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(54) Title: COLOR CHANGE MECHANISM

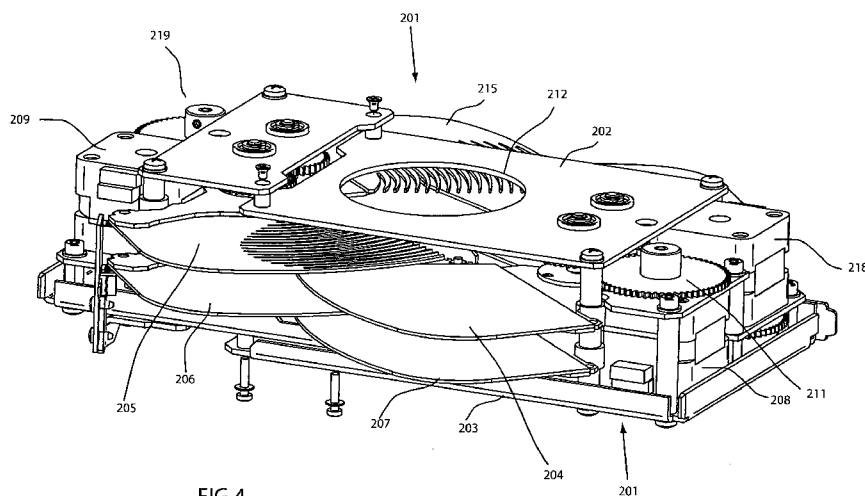


FIG 4

(57) Abstract: The present invention provides a drive system for an optical light modulation system employing multiple light modulation element pairs (205, 215, 206, 216). The each pair is driven by a single motor (209, 219) which drives one axle (228) around which one element (205) of the first pair (205, 215) rotates while the other element (215) of the first pair (205, 215) free floats and rotates about a second axle (228). While the second axle (228) drives the rotation of the first element (216) of the second pair (206, 216) and the first axle (228) provides a rotation pivot for the second element (206) of the second pair (206, 216). Thus the two pairs share the two axles (228) providing a more compact drive system that can be used more flexibly in an optical train of an automated multiparameter lighting system.



WO 2009/114635 A1

## COLOR CHANGE MECHANISM

### TECHNICAL FIELD OF THE INVENTION

[0001] The present invention generally relates to the color control of lighting systems and more specifically to mechanisms used for color control of entertainment lighting automated multiparameter luminaires.

### BACKGROUND OF THE INVENTION

[0002] Luminaires with automated and remotely controllable functionality are well known in the entertainment and architectural lighting markets. Such products are commonly used in theatres, television studios, concerts, theme parks, night clubs and other venues. As well as usually providing control over the pan and tilt functions of the luminaire allowing the operator to control the direction the luminaire is pointing a typical product will also often provide control over the color of the emitted light beam. Typically this color control is done via the movement of color wheels, flags or other similar device containing colored filters. Very often these colored filters are gradated from one end to the other with an increasing density of the color filter or increasing saturation of the color that is being filtered. Typically, in these systems the light beam only passes through a portion of the filter. By moving the gradated filter so that different portions of the filter are placed in the path of the light beam the color saturation of the light beam can be varied.

[0003] Figure 1 shows a filter of this kind with a gradated saw-tooth color coating **101**. Filter **101** is progressively moved from into the path of the light beam cross section **102** in the light train of the luminaire anywhere from position *a* to *d*. As the movement continues from position *a* to *d* an increasing portion of the light beam cross section **102**

passing through the color modulating portions **103** (shown as the hatched area in **Figure 1**) of filter **101** and thus the resultant light becomes more and more color saturated. When the filter **101** is in position *d* the entire cross section **102** passes through the color modulating portions **103** the filter **101** and the color saturation is complete for that filter.

**[0004]** Although a rectangular filter **101** is shown here with linear motion it is also common for these devices to use circular filters with a rotary motion.

**[0005]** A single filter **101** is illustrated here, however in practice multiple color filters with the same or different color modulating properties may be used so that the light passes through or bypasses each filter in turn. Such an arrangement creates a subtractive color mixing system where the color of the output light is defined by the combination and position of all the filters in use. The products manufactured by Robe Show Lighting such as the ColorSpot 1200E are typical of the art.

**[0006]** In typical color modulation systems a combination of two or more of these variable saturation mechanisms, one after the other in the optical train with different colored filters to provide a variable color mixing system across a color gamut..

**[0007]** It is very common to use three color filters, one each of Cyan, Magenta and Yellow each of variable saturation. Combining these in varying subtractive mixes allows the production of a very wide gamut of colors.

**[0008]** Lighting designers and other users of such products often have a desire to change colors very rapidly. Quickly enough that the audience does not perceive the change happening and instead sees it as an instantaneous event. The speed of these changes are typically limited by the mechanical design and construction of the mechanism used for the color change.

[0009] **Figure 2** illustrates a typical multiparameter automated luminaire system **10**. These systems typically include a plurality of multiparameter automated luminaires **12** which typically each contain on-board a light source (not shown), light modulation devices, electric motors coupled to mechanical drives systems and control electronics (not shown). In addition to being connected to mains power either directly or through a power distribution system (not shown), each luminaire is connected in series or in parallel to data link **14** to one or more control desks **16**. The luminaire system is typically controlled by an operator through the control desk **15**.

[0010] **Figure 3** illustrates different levels of control **20** of a parameter of the light emitted from a luminaire. In this example the levels are illustrated for one parameter: color. The first level of control **22** is the user who decides what he wants and inputs information into the control desk through typical through computer human user interface(s). The control desk hardware and software then processes the information **26** and sends a control signal to the luminaire via the data link **14**. The control signal is received and recognized by the luminaire's on-board electronics **28**. The onboard electronics typically includes a motor driver **30** for the color motor (not shown). The motor driver **30** converts a control signal into electrical signals which drive the movement of the color motor. The color motor is part of the color mechanical drive **32**. When the motor moves it drives the mechanical drive **32** to move the mechanical components which cause the light beam emanating from the luminaire to change color.

[0011] In some systems it may be possible that the motor driver **30** is in the control desk rather than in the luminaire **12** and the electrical signals which drive the motor are transmitted via an electrical link directly to the luminaire. It is also possible that the motor driver is integrated into the main processing within the luminaire **12**. While many

communications linkages are possible, most typically, lighting control desks communicate with the luminaire through a serial data link; most commonly using an industry standard RS485 based serial protocol called commonly referred to as DMX-512.

**[0012]** Particular problems inhibiting and limiting the speed, accuracy and repeatability of the movements of the color system of an automated luminaire are the mechanical stiffness and inertia of the color mechanism and its drive system. It is typical in such products to use a single motor or a pair of motors connected to the driven color change mechanism through either a belt drive or through a direct geared system. As well as the stated problems in both cases there is inevitably an amount of backlash or slippage or shifting which induces hysteresis in the system. Such hysteresis would manifest itself as an undesirable and visible color shift in the light output.

**[0013]** Various prior art systems have offered solutions to these problems. One solution to reducing the time needed for a color change is to reduce the length of travel of the mechanism. However compressing the length of the graded filter (component 101 in Figure 1) may have the unintended side effect of making the light field uneven as the color saturation density on one side of the aperture may be significantly different than on the other.

**[0014]** There is a need for a color change system which can provide rapid and accurate movement without backlash and hysteresis.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0015] For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings in which like reference numerals indicate like features and wherein:

[0016] FIGURE 1 illustrates a color mixing system of a multiparameter automated luminaire

[0017] FIGURE 2 illustrates a multiparameter automated luminaire lighting system;

[0018] FIGURE 3 illustrates an example of the levels of control which may be seen in controlling a parameter of an automated luminaire;

[0019] FIGURE 4 illustrates an exemplary embodiment of the mechanical elements of an embodiment of the present invention;

[0020] FIGURE 5 illustrates an partially exploded diagram of the left half of the embodiment illustrated in **Figure 4**;

[0021] FIGURE 6 illustrates an elevation for the **Figure 5** illustrated portion of the embodiment illustrated in **Figure 4**;

[0022] FIGURE 7 illustrates on example of an optical train and how the improved color mixing system can be used over a greater range than prior color mix systems;

[0023] FIGURE 8 illustrates on example of an optical train and how the improved color mix system allows for an over all more compact fixture/luminaire

[0024] FIGURE 9 illustrates an example of a prior art color mix system as viewed along the optical axis of the system;

[0025] FIGURE 10 illustrates an example of the improved color mix system as viewed along the optical axis of the system;

[0026] FIGURE 11 illustrates a color mix pair in full saturation; and

[0027] FIGURE 12 illustrates a color mix pair just entering the light beam.

## DETAILED DESCRIPTION OF THE INVENTION

[0028] Preferred embodiments of the present invention are illustrated in the FIGURES, like numerals being used to refer to like and corresponding parts of the various drawings.

[0029] The present invention generally relates to the color control of lighting systems and more specifically to mechanisms used for color control of entertainment lighting automated multiparameter luminaires.

[0030] The present invention relates to the mechanisms for driving the color filters in a color mixing system. In one embodiment the present invention utilizes a single motor for each color driving a pinion gear. The pinion gear engages with two further pinion gears to which individual color flags are attached. The axles on which the second and third pinion gears are mounted are rigidly supported with a bearing at each end of the axle between two mounting plates. The mechanical system formed is mechanically stiff and allows rapid movement of the flags with little hysteresis and vibration in very little space.

[0031] **Figure 4** illustrate the major mechanical components of the color changing system of one embodiment of the present invention. The assembly is based around two rigid mounting plates **202** and **203**. Each of these mounting plates has a light aperture **212**. The two apertures **212** are axially aligned. Attached to the mounting plates are motors **208, 218, 209, 219** (motor **219** is hidden in **Figure 4** but shown in **Figure 5** and **Figure 6**). The type of motor used is not important to the invention - the motors may include but are not limited to stepper motors, DC motors, AC motors or other types of motors.

[0032] Each motor **208, 218, 209** and **219** drives a pair of light modulators: one motor **208** drives a modulator pair **204** (the other is hidden); another motor **218** drives



another light modulation pair **207** (the other is hidden); the third motor **209** drives a third set of modulation pairs **206** and **216**; the fourth motor **219** drives a fourth pair **205** and **215** (modulator **216** is hidden in **Figure 4** but shown in **Figure 5** and **Figure 6**).

[0033] The different light modulator pairs typically have different modulating effects when introduced to the light beam. In one embodiment one pair is a pair of cyan filters, a second pair is a pair of magenta filters, a third pair is a pair of yellow filters and the fourth pair provides color temperature correction (for example to make the light beam generated by a metal halide lamp appear to have the color temperature of an incandescent lamp). Other modulators are also possible - like a dimmer or other types of modulators. It is not strictly necessary for there to be a pair of modulators only one modulator may be employed instead of a pair however, the unilateral arrangement compromises some of the benefits such as more even color distribution and lack of vibration or other movement effects due to unbalanced inertial changes due to rapid movement of the modulator as further described herein.

[0034] **Figure 5** illustrates a partially exploded view of the left hand portion of the system driven by motors **209** and **219** for two of the pairs of modulators **206**, **216** and **205**, **215** respectively in the embodiment illustrated in **Figure 4**. **Figure 6** illustrates an elevation view of the partial illustration of **Figure 5**. The following applies as well for the pairs from **Figure 4** not shown in **Figure 5** and **Figure 6**. Each motor **209** and **219** has a geared driving pinion **211** on its output shaft. The driving pinion **211** engages with a first driven pinion **223** which, in turn, engages with a second driven pinion **224**. Driven pinions **223** and **224** are the same size. In the system illustrated driven pinions **223** and **224** are smaller than driving pinion **211** thus providing a gearing increase. Such a gearing system may be advantageous for reasons of speed of movement however it is not a

requirement for the present invention. In the embodiment illustrated both instances of the first driven pinions **223** are fixed to axles **228** and second driven pinions **224** are free to rotate around axles **228**. Axles **228** are free to rotate in bearings **225** and **227** mounted in the top and bottom support plates **202** and **203** respectively. The mountings of the bearings in the support plates is rigid providing secure support for the axle **228** at both ends which in turn provides a backlash and vibration free support for the driven pinions **223** and **224**.

[0035] A flag support arm **229** is attached to each of the pinions **223** and **224**. Each flag support arm supports a color mixing filter flag **205**, **215**, **206**, **216**. The color mixing filter flags are mounted in pairs of the same color: thus **205** and **215** are one color and **206** and **216** are a second, different, color. One half of each flag pair (**206** for example) is mounted on a driven pinion **223** and the second half of each flag pair (**216** for example) is mounted on the associated driven pinion **224**. In this manner each axle **228** supports two driven pinions for two different colors. Each axle **228** will have, on one end, a driven pinion **223** which is fixed to axle **228** and has a flag of a first color and, at the other end of the axle, a driven pinion **224** which is free to rotate around axle **228** and has a flag of a second color. This combination and re-use of a single axle **228** for two flags of different colors halves the total number of axles **228** and provides an improved compact system. The assembly is constructed as two, virtually identical sub-assemblies which are mounted face-to-face sharing axles **228**.

[0036] It can be seen from **Figure 5** that rotation of driving pinion **211** in a clockwise direction will cause rotation of driven pinion **223** in a counter clockwise direction which in turn will cause rotation of driven pinion **224** in a clockwise direction. Thus driven pinions **223** and **224** along with their attached flag support arms and color mixing

filter flags **205** and **215** will be driven in contrary directions and will open and close across apertures **212** in the mounting plates **202** and **203**.

[0037] The disclosed system has a number of advantages over the prior art. Firstly the distance traveled by each of the two color mixing filter flags forming a pair is half that of a single plate system thus reducing the time for the system to operate. Additionally the use of two color mixing flags acting in opposition improves the evenness of the color mixing across the aperture. This provides for a great deal more flexibility in the positioning of the system within any given optical light train while its compact size allows for much greater flexibility in the light train designs into which it can be incorporated. This flexibility allows for more compact design of the overall automated luminaire fixture.

[0038] **Figure 7** illustrates how the more compact design and balanced entry from opposite sides of the light beam allows the present color mixing system to be used over a greater range along the optical train of a luminaire **300**. The luminaire's light train is made up of a number of components such as the lamp **302**, lamp reflector **304**, aperture **306** and a series of lenses **308**, **310**. The present inventions ranges of usefulness **330** are wider since they can be placed closer to a focal plain than many prior art color mixing systems which have a more limited range of usefulness **320**.

[0039] **Figure 8** illustrates another example of the usefulness of the present compact design. In this case the overall dimensions of the luminaire **350** can be more compact because the color mixing system **201** can be placed closer to a focal plain in the optical train of the luminaire **350**.

[0040] **Figures 9** illustrates a prior art color mixing system with gradated color wheels **402** and **404**. While **Figure 10** illustrates the more compact design of the present color

mixing system. In this view it is clear to see how much more compact the present system is in comparison to prior art systems.

**[0041]** Further because the motion of the two color mixing flags forming a pair is always equal and opposite there is no net inertial, vibrational or oscillatory movement induced into the mounting frames and the rest of the luminaire. Further a mechanically stiff system with rigidly supported axles and fully engaged pinion gears ensures accurate movement with little or no hysteresis or overshoot. Further the sharing of the axles by two color flags halves the number of axles and produces a compact system. Further the combination of a fixed pinion and a rotational pinion on a single shaft reduces the number of bearings in the system.

**[0042]** In a further embodiment both pinions **223** and **224** may be free to rotate on the axle. Both instances of the first driven pinions **223** and second driven pinions **224** are free to rotate around axles **228**.

**[0043]** While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this invention, will appreciate that other embodiments may be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

**[0044]** The invention has been described in detail, it should be understood that various changes, substitutions and alterations can be made hereto without departing from the spirit and scope of the invention as described by the appended claims.

WHAT IS CLAIMED IS:

1. A luminair with light modulation filters in which two pairs of two modulators are driven by two motors about two axels.

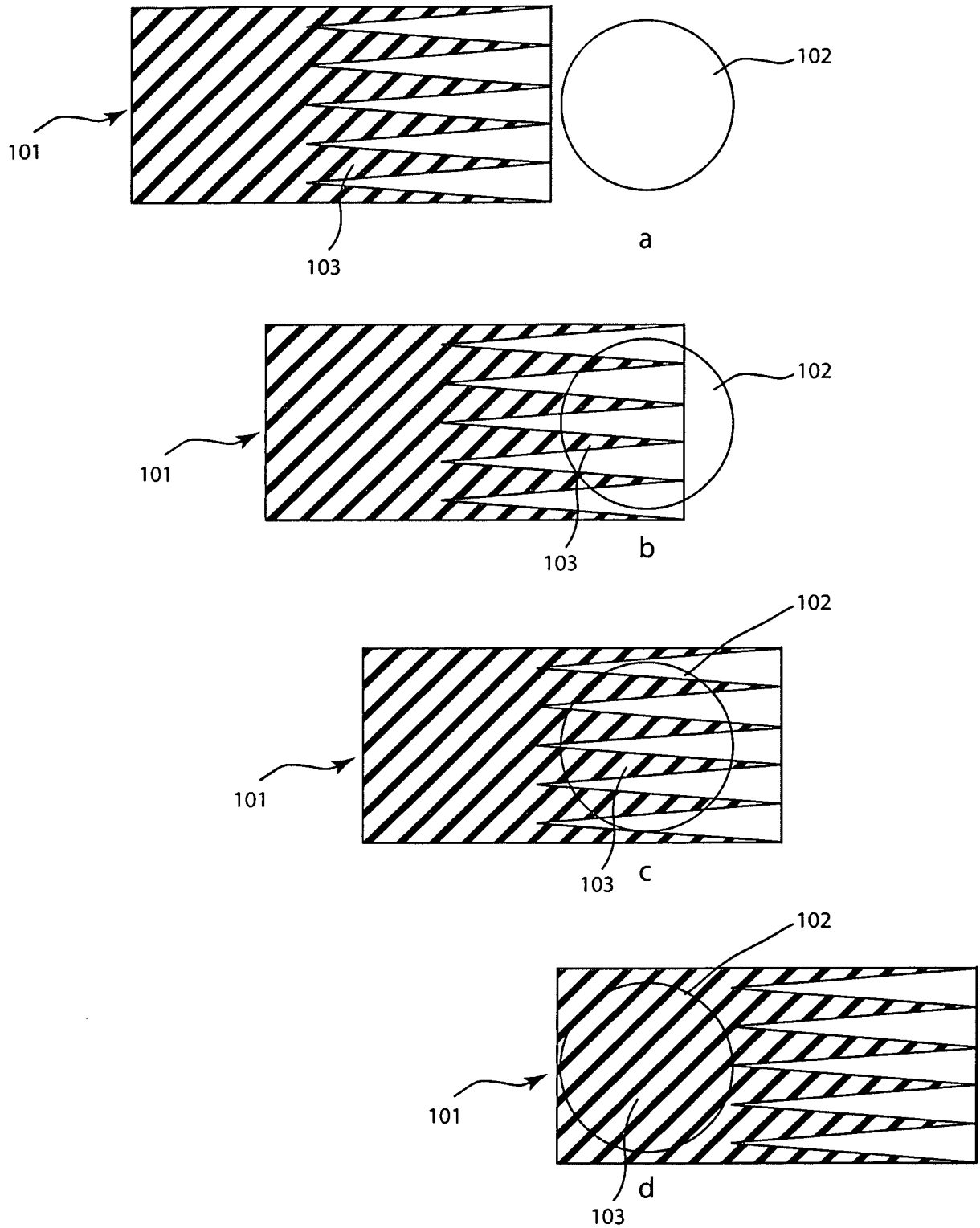


FIG 1

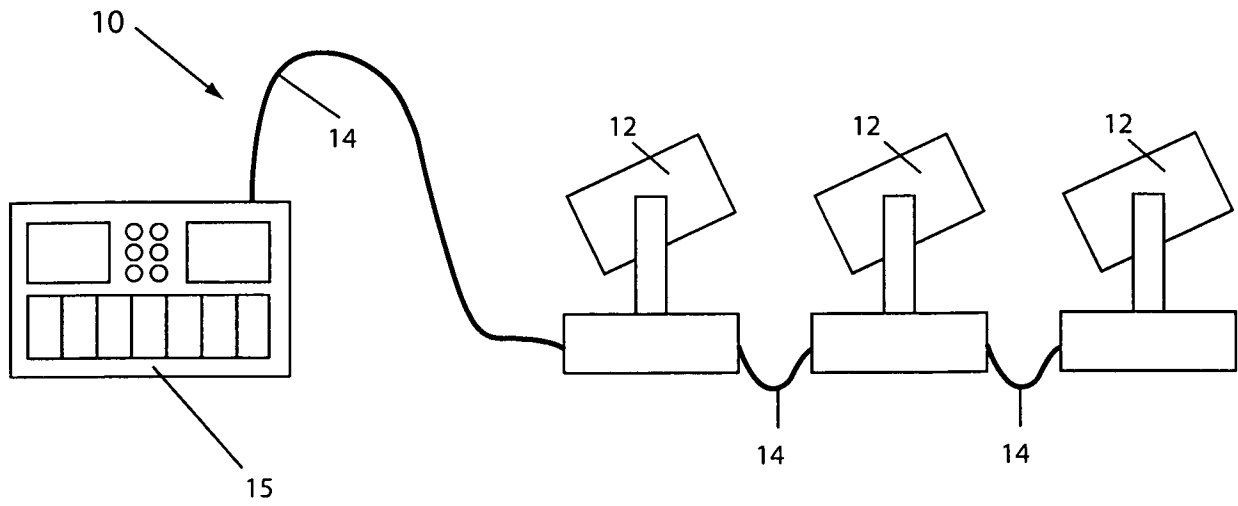


FIG 2

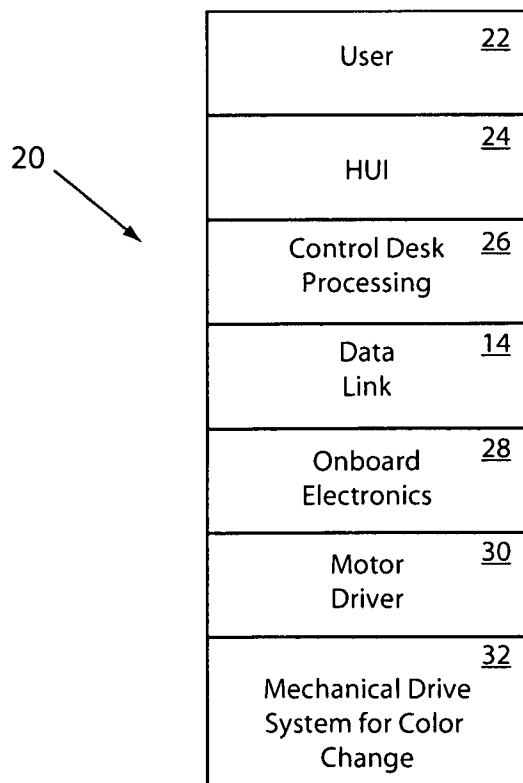


FIG 3

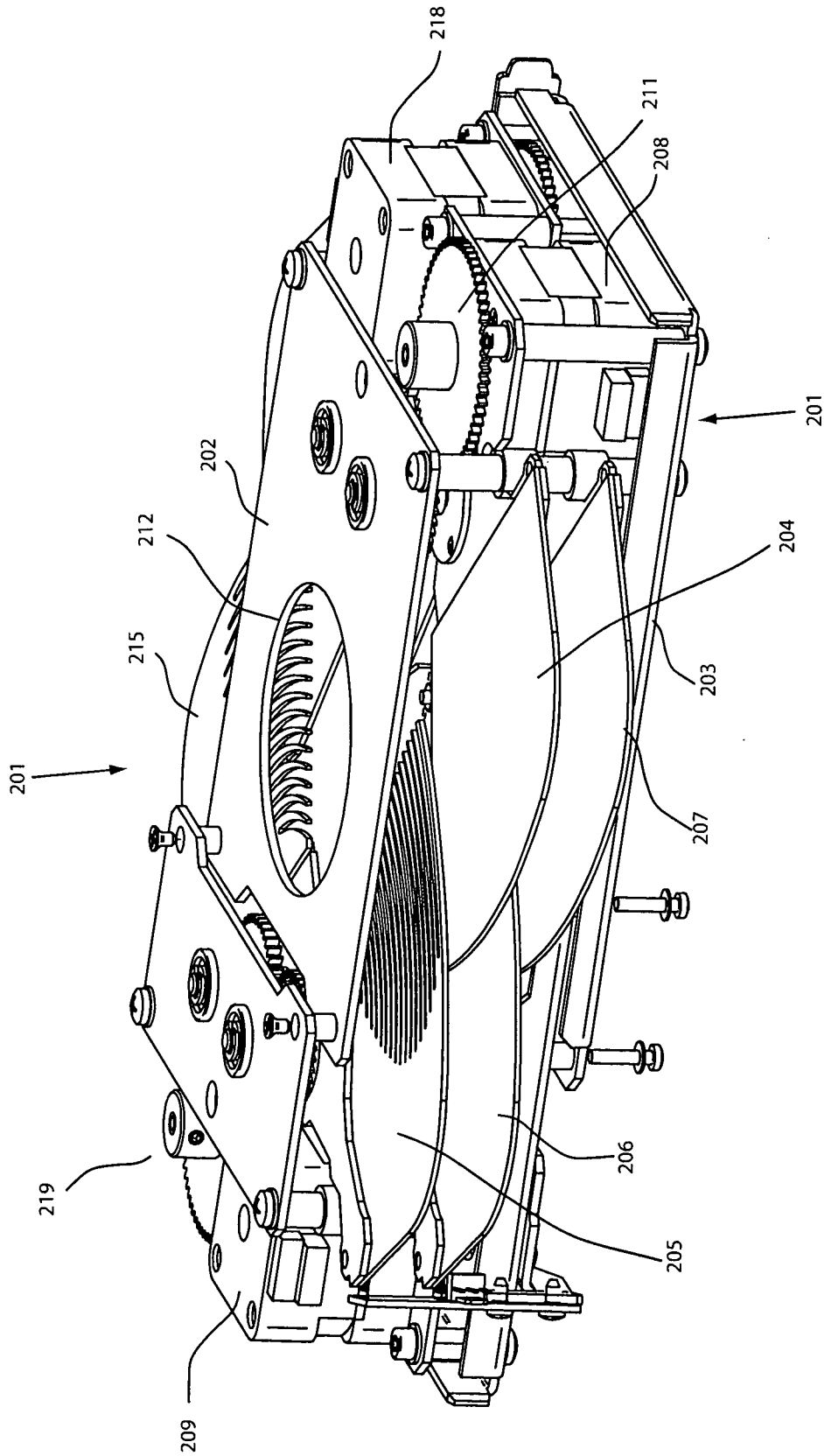


FIG 4



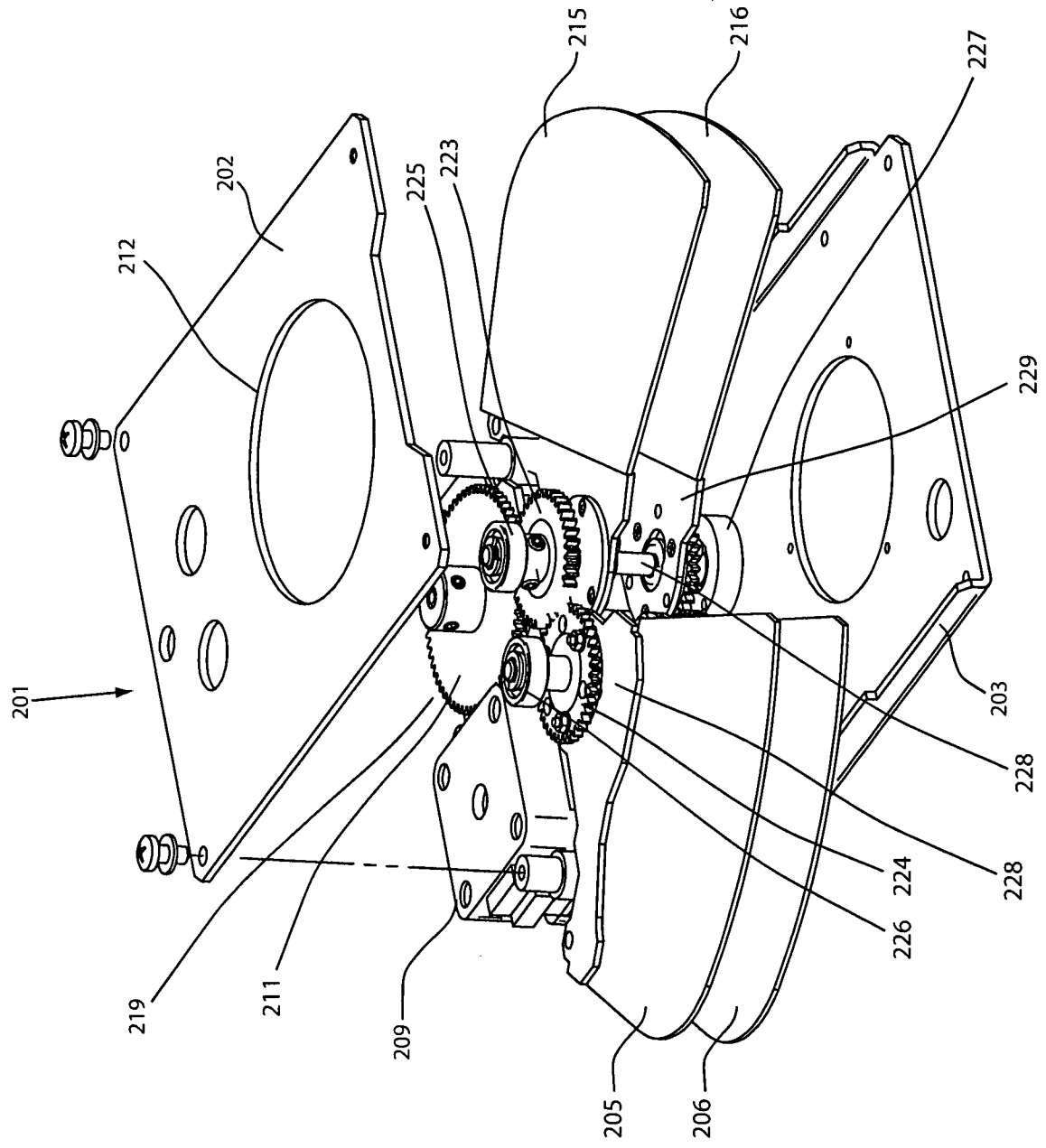


FIG 5

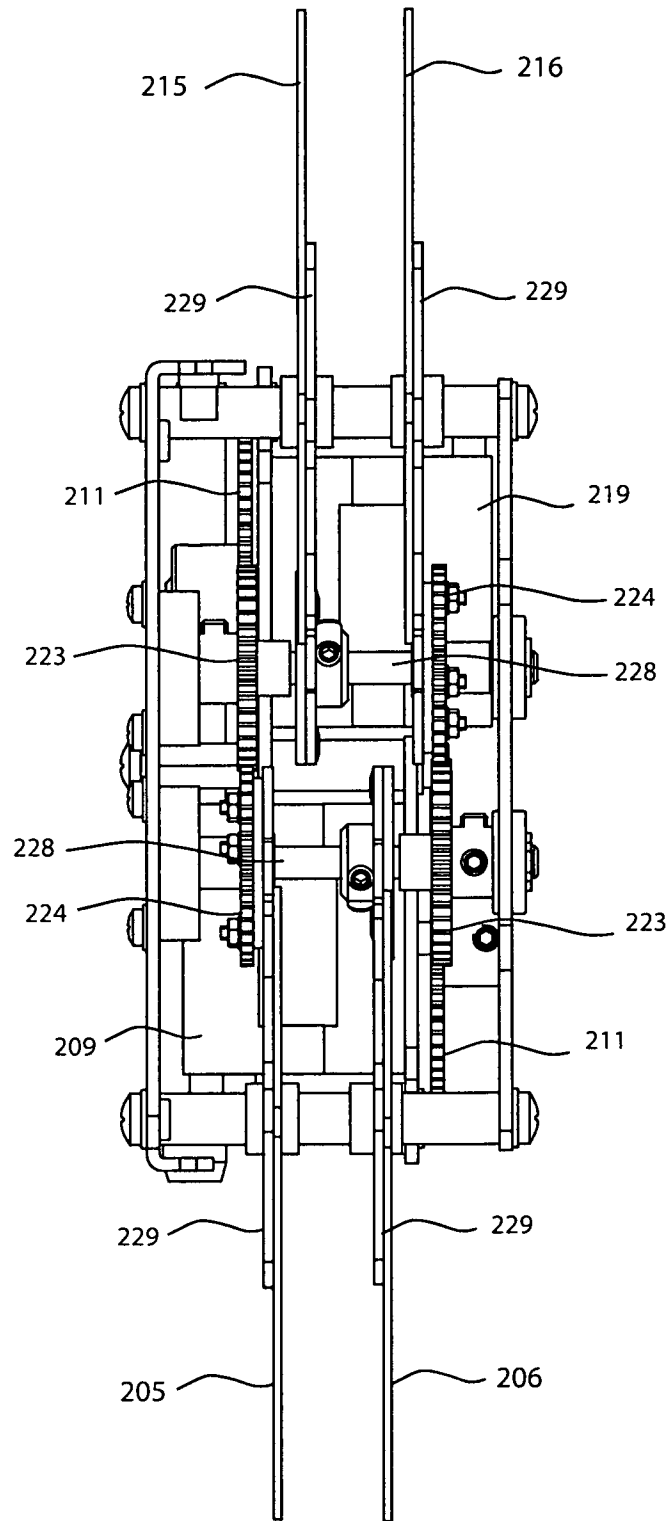


FIG 6

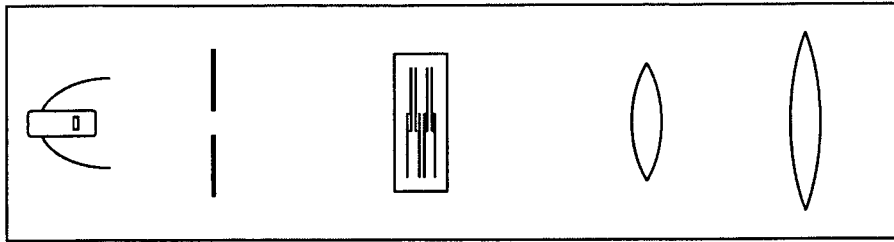


FIG 7

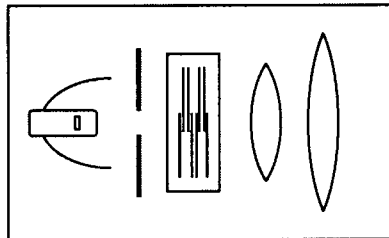


FIG 8

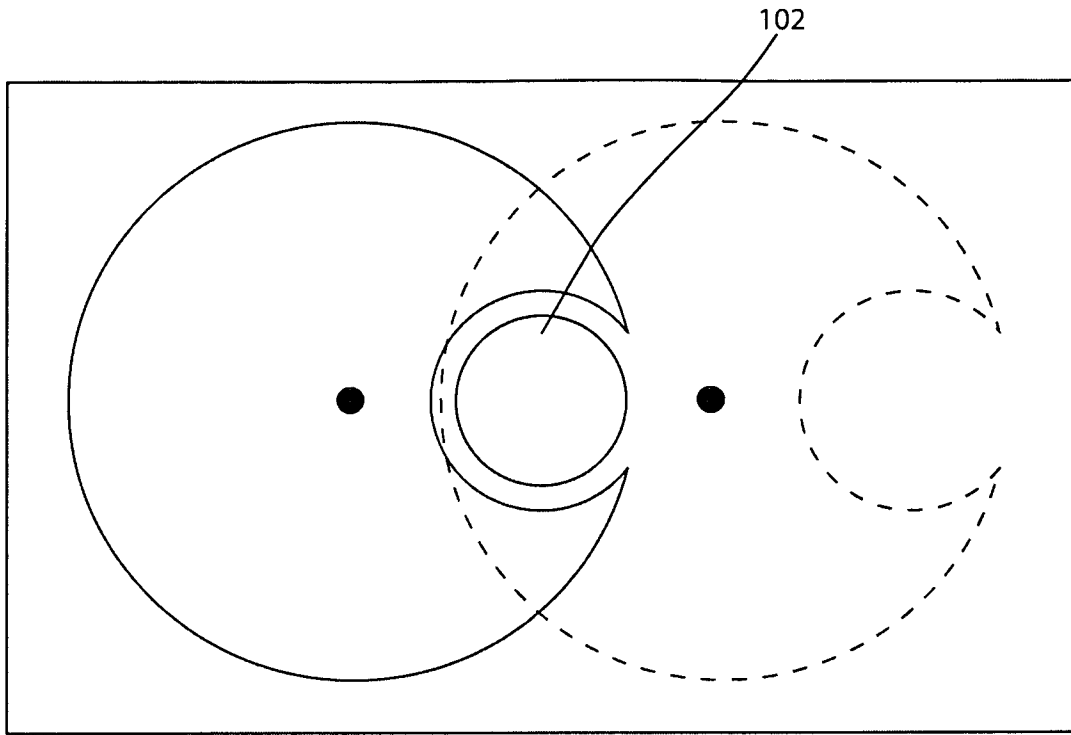


FIG 9

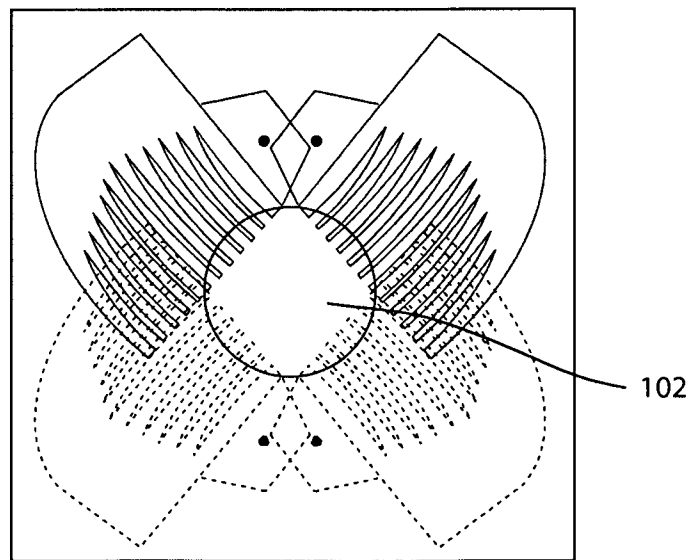


FIG 10

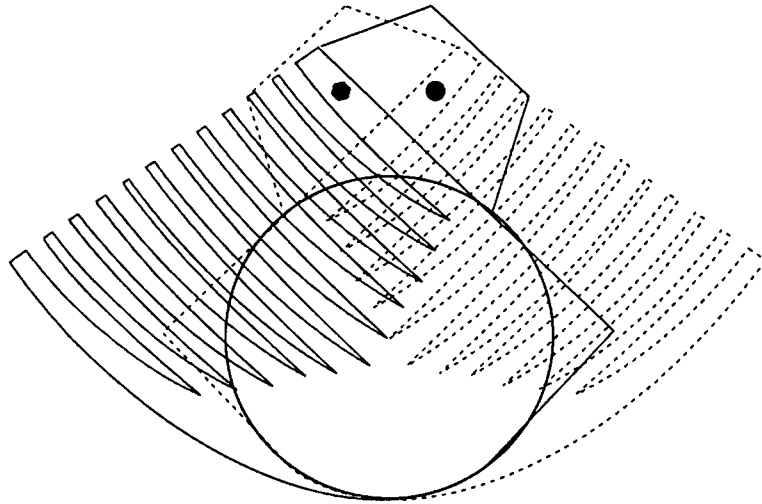


FIG 11

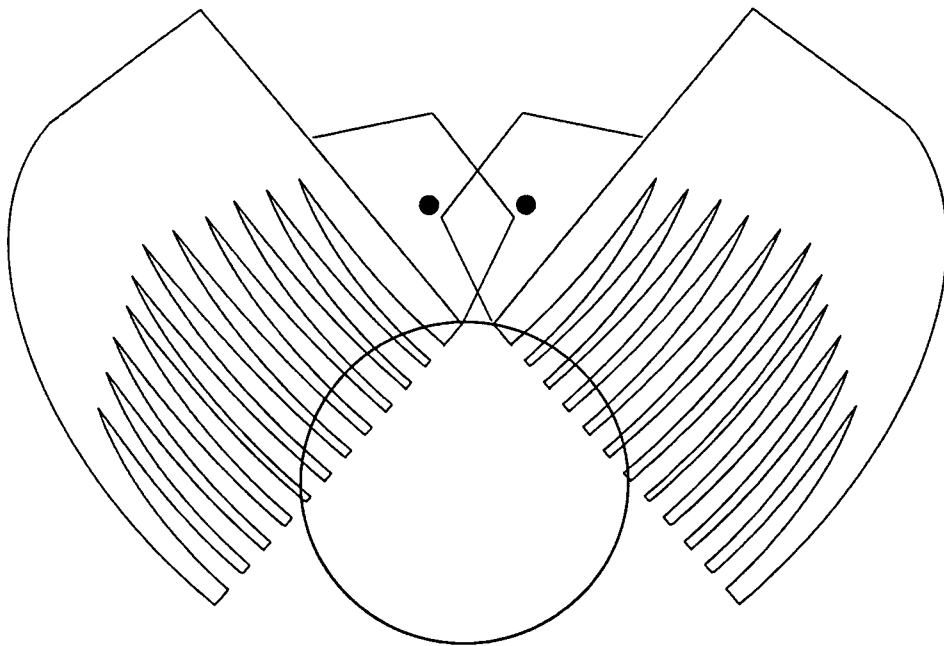


FIG 12

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2009/036845

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. F21S10/02  
ADD. F21W131/406

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
F21S F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	WO 2009/081256 A (CLAY PAKY SPA [IT]; QUADRI PASQUALE [IT]) 2 July 2009 (2009-07-02) page 5, line 7 - page 6, line 6 page 7, line 19 - line 24 page 12, line 6 figures 2-4	1
X	----- EP 1 832 807 A (COEMAR SPA [IT]) 12 September 2007 (2007-09-12) figure 3	1
X	----- GB 2 305 497 A (HILL JOHN MICHAEL [GB]) 9 April 1997 (1997-04-09) page 6, line 10 - line 21 -----	1

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

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Date of the actual completion of the international search

14 July 2009

Date of mailing of the international search report

21/07/2009

Name and mailing address of the ISA/

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 Fax: (+31-70) 340-3016

Authorized officer

De Mas, Alfonso

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2009/036845

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 2009081256	A	02-07-2009	NONE	
EP 1832807	A	12-09-2007	CN 101033831 A	12-09-2007
			US 2007211468 A1	13-09-2007
GB 2305497	A	09-04-1997	NONE	