

Sept. 20, 1966

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3,274,441

SEQUENTIAL ELECTRICAL LIGHTING ARRANGEMENT

Filed Oct. 9, 1961

3 Sheets-Sheet 1

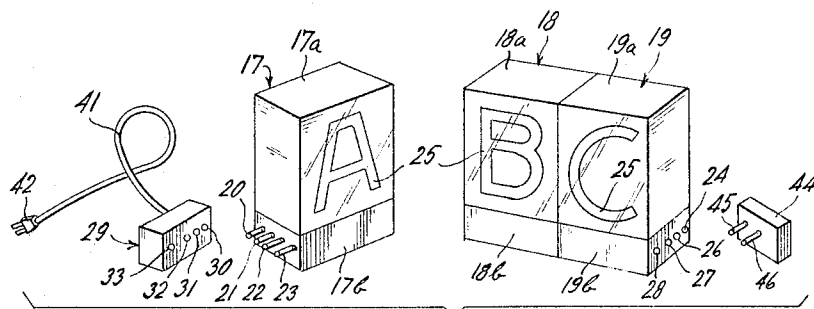


FIG. 1.

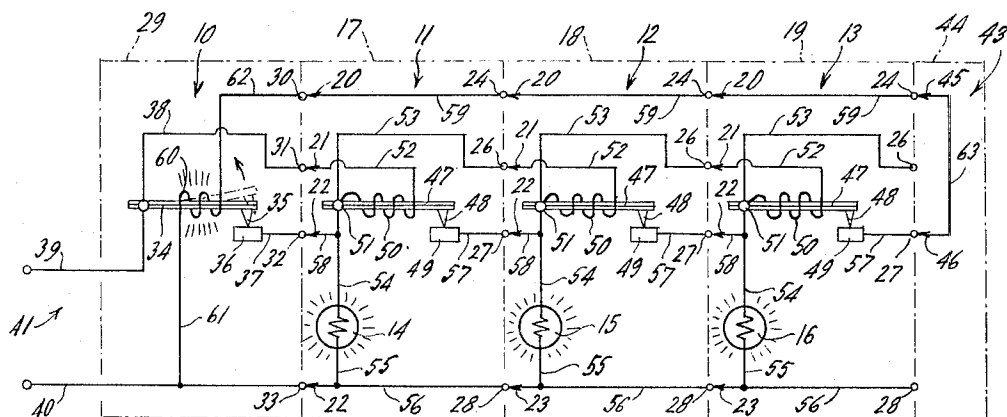


FIG. 2.

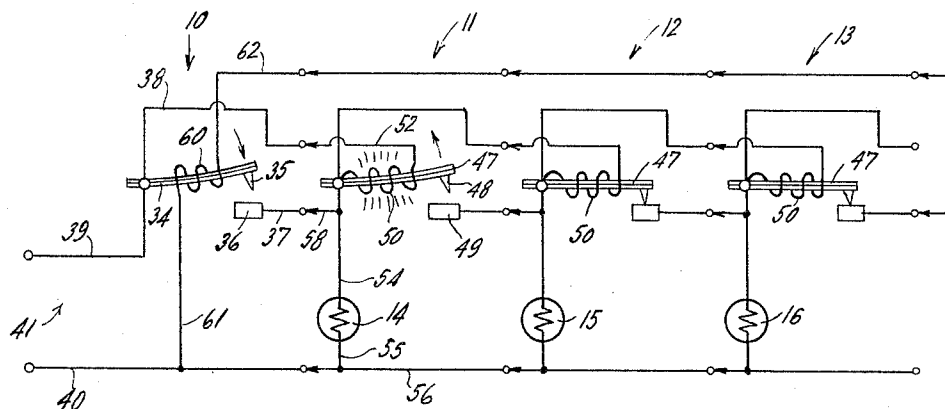


FIG. 3.

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3 Sheets-Sheet 2

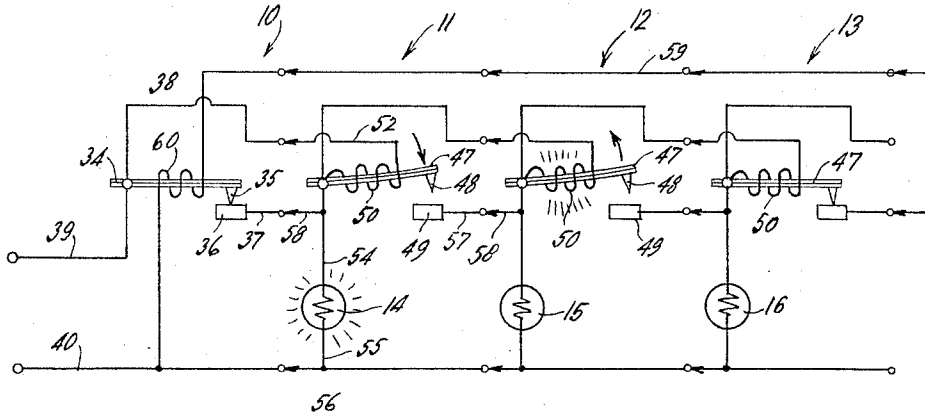


FIG. 4.

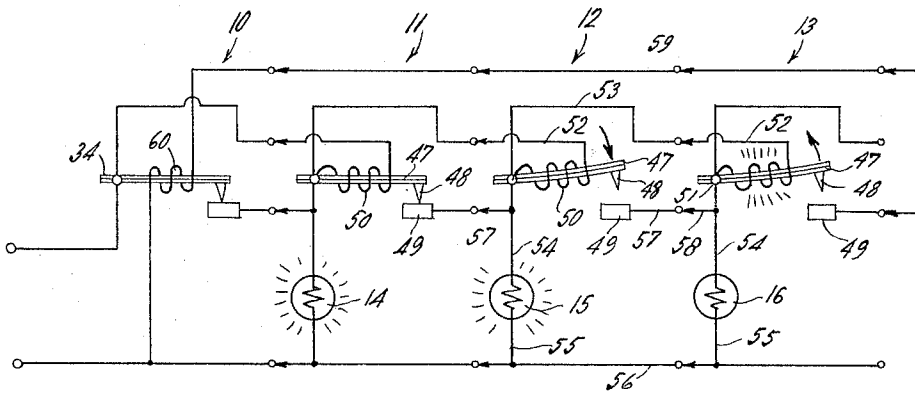


FIG. 5.

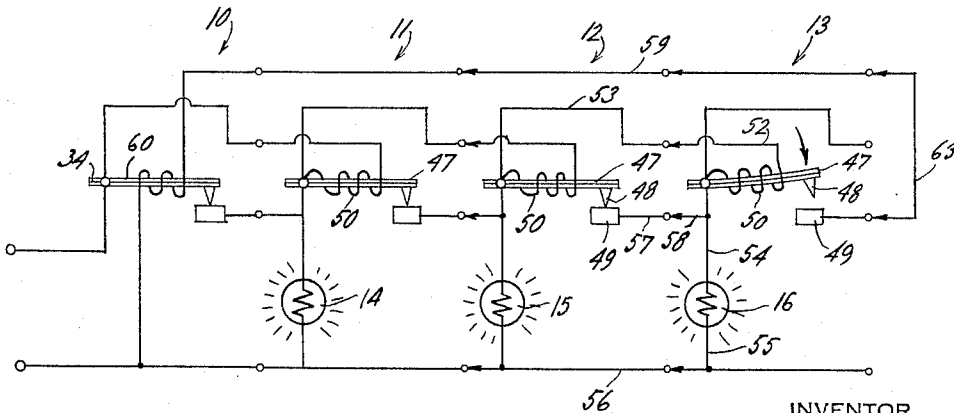


FIG. 6.

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3 Sheets-Sheet 3

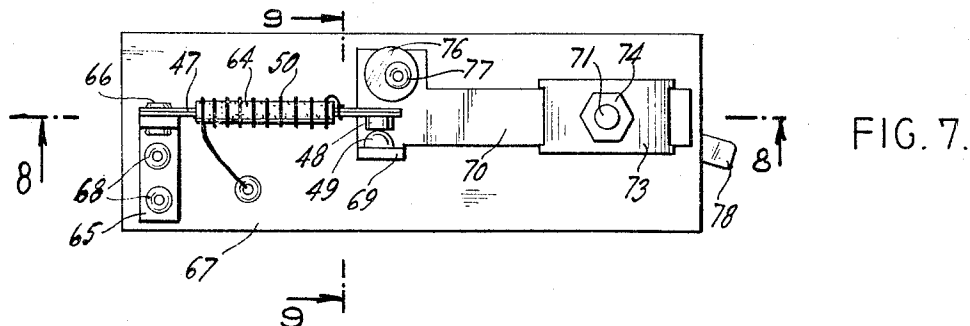


FIG. 7.

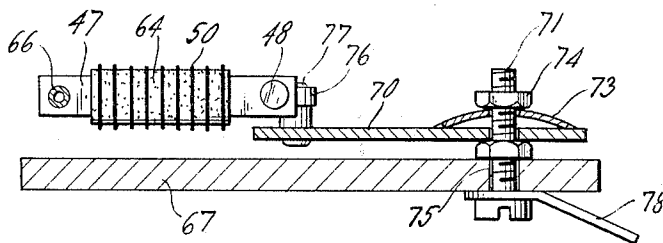


FIG. 8.

FIG. 10.

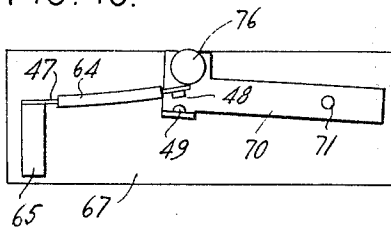


FIG. 11.

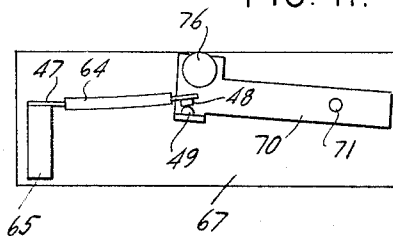


FIG. 12.

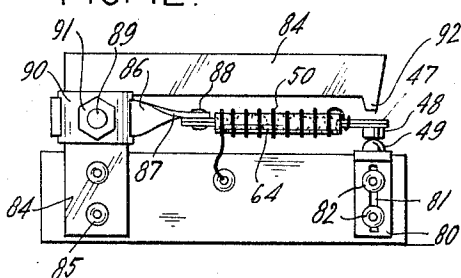
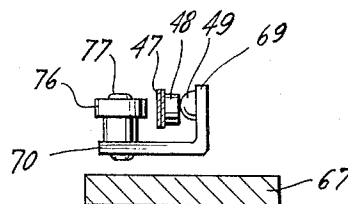


FIG. 9.

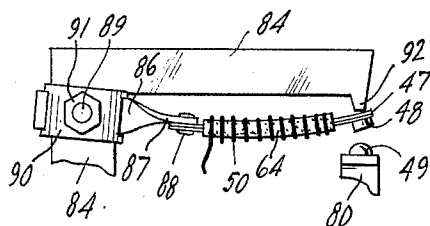


FIG. 13.

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SEQUENTIAL ELECTRICAL LIGHTING ARRANGEMENT

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6 Claims. (Cl. 315—323)

The present invention relates to improvements in sequential lighting arrangements and more particularly to a novel and improved circuit, incorporating improved bimetallic switches, for illuminating a series of electrical lamps in a selected order and in sequence.

For advertising displays, visual training aids, and the like, it is often desirable to illuminate a series of letters or words, or to illuminate portions of a display panel in a sequential pattern forming a cycle, than to extinguish the lamps and begin a new cycle. To perform such an operation automatically, it is customary to use an electric motor operating a series of switches through a step-down gearing and cam arrangement, which is expensive to manufacture and maintain. It is known to use bimetallic switches for the alternate energization and de-energization of a single light bulb or the simultaneous operation of a group of bulbs, as, for example, in the conventional Christmas tree flashers. Bimetallic switches have not hitherto been employed in a common circuit to operate a series of independent lamps, however, because the bimetals of such switches have been subject to unpredictable operation due to their inherent differences in performance. Further, in conventional bimetallic switches, the heater element for the bimetal is controlled by the bimetal itself, so that bimetallic switches cannot be made mutually interdependent.

It is an object of the present invention to provide a sequential lighting arrangement for a series of electrical lamps in which the automatic operation is performed wholly by a corresponding series of interconnected bimetallic switches, so that the assembly is extremely economical in manufacture.

In accordance with the invention, the lighting arrangement incorporates an electrical circuit in which a plurality of bimetallic switches are arranged in series. The bimetallic element of each switch has a heater coil which is connected across the switch contacts of the preceding switch in the series in such a manner that when one bimetallic switch opens, it energizes the heater of the next switch to cause said next switch to open. Each bimetallic switch (with the exception of a single switch) is associated with an electric lamp and energizes the lamp when the switch, and all the preceding switches, are closed. The lamps are wired in parallel between a bus line formed by the series of switches, and a second uninterrupted bus line.

Under the aforementioned arrangement, when the circuit is energized, the lamps are all initially illuminated, then are all automatically extinguished. The lamps are then automatically illuminated, one at a time in a sequential succession until all are illuminated, at which time the cycle is repeated.

The invention also includes the provision of a novel bimetallic switch in which one of the switch contacts is frictionally mounted for limited movement. A stop is provided for limiting the opening movement of the bimetal, and this stop resets the operating position of the frictionally-mounted contact so that the switch is self-adjusting for consistent operation under all conditions. When the bimetal of the switch is heated and the switch contacts are thus separated, the gap between the contacts is a pre-set, constant distance regardless of how much the bimetal has flexed under varying durations of heat application. This structure also provides means for the se-

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lective setting of the operating time of each switch, so that the arrangement may be adjusted to illuminate the lamps at uniform intervals in rapid succession, or at a selected slower rate, regardless of the wattage of the lamps employed.

Another object of the invention is the provision of a sequential lighting arrangement of the character described in which the circuit can be so divided that the bimetallic switches and their lamps may be enclosed in individual housings which are adapted to be plugged together to form the completed arrangement. Any selected number of housings may be interconnected to form a selected lighting arrangement with the housings carrying their own light bulbs and indicia to be illuminated, and being interchangeable. Thus, the arrangement can be quickly and easily assembled by an unskilled person to provide any selected sequence of lighting. In addition, since each housing unit is identical, any number of units may be connected to energize a corresponding number of lamps in the sequence in which the units are connected.

Additional objects and advantages of the invention will become apparent during the course of the following specification when taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of the housings incorporating the bimetallic switches and bulbs which constitute the lighting arrangement of the present invention; some of the housings being disconnected to reveal their means of attachment;

FIG. 2 is a schematic diagram of the electrical circuit of the invention, showing the switches in their starting positions;

FIGS. 3 through 6 are electrical circuit diagrams similar to FIG. 2, but showing the arrangement in progressive steps of operation;

FIG. 7 is an enlarged top plan view of a preferred form of one of the bimetallic switches employed in the circuit;

FIG. 8 is a sectional view taken along line 8—8 of FIG. 7;

FIG. 9 is a section taken along line 9—9 of FIG. 7;

FIG. 10 is a diagrammatic plan view of the switch shown in FIG. 7, illustrating the switch in open condition;

FIG. 11 is a diagrammatic plan view similar to FIG. 10, but showing the switch in a reset, closed position after it has cooled from the open position of FIG. 10;

FIG. 12 is a top plan view of a modified form of switch which may be employed in the arrangement, the switch being shown in closed condition; and

FIG. 13 is a top plan view of the switch shown in FIG. 12, but illustrating the switch in open and reset position.

Referring in detail to the drawings, it may be seen in FIG. 2 that the illuminating device of the invention includes a plurality of interconnected, self-actuating switch units 10, 11, 12 and 13 which operate in succession to illuminate a plurality of electric lamps 14, 15 and 16. The switch units are so arranged that the lamp 14 is first illuminated, then lamp 15 and finally lamp 16. After the three lamps are illuminated, the entire group of lamps are extinguished simultaneously, and the illuminating operation is repeated. For convenience, only three lamps and their corresponding switch units are described herein, it being understood, however, that any desired number of additional lamps and switch units may be employed, as will be presently explained.

In the schematic diagram of FIG. 2, it will be observed that the switch units 11, 12 and 13 and their associated lamps are enclosed by respective boxes 17, 18 and 19 drawn in broken line. These boxes each represent an individual housing for the switch unit and lamp, which

housings are adapted to be removably connected to provide the illuminating assembly.

FIG. 1 illustrates the individual housings 17, 18 and 19, which housings comprise upper lamp-receiving portions 17a, 18a, 19a and lower base portions 17b, 18b and 19b. Each lamp-receiving portion 17a, 18a, or 19a houses a respective bulb 14, 15, and 16 and may be formed with a letter of the alphabet or other type of indicia 25 which is made transparent or translucent. Thus when the contained lamp is energized, the letter becomes illuminated. Alternatively, the walls of each lamp-receiving portion 17a, 18a and 19a may be made translucent and the letter 25 opaque, to produce the same effect. It will, of course, be appreciated that instead of incorporating a lamp bulb, each housing may be provided with an electrical socket for the connection of a lamp at a remote point.

The housing base portions 17b, 18b and 19b are sized to receive the respective switch units 11, 12 and 13 as well as the circuit wiring. Each base portion also has four contact pins 20, 21, 22 and 23 projecting from one side thereof, and four corresponding sockets, 24, 26, 27 and 28 at the other side thereof. The contact pins and sockets are connected to the wires of the circuit branches and the contact pins of one housing fit within the sockets of the adjacent housing to physically couple the housings 17, 18 and 19, as well as to connect the electrical circuit of the assembly.

The switch unit 10 of the assembly is somewhat different from the other units 11, 12 and 13, in that it has no lamp or lamp housing and serves as a starter unit. This starter unit 10 may thus have a smaller housing 29, having four sockets 30, 31, 32 and 33, which receive the contact pins 20, 21, 22 and 23 of the first housing 17 and thereby connects the starter switch unit 10 within the circuit of the assembly. The starter unit 10 also has a projecting line cord 41 terminating in a plug 42 for connecting the electrical circuit to a source of live current.

The assembly also includes a bridging unit 43 which consists of a hollow insulated block 44 having a pair of projecting contact pins 45 and 46. These pins fit within two of the sockets 24 and 27 of the last housing 19, and the pins are internally connected within the block 44 by a wire 63 so as to electrically connect the leads attached to the sockets 24 and 27 of housing 19. The housing 44 of bridging unit 43 also covers over the exposed sockets 26 and 28 of housing 19.

Referring now to FIG. 2, it will be observed that each switch unit 11, 12 and 13 and its associated parts in each housing 17, 18 and 19 is identical and interchangeable. A description of the switch unit 11 in housing 17 will therefore serve for all of the switch units except the starter switch unit 10.

Switch unit 11 comprises a bimetallic element or strip 47 carrying at one end a contact 48 which engages and makes contact with a stationary contact 49. The bimetallic strip 47 may be of the conventional brass-steel type, and is so arranged that under heat it will bend in a direction to separate the contacts 48 and 49. The switch formed by the bimetal is therefore normally closed in the sense that the contact 48 is in engagement with the fixed contact 49 when the bimetal is cool, and when the bimetal is heated, the contact 48 is moved away from the fixed contact 49 to open the switch.

The bimetal 47 has a heating element 50 in the form of a coil of resistance wire wrapped around its body and insulated therefrom. One end of the heating coil is connected at 51 to the body of the bimetal 47 while the other end is connected to the contact pin 21 by lead 52. The bimetal body is also connected by lead 53 to the socket 26 and is connected by lead 54 to one end of the filament of bulb 14. The other end of the bulb filament is connected by lead 55 to a wire 56 which is connected at one end to pin 23 and at the other end to socket 28. The fixed contact 49 is connected by lead 57 to

the socket 27. A further lead 58 is connected at one end to the lead 54 and at the other end to contact pin 22, thereby connecting the body of bimetal 47 to said contact pin 22. The wiring of the housing is completed by a wire 59 extending between the contact pin 20 and socket 24 and electrically connecting the latter.

The starter unit 10 also includes a bimetallic element 34, identical to the bimetal 47 just described, and carrying a contact 35. This contact 35 normally engages a contact 36 connected by lead 37 to the socket 32. The body of bimetal 34 is connected by lead 38 to socket 31 and is also connected to one of the leads 39 of the line cord 41. The other lead 40 of the line cord 41 is connected to the socket 33. The bimetal 34 is associated with a heater element 60, one end of which is connected by lead 61 to the line cord 40 and the other end of which is connected by lead 62 to the socket 30.

When the housings 17, 18 and 19 are interconnected and the starter unit 29 and bridging unit 43 are connected at the ends of the interconnected group of housings to complete the assembly, in the manner shown in FIG. 2, it will be observed that a close circuit is formed through the switch units and electric lamps. In general, it will be seen that a first bus line is formed which consists of all the bimetals 47 and the bimetal 34 connected in series with the one terminal of the power source. Since the starter switch 10 and the other switches are all initially closed, the first bus line can be traced by the line cord lead 39, the body of bimetal 34 of the starter unit 29, thence through the closed contacts 35 and 36, lead 37, socket 32 and pin 22, leads 58 and 54 to the body of bimetal 47 of the first switch unit 11. The bus line then continues through the closed switch contacts 48, 49, lead 57, socket 27 and pin 22, leads 58 and 54 to the bimetal 47 of the second switch unit 12, and so on through the bimetal of the last switch unit 13, and to the socket 27 of the last housing 19. It will be noted that the bridging unit 43 connects the sockets 24 and 27 of the last housing 19 through the lead 63 which connects the pins 45 and 46 of the bridging unit.

A second bus line is formed by the line cord lead 40 of the starter unit 10 and the connected leads 56 of the switch units 11, 12 and 13. The lamps 14, 15 and 16 are wired in parallel between the first and second bus lines. The energizing current for selective lamps can be interrupted by the opening of the next preceding bimetallic switch, as will be presently explained.

In their cold condition, all of the bimetallic switch units 10, 11, 12 and 13 are closed, that is to say, the bimetal contacts 35, 48 are pressed against the fixed contacts 61, 68. When the circuit is energized by connecting the line cord 41 to a power source, for example, the usual 110 volt line current, electrical circuit is completed through the two aforementioned bus lines. All of the lamps 14, 15 and 16 are therefore energized and illuminated, as shown in FIG. 1. In addition, the end of the first bus line is connected through pin and socket 27, 46, bridging unit lead 63, and pin and socket 24, 45 to the interconnected return leads 59 of the switch units 11, 12, 13 and thence through pin and socket 20, 30, and lead 62 through the heater coil 60 and its lead 61 to the second bus line. Thus, while all the lamps are illuminated, the heater coil 60 of the starter unit 10 is also energized.

When the heater coil 60 heats the bimetallic element 34 to a sufficient temperature, it causes the bimetal 34 to flex upwardly so that its contact 35 moves out of engagement with the fixed contact 36 of starter element 10, as shown in broken line in FIG. 2. This interrupts the first bus line at its source, and extinguishes all of the lamps 14, 15 and 16. This also de-energizes the heater coil 60, so that the latter begins to cool, and the bimetal 34 begins to flex downwardly to return to its closed position.

As soon as the switch formed by bimetal 34 is opened,

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however, an energizing current passes through the heater coil 50 in the first switch unit 11. It will be observed in FIG. 2 that a circuit is now formed from line cord lead 39 through the body of bimetal 34, lead 38, pin and socket 21, 31, and lead 52, through heater element 50 and thence through bimetal connection 51, lead 54, lamp 14, leads 55 and 56, and the pin and socket 23, 33 to the line cord lead 40. The resistance of the heater wire of coil 50 is considerably higher than that of lamp 14 so that a greater voltage drop occurs across the heater coil 50 than across the lamp 14. The coil 50 therefore heats, but the lamp 14 remains unilluminated.

In this condition, the bimetal 47 is being heated while the bimetal 34 is cooling. The bimetal 47 therefore flexes upwardly lifting its contact 48 from the corresponding fixed contact 49 and thus opening the switch of the first switch unit 10. This is shown in FIG. 3. Subsequently, the starter bimetal 34 will return to its original position, bringing contact 35 back into engagement with the fixed contact 36 and reclosing the starter unit switch as shown in FIG. 4. This produces three simultaneous results: it illuminates lamp 14, it de-energizes the heater coil 50 of the switch unit 11, and it energizes the heater coil 50 of the next switch unit 12. The starter contacts 35, 36 close and a direct circuit is closed through bulb 14, such circuit being traced from line cord lead 39, through the body of bimetal 34 and its closed contacts 35, 36, through lamp 14 by way of leads 37, 54, and 55 to the line cord lead 40. This circuit shorts out the heater coil 50 of the first switch unit 11, and the latter is de-energized.

A parallel circuit is simultaneously closed through the heater coil 50 of the second switch unit 12. This circuit can be traced from line cord lead 39, through starter bimetal 34 and its closed contacts 35, 36, and lead 37, thence through leads 58, 54 and 53 of the first switch unit 11, then through heater coil 50, leads 54, 55 and lamp 15 to the second bus line formed of connected leads 56 and the line cord lead 40. In this condition, therefore, the lamp 14 is illuminated, the bimetal 47 of the first switch unit 11 is cooling and closing, and the bimetal 47 of the second switch unit 12 is heating and opening.

Subsequently, the bimetal 47 of the first switch unit 11 cools sufficiently to close its contacts 48, 49. This illuminates the second lamp 15, shorts out the circuit through the heater coil 50 of the second switch unit 12, and energizes the heater coil 50 of the third switch unit 13. At this stage, shown in FIG. 5, two lamps 14 and 15 are illuminated, the bimetal 47 of the second switch unit 12 is cooling and closing, and the bimetal 47 of the third switch unit is heating and opening.

The next stage, shown in FIG. 6, occurs when the bimetal 47 of the second switch unit 12 cools and brings its movable contact 48 into engagement with the corresponding fixed contact 49. This completes the first bus line for all of the lamps 14, 15 and 16, so that all three lamps are illuminated. No heater coils are now energized, but the bimetal 47 of the last switch unit 13 is cooling and closing. When this last bimetal closes, the lamps remain lit, and the assembly is back in the condition shown in FIG. 1, ready to commence another cycle, which is initiated by the heating of the starter heater coil 60 when the last bimetal 47 of the switch unit 13 closes to connect the completed first bus line, through return lead 63, 69, 62, to one end of the heater coil 60. The bimetallic switch of unit 13 thus performs delay function in maintaining the entire series of lamps illuminated for a selected period before the cycle is repeated. This period is the sum of the cooling time of bimetal 47 of the last unit 13 and the heating time of bimetal 34 of starter unit 10. In all other instances, the time between the illumination of one lamp and the illumination of the next succeeding lamp is only the cooling time of one bimetal.

In summary, it may be seen that in starting condition,

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the lamps are all illuminated, the lamps are then all extinguished, and are individually and successively illuminated until all are lit, at which time the cycle is automatically repeated. It will also be appreciated that any number of lamps can be incorporated in the line, merely by plugging in further units between the starter unit and the bridge unit.

It will also be observed that the heating elements of each unit is controlled by the last preceding bimetal switch, as is the lamp of each unit. The heater elements are connected across the switch contacts of the preceding bimetal switch.

It can also be appreciated that the heating time of any one of the bimetals is exactly the cooling time of the preceding bimetal. This can be seen in FIG. 4 wherein the heater coil 50 of the last unit 13 is not energized although the bimetallic switch of unit 12 preceding it has already opened. This is because the bus line carries no current to the switch of unit 12, the bus line being interrupted by the open switch of unit 11. The instant, however, that the switch of unit 11 closes, the bimetal of the next unit 12 begins to cool, and simultaneously the heater coil of the switch in unit 13 is energized.

The necessary heating time for the bimetals can be made shorter than the actual cooling times as a safety feature to insure full opening of the bimetal switches to a predetermined degree. The difference between the heating and cooling times is compensated for by providing a movable mount for one of the contacts of the bimetal switch to effect a self-adjusting feature, in a manner which will now be described.

It will be appreciated that in the previously described arrangement for the progressive illumination of a series of lamps, the opening and closing periods for the individual bimetal switches can become a critical factor. For example, it is practically impossible to obtain two bimetals with their associated heating elements which react in an identical manner, and if one of the bimetals of the series requires a relatively long cooling period to return to its closed position, this means that the next bimetal is being heated a correspondingly longer period than it was designed for, causing it to flex excessively and thus making the closing time excessive so that the defect is compounded. As a result, the heating and cooling periods are constantly increased to the point where ultimately the heater coils will be burned out, or at least the lighting intervals of the lamps will be too long.

The bimetal switches of the present invention are therefore provided with a novel structure which makes their operation completely controllable and eliminates the aforementioned difficulties. One benefit of this structure is that the lamp-lighting intervals can be selectively made short, so that the lamps can be illuminated in rapid succession.

FIGS. 7 through 11 illustrate one preferred embodiment of such bimetal switch structure, it being understood that all of the switch units 10, 11, 12 and 13, of the circuit arrangement shown in FIGS. 2 through 6, may be constructed in this manner. For convenience of explanation, the structure will be described as applied to the switch unit 11.

In FIG. 7, the bimetal strip 47 is shown carrying the contact 48 which is normally in engagement with the fixed contact 49, as previously explained. The intermediate portion of bimetal 47 is covered by a layer of non-flammable insulation 64, preferably a thin sheet of asbestos, in the usual manner. The heater coil 50 is wound about this layer of asbestos 64. The end of the bimetal 47 is mounted on a support bracket 65, as by a rivet 66, and the support bracket is in turn mounted on an insulated base 67 or the like, by rivets 68.

The fixed contact 49, in this instance, is not mounted rigidly on the base 67, but is rather frictionally mounted thereon for a limited degree of movement. For this

purpose, the fixed contact 49 is secured to and carried by an upstanding flange 69 of an electrically conductive plate 70 as shown in FIGS. 7 and 9. The plate 70, at its other end, is mounted on a screw bolt 71 which is secured in upstanding position to the base 67 by a nut 72. The plate 70 has an aperture 75 which receives the shank of bolt 71, and overlies the nut 72, being held on the bolt 71 by an arcuate leaf spring 73 engaged and depressed at its center by a nut 74 threaded on bolt 71. The nut 74 holds the leaf spring 73 under selected tension, so that the conductive plate 70 is pivotally mounted on base 67 with a selected amount of friction. Referring to FIG. 7, it may therefore be seen that the fixed contact may be frictionally moved in an arc about the bolt 71. A terminal lug 78 is also connected to bolt 71 for connection of the contact 49 within the circuit.

The conductive plate 70 also carries a cylindrical stop member 76 which is eccentrically mounted on the plate 70 by an off-set eyelet or rivet 77. This stop member 76 is made of electrically insulating material and is located to engage the free end rear face of the bimetal 47 when the latter flexes under heat. The distance between the stop member 76 and the bimetal 47 may be adjusted by turning the stop member about its off-center mount 77, so that a selected heating interval for the bimetal may be obtained before it engages the stop 76.

With the bimetals of the sequential lighting arrangement all made in accordance with the aforementioned construction, the heating and cooling periods of the individual bimetals can all be made uniform, and in addition can be selectively adjusted as to duration. It will be observed that when the bimetal 47 in FIG. 7 is heated, it will flex upwardly so that its contact 48 separates from the fixed contact 49. As the heating continues, the bimetal 47 engages the stop 76 and presses the latter upwardly, causing the plate 70 to turn in a clockwise direction about its pivot 71 against the frictional tension of spring 73. This is shown in FIG. 10. The plate 70 will continue to turn in this manner, carrying with it the fixed contact 49, no matter how long the bimetal 47 is heated and how much it flexes. When the bimetal cools, it will return to pressing engagement with the fixed contact 49, but the distance it travels during the cooling period is always constant and therefore the period in which the switch remains open is always constant. More specifically, it will be observed that no matter how long the bimetal has been heated, when it flexes downwardly in cooling it travels only the pre-selected and constant distance determined by the stop 76 and the fixed contact 49. Thus, the operating time for the individual switch is always the same despite line voltage fluctuations, changes in ambient temperatures, variations in the wattage of lamps employed, and other variables which would ordinarily influence bimetal operation. In addition, the inherent variations in performance characteristics between the various bimetallic units will not influence the sequential timing uniformity of the assembly. The heating period is made slightly larger than required for opening the contacts and may vary from unit to unit, but the subsequent cooling period is made the controlling factor and this latter is uniform.

In adjusting the series of bimetals for uniform operation, a flat gauge may be placed between the contacts 48 and 49 of each bimetal to space the contacts a desired distance. The eccentric stop member 76 is then turned until it engages the rear face of the bimetal 47. The gauge is then removed and the plate 90 turned until the contact 49 engages the contact 48. The bimetal 47 is thus adjusted so that its return distance during cooling is equal to the thickness of the gauge. Each of the other bimetals can then be similarly adjusted, so that their operations will be identical. If an extremely thin gauge is employed, the return distances of the bimetals will be very small so that the lamps will be illuminated in rapid succession.

The contacts 48 and 49 in FIG. 7 are pressed together

under a certain amount of tension determined by the amount of friction in the pivotal suspension of arm 70. This tension is adjusted by nut 74 bearing on spring 73 and is made equal in all units. It is advantageous to make it as small as practicable, as will be seen presently.

Starting from position of FIG. 7, the heater 50 is energized, causing bimetal 47 to flex upwardly. At first no physical movement takes place as the pressure existing between the contacts 48 and 49 is reduced to zero. The time required for this is directly proportional to the pressure existing originally, which in turn depends on the amount of friction. This friction has been made small so as to shorten the time period during which the bimetal is motionless while energized.

Once the contact pressure has been overcome, the bimetal proceeds to traverse the gap to the stop 76. Although the heater continues to energize the bimetal, movement of the bimetal stops when it engages the stop 76. The bimetal now builds up energy until its flexing force equals the friction in the pivotal suspension of arm 70. This time, incidentally, is equal to the time required previously to separate the contacts 49, 48.

The bimetal continues flexing, and by bearing against stop 76, it carries arm 70 along in the same direction, it is flexing. This continues until the heater is deenergized. FIG. 10 shows the bimetal position at this instant, in which the bimetal as well as arm 70 are displaced from their original positions of FIG. 7.

Different units may have inherently different heating characteristics, so that if energized for the same time period, the displacement of bimetal and arm shown in FIG. 10 may vary from unit to unit. All units, however, will have their bimetals 47 pressing against their respective stops 76 with exactly the same pressure, since the friction pivot in each unit has been adjusted to provide the same tension. Furthermore, all units have exactly the same size of gap between the respective contacts 48, 49.

When the heater coil 50 is deenergized, the bimetal 47 cools and begins to straighten out. It has been pointed out that the position of FIG. 10 for various units may be different; however, the conditions under which the different units will operate in closing the contacts under pressure, are the same. The force residing in the bimetal in straightening out causes the bimetal to retrace its flexing movement in the reverse direction. Initially the pressure against the stop will be reduced to zero, then the gap will be traversed, and then pressure will be built up between the contacts. Depending upon the temperature, ambient or residual, the unit may come to rest in a reset position such as shown in FIG. 11, which position is slightly different from the original position of FIG. 7. It is important to note that the unit is ready to start on its heating cycle from either position under the same conditions.

FIGS. 12 and 13 illustrate a modified form of bimetal switch construction which will produce the same controlled and uniform bimetal operation, but in which the bimetal is frictionally mounted for a limited degree of lost motion movement, rather than the fixed contact as in the embodiment of FIGS. 7 to 11. Again, in this embodiment, the mounting structure is described as applied to the switch unit 11.

In FIG. 12 it may be seen that the fixed contact 49 is mounted on a conductive bracket 80 which has an elongated slot 81 receiving screws or rivets 82 for adjustable but secure mounting of the bracket 80 on an insulated base 83. A generally L-shaped arm 84 is secured to the base 83, as by rivets or eyelets 85. The arm 84 is electrically conductive and the rivets 85 may therefore serve as terminal soldering posts for the bimetal. The bimetal 47 is carried by a conductive strip 86, the latter having a twisted end portion 87 to which the bimetal 47 is secured, as by a rivet 88.

The strip 86 is frictionally mounted on the L-shaped arm 84 in a manner similar to the mounting of the plate 70 in FIGS. 7 to 11, and previously described. That is

to say, the strip 86 is loosely mounted on an upstanding bolt 89 affixed to the arm 84, with an arcuate leaf spring 90 overlying the strip 86 and being depressed at its center by a nut 91. The bimetal 47 and its contact 48 can therefore be turned about the bolt 89, under frictional tension of the spring 90.

The end of the L-shaped arm 84 has a small projection 92 which is located to contact the rear face of the free end of bimetal 47 and act as a stop therefor. When the bimetal 47 is heated through energization of its heater element 50, it will engage the stop 47, so that further flexing movement of the bimetal will reposition its mounting. That is to say, when the bimetal 47, in the closed position of FIG. 12, is heated, it will flex upwardly, the contact 48 moving away from contact 49. The rear face of the bimetal 47 then engages the projection 92 which acts as a fixed stop and prevents the free end of the bimetal 47 from moving further away from the fixed contact 49. As the bimetal continues to heat, it flexes at its center, as shown in FIG. 13, causing the mounted end thereof to turn about the bolt 89. The bimetal thus resets its mounting position, and the spring 90 and nut 91 maintain this reset position. On cooling, the free end of the bimetal 47, carrying contact 48, need only travel the distance between the projection 92 and the fixed contact 49.

The operational timing of the bimetal 47 may be adjusted by loosening the screws 82 and sliding the bracket 80 to vary the gap between the fixed contact 49 and the projection 92. A gauge may be used for this purpose, as previously explained.

While preferred embodiments of the invention have been shown and described herein, it is obvious that numerous additions, changes and omissions may be made in these embodiments without departing from the spirit and scope of the invention.

What I claim is:

1. A sequential lighting arrangement for successively energizing a plurality of electric lamps, comprising a plurality of switches each including a pair of normally closed contacts, a heat-sensitive element coupled to one of said contacts for opening said contacts upon the application of heat thereto, and a heater element intimately associated with said heat-sensitive element, circuit means connecting all of the pairs of switch contacts in series with one terminal of a source of electrical current to provide a first bus line, means connecting each heater element across the pair of contacts of the preceding switch to place said heater element in the first bus line for energization thereof when the pair of contacts of the preceding switch are open and the bus line is completed to said preceding switch, a second bus line connected to the other terminal of said current source, and means connecting each of said lamps in parallel between the second bus line and one of the contacts of a switch in the first bus line independently of said heater elements for energization of said lamp when the bus line is completed to said connected contact.

2. A sequential lighting arrangement for successively energizing a plurality of electric lamps comprising a plurality of switches each including a heat-sensitive element controlling a pair of normally-closed contacts and a heater element associated with the heat-sensitive element heating the latter to open said contacts, circuit means connecting said switches in series with one terminal of a source of electrical current to provide a first bus line, a second bus line connected to the other terminal of said current source, means connecting the heater element of the first switch in the first bus line between the second bus line and the contact of the last switch in the first bus line most remote from said one current source terminal, means connecting each remaining heater element across the contacts of the preceding switch to insert said heater element in the first bus line for energization thereof when the contacts of the preceding switch are open and the bus line is completed to said preceding switch, and means connecting

each of said lamps in parallel between the second bus line independently of said heater element and a switch in the first bus line for energization of said lamp when the bus line is completed to said connected switch.

3. A sequential lighting arrangement for successively energizing a plurality of electric lamps, comprising a plurality of bimetallic switches each including a bimetallic element controlling a pair of normally-closed contacts and a heater element associated with the bimetallic element for heating the latter to open said contacts, circuit means connecting said bimetallic switches in series with one terminal of a source of electrical current to provide a first bus line, means connecting each heater element across the contacts of the preceding switch to place said heater element in the first bus line for energization thereof when the contacts of the preceding switch are open and the bus line is completed to said preceding switch, a second bus line connected to the other terminal of said current source, means connecting each of said lamps in parallel between the second bus line and a respective switch in the first bus line for energization of said lamp when the bus line is completed to said connected switch, a starter switch for said arrangement including a bimetallic element controlling a pair of normally-closed contacts and a heater element associated with the bimetallic element for heating the latter to open said contacts, and means connecting the heater element of said starter switch between the last bimetallic switch and the second bus line for energization of said starter heater element when the contacts of the last bimetallic switch are open and the first bus line is completed to the last bimetallic switch.

4. A sequential lighting arrangement for successively energizing a plurality of electric lamps, comprising a plurality of switch units, each comprising a housing having a group of sockets at one side and a corresponding group of pins at the other side which fit within the sockets of an adjacent housing to couple and electrically connect said housings, a bimetallic switch contained in each housing and including a bimetallic element controlling a pair of normally-closed contacts and a heater element associated with the bimetallic element for heating the latter to open said contacts, circuit means in each housing and connected to respective pins and sockets thereof to connect said bimetallic switches in series with one terminal of a source of electrical current to provide a first bus line when said housings are connected by means of said pins and sockets, additional circuit means in each housing and connected to respective pins and sockets thereof for connecting each heater element across the contacts of the switch in the preceding housing to insert said heater element in the first bus line for energization thereof when the contacts of the preceding switch are open and the bus line is completed to said preceding switch, further circuit means in each housing interconnected by said pins and sockets to provide a second bus line connected to the other terminal of said current source, one of said electric lamps being associated with a respective housing and having means within said housing connecting said lamp between the second bus line and the switch in said housing for energization of said lamp when the bus line is completed to said connected switch.

5. In a sequential lighting arrangement for successively energizing a plurality of electric lamps, a plurality of individual switch units adapted for removable interconnection to operate in sequence for energizing said lamps, each switch unit comprising a housing, a normally-closed bimetallic switch mounted in said housing and including a bimetallic element, a heater element associated with the bimetallic element for heating the latter, a movable contact carried by said bimetallic element, and a relatively fixed contact engaged by said movable contact when the bimetallic element is in unheated condition, a first group of connecting elements at one side of said housing, a second group of connecting elements at another side of

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said housing, said first and second groups each including first, second, third and fourth connecting elements sized and positioned to couple with the first, second, third and fourth connecting elements of the other group in an adjacent housing to couple the housings and electrically connect the switch units thereof, means electrically connecting the first elements of each group, means electrically connecting one end of the heater element to the second connecting element of the first group, the other end of said heating element being electrically connected to said bimetallic element, means electrically connecting the bimetallic element to the second connecting element of the second group, means electrically connecting the bimetallic element to the third connecting element of the first group, means electrically connecting the fixed contact to the third connecting element of the second group, means electrically connecting the fourth elements of both groups, an electric lamp associated with said housing, and means electrically connecting said lamp between the third and fourth connecting elements of the first group.

6. A sequential lighting arrangement according to claim 5 which also includes a starter unit and a bridging unit, said starter unit comprising a housing, a normally-closed bimetallic switch in said housing and including a bimetallic element, a heater element associated with said bimetallic element, a movable contact carried by said bimetallic element, and a relatively fixed contact, a group of connecting elements on said housing including first, second, third and fourth connecting elements sized and positioned to couple with the respective first, second, third and fourth connecting elements of the first group in a switch housing, means electrically connecting one end of said heater element to the first connecting element,

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means for connecting the other end of the heater element to one terminal of a power source, means connecting said bimetallic element to the second connecting element, means connecting said fixed contact to the third connecting element, means connecting the fourth connecting element to said one power source terminal, and means connecting said bimetallic element to the other terminal of said power source, said bridging unit including a housing having first and second connecting elements sized and positioned to couple respectively with the first and third connecting elements of the second group in a switch housing, and means electrically connecting said first and second connecting elements of the bridging unit.

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