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(54) **OPTICAL SCANNER HAVING ENHANCED ITEM SIDE COVERAGE**

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Filed: **Oct. 30, 1995**

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G06K 7/10 (2006.01)

(52) **U.S. Cl.** **235/462.38**; 235/462.33; 235/462.36; 235/462.4; 235/383

(58) **Field of Classification Search** 235/462.36, 235/462.37, 462.38, 462.39, 462.4, 383, 235/384, 462.33, 454, 217, 218, 738, 379; 359/201, 212, 216, 217, 218, 738, 739
See application file for complete search history.

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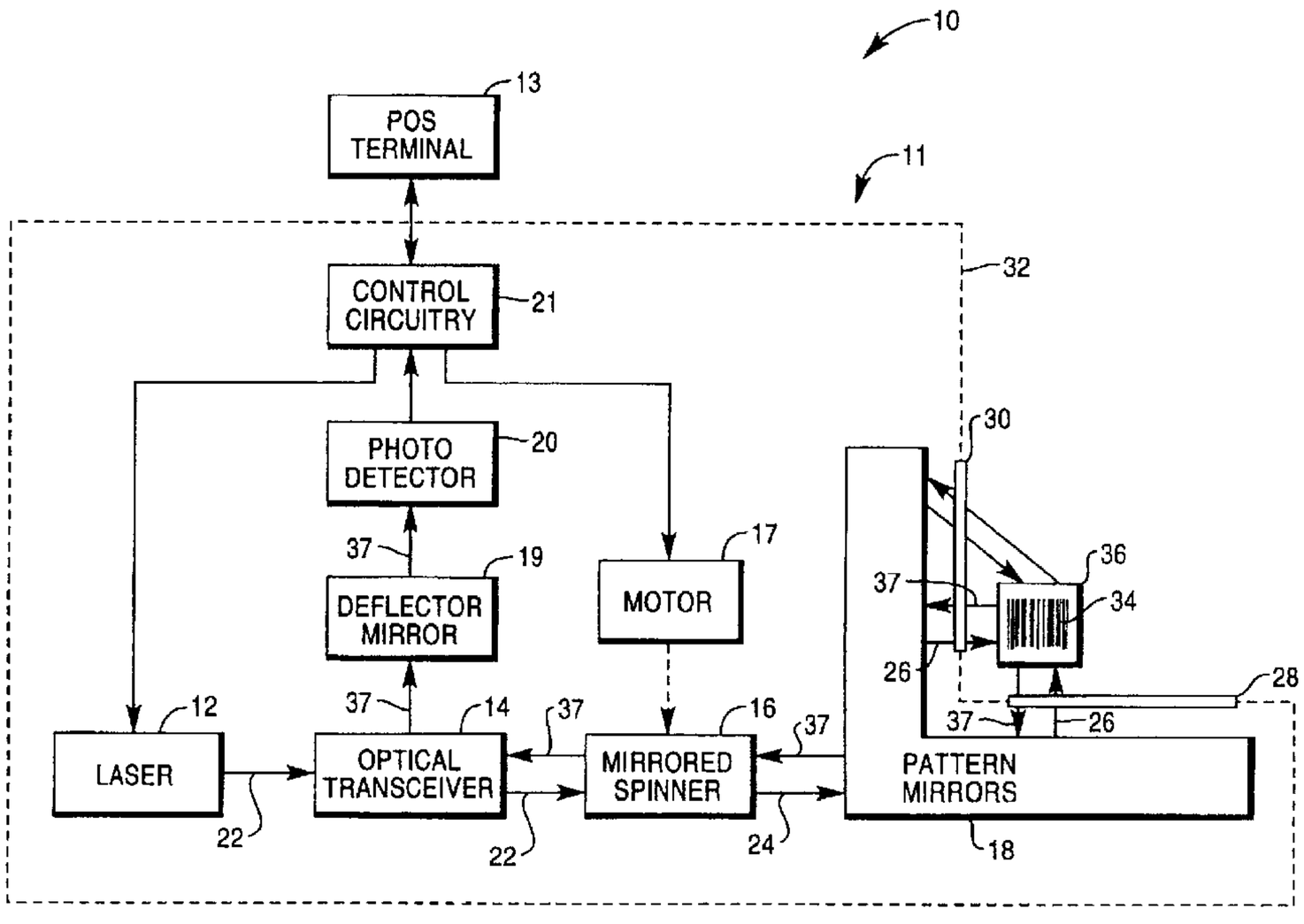
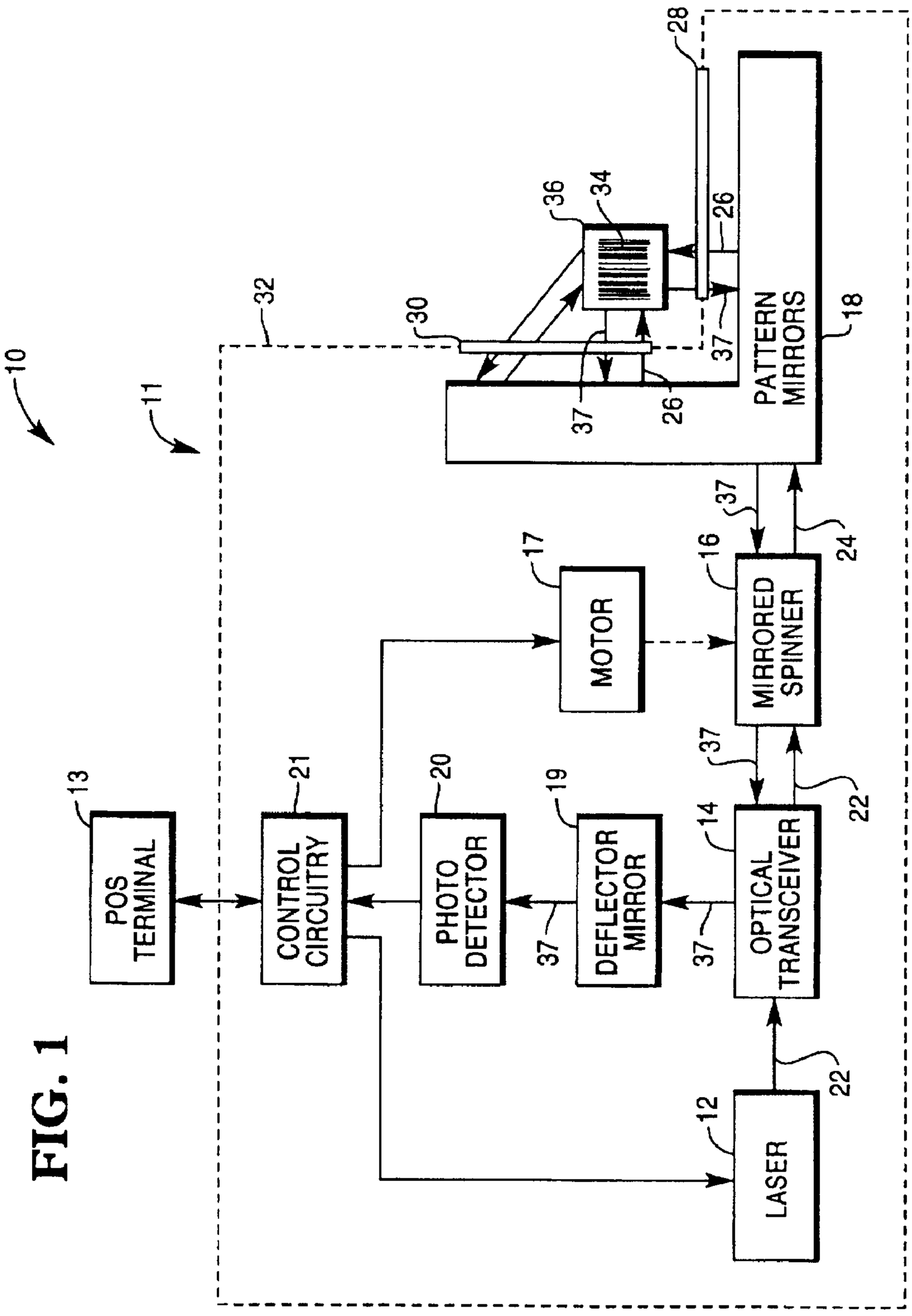
(57) **ABSTRACT**

A dual aperture optical scanner which produces horizontal, vertical, and diagonal scan patterns. The optical scanner includes a housing having a substantially vertical surface containing a first aperture and a substantially horizontal surface containing a second aperture. A laser diode produces a laser beam. A spinner produces first, second, and third groups of scanning beams. A plurality of pattern mirrors reflects the first group of scanning beams in a substantially horizontal direction through the first aperture, the second group of scanning beams in a substantially downward diagonal direction through the first aperture, and the third group of scanning beams in a substantially vertical direction through the second aperture.

34 Claims, 7 Drawing Sheets

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POS TERMINAL
CONTROL CIRCUITRY
PHOTO DETECTOR
DEFLECTOR MIRROR
OPTICAL TRANSCEIVER
MOTOR
MIRRORED SPINNER
PATTERN MIRRORS
LASER

FIG. 1

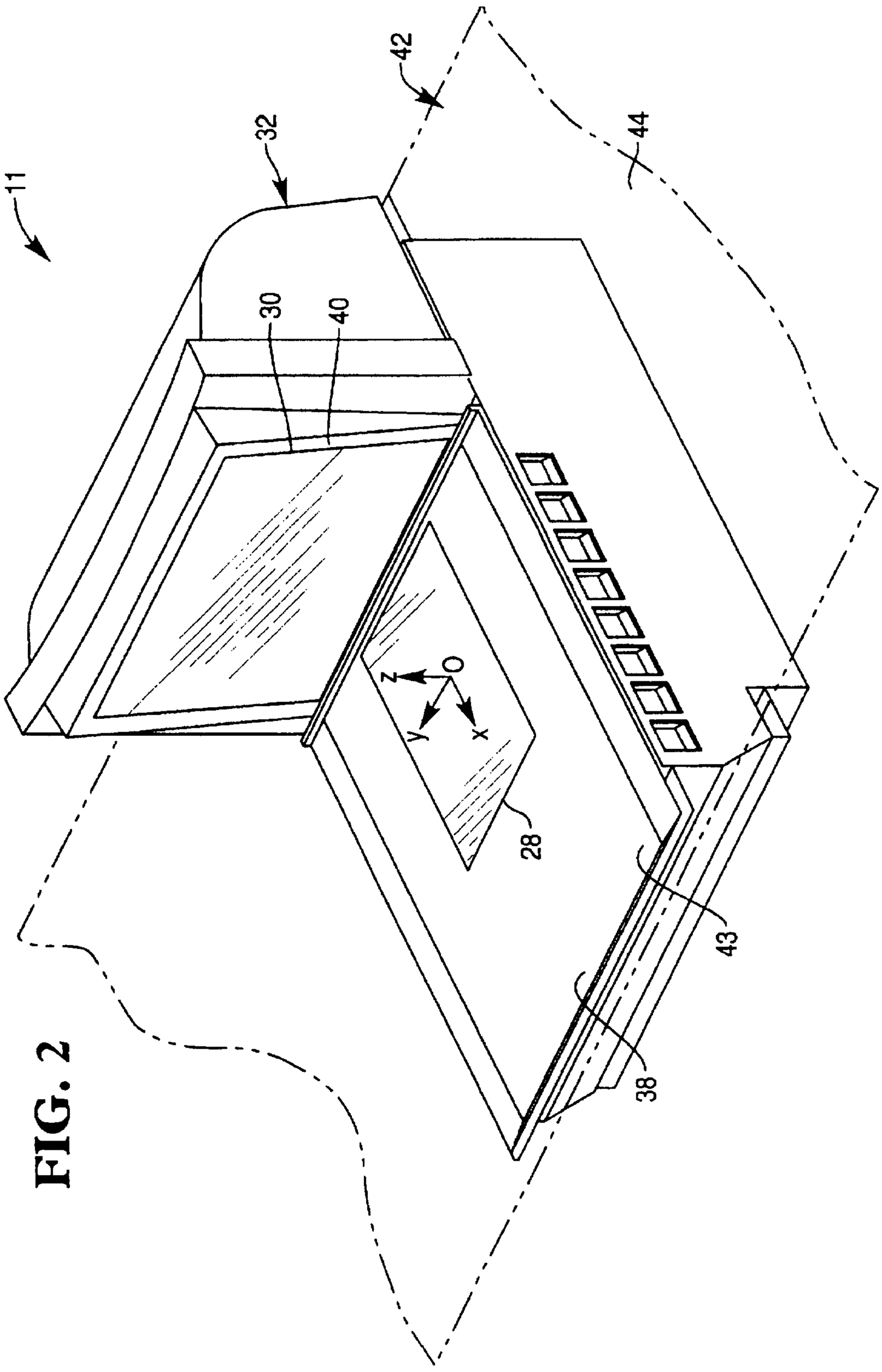
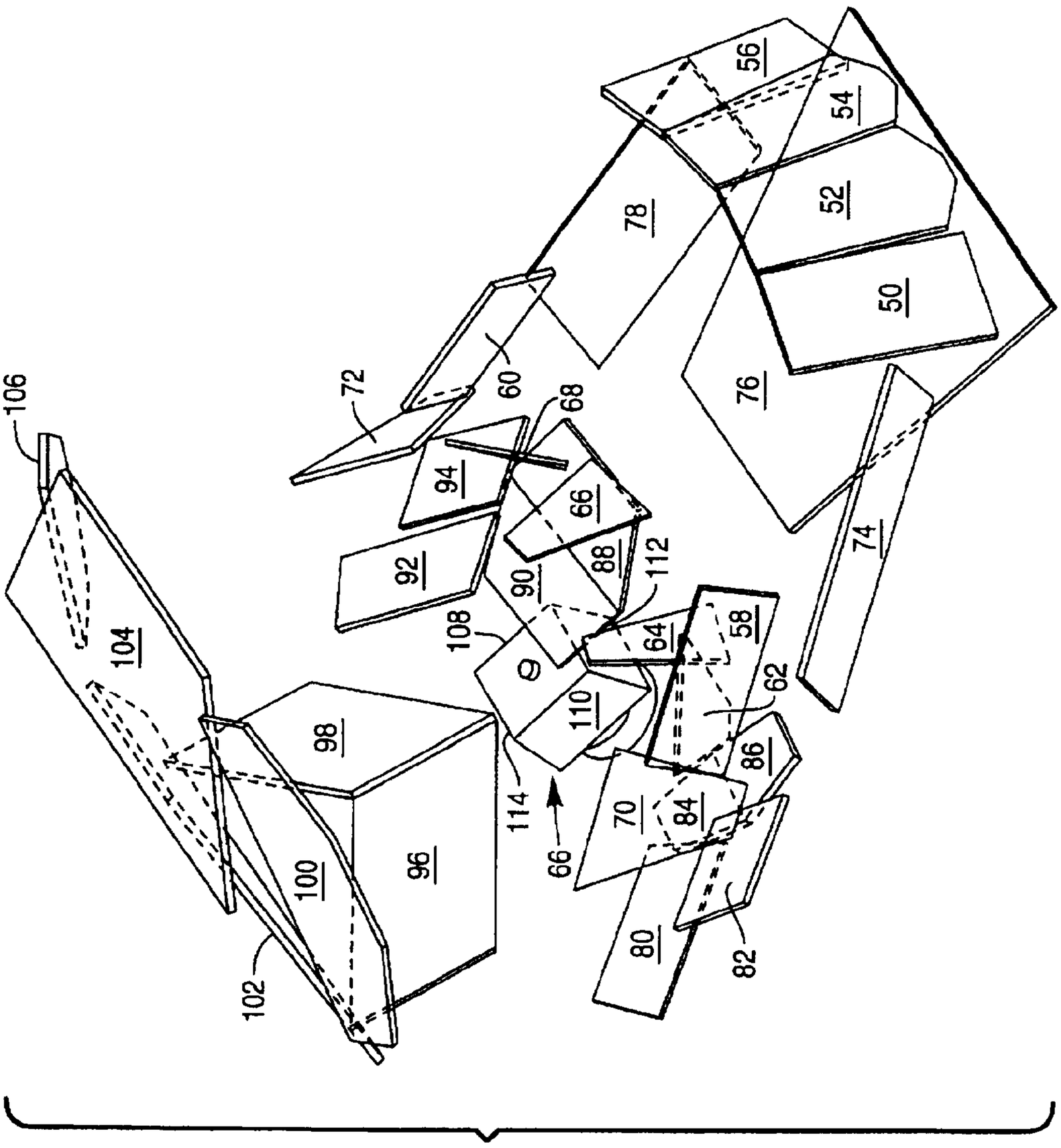


FIG. 2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114
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100
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104
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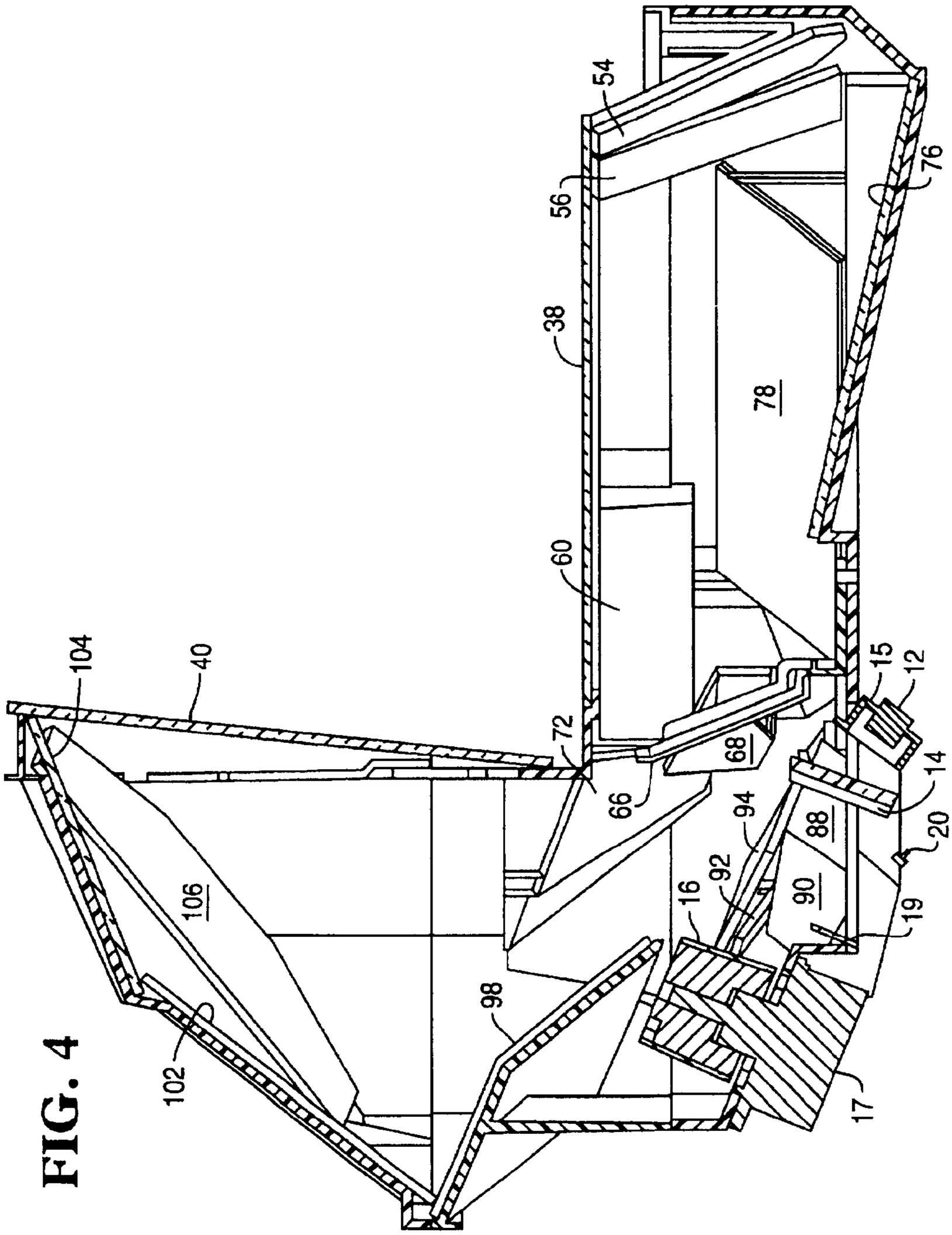
FIG. 3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102
17

FIG. 4

FIG. 5

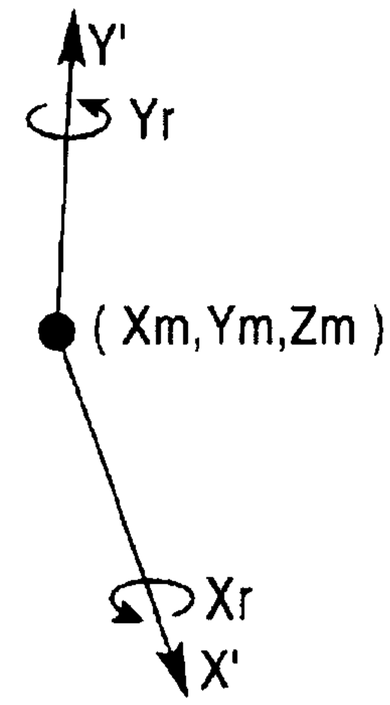

Y'
Yr
(Xm, Ym, Zm)
Xr
X'

FIG. 6

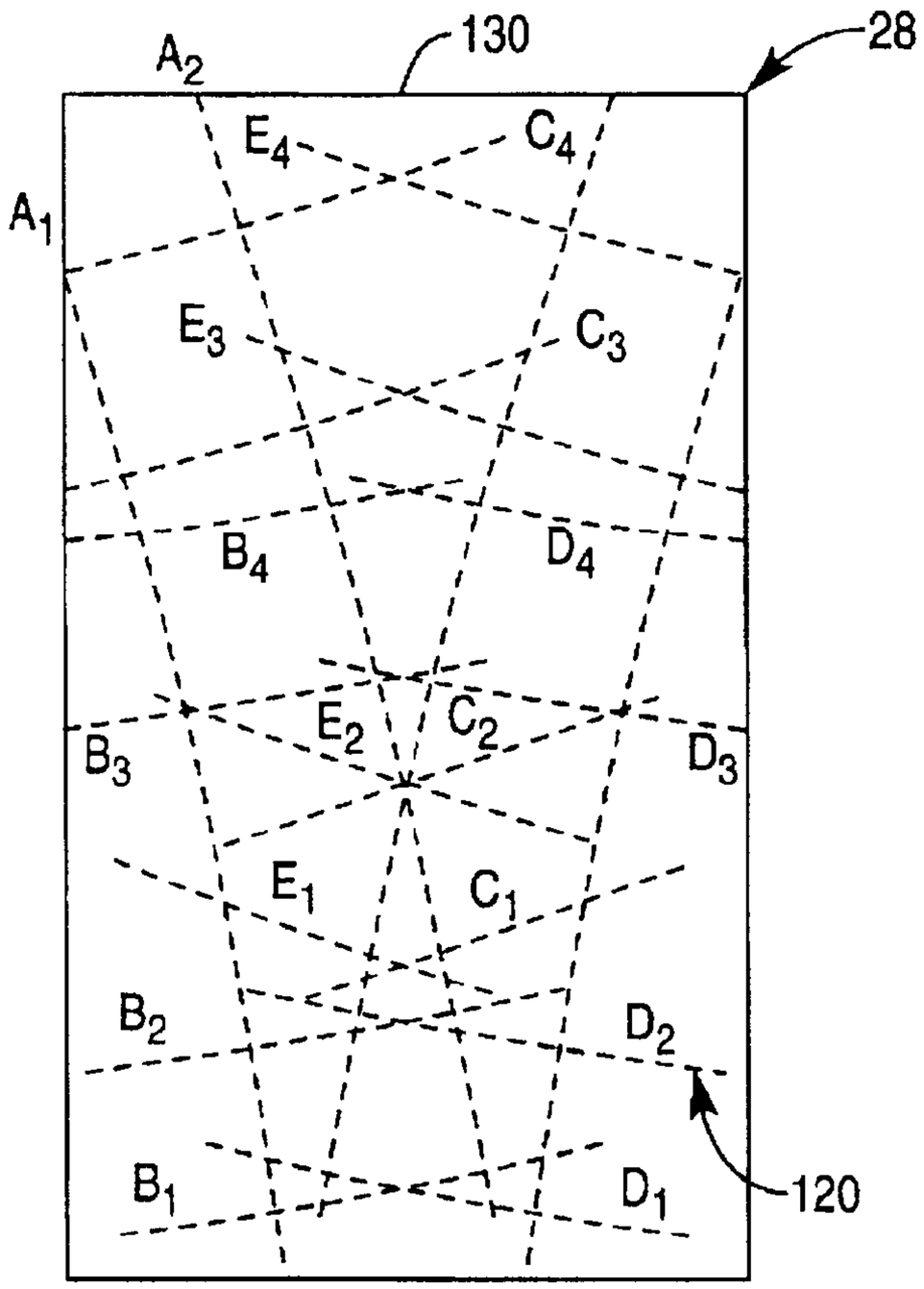

130
28
A2
E4
C4
A1
E3
C3
B4
D4
E2
C2
B3
D3
E1
C1
B2
D2
B1
D1
120

FIG. 7

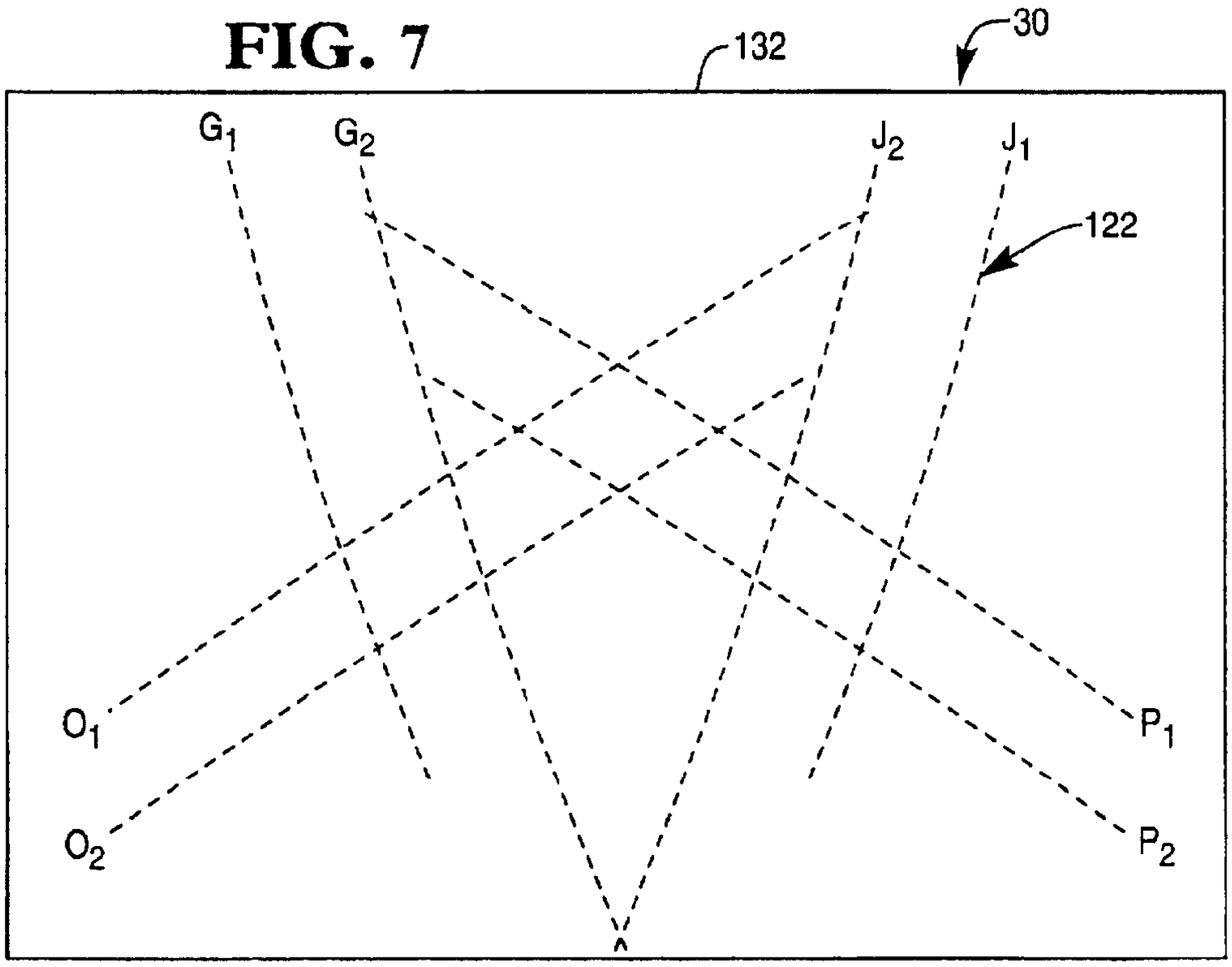

132
30
G1
G2
J2
J1
122
O1
O2
P1
P2

FIG. 8

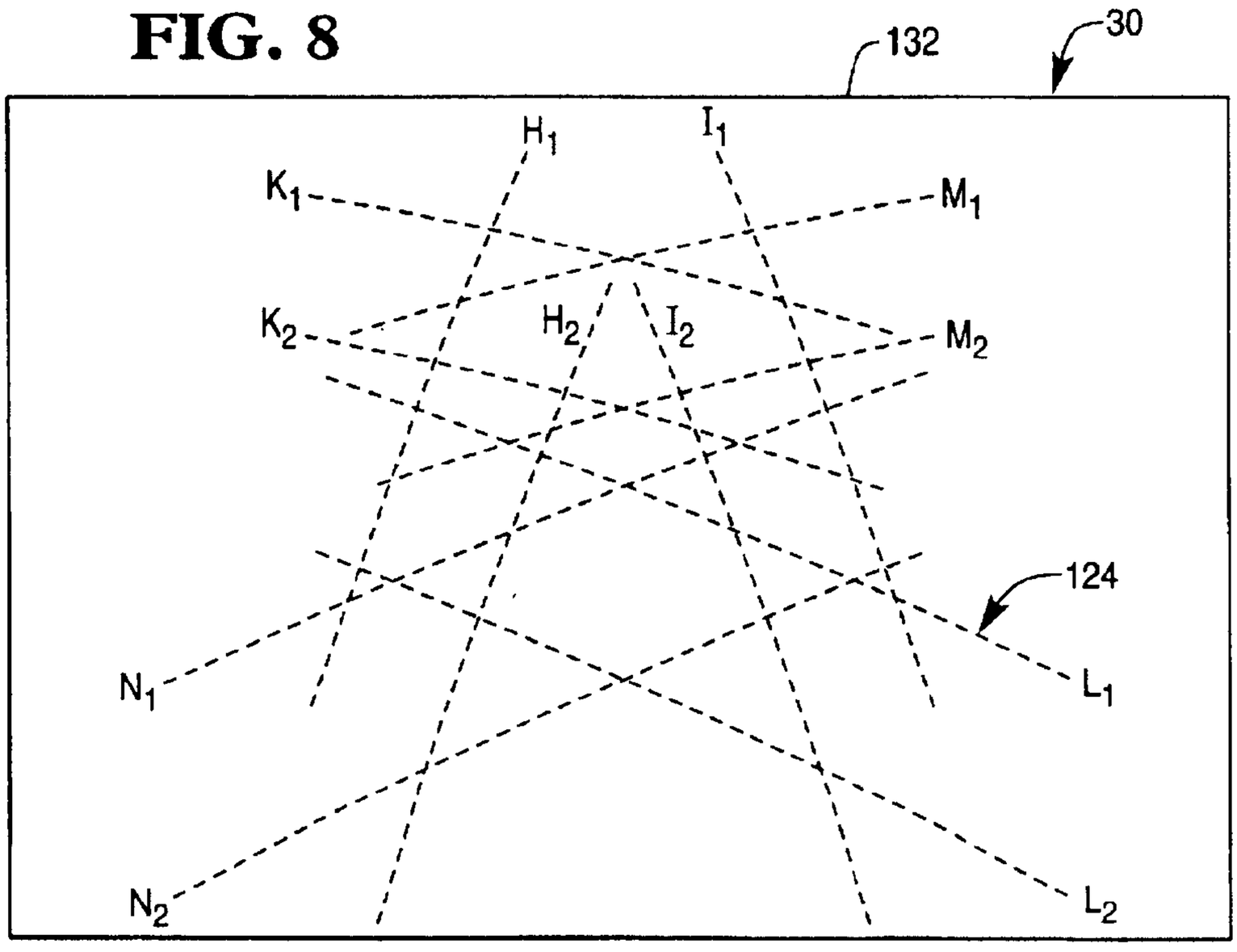
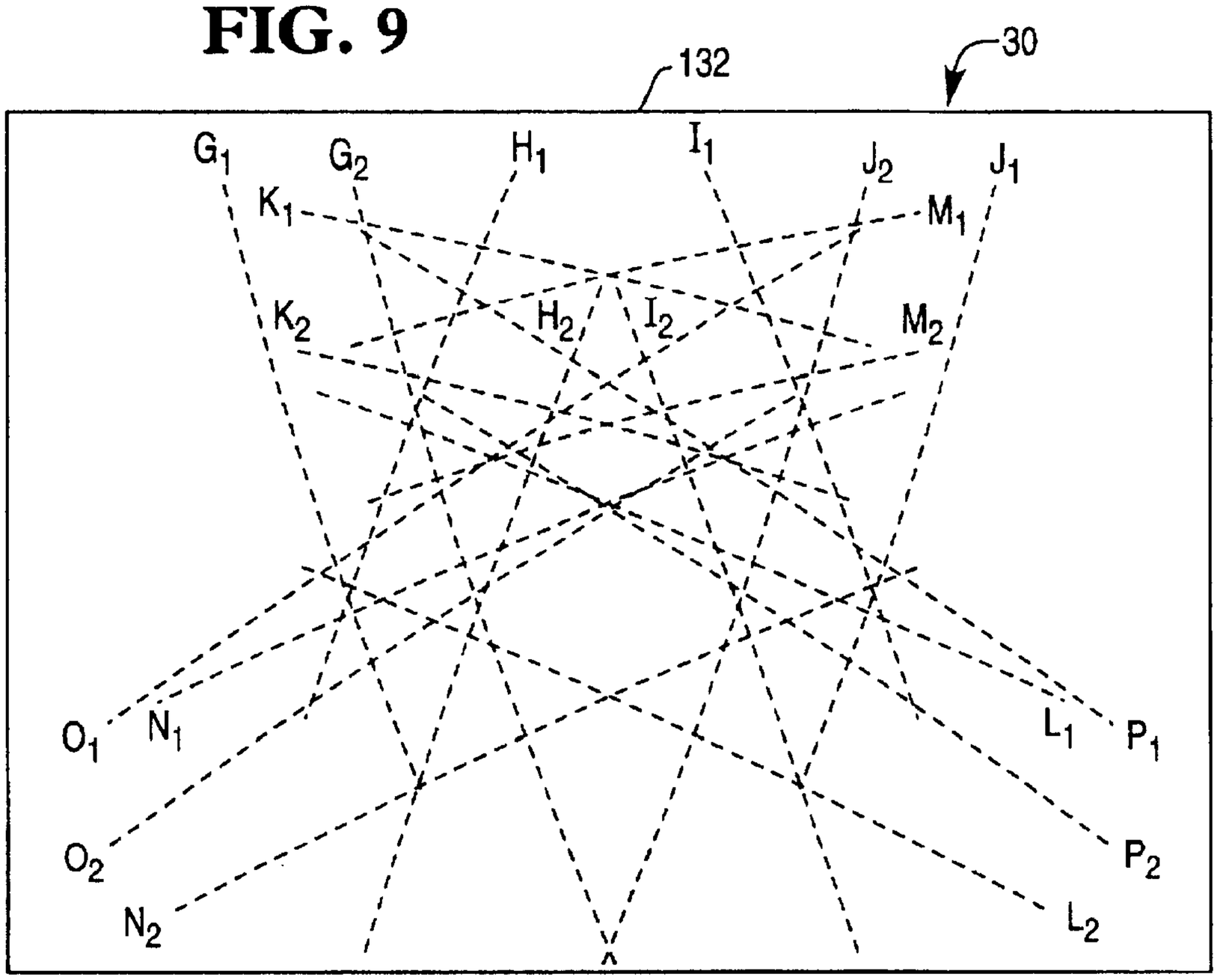

132
30
H1
I1
K1
M1
K2
H2
I2
M2
124
N1
L1
N2
L2

FIG. 9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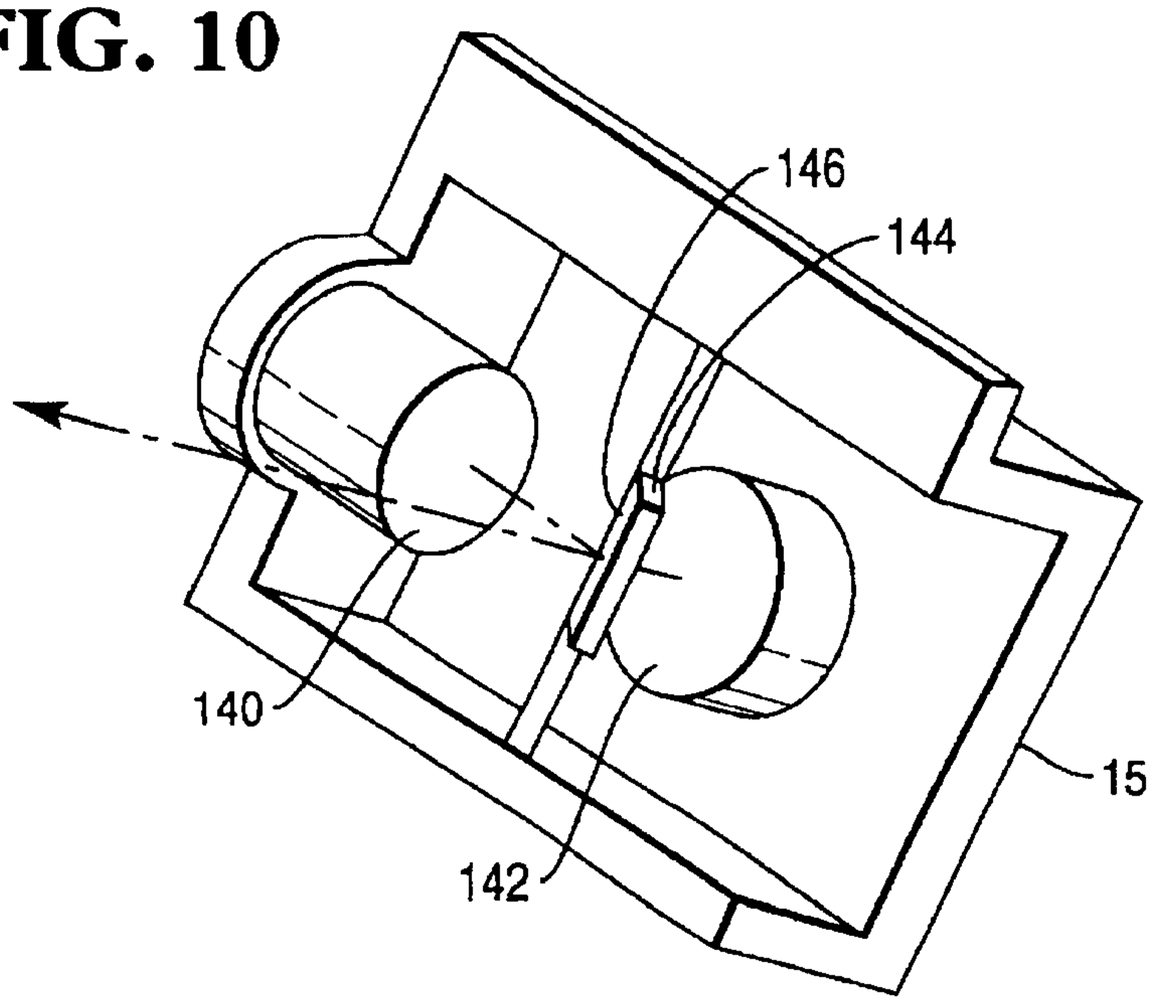
30
G1
G2
H1
I1
J2
J1
K1
M1
K2
H2
I2
M2
O1
N1
L1
P1
O2
P2
N2
L2

FIG. 10


146
144
140
142
15

OPTICAL SCANNER HAVING ENHANCED ITEM SIDE COVERAGE

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

The present invention relates to optical scanners and more specifically to an optical scanner having enhanced item side coverage.

[U.S. Pat. No. 5,229,588 to Detwiler et al. discloses a dual aperture optical scanner which includes horizontal and vertical apertures. The scanning light beams from a single laser diode pass through these apertures to provide coverage for up to four sides of a scanned item: the side facing the vertical aperture (front), the side facing the horizontal aperture (bottom), and the left and right sides.]

U.S. Pat. No. 5,229,588 to Detwiler et al. disclosed a dual aperture optical scanner which includes horizontal and vertical apertures. The scanning light beams from a single laser diode pass through these apertures to provide coverage for the bottom and sides of a scanned item.

[While this scanner requires much less item orientation than a single aperture scanner, it is not capable of scanning the top and rear sides of scanning items. Therefore, it would be desirable to provide an optical scanner which is capable of scanning as many as five sides of a typical merchandise item.]

While this scanner requires much less item orientation than a single aperture scanner, it is not capable of scanning the top of items. Therefore, it would be desirable to provide an optical scanner which is capable of scanning the top, bottom and sides of a typical merchandise item using an increased number of scan lines.

SUMMARY OF THE INVENTION

In accordance with the teachings of the present invention, an optical scanner having enhanced item side coverage is provided. The optical scanner preferably also includes a housing having first and second apertures, a laser beam source, a mirrored spinner for reflecting the laser beam in a plurality of directions, and a plurality of pattern mirrors within the housing for reflecting the laser beam from the spinner through the first and second apertures to an article having a bar code label to be scanned. Preferably, the first aperture is substantially horizontal and the second aperture is substantially vertical to maximize scan pattern coverage and to minimize required item orientation.

The optical scanner also preferably includes an optical transceiver for passing the laser beam and for collecting reflected light from the scanned article and a photodetector for generating signals representing the intensity of the light reflected from the article.

The scanner of the present invention produces horizontal, vertical, and diagonal scan patterns. A first set of pattern mirrors is positioned adjacent the horizontal aperture. A second set of pattern mirrors is positioned adjacent the vertical aperture and includes first, second, and third subsets of pattern mirrors. The spinner reflects a first group of scanning beams across the first set of pattern mirrors and out the first window, reflects a second group of scanning beams across the first and third subsets of pattern mirrors and out the second window, and reflects a third group of scanning beams across the second and third subsets of pattern mirrors and out the second window.

It is a feature of the present invention that the mirrored spinner and pattern mirrors combine to produce a plurality of scan lines which pass through the horizontal and vertical apertures. The scanner produces a scan pattern which more effectively covers multi-sided articles than single aperture scanners. The mirrored spinner includes four facets which are oriented at different angles with respect to a predetermined reference. The pattern mirrors are flat and include a first set of mirrors for reflecting the laser beam from the spinner, a second set of mirrors for reflecting the laser beam from the first set of mirrors, and for some scan lines, a third set of mirrors for reflecting the laser beam from the second set of mirrors. Preferably, the optical scanner produces forty scan lines.

It is accordingly an object of the present invention to provide an improved dual aperture optical scanner having enhanced item coverage.

It is another object of the present invention to provide an improved dual aperture optical scanner in which a first aperture is substantially vertical and a second aperture is substantially horizontal.

It is another object of the present invention to provide a dual aperture optical scanner which substantially increases the illuminated surface area of an article to be scanned.

It is another object of the present invention to provide a dual aperture optical scanner which may be suitably employ a single laser and motor for cost conscious applications in which cost may be design determinant.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional benefits and advantages of the present invention will become apparent to those skilled in the art to which this invention relates from the subsequent description of the preferred embodiments and the appended claims, taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a block diagram of the optical scanner having enhanced item side coverage of the present invention;

FIG. **2** is an exterior perspective view of the scanner of the present invention, including a reference coordinate system for the group of pattern mirrors within the scanner of the present invention;

FIG. **3** is an interior perspective view of the scanner of the present invention;

FIG. **4** is a sectional view of the scanner of the present invention along lines **4-4** of FIG. **3**;

FIG. **5** is a reference coordinate system for determining one-suitable orientation for the group of pattern mirrors within the scanner of the present invention;

FIG. **6** is a plan view of the scan pattern emanating upwardly from a horizontal aperture;

FIG. **7** is a plan view of a first scan pattern emanating outwardly from a vertical aperture;

FIG. **8** is a plan view of a second scan pattern emanating outwardly from the vertical aperture;

FIG. **9** is a plan view of the combined first and second scan patterns of FIGS. **7** and **8**; and

FIG. **10** is a perspective view of a laser assembly showing two lasers.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. **1**, a point-of-service (POS) system **10** includes optical scanner **11** and POS terminal **13**.

POS terminal **13** receives transaction data, for example, in the form of SKU numbers from scanner **11** and completes a transaction by finding price data for the SKU numbers in a price-lookup data file.

Scanner **11** of the present invention includes laser **12**, optical transceiver **14**, mirrored spinner **16**, pattern mirrors **18**, deflector mirror **19**, photodetector **20**, and control circuit **21**. Laser **12** includes a laser diode or other suitable laser source.

A focusing lens or lenses and a collimating aperture are also preferably used to produce a focused and collimated laser beam **22**. In the preferred embodiment, the laser diode emits visible light within a wavelength range of 670-690 nm and the collimating aperture and focusing lens produce a beam **22** having a beam waist of 220 microns in the center of the read zone. Other wavelengths and beam waists may be suitably employed.

Beam **22** passes through optical transceiver **14**, which includes a mirrored collecting surface and an aperture for passing beam **22**. The mirrored collecting surface preferably has an ellipsoidal or other curved surface.

Beam **22** contacts mirrored spinner **16**, which preferably has four planoreflective mirrored facets **108-114** for producing scanning beams **24** (FIG. **3**). Four facets were chosen as an optimal compromise between the increased line length created by using three facets and the increased rastering provided by spinners having more than four facets.

Scanning beams **24** impact pattern mirrors **18**, which produce a plurality of scan lines **26**. In the preferred embodiment, pattern mirrors **18** are preferably flat and produce forty scan lines **26** for each complete revolution of mirrored spinner **16**. Advantageously, all forty scan lines **26** are preferably produced by only one laser **12** and motor **17**. Use of a greater or lesser number of scan lines and pattern mirrors will be apparent to those skilled in the art.

Some scan lines **26** pass through a substantially horizontal aperture **28** and some pass through a substantially vertical aperture **30** in scanner housing **32** on their way to bar code label **34** on merchandise item **36**. Substantially vertical aperture **30** is preferably oriented at 5¾ degrees from a vertical plane. The choice of angle is chosen to optimize the scan volume and line length of the scan lines. It is desirable to achieve a ratio of the minimum length of the longest scan line to the maximum length of the shortest scan line as close as possible to one. At about ten degrees, scanning is adversely impacted for the configuration of pattern mirrors **18** illustrated herein.

According to the present invention, scan lines **26** are divided into three groups. Scan lines within a first group (Group I) emanate outwardly and downwardly from vertical aperture **30** to illuminate the top and customer sides of an item.

Scan lines within a second group (Group II) emanate outwardly from aperture **30** as three sub-groups to illuminate the customer side (Sub-group IIa), the customer and leading sides (Sub-group IIb), and customer and trailing sides (Sub-group IIc).

Scan lines from the third group (Group III) emanate upwardly from horizontal aperture **28** as three sub-groups to illuminate the bottom (Sub-group IIIa), leading side (Sub-group IIIb), and trailing side (Sub-group IIIc).

Reflected light **37** is redirected by pattern mirrors **18** towards spinner **16**, which further directs it towards optical transceiver **14**. Optical transceiver **14** directs and focuses reflected light **37** at deflector mirror **19**, which further directs reflected light **37** towards photodetector **20**. Photodetector **20** generates electrical signals representing the intensity of reflected light **37**.

Control circuitry **21** decodes bar code label **34** and controls power to laser **12** and motor **17**. Control circuitry **21** may remove power from laser **12** and motor **17** to increase the longevity of laser **12** and motor **17**. When scanner **11** is equipped with two lasers (FIG. **10**), control circuitry **21** alternates power removal from lasers **140** and **142**. For example, control circuitry **21** may remove power from laser **140** during one complete revolution of spinner **16**, and remove power from laser **142** during the following revolution.

Turning now to FIG. **2**, scanner **11** is shown in perspective. Horizontal aperture **28** is located within substantially horizontal surface **38** of housing **32**. Vertical aperture **30** is located within substantially vertical surface **40**.

Preferably, scanner **11** may be easily adapted to fit in a typical checkout counter **42**. Standard dimensions for apertures in checkout counters like checkout counter **42** are about eleven inches in length (i.e., in the direction of item flow), twenty inches in width (i.e., in the direction across the direction of item flow), and five inches deep. Thus, despite its improved scan coverage, scanner **11** easily fits within standard apertures. This is due to the optimal size and arrangement of components within scanner **11**.

It is envisioned that top surface **38** be made substantially flush with the top surface **44** of counter **42**, and also include a scale **43**. Scanner **11** is installed within checkout counter **42** so that substantially vertical aperture **30** faces a store employee.

Referring now to FIGS. **3** and **4**, the presently preferred arrangement of scanner components is shown in more detail. Laser **12** is preferably oriented at thirty-five degrees from the horizontal or X-axis as shown in FIG. **2**. Laser **12** is mounted within a bracket **15** which attaches to the lower wall of scanner **11**. Beam **22** contacts planoreflective surfaces **108-114** of mirrored spinner **16** (FIG. **4**). Spinner axis **116** is preferably oriented at twenty-two and a half degrees from a vertical or Z-axis. Facets **108-114** are preferably oriented at two and half degrees, four degrees, seven degrees, and eight and a half degrees, respectively, from spinner axis **116**. These angles cause spinner **16** to generate four different sets of scan lines (Table III below) and are chosen to balance spinner **16** as much as possible consistent with the goal of generating four different sets of scan lines.

Pattern mirrors **18** are all preferably flat mirrors. Scanning beams **24** from spinner **16** impact a first set of mirrors **50-72** and reflect therefrom to a second set of mirrors **74-98**. Mirrors **80-98** within the second set further direct beams **24** to a third set of mirrors **100-106**.

The reference coordinate system for mirrors **50-106** is shown in FIGS. **2** and **5**, and includes X, Y, and Z axes, with the Z-axis being out of the page. Coordinates Xm, Ym, and Zm are measured in inches, and angles Xr and Yr, are measured in degrees, with positive angles being measured in a counter-clockwise direction. Pattern mirrors **18** are positioned or located with respect to this coordinate system as described below. Each mirror is first oriented parallel to the X-Y plane through a point (Xm, Ym Zm). Each mirror is rotated through an angle Xr about a line X parallel to the X-axis and containing the point (Xm, Ym, Zm). Each mirror is rotated through an angle Yr about a line Y parallel to the Y-axis and containing the point (Xm, Ym Zm). Thus, these five variables uniquely define planes for mirrors **50-106** and are shown in Table I. Presently preferred values are shown.

Origin **0** is defined such that:

X=0 is on the centerline of the scanner;

Z=0 is on the centerline of the scanner; and

Y=0 is on the substantially horizontal surface **38**.

TABLE I

Mirror	Xm	Ym	Zm	Xr	Yr
50	+3.375	−0.825	+3.200	+19.50	−108.50
52	+4.200	−0.825	+0.010	+24.00	−100.00
54	+4.200	−0.825	−0.010	+24.00	−80.00
56	+3.375	−0.825	−3.200	+19.50	−71.50
58	−3.400	−2.010	+4.345	+14.00	−168.25
60	−3.400	−2.010	−4345	+14.00	−11.75
62	−3.905	−1.635	+3.850	−11.00	−125.00
64	−2.950	−3.410	+1.030	+21.50	−85.00
66	−2.950	−3.410	−1.030	+21.50	−95.00
68	−3.905	−1.635	−3.850	−11.00	−55.00
70	−5.430	−0.050	+4.720	−30.00	−132.50
72	−5.430	−0.050	−4.720	+30.00	−4730
74	−1.315	−2.300	+4.585	−30.00	−167.25
76	+4.900	−4.725	+0.000	−77.50	+90.00
78	−1.315	−2.300	−4.585	−30.00	−12.75
80	−5.185	−3.095	+3.795	−60.00	+77.50
82	−4.880	−2.910	+3.685	−66.00	+102.50
84	−4.600	−3.155	+4.040	−52.25	+136.25
86	−4.600	−3.165	+4.040	−58.75	+149.00
88	−4.600	−3.165	−4.040	−58.75	+31.00
90	−4.600	−3.155	−4.040	−52.25	+43.75
92	−5.185	−3.095	−3.795	−60.00	+102.50
94	−4.880	−2910	−3.685	−66.00	+77.50
96	−7.515	+0.485	+0.060	−37.00	+67.50
98	−7.515	+0.485	−0.060	−37.00	+112.50
100	−3.745	+6.250	+2.610	+50.00	+137.50
102	−6.420	+4.900	+0.000	+38.25	+90.00
104	−3.165	+6.275	+0.000	+69.25	+90.00
106	−3.745	+6.250	−2.610	+50.00	+42.50

Table II shows orientation and location data for the laser, spinner, and photodetector:

TABLE II

Component	Xm	Ym	Zm
Laser	−4.050	−3.940	+0.000
Spinner	−6.875	−2.175	+0.000
Photodetector	−4.645	−4.580	+0.000

In operation, laser beam **22** strikes each facet of mirrored spinner **16** in sequence. Table III summarizes the facet and mirrors involved in generating the forty scan lines (FIGS. **6-9**) during one revolution of spinner **16**. The forty scan lines are arranged in the sequence in which they are generated as spinner **16** rotates in a counter-clockwise direction as viewed from above.

TABLE III

Scan Line	Facet	Primary Mirror	Secondary Mirror	Tertiary Mirror	Group	Sub-group
H1	108	70	82	104	I	
O1	108	62	96	102	II	IIa
L1	108	64	86	104	I	
E1	108	50	76		III	IIIA
D1	108	52	76		III	IIIa
B1	108	54	76		III	IIIA
C1	108	56	76		III	IIIa
N1	108	66	88	104	I	
P1	108	68	98	102	II	IIa
I1	108	72	94	104	I	
G1	112	70	80	100	II	IIb
F2	112	58	78		III	IIIc
K1	112	64	84	104	I	
E3	112	50	76		III	IIIa
D3	112	52	76		III	IIIa
B3	112	54	76		III	IIIa
C3	112	56	76		III	IIIa
M1	112	66	90	104	I	IIIa
A2	112	60	74		III	IIIb

TABLE III-continued

Scan Line	Facet	Primary Mirror	Secondary Mirror	Tertiary Mirror	Group	Sub-group
J1	112	72	92	106	II	IIc
H2	110	70	82	104	I	
O2	110	62	96	102	II	IIa
L2	110	64	86	104	I	
E2	110	50	76		III	IIIa
D2	110	52	76		III	IIIa
B2	110	54	76		III	IIIa
C2	110	56	76		III	IIIa
N2	110	66	88	104	I	
P2	110	68	98	102	II	IIa
I2	110	72	94	104	I	
G2	114	70	80	100	II	IIb
F1	114	58	78		III	IIIc
K2	114	64	84	104	I	
E4	114	50	76		III	IIIa
D4	114	52	76		III	IIIa
B4	114	54	76		III	IIIa
C4	114	56	76		III	IIIa
M2	114	66	90	104	I	
A1	114	60	74		III	IIIb
J2	114	72	92	106	II	IIc

Referring now to FIGS. **6-9**, horizontal scan pattern **120**, vertical scan pattern **122**, and top-down scan pattern **124** are shown. Some of scan lines **26** appear to be curved. This is because scan beams **24** from spinner **16** do not lie in a flat plane; they lie on the surface of a shallow cone. The curvature of scan lines **26** represents the intersection of that cone and a particular intersecting plane (e.g., an aperture). The amount of curvature depends on the relative angle between the projected cone and this plane. Since the cone of light projects at different angles for the various scan lines **26**, scan lines **26** may appear to have different curvatures.

Horizontal scan pattern produces Group III scan lines which emanate from horizontal aperture **28**. Scan lines within Sub-group IIIa include B**1**-B**4**, C**1**-C**4**, D**1**-D**4**, and E**1**-E**4**. Scan lines within Sub-group IIIb include A**1**-A**2**. Scan lines within Sub-group IIIc include F**1**-F**2**. Side **130** of aperture **28** is the operator side.

Vertical scan pattern **122** (FIG. **7**) produces Group II scan lines which emanate from vertical aperture **30**. Scan lines within Sub-group IIa include **01**-**02** and P**1**-P**2**. Scan lines within Sub-group IIb include G**1**-G**2**. Scan lines within Sub-group IIc include J**1**-J**2**. Side **132** of aperture **30** is the top side.

Top-down scan pattern **124** (FIG. **8**) produces Group I scan lines which emanate from vertical aperture **30** and include scan lines H**1**-H**2**, Ii-I**2**, K**1**-K**2**, L**1**-L**2**, M**1**-M**2**, and N**1**-N**2**.

FIG. **9** illustrates the combined scan lines emanating from vertical aperture **30**.

Turning now to FIG. **10**, bracket **15** may contain two lasers **140** and **142**. Lasers **140** and **142** are preferably combined such that their laser beams are co-linear. This is accomplished by using a transparent window **144** with one partially reflective side **146**. Window **144** is mounted on a support member and placed in front of laser **140** so that its beam strikes window **144** at a forty-five degree incidence angle. Laser **142** is oriented so that its beam is orthogonal to the beam of laser **140** and has a forty-five degree incidence angle with window **146**. The resulting co-linear beams of both lasers **140** and **142** are parallel to and substantially co-linear with the path of the beam of laser **12** in the single-laser embodiment.

Additional lasers may be easily incorporated by adding additional windows. Bracket **15** may be easily modified to accommodate three or more lasers.

Preferably, lasers **140** and **142** are substantially identical and have substantially identical foci. The foci are preferably

offset to increase the effective depth of field of scanner **11**. Alternatively, the foci of lasers **140** and **142** may be different to enable scanner **11** to read bar codes of various spatial frequencies.

Although the invention has been described with particular reference to certain preferred embodiments thereof, variations and modifications of the present invention can be effected within the spirit and scope of the following claims.

What is claimed is:

[1. An optical scanner comprising:

a housing having a substantially vertical surface containing a first aperture and a substantially horizontal surface containing a second aperture;

a single laser which produces a laser beam within the housing;

a polygon spinner having mirrored facets for reflecting the laser beam in a plurality of directions to produce a plurality of scanning beams including a first group of scanning beams, a second group of scanning beams, and a third group of scanning beams; and

a plurality of pattern mirrors, including a plurality of groups of pattern mirrors, for reflecting the first group of scanning beams through the first aperture to produce a first scan pattern consisting of a plurality of intersecting scan lines, for reflecting the second group of scanning beams through the first aperture to produce a second scan pattern consisting of a plurality of intersecting scan lines, and for reflecting the third group of scanning beams through the second aperture to produce a third scan pattern consisting of a plurality of intersecting scan lines.**]**

[2. The optical scanner as recited in claim **1**, further comprising:

an optical transceiver for passing the laser beam and for collecting reflected light from the scanned article; and

a photodetector for generating signals representing the intensity of the light reflected from an article having a bar code label to be scanned.**]**

[3. The optical scanner as recited in claim **1**, wherein the housing comprises:

a substantially horizontal surface containing the first aperture; and

a substantially vertical surface containing the second aperture.**]**

[4. The optical scanner as recited in claim **1**, wherein the laser comprises a laser diode.**]**

[5. The optical scanner as recited in claim **1**, wherein the spinner has four planoreflective facets.**]**

[6. The optical scanner as recited in claim **5**, wherein the four facets are oriented at different angles with respect to a predetermined reference.**]**

[7. The optical scanner as recited in claim **6**, wherein the angles of pairs of opposite facing facets have values which tend to balance the spinner.**]**

[8. The optical scanner as recited in claim **1**, wherein the pattern mirrors are flat.**]**

[9. The optical scanner as recited in claim **1**, wherein the pattern mirrors comprise:

a first group of mirrors for reflecting the laser beam from the spinner;

a second group of mirrors for reflecting the laser beam from the first group of mirrors; and

a third group of mirrors for reflecting the laser beam from some of the mirrors in the second group of mirrors.**]**

[10. An optical scanner comprising:

a housing including a substantially vertical surface containing a first aperture and a substantially horizontal surface containing a second aperture;

a laser diode for producing a laser beam;

an optical transceiver for passing the laser beam and for collecting reflected light from an article having a bar code label to be scanned;

a spinner having a plurality of sides oriented at different angles with respect to a predetermined reference for reflecting the laser beam in a plurality of directions to produce a plurality of scanning beams, and for directing light from the article to the optical transceiver; and

a plurality of pattern mirror for reflecting a first group of scanning beams in a substantially horizontal direction through the first aperture, a second group of scanning beams in a substantially downward diagonal direction through the first aperture, and a third group of scanning beams in a substantially vertical direction through the second aperture and including a first group of mirrors for reflecting the laser beam from the spinner, a second group of mirrors for reflecting the laser beam from the first group of mirrors, and a third group of mirrors for reflecting the laser beam from some of the mirrors in the second group of mirrors; and

a photodetector for generating signals representing the intensity of the light reflected from the article.**]**

[11. A method for scanning an article having a bar code label with minimal article orientation comprising the steps of:

(a) generating a single laser beam;

(b) providing a polygon spinner including a plurality of mirrored facets;

(c) reflecting the laser beam from the polygon spinner at a plurality of pattern mirrors within a scanner housing; and

(d) reflecting a first group of scan lines from the pattern mirrors through a vertical aperture within the scanner housing to produce a first scan pattern consisting of a plurality of intersecting scan lines, reflecting a second group of scan lines from the pattern mirrors through said vertical aperture within the scanner housing to produce a second scan pattern consisting of a plurality of intersecting scan lines, and reflecting a third group of scan lines through a horizontal aperture within the scanner housing to produce a third scan pattern consisting of a plurality of intersecting scan lines.**]**

[12. The method as recited in claim **11**, further comprising the step of:

(e) moving the article through the scan lines.**]**

[13. The method as recited in claim **11**, wherein step (c) comprises the substep of:

(1) rotating a spinner having a plurality of mirrored facets in the path of the laser beam, each facet having a predetermined elevation angle; and

(2) reflecting the laser beam from each of the facets in turn as the spinner rotates.**]**

[14. The method as recited in claim **13**, wherein the spinner has four mirrored facets.**]**

[15. The method as recited in claim **13**, wherein substep (c-1) comprises the substep of:

(A) energizing a motor coupled to the spinner.**]**

[16. The method as recited in claim **11**, wherein step (d) comprises the substeps of:

(1) reflecting the laser beam from the spinner by a first group of the pattern mirrors; and

(2) reflecting the laser beam from the first group of the pattern mirrors to a second group of the pattern mirrors; and

(3) reflecting the laser beam from some of the pattern mirrors in the second group to a third group of the pattern mirrors.]

[17. The method as recited in claim 16 wherein substep (d) further comprises:

(3) reflecting a first group of the scan lines through the vertical aperture in a substantially horizontal direction through the first aperture;

(4) reflecting a second group of scanning beams in a substantially downward diagonal direction through the first aperture; and

(5) reflecting a third group of the scan lines through the horizontal aperture in a substantially vertical direction through the second aperture.]

[18. A method of scanning an item having a bar code from multiple directions, comprising the steps of

generating laser light;

providing a single multi-faceted mirrored polygon in a path of said laser light;

generating a first group of scanning beams, a second group of scanning beams, and a third group of scanning beams by reflecting said laser light off said mirror polygon;

directing said first group of scanning beams through a first transparent member oriented in a first plane to scan a surface of the item from one orthogonal direction;

directing said second group of scanning beams through the first transparent member oriented in the first plane to scan the item from a diagonal direction; and

directing said third group of scanning beams through a second transparent member oriented in a second plane orthogonal to said first plane to scan the item from another orthogonal direction.]

[19. A method of scanning an item having a bar code from multiple directions, comprising the steps of

providing a single multi-faceted mirror polygon in a scanner housing;

impinging laser light onto said mirror polygon;

rotating said mirror polygon;

generating a first group of scanning beams, a second group of scanning beams, and a third group of scanning beams by reflecting said laser light off said mirror polygon as it is being rotated;

directing said first group of scanning beams through a first transparent member oriented in a first plane to scan a surface of the item from a first orthogonal direction;

directing said second group of scanning beams through the first transparent member oriented in the first plane to scan the item from a diagonal direction; and

directing said third group of scanning beams through a second transparent member oriented in a second plane at about ninety degrees to said first plane to scan the item from another orthogonal direction.]

[20. A method of scanning an item having a bar code label thereon from multiple directions, comprising the steps of:

generating laser light;

providing a single multi-faceted mirror polygon in a scanner housing;

producing a first group of scanning beams, a second group of scanning beams, and a third group of scanning beams by reflecting the laser light off the mirrored polygon;

directing the first, second, and third groups of scanning beams to a first group of pattern mirrors;

reflecting the first, second, and third groups of scanning beams off the first group of pattern mirrors towards a second group of pattern mirrors;

reflecting the first group of scanning beams off the second group of pattern mirrors and out a first surface to produce a first scan pattern consisting of a plurality of intersecting scan lines;

reflecting the second and third groups of scanning beams off the second group of pattern mirrors towards a third group of pattern mirrors;

reflecting the second group of scanning beams off the third group of pattern mirrors and out a second surface which is arranged orthogonally to the first surface to produce a second scan pattern consisting of a plurality of intersecting scan lines; and

reflecting the third group of scanning beams off the third group of pattern mirrors and out the second surface to produce a third scan pattern consisting of a plurality of intersecting scan lines.]

[21. A bar code scanning system comprising:

a housing having a first window and a second window arranged generally orthogonally to one another;

a first set of pattern mirrors positioned adjacent the first window;

a second set of pattern mirrors positioned adjacent the second window, including first, second, and third subsets of pattern mirrors;

a laser within the housing which produces a laser beam;

a single scanning means within the housing comprising a mirror polygon; and

a motor for rotating the mirror polygon;

wherein said mirror polygon reflects a first group of scanning beams across the first set of pattern mirrors and out the first window, reflects a second group of scanning beams across the first and third subsets of pattern mirrors and out the second window, and reflects a third group of scanning beams across the second and third subsets of pattern mirrors and out the second window.]

22. A mirror assembly for use in an optical scanner having a substantially vertical aperture and a substantially horizontal aperture, comprising:

a first set of pattern mirrors including at least primary and secondary mirrors, and at least one tertiary mirror;

a second set of pattern mirrors including at least primary, secondary, and tertiary mirrors;

a third set of pattern mirrors including at least primary and secondary mirrors;

wherein each of the primary mirrors of the first set being disposed to receive an incident light beam at an oblique angle to reflect the incident beam onto at least one of the secondary mirrors of the first set;

wherein each of the secondary mirrors of the first set being disposed to receive an incident light beam at an oblique angle to reflect the incident beam onto at least one of the tertiary mirrors of the first set;

wherein the tertiary mirror of the first set being disposed at an oblique angle with respect to an incident light beam from at least one of the secondary mirrors of the first set, and positioned to reflect the incident beam outwardly and downwardly through said substantially vertical aperture;

wherein each of the primary mirrors of the second set being disposed to receive an incident light beam at an oblique angle to reflect the incident beam onto at least one of the secondary mirrors of the second set;

wherein each of the secondary mirrors of the second set being disposed to receive an incident light beam at an

oblique angle to reflect the incident beam onto at least one of the tertiary mirrors of the second set;

wherein each of the tertiary mirrors of the second set being disposed at an oblique angle with respect to an incident light beam from at least one of the secondary mirrors of the second set, and positioned to reflect the incident beam through said substantially vertical aperture;

wherein each of the primary mirrors of the third set being disposed to receive an incident light beam at an oblique angle to reflect the incident beam onto at least one of the secondary mirrors of the third set;

wherein each of the secondary mirrors of the third set being disposed to receive an incident light beam at an oblique angle to reflect the incident beam through said substantially horizontal aperture;

wherein the primary mirrors of the first set include a plurality of generally trapezoidal mirrors;

wherein the secondary mirrors of the first set operate to receive a light beam from said generally trapezoidal mirrors; and

wherein the tertiary mirror of the first set is a generally trapezoidal mirror which operates to receive a light beam from said secondary mirrors of the first set.

23. A mirror assembly for use in an optical scanner having a substantially horizontal aperture and a substantially vertical aperture, comprising:

a first set of pattern mirrors including at least primary and secondary mirrors, and at least one tertiary mirror;

a second set of pattern mirrors including at least primary, secondary, and tertiary mirrors;

a third set of pattern mirrors including at least primary and secondary mirrors;

a source of light beams;

wherein the primary mirrors of the first set are disposed at oblique angles with respect to an incident light beam from said source, to reflect the light beam onto the secondary mirrors of the first set;

wherein the secondary mirrors of the first set are disposed at oblique angles with respect to an incident light beam from said source, to reflect the light beam onto the tertiary mirror of the first set;

wherein the tertiary mirror of the first set is disposed at oblique angles with respect to an incident light beam from the secondary mirrors of the first set, and positioned to reflect light outwardly and downwardly through said substantially vertical aperture;

wherein the primary mirrors of the second set are disposed at oblique angles with respect to an incident light beam from said source, to reflect light onto the secondary mirrors of the second set;

wherein the secondary mirrors of the second set are disposed at oblique angles with respect to an incident light beam from said source, to reflect light onto the tertiary mirrors of the second set;

wherein the tertiary mirrors of the second set are disposed at oblique angles with respect to an incident light beam from the secondary mirrors of the second set, and positioned to reflect light outwardly through said substantially vertical aperture;

wherein the primary mirrors of the third set are disposed at oblique angles with respect to an incident light beam from said source, to reflect light onto the secondary mirrors of the third set;

wherein the secondary mirrors of the third set are disposed at oblique angles with respect to an incident light beam from the primary mirrors of the third set, and positioned to reflect light outwardly through said substantially horizontal aperture;

wherein the primary mirrors of the first set include a plurality of generally trapezoidal mirrors;

wherein the secondary mirrors of the first set operate to receive a light beam from said generally trapezoidal mirrors; and

wherein the tertiary mirror of the first set is a generally trapezoidal mirror which operates to receive a light beam from said secondary mirrors of the first set.

24. An optical scanner for scanning the surfaces of an object by means of light beams from a substantially vertical aperture and a substantially horizontal aperture, comprising:

a housing having said substantially vertical and horizontal apertures;

a rotating mirror polygon positioned at a predetermined location within an area in said housing;

at least first, second, and third sets of pattern mirrors located within the housing along the periphery of said area;

said first set of pattern mirrors being located in one region along said periphery, and having primary and secondary mirrors, and at least one tertiary mirror for reflecting light beams outwardly and downwardly through said substantially vertical aperture;

said second set of pattern mirrors being located in a similar region along said periphery, and having primary, secondary, and tertiary mirrors for reflecting light beams outwardly through said substantially vertical aperture;

said third set of pattern mirrors being located in a different region along said periphery, and having primary and secondary mirrors for reflecting light beams through said substantially horizontal aperture;

wherein the primary mirrors of the first set include a plurality of generally trapezoidal mirrors;

wherein the secondary mirrors of the first set operate to receive a light beam from said generally trapezoidal mirrors; and

wherein the tertiary mirror of the first set is a generally trapezoidal mirror which operates to receive a light beam from said secondary mirrors of the first set.

25. An optical scanner as in claim **24**, in which said rotating mirror polygon produces light beams that pass radially outward therefrom to scan the primary mirrors of the first set of pattern mirrors, one after another, to scan the primary mirrors of the second set of pattern mirrors, one after another, and to scan the primary mirrors of the third set of pattern mirrors, one after another.

26. An optical scanner as in claim **24**, in which said rotating mirror polygon reflects light beams onto the primary mirrors of said first, second, and third sets of pattern mirrors as it rotates.

27. An optical scanner as in claim **24**, in which said rotating mirror polygon reflects light onto the primary mirrors of said first, second, and third sets of pattern mirrors.

28. A mirror assembly for use in an optical scanner having a substantially vertical aperture and a substantially horizontal aperture, comprising:

a first set of pattern mirrors including at least primary and secondary mirrors, and at least one tertiary mirror;

a second set of pattern mirrors including at least primary, secondary, and tertiary mirrors;

a third set of pattern mirrors including at least primary and secondary mirrors;

a source of light;

the primary mirrors of the first set being disposed at oblique angles with respect to the source of light, to reflect the source of light onto the secondary mirrors of the first set;

the secondary mirrors of the first set being disposed at oblique angles with respect to incident light beams from the primary mirrors of the first set, and positioned to reflect the light beams onto the tertiary mirror of the first set;

the tertiary mirror of the first set being disposed at oblique angles with respect to incident light beams from the secondary mirrors of the first set, and positioned to reflect the light beams outwardly and downwardly through said substantially vertical aperture;

the primary mirrors of the second set being disposed at oblique angles with respect to the source of light, to reflect the source of light onto the secondary mirrors of the second set;

the secondary mirrors of the second set being disposed at oblique angles with respect to the source of light, to reflect the source of light onto the tertiary mirrors of the second set;

the tertiary mirrors of the second set being disposed at oblique angles with respect to incident light beams from the secondary mirrors of the second set, and positioned to reflect the light beams outwardly through said substantially vertical aperture;

the primary mirrors of the third set being disposed at oblique angles with respect to the source of light, to reflect the source of light onto the secondary mirrors of the third set;

the secondary mirrors of the third set being disposed at oblique angles with respect to the source of light, to reflect the source of light beams through said substantially horizontal aperture; and

the primary mirrors of the first set including two pairs of opposite side mirrors.

29. A mirror assembly as in claim **28**, wherein

the secondary mirrors of the first set include opposite groups of three mirrors, wherein each secondary mirror operates to receive a light beam from one of the primary mirrors of the first set.

30. A mirror assembly as in claim **28** in which

at least two of the secondary mirrors of the first set operate to receive a light beam from a common primary mirror of the first set.

31. An optical scanner as in claim **28**, in which

the source of light includes a rotating mirrored surface that directs light onto the primary mirrors of said first, second, and third sets of pattern mirrors as it rotates.

32. An optical scanner as in claim **28**, in which

the source of light includes a rotating polygon with mirrors on each its sides to reflect light onto the primary mirrors of said first, second, and third sets of pattern mirrors.

[33. An optical scanner comprising:

a housing including a substantially vertical surface containing a first aperture and a substantially horizontal surface containing a second aperture;

first and second lasers for producing first and second laser beams;

an optical transceiver for passing the laser beam and for collecting reflected light from an article having a bar code label to be scanned;

a spinner having a plurality of sides oriented at different angles with respect to a predetermined reference for reflecting the first and second laser beams in a plurality of directions to produce a plurality of scanning beams, and for directing light from the article to the optical transceiver; and

a plurality of pattern mirrors for reflecting a first group of scanning beams in a substantially horizontal direction through the first aperture, a second group of scanning beams in a substantially downward diagonal direction through the first aperture, and a third group of scanning beams in a substantially vertical direction through the second aperture and including a first group of mirrors for reflecting the laser beam from the spinner, a second group of mirrors for reflecting the laser beam from the first group of mirrors, and a third group of mirrors for reflecting the first and second laser beams from some of the mirrors in the second group of mirrors; and

a photodetector for generating signals representing the intensity of the light reflected from the article.**]**

[34. An optical scanner as recited in claim **33**, further comprising:

control circuitry which alternately applies power to the first and second lasers.**]**

[35. An optical scanner as recited in claim **33**, wherein the first and second lasers have different depths of field.**]**

36. The mirror assembly as in claim 28 wherein the second set of mirrors includes three tertiary mirrors.

37. The mirror assembly as in claim 36 wherein at least two of the tertiary mirrors of the second set of mirrors reflect light beams downwardly through the substantially vertical aperture.

38. The mirror assembly as in claim 28 wherein the mirror assembly is for scanning bar codes on articles, and the light reflected downwardly through the substantially vertical window from the tertiary mirror of the first set scans a bar code on the top surface of an article.

39. The mirror assembly as in claim 38 wherein the light reflected downwardly produces beams that intersect one another.

40. The mirror assembly as in claim 39 wherein the light beams from the substantially vertical aperture scan the top and customer side of the article, and the light beams from the substantially horizontal aperture scan the bottom of the article and its leading and trailing sides.

41. The mirror assembly as in claim 28 wherein the mirror assembly includes at least six primary mirrors, at least five secondary mirrors and at least four tertiary mirrors said at least six primary mirrors reflecting light to said at least five secondary mirrors, and said at least five secondary mirrors reflecting light to said at least four tertiary mirrors.

42. The mirror assembly as in claim 41 wherein the source of light includes at least two lasers.

43. The mirror assembly as in claim 28 wherein the light source includes at least one laser, further including a mirrored polygon having at least three sides, each side having a mirrored surface and being disposed at an angle from the axis of the polygon different than the angle of the other two sides, and wherein the tertiary mirrors of the first and second sets of mirrors receive light that has been reflected from the mirrored polygon and produce at least six scan lines through the substantially vertical aperture during each rotation of the mirrored polygon.

44. The mirror assembly as in claim 43 having just a single substantially vertical aperture and just a single substantially horizontal aperture, further including a housing having a first housing section and a second housing section connected at proximate ends forming a generally L-shaped structure, the substantially vertical aperture being located in the first hous-

ing section and the substantially horizontal aperture being located in the second housing section.

45. An optical scanner comprising:

a housing having a substantially vertical surface containing a first aperture and a substantially horizontal surface containing a second aperture;

a single laser which produces a laser beam within the housing;

a plurality of groups of pattern mirrors;

a polygon spinner having mirrored facets for reflecting the laser beam to produce a single reflected beam in a plurality of directions as the spinner rotates to cause the beam to strike at least some of the pattern mirrors, to produce a plurality of scanning beams including a first group of scanning beams, a second group of scanning beams, and a third group of scanning beams; and

a first group of pattern mirrors including a first, second and third subsets of pattern mirrors for reflecting the first group of scanning beams through the first aperture to produce a first scan pattern consisting of a plurality of intersecting scan lines,

a second group of pattern mirrors including a first, second and third subsets of pattern mirrors reflecting the second group of scanning beams through the first aperture to produce a second scan pattern consisting of a plurality of intersecting scan lines; and

a third group of pattern mirrors for reflecting the third group of scanning beams through the second aperture to produce a third scan pattern consisting of a plurality of intersecting scan lines;

the first group of scanning beams reflecting off multiple mirrors of the first subset of pattern mirrors of the first group to the second subset thereof, then reflecting off multiple mirrors of said second subset to the third subset thereof, and then off at least one mirror of said third subset out the first aperture;

the second group of scanning beams reflecting off multiple mirrors of the first subset of pattern mirrors of the first group to the second subset thereof, then reflecting off multiple mirrors of said second subset to the third subset thereof, and then off at least one mirror of said third subset out the first aperture;

the first subset of mirrors of the first group include a plurality of generally trapezoidal mirrors;

the second subset of mirrors of the first group operate to receive a light beam from said generally trapezoidal mirrors; and

the third subset of mirror of the first group is a generally trapezoidal mirror which operates to receive a light beam from said second subset mirrors of the first group.

46. An optical scanner as in claim 45, wherein

the third subset of mirrors in the second group includes multiple mirrors and the scanning beams from the second subset of the second group reflect off multiple mirrors of the second group and then pass out the first aperture.

47. An optical scanner comprising:

a housing having a substantially vertical surface containing a first aperture and a substantially horizontal surface containing a second aperture;

a single laser which produces a laser beam within the housing;

a plurality of groups of pattern mirrors;

a polygon spinner having mirrored facets for reflecting the laser beam in a plurality of directions as the spinner rotates to produce a plurality of scanning beams including a first group of scanning beams, a second group of scanning beams, and a third group of scanning beams; and

a first group of pattern mirrors including a first, second and third subsets of pattern mirrors for reflecting the first group of scanning beams through the first aperture to produce a first scan pattern consisting of a plurality of intersecting scan lines,

a second group of pattern mirrors including a first, second and third subsets of pattern mirrors reflecting the second group of scanning beams through the first aperture to produce a second scan pattern consisting of a plurality of intersecting scan lines, each of the subsets of the second group having multiple mirrors; and

a third group of pattern mirrors including a first and second subsets of pattern mirrors for reflecting the third group of scanning beams through the second aperture to produce a third scan pattern consisting of a plurality of intersecting scan lines;

the first subset of mirrors of the first group include a plurality of generally trapezoidal mirrors;

the second subset of mirrors of the first group operate to receive a light beam from said generally trapezoidal mirrors;

the third subset of mirrors of the first group is a generally trapezoidal mirror which operates to receive a light beam from said second subset of mirrors of the first group;

the first group of scanning beams reflecting off the first subset of pattern mirrors of the first group to the second subset thereof, then reflecting off said second subset to the third subset thereof, and then off said third subset out the first aperture,

the second group of scanning beams reflecting off the first subset of pattern mirrors of the first group to the second subset thereof, then reflecting off said second subset to the third subset thereof, and then off said third subset out the first aperture,

at least one of the mirrors of the first group of pattern mirrors being positioned adjacent the first aperture to reflect certain of the first group of scanning beams outwardly through the first aperture to scan the side of an article,

at least one of the mirrors of the second group of pattern mirrors being positioned adjacent the first aperture and angled to reflect certain of the first group of scanning beams outwardly and laterally through the first aperture toward the leading side of the article, and at least one positioned adjacent the first aperture and angled to reflect certain of the first group of scanning beams outward and laterally through the first aperture to scan the trailing side of the article, and

at least one of the mirrors of the first group of pattern mirrors being positioned adjacent the first aperture and angled to reflect certain of the first group of scanning beams downwardly and outwardly through the first aperture to scan the top of the article.

48. A method of scanning an item having a bar code from multiple directions, comprising the steps of

generating laser light;

providing a single multi-faceted mirrored polygon in a path of said laser light;

rotating the mirror polygon and directing the laser light at the polygon, as it is rotating, to produce a single laser beam reflected off each facet of the polygon;

generating a first group of scanning beams, a second group of scanning beams, and a third group of scanning beams

by reflecting said laser light off said mirror polygon and then reflecting the laser beam off groups of pattern mirrors;

generating the first group of scanning beams comprises directing the laser beam to a first set of generally trapezoidal pattern mirrors, reflecting the beam from those mirrors to a second set of generally trapezoidal pattern mirrors and reflecting the beam from those mirrors to at least one additional generally trapezoidal pattern mirror;

directing said first group of scanning beams from said at least one additional mirror through a first transparent member oriented in a first plane to scan a surface of the item from one orthogonal direction to scan at least the top of an item;

generating the second plurality of scanning beams comprises directing the laser beam to a third set of pattern mirrors, reflecting the beam from those mirrors to a fourth set of pattern mirrors and reflecting the beam from those mirrors to a fifth set of pattern mirrors;

directing said second group of scanning beams from at least one mirror of said fifth set of mirrors directly outwardly through the first transparent member oriented in the first plane to scan one side of the item and from further mirrors of said fifth set of mirrors diagonally outwardly through the first transparent member oriented in the first plane to scan the item from a diagonal direction to scan the leading and trailing sides of the item; and

generating the third plurality of scanning beams comprises directing the single laser beam to a sixth set of pattern mirrors, reflecting the beam from those mirrors to a seventh set of pattern mirrors and reflecting the beam from the mirrors of the seventh set,

directing said third group of scanning beams from said seventh set of mirrors through a second transparent member oriented in a second plane orthogonal to said first plane to scan the item from another orthogonal direction to scan at least the bottom of the item.

49. A method of scanning as in claim 48 wherein

the first group of scanning beams is directed through the first transparent window in an outwardly and downwardly direction to scan the top of the item, and

the second group of scanning beams is directed through the first transparent window in at least a diagonally rearward direction and a diagonally forward direction to scan the leading and trailing sides of the item.

50. A method of scanning as in claim 49 wherein certain of the beams of the second group are directed through the first transparent window in a diagonally rearward direction to scan the leading side of the item, other beams of the second group are directed through the first transparent window in a diagonally forward direction to scan the trailing side of the item and other beams of the second group are directed outwardly through the first transparent window in a generally lateral direction to scan another side of the item.

51. A method of scanning as in claim 48 where at least certain of the third group of scanning beams is generated by directing the beam from the polygon between mirrors of either the first or second set to the mirrors of the sixth set.

52. A method of scanning as in claim 48 wherein scanning beams are directed through the first transparent window and through the second transparent window alternatingly, and this alternative operation occurs repeatedly, for beams originating from a single facet of the polygon, during each rotation of the polygon.

53. A method of scanning as in claim 48 wherein generating laser light comprises generating a single laser beam, and only said single laser beam is reflected off each of the facets of the polygon.

54. A method of scanning an item having a bar code from multiple directions, comprising the steps of

generating laser light in the form of a single laser beam;

providing a single multi-faceted mirrored polygon in a path of said single laser light beam;

rotating the mirror polygon and reflecting the single laser beam from each of the facets of the polygon, as the polygon is rotating, to form from the single laser beam a plurality of scanning beams that pass through both horizontal and vertical transparent members;

generating a first group of scanning beams, a second group of scanning beams, and a third group of scanning beams by reflecting said laser beam off said mirror polygon and then off groups of pattern mirrors;

generating the first group of scanning beams comprises directing the laser beam to a first set of generally trapezoidal pattern mirrors, reflecting the beam from those mirrors to a second set of generally trapezoidal pattern mirrors and reflecting the beam from those mirrors to at least one additional generally trapezoidal pattern mirror;

directing said first group of scanning beams from said at least one additional generally trapezoidal mirror through a vertical transparent member oriented in a first plane to scan a surface of the item from one orthogonal direction;

generating the second plurality of scanning beams comprises directing the laser beam to a third set of pattern mirrors, reflecting the beam from those mirrors to a fourth set of pattern mirrors and reflecting the beam from those mirrors to at least one further mirror;

directing said second group of scanning beams from said at least one further mirror through the vertical transparent member oriented in the first plane to scan the item from a diagonal direction to scan at least one side of the item; and

generating the third plurality of scanning beams comprises directing the laser beam to a fifth set of pattern mirrors, reflecting the beam from those mirrors to a sixth set of pattern mirrors and reflecting the beam from the mirrors of the sixth set,

directing said third group of scanning beams from said sixth set of mirrors through a horizontal transparent member oriented in a second plane orthogonal to said first plane to scan the item from another orthogonal direction.

55. A method of scanning as in claim 54 wherein

the first group of scanning beams is directed through the first transparent window in an outwardly and downwardly direction to scan the top of an item, and

the second group of scanning beams is directed through the first transparent window in a diagonally rearward direction to scan the leading side of an item.

56. A method of scanning as in claim 55 wherein

certain of the beams of the second group are directed through the first transparent window in a diagonally rearward direction to scan the leading side of an item, and other beams of the second group are directed through the first transparent window in a diagonally forward direction to scan the trailing side of an item.

57. A scanner as in claim 54 wherein

scan lines are directed through the first transparent window and through the second transparent window alter-

natingly, and this alternative operation occurs repeatedly, for beams originating from a single facet of the polygon, during each rotation of the polygon.

58. An optical scanner comprising:

a housing having a substantially vertical surface containing a first aperture and a substantially horizontal surface containing a second aperture;

a single laser which produces a laser beam within the housing;

a polygon spinner having mirrored facets for reflecting the laser beam in a plurality of directions to produce a plurality of scanning beams including a first group of scanning beams, a second group of scanning beams, and a third group of scanning beams; and

a plurality of pattern mirrors, including a plurality of groups of pattern mirrors, for reflecting the first group of scanning beams through the first aperture to produce a first scan pattern consisting of a plurality of intersecting scan lines, for reflecting the second group of scanning beams through the first aperture to produce a second scan pattern consisting of a plurality of intersecting scan lines, and for reflecting the third group of scanning beams through the second aperture to produce a third scan pattern consisting of a plurality of intersecting scan lines;

wherein the pattern mirrors include

a first group of generally trapezoidal mirrors for reflecting the laser beam from the spinner;

a second group of generally trapezoidal mirrors for reflecting the laser beam from the first group of mirrors, including at least one mirror positioned and angled to reflect an incident beam in a substantially vertical direction to scan the bottom of an article and at least one mirror is positioned and angled to reflect an incident beam rearwardly to scan the forward side of the article; and

a third group of generally trapezoidal mirrors for reflecting the laser beam from some of the mirrors in the second group of mirrors.

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