United States Patent

Botskor

[15] **3,656,844**

[45] **Apr. 18, 1972**

[54] SUN FOLLOWING DEVICE

[72] Inventor: **Ivan Botskor,** Breisgan, Germany

[73] Assignees: **Tibor Horvath; George Kalnay,** , a part interest to each

[22] Filed: **June 26, 1969**

[21] Appl. No.: **836,917**

[52] **U.S. Cl.** **353/3**

[51] **Int. Cl.** **G03b 21/00**

[58] **Field of Search** 353/3; 350/299, 6

[56] **References Cited**

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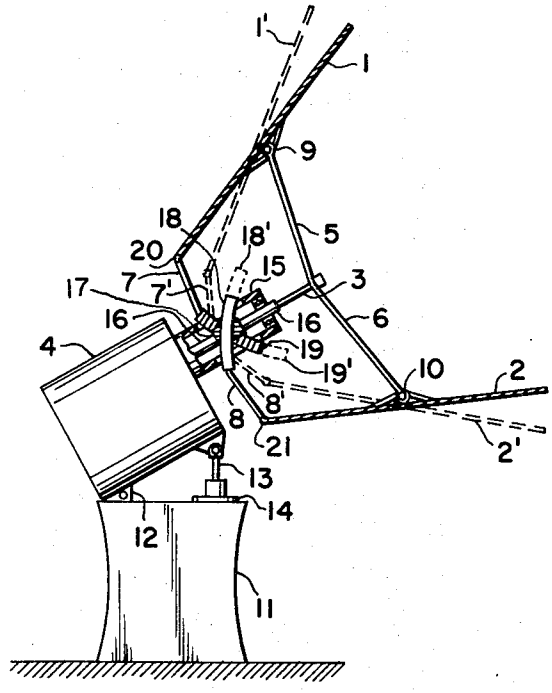
Primary Examiner—Harry N. Haroian

Attorney—J. Bradley Cohn

[57] **ABSTRACT**

A heliostat has an axle parallel to the earth's axis which is driven to revolve once each 48 hours, the axle having two oppositely disposed mirrors mounted thereon to each reflect the sun's light on alternate days, the mirrors being automatically adjusted to compensate for the declination of the sun by means of gears and a cam driven by the rotation of the axle.

9 Claims, 18 Drawing Figures



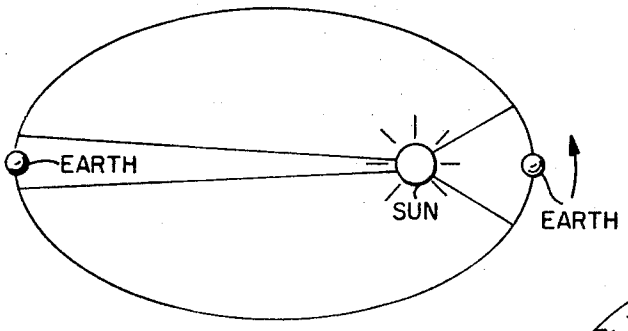


Fig. 1.

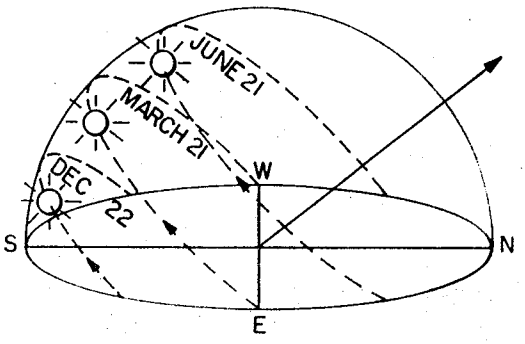


Fig. 2.

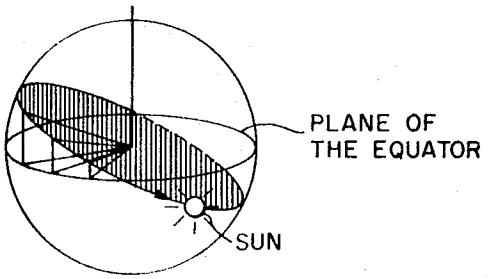


Fig. 3.

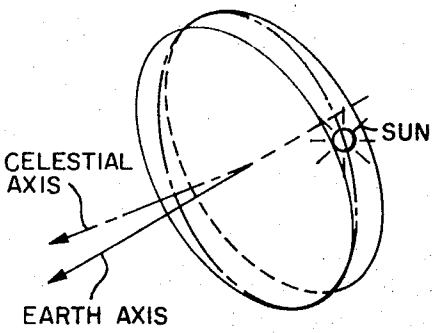


Fig. 4.

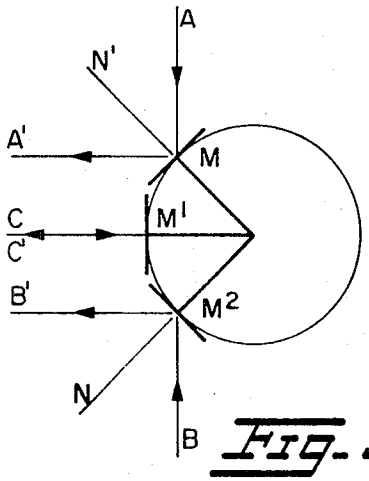


Fig. 5.

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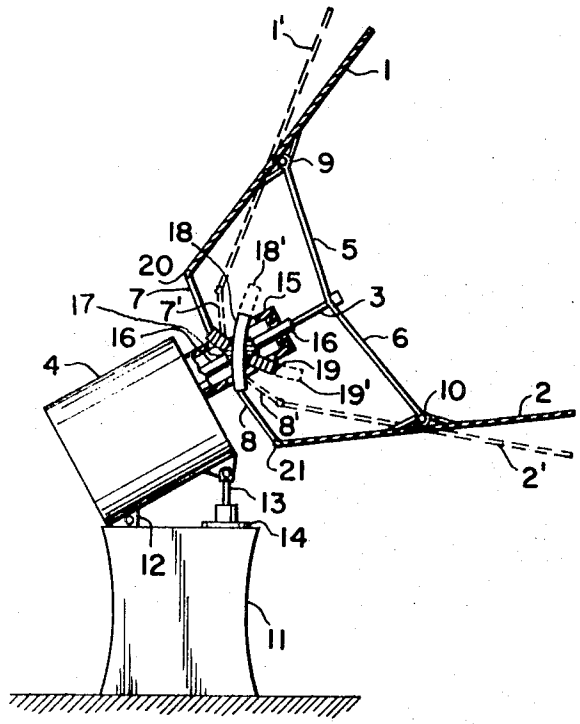


Fig. 6.

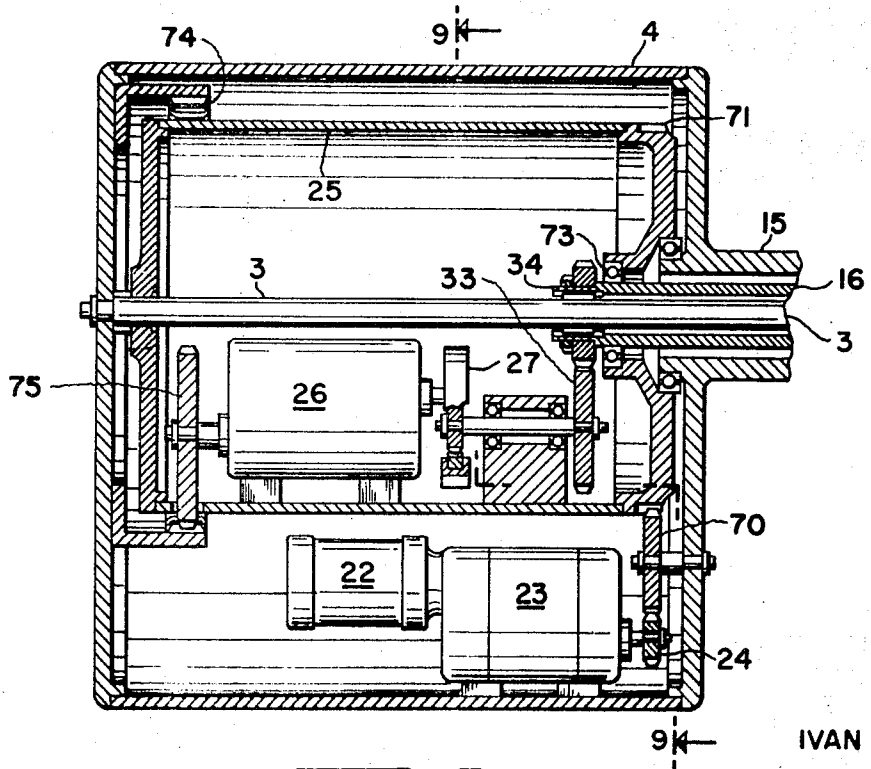


Fig. 7.

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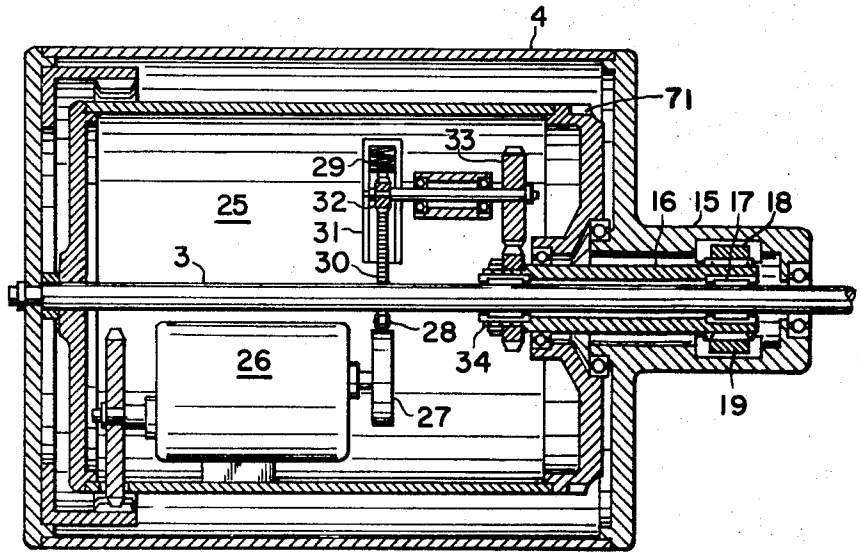


Fig. 8.

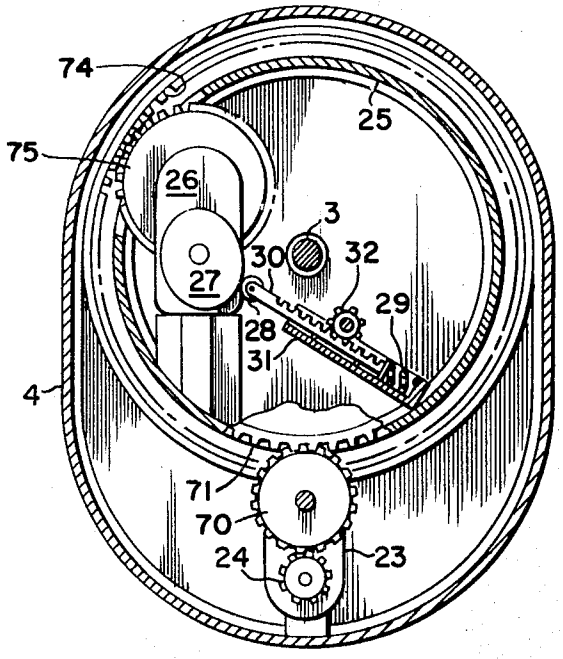


Fig. 9.

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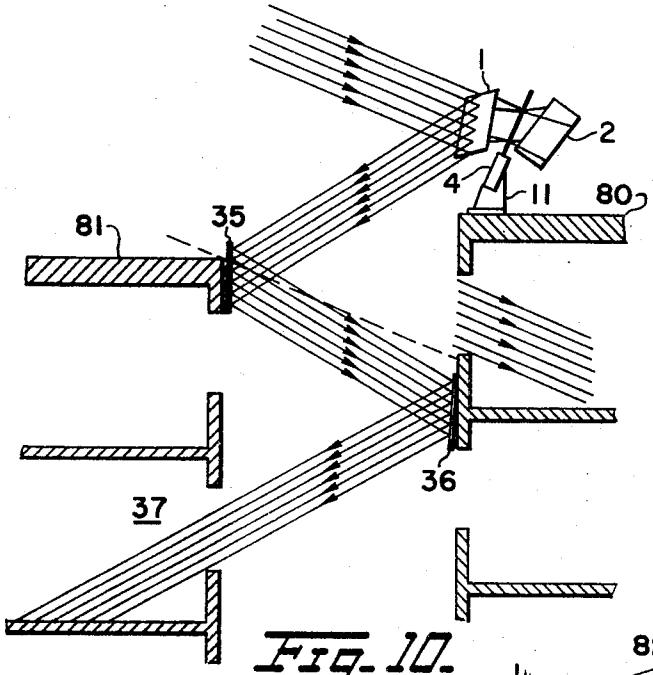


Fig. 10.

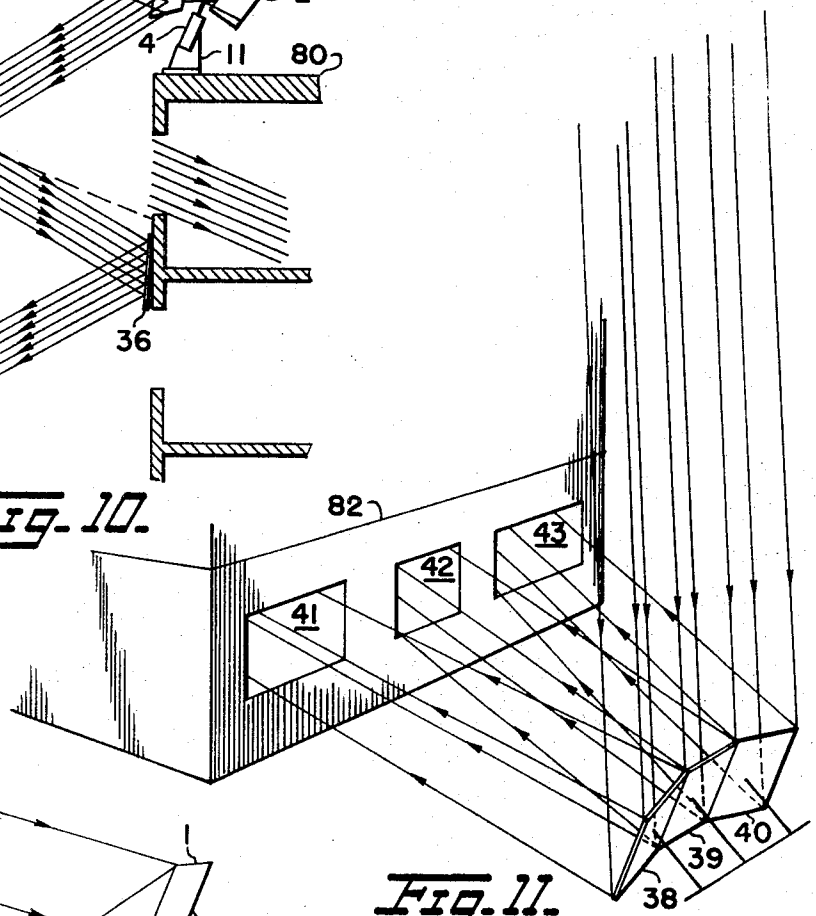


Fig. 11.

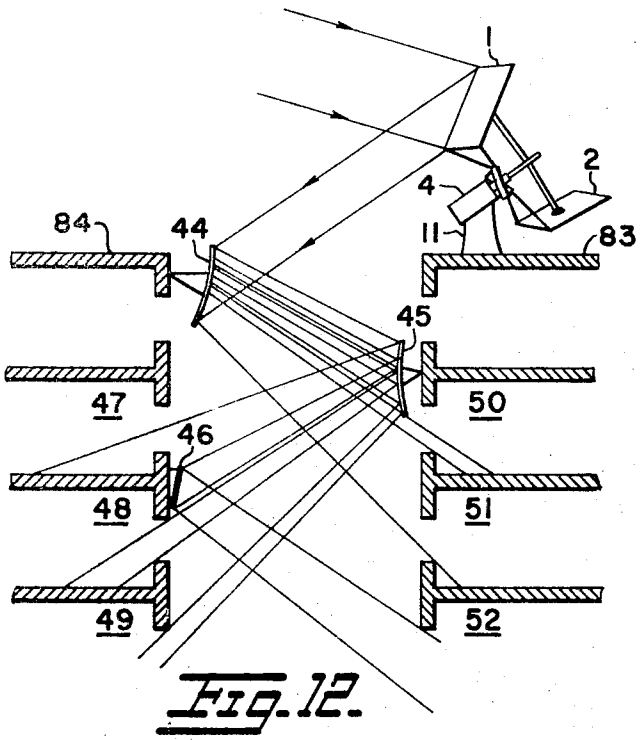


Fig. 12.

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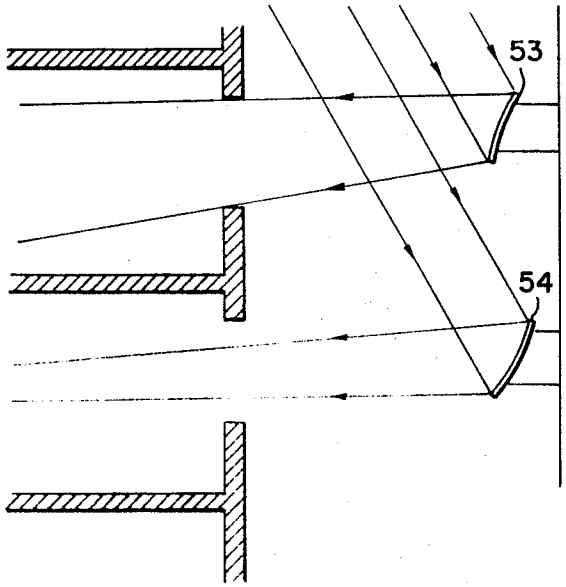


Fig. 13.



Fig. 14.

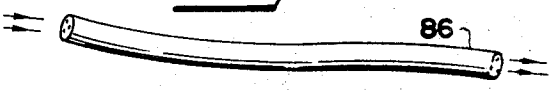


Fig. 15.

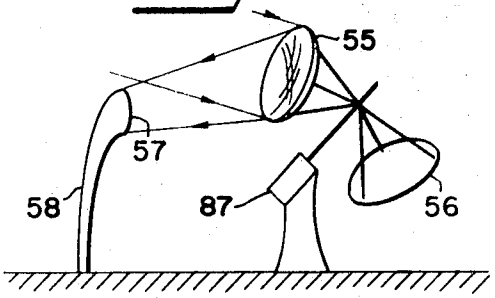


Fig. 16.

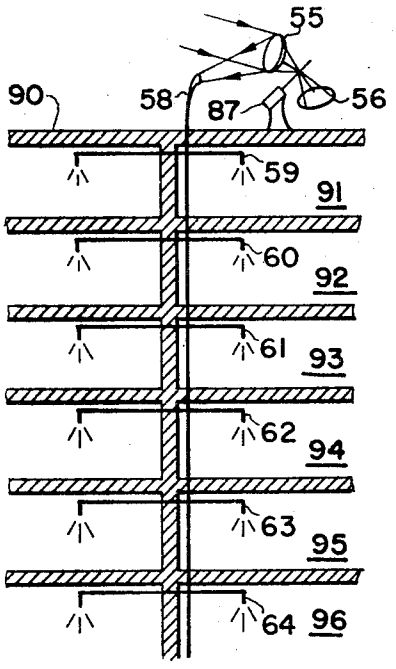


Fig. 17.

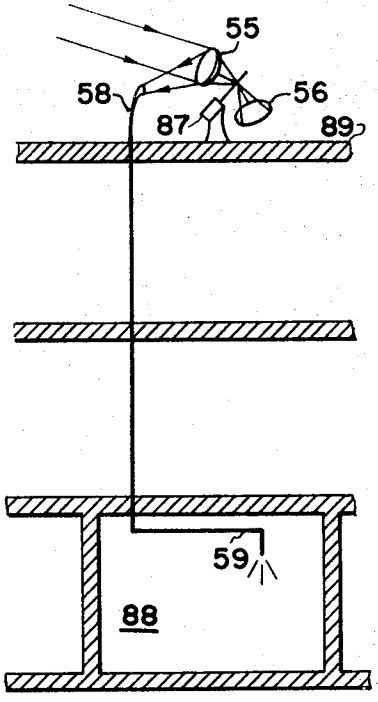


Fig. 18.

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SUN FOLLOWING DEVICE

BACKGROUND OF THE INVENTION

Heliostats to reflect the light of the sun to dwellings and for other purposes are known. This invention provides a fully automatic heliostat which is less costly, easier to orient, and more effective and reliable in use.

BRIEF DESCRIPTION OF THE DRAWING

Fig 1 is a plan view of an exaggerated orbit of the earth about the sun;

FIG. 2 is a diagram showing the positions of the plane of the apparent rotation of the sun during different seasons;

FIG. 3 is a diagram showing the position of the plane of the equator in relation to the plane of the apparent rotation of the sun;

FIG. 4 is a diagram showing the divergence of the celestial axis and the earth's axis;

FIG. 5 is a diagram of flat mirrors positioned to reflect light from three directions in a single direction;

FIG. 6 is a side view of a heliostat according to my invention with its axle housing partly broken away in section and with its mirrors shown in dotted lines in alternate positions adjusted for declination;

FIG. 7 is a vertical longitudinal section through the heliostat housing; FIG. 8 is a transverse longitudinal section through the heliostat housing;

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

FIGS 10–13 show the heliostat of this invention being used with mirrors to illuminate buildings;

FIGS. 14 and 15 show, respectively, the conduction of light through a light pipe and through a fiber optical bundle; and

FIGS. 16–18 show the heliostat of this invention being used to illuminate buildings using light pipes or optical bundles.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIG. 1, the earth makes a yearly orbit about the sun describing an ellipse having the sun at one of its foci. For this reason, the apparent speed of rotation of the earth about the sun is greater at one portion of its orbit. As shown in FIGS. 2 and 3, the sun, as seen from the earth, moves on the celestial axis with its plane of rotation varying continually throughout the year with respect to the plane of the equator. This variation is known as declination which is the angular value of the difference between the plane of the apparent rotation of the sun and the plane of the equator. The declination varies between plus and minus 23 degrees and 27 minutes. FIG. 4 shows the divergence between the axes of rotation of the earth and its orbit about the sun.

FIG. 5 is a schematic diagram of the laws of light reflection from a flat mirror in positions M, M^1, and M^2. The mirror in position M and M^2 has the perpendiculars N and N^1. In position M, the mirror reflects light from A in the direction indicated by A'. In position M^1, light from C is directly reflected back in the direction indicated by C'. In position M^2, the mirror reflects light from B in the direction indicated by B'. Thus it may be seen that in order for a mirror to reflect light in the same direction from sources moved through 180°, the mirror need only be moved through 90°. The heliostat of this invention thus moves its mirrors at one-half the apparent speed of rotation of the sum to reflect its rays in one direction.

FIG. 6 shows the heliostat of this invention. A housing 4 has an axle 3 projecting from it which is driven to make one revolution each 48 hours. Housing 4 is mounted on a base 11 by means of a hinge 12 and a jack 13 having a height adjusting wheel 14. This mounting of housing 4 allows axle 3 to be aligned with the axis of the earth. Flat mirrors 1 and 2 are attached to each side of axle 3 by means of the arms 5, 6, 7 and 8. The mirrors 1 and 2 are pivotally attached to the arms 5 and 6 by the clevis connections 9 and 10 so that they may be axially aimed.

Housing 4 has a protruding axle housing 15 which rotatably mounts axle 3 within a sleeve 16. Sleeve 16 has a gear 17 mounted on it so that right or left hand rotation of sleeve 16 relative to axle 3 will urge the rack gear sections 18 and 19 inward or outward. Since the rack gears 18 and 19 are fixed to the arms 7 and 8 which are connected to mirrors 1 and 2 by the pivots 20 and 21, relative rotation of sleeve 16 will axially aim mirrors 1 and 2. An alternate position of these elements is shown in dotted lines and indicated by the reference numerals 1', 2', 7', 8', 18' and 19'.

Since the earth turns on its axis once in 24 hours, axle 3 makes one complete revolution each 48 hours to position mirrors 1 and 2 to reflect light on alternate days. Since the angle of incidence of the sun's rays on the flat mirrors 1 and 2 is equal to the angle of reflection, the axial aiming of the mirrors 1 and 2 need only be one-half the angle of declination to follow the sun.

Referring now to FIGS. 7, 8 and 9, a synchronous motor 22 drives a reduction gear transmission 23 which, by means of gears 24 and 70, drive the drum 25 having the gear 71 formed thereon. Drum 25 is mounted on axle 3 and drives it. An internal gear 74 is mounted in housing 4 about one end of drum 25. Gear 75 extends through drum 25 to mesh with internal gear 74 and thus be driven as drum 25 rotates. Gear 75 is mounted on transmission 26 which rotates cam 27 through one complete revolution each year.

Rack gear 30 is slidably disposed in guide 31 and urged toward cam 27 by spring 29 so that roller 28 rides on cam 27. Thus rotation of cam 27 moves rack gear 30 to drive pinion 32 and gear 33 to drive gear 34 which is mounted on sleeve 16. In this manner,rotation of cam 27 axially aims the mirrors 1 and 2. Suitable high precision bearings are provided for all moving parts.

Since the flat mirrors 1 and 2 of the heliostat may be about 60 meters from the first surface that reflects them, divergence between the actual rotation of the earth and the apparent rotation of the sun may be compensated by stopping the motor 22 for short intervals with a timer (not shown) for a maximum of 2 minutes every 4 days to a minimum of 2 minutes every seven days.

As shown in FIG. 10, a heliostat according to this invention has been mounted on a building 80 to reflect light to the mirrors 35 and 36 in the apartment 37 in building 81. FIG. 11 shows light from a heliostat being reflected from three fixed and aimed mirrors 38, 39, and 40 into apartments 41, 42 and 43 in building 82. As shown in FIG. 12, a heliostat on building 83 reflects light to the convex mirrors 44 and 45 and the flat mirror 46 to light the lower apartments 47–39 in building 84 and apartments 50–52 in building 83. FIG. 13 shows how both convex mirrors 53 and concave mirrors 54 may be used to direct heliostat light into apartments.

FIGS. 14 and 15 show a light pipe 85 of Lucite or glass and a fiber optical bundle 86 both of which pass light therethrough. FIG. 16 shows a heliostat 87 having parabolic mirrors 55 and 56 which direct light into the flared end 57 of a light pipe 58. As may be seen in FIG. 18, pipe 58 terminates at 59 to light apartment 88 in building 89. FIG. 17 shows a heliostat 87 directing light into the end of a light pipe 58 which is split to light the apartments 91–96 in building 90 with the light emitting ends 59–64.

While this invention has been shown and described in the best forms known, it will nevertheless be understood that these may be modified without departing from the spirit and scope of the invention except as it may be more limited in the appended claims wherein I claim:

1. A heliostat comprising, in combination, an axle aligned with the earth's axis, means rotating said axle axle in 48 hours, means mounting two mirrors on opposite sides of said axle, each mirror reflecting the light of the sun on alternate days, each mirror moving with said axle at one-half the apparent speed of rotation of the sun, and means axially aiming said mirrors on said axle compensating for declination.

2. The combination according to claim 1 with the addition of first arms fixed to extend from opposite sides of said axle, said mirrors being pivotally mounted on said first arms, said

means axially aiming said mirrors pivoting said mirrors on said first arms.

3. The combination according to claim 2 wherein said means axially aiming said mirrors comprises a sleeve rotatably mounted on said axle, a first gear mounted on said sleeve, rack gear sections engaging opposite sides of said first gear, second arms connecting said rack gear sections to said mirrors, and means rotating said sleeve relative to said axle to axially aim said mirrors.

4. The combination according to claim 3 wherein said means rotating said axle comprises a drum disposed about said axle rotating said axle, a synchronous motor, and a first reduction gear transmission driven by said motor rotating said drum once in 48 hours.

5. The combination according to claim 4 wherein said means rotating said sleeve relative to said axle comprises a second reduction gear transmission mounted in said drum, means driving said second transmission on rotation of said drum, a cam driven by said second transmission, a cam follower engaging said cam, and means responsive to motion of said can follower rotating said sleeve relative to said axle.

6. The combination according to claim 5 wherein said means driving said second transmission on rotation of said drum comprises an internal gear disposed about said drum and a second gear mounted on said second transmission, said second gear engaging said internal gear driving said second transmission.

7. The combination according to claim 6 wherein said means responsive to said cam follower rotating said sleeve comprises a rack fixed to said cam follower, means slidably mounting said rack, means urging said rack and said cam follower toward said cam, and a pinion on said sleeve meshing with said rack, said cam sliding said rack rotating said pinion and thereby said sleeve relative to said axle.

8. The combination according to claim 1 with the addition of fixed mirrors reflecting light from said heliostat to light dwellings.

9. The combination according to claim 1 wherein said heliostat has parabolic mirrors and with the addition of light conducting means conducting light from said heliostat to light dwellings.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,656,844 Dated April 18, 1972

Inventor(s) Ivan Botskor

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 63, "sum" should read --sun--.

Claim 1, column 2, line 67, the phrase "means rotating said axle axle in 48 hours," should read --means rotating said axle once in 48 hours,--.

Signed and sealed this 19th day of September 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334