produce a pattern of illuminated pins on the form board corresponding to the pattern of apertures on the mask 31.

It should be noted that the masks 31 may be made of any suitable opaque material such as cardboard or thin aluminum plate which may be easily perforated to create the mask and are preferably made light absorbent so as to prevent any stray reflections which might cause illumination of those light conductors which are to be rendered opaque by covering with the mask. To prevent this and to allow maximum illumination of each light conductor, it is desired that the gap indicated at 37 in FIGURE 3 between the rear face 27 of the terminal board and the mask 31 be made as small as possible. Likewise, the apertures 32 in the mask are made to have a diameter slightly greater than that of the fiber bundle 18, since these fiber bundles will admit light lying within a cone formed around the axis of the metal ferrule. Thus, a certain amount of enlargement of the aperture 32 will increase the intensity of the light transmitted through the light conductors 16 since it will increase the apex angle of the cone of incident light on the end of the fiber bundle.

The complete cable harness assembly is generally formed of a number of wires, ranging from 10 to 20 up to possibly several hundred, and these wires are often made of different gauges depending upon the amount of current they carry. In addition, it is customary to provide the wires with different color coding in the well known manner by marking the insulation so that the paths of the wires may be traced throughout the cable harness to check for correct assembly. Thus, assembly of the harness requires the selection of one of a large number of different wires, and accordingly it is customary to provide a plurality of supply spools 40 which may be mounted on a suitable rack 41 above the form board 10. The wire is arranged to be drawn off of supply spool 40 and pass through a suitable opening 43 in the rack which may be provided with a cutter bar for severing the wire after the proper length has been withdrawn. In order to insure that the operator will select the wire to be placed along the path indicated by the lighted pins on the form board from the proper spool, the masks 31 may be provided with an additional row of apertures 45 of which only one is open to illuminate a single one of another set of light conductors 47 which extend from the terminal board 14 to the rack 41 so as to provide a point of illumination adjacent the wire at each supply spool. Thus, not only does each of the masks 31 cause selective illumination of the pins on the form board so as to indicate pattern the wire is to follow, but it also may be used to indicate the supply from which the wire is to be drawn and thereby eliminate any need on the part of the operator to consult separate running lists for additional information required in assembling the harness on the form board.

Since the finished harness will consist of a plurality of individual wires, there will generally be a separate mask for each of the individual wires in the harness. These masks may be collected together for selective and successive insertion behind the terminal board by a suitable apparatus such as that used for changing slides in photographic projectors. Thus, a plurality of the masks may be mounted on a tray 51 and individually inserted behind the terminal board by an operating bar 52. This structure has been shown only generally, since it is recognized that there are a large number of mechanisms available for changing the masks in their position behind the terminal board. Thus, while the individual masks may be arranged in a linear tray such as shown in FIGURE 1, they may also be arranged in a circular tray and individually placed behind the image plate and replaced in their original position in the circular tray so that after the complete set of masks has been run through and a complete harness assembled, continued rotation of the tray will bring the first mask back into position for a repetition of the assembly cycle for the next harness. It is desirable that the mask changing mechanism be arranged so that it will operate accurately and quickly in response to a signal from the operator, such as by pushing a change button, so as to quickly remove the current mask and replace it with the next successive mask so that a minimum of time is lost and the operator has a maximum amount of time to spend in the process of actually assembling the wires on the form board.

If it is desired to use the apparatus of the image plate and light conductors as shown in FIGURE 1 with different form boards, such as form boards having an even larger number of pins or having pins spaced at different distances as would be required for the assembly of harnesses for greater length, it may be possible to use the appartus with a fewer number of light conductors than there are pins on the form board for certain arrangements of harnesses. In such cases, it may be desirable to arrange the light conductors so that they may be easily

removable from their position on the form board pins for selective attachment to different pins so that a minimum number of light conductors may be employed for illuminating larger size form boards.

In such case, it may be desirable to have the ends of the light conductors mounted in the pins on the form board in a easily releasable manner, rather than securing them in place as described hereinabove. To do this, the pins in the form board 10 may take the form of the pin 55 shown in FIGURE 4. This pin is provided with a bore therethrough within which the light conductor is positioned. However, the metal ferrule 21 of the light conductor is an easily removable slip fit within the pin 55. To secure the ferrule into position, pin 55 has a notch 57 on the shank portion thereof which extends beyond the rear face of the form board. A spring clip 58 may be arranged to have a flat blade portion 59 which fits within the notch 57 so as to clamp the ferrule of the light conductor in place.

In the case of extremely large form boards it is likely that the operator will be viewing the pins from a relatively large angle of the axis of the pins. To insure that the operator will be easily able to recognize which pins are illuminated, it may be desirable to mount a light diffusing button 62 in the recess on the end of the pin. This button 62 may be made of glass or plastic and be either frosted or faceted so that it diffuses enough light sideways from the pin so as to be observable at high angle from the pin axis.

It may also be desirable that for certain arrangements the pins be illuminated in particular colors so that several patterns may be displayed on the form board at the same time. This can be easily accomplished by merely placing a small color mask or filter over the particular aperature on the mask 31. Thus, if two patterns were to be displayed at the same time, the mask would have apertures corresponding to the pins of both patterns and the two patterns would be differentiated by covering each of the sets of apertures of the patterns by a different colored light filter so as to insure that only light of that color would enter the light conductor and therefore be displayed at the selected pins. Thus, to provide different colors of display, it is not necessary that the color of the light source be changed but merely the color of the light striking the individual light conductor connected to that particular pin.

Another variation that may be employed to increase the visibility of the lighted pins is to have them blink or flash on and off. This may be done easily with the present apparatus by either turning the light source on and off or by placing a shutter between the light source and the mask.

In using the apparatus of the present invention to assemble a cable harness, the operator will take a set of masks corresponding to the individual wires in that harness and place them in the mask changing mechanism so that they may be successively placed behind the terminal board 14 to provide the successive displays of lighted pins necessary for assembling the harness. The supply spools 40 are then arranged to have the proper color coded wires to be used in that harness. After this has been done, the operator places the first mask in position behind the image plate so as to display the proper pattern of lighted pins on the form board corresponding to the first wire. When this is done, one of the lights will be illuminated along the rack 41 to indicate the proper supply spool from which that wire is to be drawn so that it will have the proper color code. The wire is then pulled from the spool and placed around the pattern of pins and cut to the desired length. After this has been done the operator merely removes the first mask and substitutes the second mask, preferably by use of an automatic mask changing mechanism, and then takes the next wire from the appropriately indicated spool and lays it out along the pattern shown so that the second wire is in position. The operator then proceeds in like manner until the entire sequence has been completed, after which the completed wiring harness may be bound together and removed from the form board and the sequence of masks repeated for the assembly of another harness.

Although the invention has been described in particular detail in connection with the preferred embodiment of the invention, it is recognized that various modifications and rearrangements of the apparatus will become obvious to persons skilled in the art upon a complete understanding of the invention, and such modification and rearrangements may be resorted to without departing from the scope of the invention as defined in the claims.

What is claimed is:

1. Apparatus for use in assembling an electrical wiring harness comprising a form board having front and rear faces, a plurality of hollow tubular pins extending from the front face of said form board, said pins being arranged in an array whereby a selective pattern designates the pattern for assembling an individual wire of the harness on said form board, a plurality of elongated flexible light conductors, a light source, each of said conductors having one end extending adjacent said light source, mask means to selectively control the admission of light to selected ones of said conductors, each of said conductors extending toward the rear face of said form board and having its other end positioned at a pin on said form board whereby the pattern of light admitted to said conductors is displayed on the pins on said form board.

2. Apparatus for use in assembling an electrical wiring harness comprising a form board having front and rear faces, a plurality of hollow tubular pins mounted on said form board and extending from the front face thereof, said pins being arranged in an array whereby a selective pattern of pins designates a pattern for assembling an individual wire of the harness on said form board, a plurality of elongated flexible light conductors, a light source, each of said conductors having one end extending adjacent said light source, means to selectively control the admission of light to selected ones of said conductors, each of said conductors extending toward the rear face of said form board and having its other end inserted within a hollow pin whereby the pattern of light admitted to said conductors is displayed on the pins on said form board.

3. Apparatus for use in assembling an electrical wiring harness comprising a form board having front and rear faces, a plurality of hollow tubular pins mounted on said form board and projecting from the front face thereof, said pins being arranged in an array whereby a selective pattern of pins designates a pattern for assembling an individual wire of the harness on said form board, a conical light diffusing recess in the front end of each of said pins, a plurality of the elongated flexible light conductors, a light source, each of said light conductors having one end extending adjacent said light source, means to selectively control the admission of light to selected ones of said conductors, each of said conductors extending toward the rear face of said form board and having its other end inserted within a hollow pin thereon whereby the pattern of light admitted to said conductors is displayed in said light diffusing recess on said pins.

4. Apparatus for use in assembling an electrical wiring harness comprising a form board having front and rear faces, a plurality of hollow tubular pins mounted on said form board and projecting from the front face thereof, said pins being arranged in an array whereby a selective pattern of pins designates a pattern for assembling an individual wire of the harness on said form board, a light diffusing member mounted on the front end of each of said pins, a plurality of the elongated flexible light conductors, a light source, each of said light conductors having one end extending adjacent said light source, means to selectively control the admission of light to selected ones of said conductors, each of said conductors extending

toward the rear face of said form board and having its other end inserted within a hollow pin thereon whereby the pattern of light admitted to said conductors is displayed from said light diffusing members on said pins.

5. Apparatus for use in assembling an electrical wiring harness comprising a form board having front and rear faces, a plurality of hollow tubular pins mounted on said form board and projecting from the front face thereof, said pins being arranged in an array whereby a selective pattern of pins designates a pattern for assembling an individual wire of the harness on the said form board, a plurality of elongated flexible light conductors, a light source, each of said conductors having one end extending adjacent said light source, means to selectively control the admission of light to selected ones of said conductors, each of said conductors having its other end inserted within a hollow pin on said form board whereby a pattern of light admitted to said conductors is displayed on said form board, and clamp means for detachably securing said other ends of said light conductors in said pins.

6. Apparatus for use in assembling an electrical wiring harness comprising a form board having front and rear faces, a plurality of hollow tubular pins mounted on said form board and projecting from the front face thereof, said pins being arranged in an array whereby a selective pattern of pins designates a pattern for assembling an individual wire of the harness on the said form board, a plurality of elongated flexible light conductors, a light source, each of said conductors having one end extending adjacent said light source, means to selectively control the admission of light to selected ones of said conductor, each of said conductors having its other end inserted within a hollow pin on said form board whereby a pattern of light admitted to said conductors is displayed on said form board, a transverse slot in each of said pins adjacent said light conductor, and spring clamp means in said slot detachably securing said other ends of said light conductors in said pins.

7. Apparatus for use in assembling an electrical wiring harness comprising a form board having front and rear faces, a plurality of pins mounted on said form board and projecting from the front face thereof, said pins being arranged in an array whereby a selective pattern of pins designates a pattern for assembling an individual wire of the harness on said form board, a plurality of elongated flexible light conductors, a light source, a terminal board positioned adjacent said light source, each of said conductors having one end secured to said terminal board to receive light from said light source, each of said conductors extending from said terminal board toward the rear face of said form board and having its other end positioned adjacent a pin on said form board, and a perforated mask interposable between said light source and said terminal board, whereby the pattern of perforations on said mask selectively admits a pattern of light to said light conductors to display said pattern by illumination emitted from said other ends of said light conductors on said form board.

8. Apparatus for use in assembling an electrical wiring harness comprising a form board having front and rear faces, a plurality of hollow tubular pins mounted on said form board and projecting from the front face thereof, said pins being arranged in an array whereby a selective pattern of pins designates a pattern for assembling an individual wire of the harness on said form board, a plurality of elongated flexible light conductors, a light source, a terminal board positioned adjacent said light source, each of said conductors having one end secured to said terminal board to receive light from said light source, each of said conductors extending from said terminal board toward the rear face of said form board and having its other end inserted within a hollow pin on said form board, and a perforated mask interposable between said light source and said terminal board, whereby the pattern of perforations on said mask selectively admits a pattern of light to said light conductors to display said pattern by illumination emitted from the ends of the pins on said form board.

9. Apparatus for use in assembling an electrical wiring harness comprising a form board having front and rear faces, a plurality of pins mounted on said form board and projecting from the front face thereof, said pins being arranged in an array whereby a selective pattern of pins designates a pattern for assembling an individual wire of the harness on said form board, a plurality of elongated flexible light conductors, a light source, a terminal board positioned adjacent said light source, each of said conductors having one end secured to said terminal board to receive light from said light source, each of said conductors extending from said terminal board toward the rear face of said form board and having its other end positioned adjacent a pin on said form board, a perforated mask interposable between said light source and said terminal board, whereby the pattern of perforations on said mask selectively admits a pattern of light to said light conductors to display said pattern by illumination emitted from said other ends of said light conductors on said form board, and selector means to successively position different masks between said light source and said terminal board.

10. Apparatus for use in assembling an electrical wiring harness comprising a form board having front and rear faces, a plurality of pins mounted on said form board and projecting from the front face thereof, said pins being arranged in an array whereby a selective pattern of pins designates a pattern for assembling an individual wire of the harness on said form board, a plurality of elongated flexible light conductors, a light source, a terminal board positioned adjacent said light source, each of said conductors having one end secured to said terminal board to receive light from said light source, each of said conductors extending from said terminal board toward the rear face of said form board and having its other end positioned adjacent a pin on said form board, a mask interposable between said light source and said terminal board, a pattern of perforations on said mask, and colored light filter means in said perforations whereby the pattern of perforations on said mask selectively admits a pattern of colored light, said light conductors to display said pattern in color by illumination emitted from said other ends of said light conductors on said form board.

11. Apparatus for use in assembling an electrical wiring harness comprising a form board having front and rear faces, a plurality of pins extending from the front face of said form board, said pins being arranged in an array whereby a selective pattern of pins designates a pattern for assembling an individual wire of harness on said form board, a plurality of elongated light conductors, a light source, each of said conductors having one end extending adjacent said light source, means to selectively control the admission of light to said conductors, each of said conductors having its other end extending to the rear face of said form board to project light from said conductor away from said front face of said form board at a pin thereon whereby the pattern of light admitted to said conductors is displayed on said form board by a pattern of individual lights corresponding to a selected pattern of pins.

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