



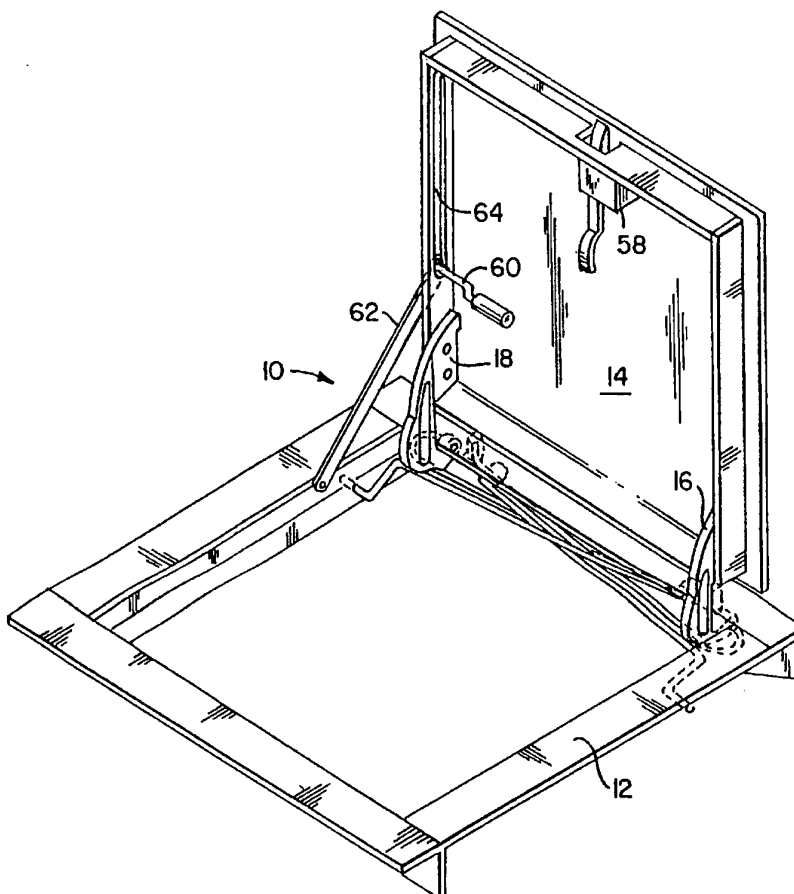
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>5</sup> : E05F 1/10, 1/08	A1	(11) International Publication Number: WO 94/24394 (43) International Publication Date: 27 October 1994 (27.10.94)
(21) International Application Number: PCT/US93/10141 (22) International Filing Date: 22 October 1993 (22.10.93) (30) Priority Data: 08/045,964 9 April 1993 (09.04.93) US (71) Applicant: THE BILCO COMPANY [US/US]; 37 Water Street, West Haven, CT 06516 (US). (72) Inventor: LYONS, Robert, J., Sr.; 1060 Ridge Road, Hamden, CT 06517 (US). (74) Agents: DeLIO, Anthony, P. et al.; DeLio & Peterson, 121 Whitney Avenue, New Haven, CT 06511 (US).		(81) Designated States: CA, JP, RU, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  Published With international search report.

(54) Title: DOOR ASSEMBLY WITH AUGMENTED COUNTERBALANCING

## (57) Abstract

A counterbalance assembly and a non-vertically hinged door assembly (10) incorporating the same include a first pair of torque rods (24 and 26) directly connected between a door (14) and a frame (12) which produce a partial counterbalancing torque. A second pair of torque rods (32 and 34) acting through cams to produce an augmenting counterbalancing torque such that the sum of the partial and augmenting torques fully counterbalance the door (14) throughout its arc of motion.



**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

DescriptionDoor Assembly With Augmented CounterbalancingTechnical Field

- 5        This invention relates to non-vertically hinged doors and associated counterbalancing mechanisms. More particularly, it relates to counterbalancing mechanisms which substantially exactly counterbalance the weight of the door at all angles throughout its arc of motion.

10    Background Art

- There are numerous applications in which a door is mounted with a non-vertical hinge line and requires counterbalancing. Such applications include, among others, hatch covers for roof openings, flush mounted sidewalk doors, and exterior basement entrance
- 15    doors.

- Doors for use in these applications are often made of metal, for strength and durability and, accordingly, can be quite heavy. Counterbalancing allows the door to be opened and closed more easily, and improves safety by reducing the tendency of the door
- 20    to close rapidly and with great force when released.

- Typically, partial counterbalancing has been derived from one or more torque rods, springs, gas cylinders or weights. Torque rods have been particularly widely used because they provide a counterbalancing torque as a result of the rotation of one end of
- 25    the rod relative to the other. Thus, the opposite ends of the torque rod may be connected to the door and the door frame, respectively, to provide a simple, but reliable, counterbalancing mechanism. Through appropriate selection of the torque rod diameter and length, a variety of doors of different weights and
- 30    sizes may be approximately counterbalanced with this direct connection method.

- Torque rods also have the advantage that their long, thin shape can be positioned out of the way behind, or within the thickness of the door frame, producing a door assembly that takes
- 35    the minimum space when held in inventory and is easy to transport through the distribution chain. Moreover, torque rods are extremely

-2-

rugged and reliable, an important consideration in doors which are often used for exterior access or in exposed locations.

However, a torque rod counterbalancing design using the simple direct connection between door and frame does not  
5 perfect counterbalancing. This is because a torque rod provides a counterbalancing torque which, in the usual operating range, is linearly proportional to the amount of rotation or twist applied to it. In contrast, a non-vertically hinged door requires a counterbalancing torque which is non-linearly related to the  
10 opening angle of the door. The weight of the door unsupported by a non-vertical hinge line increases as a sinusoidal function of the opening angle.

As a result, counterbalancing systems using torque rods directly connected between the door and the frame only provide  
15 exact counterbalancing for the door at two different opening angles of the door. These angles may be found on a graph of torque (measured at the hinge line) versus opening angle (zero degrees equals closed) where the line of torque rod generated counterbalancing torque intersects the cosine curve of the torque  
20 due to the unsupported weight of the door. For a horizontally hinged door, the entire weight of the door is unsupported by the hinge when the door is just being opened, and all the weight is supported by the hinge as it reaches the fully open, ninety degree, position.

25 While the specific two opening angles where the door is exactly counterbalanced in a linear counterbalancing system are under the designer's control, they have usually been selected to be at approximately the fully open and fully closed positions. At the fully open position no counterbalancing torque is required, and the  
30 torque rod is not twisted. At the fully closed position, the torque rod is adjusted to provide the exact counterbalance torque required for the full weight of the door. Unfortunately, except at these two angles, the door is insufficiently counterbalanced and may begin to move if released.

35 In addressing this deficiency, subsequent designs for counterbalancing systems have used a cam system with single or multiple torque rods to nearly exactly counterbalance the door

-3-

throughout its range of motion. In these designs, the torque rod is not directly connected between the door and the frame, but instead acts through a cam which modifies the linear torque produced by the torque rod to match the sinusoidal torque  
5 needed to balance the weight of the door. Doors with counterbalancing mechanisms of the cam-based type are seen in United States Patent Nos. 4,873,791 and 5,136,811.

In such cam-based designs, the entire counterbalancing force for the door is applied through the cam mechanism. The  
10 present invention, however, uses a hybrid direct connection/cam based design. A portion of the counterbalancing torque is produced by one or more torque rods directly connected between the door and the door frame, and the remainder of the counterbalancing torque (the "augmenting" torque), as needed to  
15 provide nearly exact sinusoidal counterbalancing, is applied by one or more additional torque rods through a cam system.

By applying the majority of the counterbalancing torque with the directly connected torque rod, less force passes through the cam system, which reduces friction and wear as compared to  
20 earlier designs. Another advantage lies in the flexibility of the choices available in a hybrid direct connection/cam based torque rod design. Because torque rods are often available only in standard diameters, it may be difficult to match the counterbalance requirements of some doors. With the hybrid  
25 design, differently sized torque rods may be combined to optimally match the counterbalancing requirements of a wide variety of doors.

Yet another advantage lies in the fact that the augmenting torque rod counterbalancing system may be provided as a factory  
30 installed option to a door also sold with only direct torque rod counterbalancing, or it may be used as an add on field installed accessory for an existing directly counterbalanced door.

Bearing in mind the above, it is therefore an object of the present invention to provide a new and improved  
35 counterbalanced door and counterbalancing assembly in which the counterbalancing is performed in part by a counterbalancing mechanism producing linear counterbalancing and in part by an

-4-

augmenting counterbalancing mechanism to counterbalance the door throughout its arc of motion.

#### Disclosure of Invention

The invention comprises a counterbalancing assembly for  
5 augmenting the counterbalancing of a partially counterbalanced door and a complete door assembly incorporating the counterbalancing assembly. The door assembly includes a frame, a door hinged to the frame along a non-vertical hinge axis for motion from an open position to a closed position and a first  
10 counterbalancing means connected between the door and the frame which produces a partial counterbalancing torque about the hinge axis. The first counterbalancing means may comprise a torque rod, or any other linear counterbalancing mechanism, and may be connected directly between the frame and the door or  
15 between the hinge leaves of the hinge mechanism upon which the door is hinged.

The door assembly further includes an augmenting counterbalancing system comprising a cam having a cam surface and a second counterbalancing means which applies a force to  
20 the cam surface to produce the augmenting counterbalancing torque about the hinge axis of the door. The sum of the partial counterbalancing from the first counterbalancing means and the augmenting counterbalancing torque counterbalances the door between the open and the closed positions.

25 In the preferred design, the first and second counterbalancing means are torque rods which are twisted in opposite directions as the door swings from the open to the closed position. The second torque rod is mounted with a first end non-rotatably connected to the frame and a second end rotatably  
30 connected to the frame. A portion of the second torque rod is bent outward from the axis of rotation of the second end and contacts the cam surface at a point displaced from the axis of rotation to provide the augmenting torque.

In the most highly preferred design, there are a total of four  
35 torque rods in the counterbalancing assembly. The first counterbalancing means includes first and third torque rods,

forming a pair, directly connected between the door and the frame. The second counterbalancing means includes second and fourth torque rods, forming a second pair, which act against first and second cam surfaces to produce the augmenting torque.

5       The first and second cams are preferably integrally formed as part of the door hinges. The hinges may be formed as gooseneck hinges such that the hinge axis of the door is located beneath a portion of the frame.

#### 10   Brief Description of the Drawings

Fig. 1 is a perspective view of a horizontally hinged door and frame assembly incorporating the counterbalancing mechanism of the present invention.

15       Fig. 2 is a detail side elevational view, partly in section, of a portion of the hinge mechanism and counterbalancing assembly showing the door of Fig. 1 in the fully open position.

      Figs. 3, 4 and 5 are side elevational views, partly in section, corresponding to Fig. 2, but showing the door at different opening angle positions as the door moves from the fully open position in Fig. 2 to the fully closed position of Fig. 5.

20       Fig. 6 is a detail side elevational view at an enlarged scale of a gooseneck hinge leaf of the type seen in Figs. 1-5 with an integral cam and cam surface.

      Fig. 7 is a perspective view of first and third torque rods from Fig. 1 which act directly between the door and frame to produce partial counterbalancing of the door.

      Fig. 8 is a perspective view of second and fourth torque rods from Fig. 1 which act through the cam surfaces of two gooseneck hinge as seen in Fig. 6 to produce the augmenting counterbalancing of the door.

#### Modes for Carrying Out the Invention

35       Figure 1 shows a perspective view of a door assembly incorporating the augmented counterbalancing system of the present invention. The door assembly 10 includes a frame 12 and a door 14 hinged along a non-vertical hinge axis by gooseneck

hinges 16 and 18 shown at an enlarged scale in Fig. 6. Gooseneck hinges 16 and 18 are fastened to the door 14 and rotate about hinge pins 28, 30 extending through opening 20 in the hinge (see Fig. 6) and into a corresponding opening in hinge mount 22.

5 In the preferred design the hinge pins 28, 30 are part of the direct connection torque rods 24, 26 (seen in Fig. 7). They are formed by the end of the torque rods 24, 26 which are reverse curved to engage their corresponding hinge leaf with a direct connection that also acts as a hinge pin. The door assembly  
10 illustrated in Fig. 1 includes four (4) torque rods 24, 26, 32 and 34, shown individually in Figs. 7 and 8. Torque rods 24 and 26 form a first counterbalancing means which produces the linear counterbalancing force through direct connection between the door and frame. Torque rods 32 and 34 form a second  
15 counterbalancing means which produce an augmenting counterbalancing force by acting between the door and frame through corresponding cam surfaces on the gooseneck hinges.

The gooseneck hinge design of hinges 16 and 18 in Fig. 6 permit the hinge point to be located underneath the frame 12 and  
20 still allow the door to reach the fully open position.

Referring to Fig. 7, torque rod 26 is a mirror image of torque rod 24. Referring to Fig. 8, torque rod 32 is a mirror image of torque rod 34. First torque rod 26 and second torque rod 32 act upon gooseneck hinge 18 in the same way that their mirror images, third  
25 torque rod 24 and fourth torque rod 34 act upon gooseneck hinge 16. As such, each hinge 16, 18 has fifty percent of the total counterbalancing torque applied through it. Due to this symmetry, and for the sake of clarity, in the cross sectional views of Figs. 2 through 5 the third and fourth torque rods 24, 34 have been  
30 eliminated and only the first and second torque rods 26 and 32 have been shown.

Referring to Figs. 1, 2 and 7, the first torque rod 26 is connected at its opposite ends between the door and the frame by means of an upturned end 36 attached to the frame 12 and a  
35 recurved end 30, 42 which engages hinge 18 on the door. The upturned end 36 is held in a holder 38, which is permanently



-7-

fastened to the frame 12 and is retained therein by pin 40. The recurved end includes a 180° bend from portion 42 to portion 30.

Portion 30, as previously described, passes through hole 20 in hinge 18 and acts as a hinge pin along the hinge axis. Portion 42 is engaged by recess 44 in hinge 18. In this way, the end 30, 42 is non-rotatably connected to the door through hinge 18, and the other end 36 is non rotatably connected to the frame.

This direct connection between the frame and the door causes torque rod 26 to be twisted linearly as the door moves from the fully open position of Fig. 2 (torque rod 26 untwisted) to the fully closed position of Fig. 5 (torque rod 26 twisted to its maximum extent). The length of torque rod 26 and its diameter are selected such that the door is approximately fully counterbalanced when the door reaches the fully closed position shown in Fig. 5. Fifty percent of the counterbalancing torque is, of course, provided by torque rod 26 and fifty percent of the counterbalancing torque at this position is provided by mirror image torque rod 24.

As described above, even in the absence of torque rods 32 and 34, the door will be nearly perfectly counterbalanced at the fully open position shown in Fig. 2 and the fully closed position shown in Fig. 5 by torque rods 24 and 26. Thus, at these two positions, the torque rods 32 and 34 produce no augmenting counterbalancing torque. However, at the intermediate positions shown in Figs. 3 and 4, the door is only partially counterbalanced by torque rods 24 and 26 and torque rods 32 and 34 must produce an augmenting torque that varies non-linearly with the opening angle to produce the additional torque needed to produce near perfect counterbalancing throughout the arc of motion of the door.

This augmenting torque is produced by modifying the force from the torque rods 32 and 34 through cams on hinges 16, 18 to produce the desired counterbalancing torque. Referring to Figs. 2 and 6, hinges 16, 18 include a cam portion 46 having a cam surface 48.

Referring to Fig. 8, torque rod 32 includes a bent end 50 mounted in a holder 52 which, like holder 38, is permanently affixed to the frame 12. The other end of torque rod 32 includes a double bend from portion 54 to 56. Portion 54 contacts the cam surface 48

on the hinge 18, and portion 56 is inserted into an opening in the frame 12 to form a rotating connection relative to the frame 12. As the door 14 moves from the open position in Fig. 2 to the closed position in Fig. 5, the cam surface 48 presses down against portion 54 of torque rod 32 causing it to rotate about end 56. This rotation defines a second axis of rotation through portion 56.

As indicated in Figs. 2-5, torque rod 32 rotates clockwise as torque rod 26 rotates counter-clockwise. As the door closes, the cam surface 48 rotates portion 54 around end 56 twisting the torque rod 32. This twist generates an augmenting counterbalancing force  $F_1$ - $F_3$  at each of the opening angles in Figs. 3-5 which is exerted in a normal direction to the cam surface 48.

The counterbalancing force is directed by the shape of cam surface 48 to act at a distance  $d$  from the first hinge axis. The distance  $d$  is the perpendicular distance between the hinge axis of the door and the line of force defined by the normal to the cam surface at the point of contact 54 with the torque rod 32. This relationship produces an augmenting counterbalancing torque about the hinge axis which is the product of the augmenting counterbalancing force times the distance  $d$ .

This product of force times distance varies exactly as required to augment the partial counterbalancing torque produced by torque rod 26. This may be more easily seen by reference to the drawings and angles in Figs. 2 through 5. In the fully open position, the door is balanced over the hinge axis and neither the first torque rod 26 nor the second torque rod 32 is twisted. As the door 14 swings  $90^\circ$  to the closed position, torque rod 26 will also rotate  $90^\circ$  as indicated by the angle  $\theta_2$ . However, torque rod 32 rotates less than  $90^\circ$  by virtue of the relationship with the cam. The maximum angle of rotation of torque rod 32 is shown as  $\theta_1$  in Fig. 2.

At the first intermediate position shown in Fig. 3, torque rod 32 has begun to twist producing a small counterbalancing force  $F_1$  acting at a distance  $d_1$  from the first hinge axis. In Fig. 4, the door has closed further causing an increase in the counterbalancing force  $F_2$  acting at a new distance  $d_2$  to produce new counterbalancing torque. In Fig. 5, the door has reached the fully closed position and torque rod 32 has reached its maximum angle

-9-

of twist producing a maximum force  $F_3$ . However, the shape of cam surface 48 is such that  $F_3$  is aimed directly towards the hinge axis of the door. Thus, the distance  $d_3$  is zero producing a net augmenting counterbalancing force of zero at this angle.

5 In this way, the augmenting counterbalancing torque rod produces a counterbalancing torque which is a minimum at the fully opened position, reaches a maximum at an intermediate position, and decreases to another minimum as the door reaches the fully closed position. This is exactly the augmenting force  
10 needed to fill in the missing counterbalancing torque from the partial counterbalancing provided by torque rods 24 and 26.

The torque rod 32 may be allowed to directly contact the cam surface 48 at point 54, however, the sliding friction and wear can be reduced and door operation made quieter by snapping a  
15 plastic sleeve 55 around the torque rod 32 at point 54. Alternatively, a wheel may be mounted around the torque rod at this point.

The door and frame of Fig. 1 also show a latch mechanism 58, a hold open arm 62 and a handle 60 which slides in a track 64.  
20 Alternative designs for these elements would also be suitable and will vary depending on the type of door and the desired locking and closing mechanisms.

Thus, having described the invention, what is claimed is:

-10-

**Claims**

1. A door assembly with augmented counterbalancing comprising:
  - a frame;
  - a door hingedly connected to the frame along a non-vertical hinge axis for motion from an open position to a closed position;
  - a first counterbalancing means connected between the door and the frame, the first counterbalancing means producing a partial counterbalancing torque about the hinge axis;
  - a cam having a cam surface; and
  - a second counterbalancing means applying a force to the cam surface, the cam and the second counterbalancing means being connected between the door and the frame to produce an augmenting counterbalancing torque about the hinge axis, the sum of the partial and augmenting counterbalancing torques substantially counterbalancing the door throughout an arc of motion between the open and the closed positions.
2. A door assembly according to claim 1 wherein the first counterbalancing means includes a first torque rod and the second counterbalancing means includes a second torque rod, the first and second torque rods twisting as the door swings from the open to the closed position.
3. A door assembly according to claim 2 wherein the first and second torque rods twist in opposite directions as the door swings from the open to the closed position.
4. A door assembly according to claim 2 wherein the second torque rod has a first end non-rotatably connected to the frame and a second end rotatably connected to the frame for rotation about a second axis offset from the hinge axis.
5. A door assembly according to claim 4 wherein the second torque rod is bent outward from the second axis and contacts the cam surface at a point displaced from the second axis.

-11-

6. A door assembly according to claim 2 further including a second cam having a second cam surface and wherein:  
the first counterbalancing means includes the first torque rod and a third torque rod connected between the door and the frame, the third torque rod twisting as the first torque rod twists; and  
the second counterbalancing means includes the second torque rod and a fourth torque rod applying a force to the second cam surface, the fourth torque rod twisting as the second torque rod twists.
7. A door assembly according to claim 6 wherein the first and third torque rods are bent at one end, the bent portion of each torque rod passing through the hinge axis forming hinge pins between the door and the frame.
8. A door assembly according to claim 7 wherein each of the first and second cams is integrally formed as part of a hinge attached to the door for hinging the door to the frame along the hinge axis.
9. A door assembly according to claim 8 wherein the hinges are formed as gooseneck hinges with the hinge axis being located beneath a portion of the frame when the frame is mounted horizontally.
10. A door assembly according to claim 1 wherein the first counterbalancing means generates a partial counterbalancing torque that is linearly related to an opening angle measured about the hinge line between the door and the frame, and the second counterbalancing means generates an augmenting counterbalancing torque through the cam that is sinusoidally related to the opening angle, the sum of the partial counterbalancing and augmenting counterbalancing torques substantially counterbalancing the door at all angles between the open and the closed positions.

-12-

11. A door assembly according to claim 10 wherein the second counterbalancing means generates an augmenting counterbalancing torque that reaches a maximum at an intermediate position between the open and the closed positions.
- 5 12. A door assembly according to claim 11 wherein the second counterbalancing means generates an augmenting counterbalancing torque that is approximately zero at the open and the closed positions.
13. A door assembly with augmented counterbalancing  
10 comprising:  
a frame;  
a door hinged to the frame along a hinge axis for motion from an open to a closed position;  
15 a first torque rod connected between the door and the frame, the first torque rod twisting as the door swings between the open and the closed position to produce a partial counterbalancing torque about the hinge axis;  
a second torque rod; and  
a cam having a cam surface;  
20 the second torque rod and cam being connected between the door and the frame, the cam surface contacting and twisting the second torque rod in an opposite direction from the first torque rod to produce an augmenting counterbalancing torque about the hinge axis.
- 25 14. A door assembly according to claim 13 further including a second cam, a third torque rod and a fourth torque rod, the third torque rod twisting as the first torque rod twists, the fourth torque rod and second cam being connected between the door and the frame with the second cam surface contacting and twisting the  
30 fourth torque rod as the door swings between the open and the closed position.
15. A door assembly according to claim 14 wherein the first and third torque rods are bent at one end, the bent portion of each torque rod passing through the hinge axis forming hinge pins  
35 between the door and the frame.

-13-

16. A door assembly according to claim 15 wherein each of the first and second cams is integrally formed as part of a hinge attached to the door for hinging the door to the frame along the hinge axis.
- 5 17. A door assembly according to claim 16 wherein the hinges are formed as gooseneck hinges with the hinge axis being located beneath a portion of the frame when the frame is mounted horizontally.
- 10 18. A door assembly according to claim 13 wherein the second torque rod has a first end non-rotatably connected to the frame and a second end rotatably connected to the frame for rotation about a second axis offset from the hinge axis.
- 15 19. A door assembly according to claim 18 wherein the second torque rod is bent outward from the second axis and contacts the cam surface at a point displaced from the second axis.
20. A door assembly with augmented counterbalancing comprising:  
a frame;  
a hinge;  
20 a door hinged to the frame by the hinge along a non-vertical hinge axis for motion from an open position to a closed position;  
a first counterbalancing means connected between the door and the frame to produce a partial counterbalancing  
25 torque about the hinge axis which is linearly related to the angle between the door and the frame;  
a cam having a cam surface; and  
a second counterbalancing means applying a force to the  
30 cam surface, the cam and the second counterbalancing means being connected between the door and the frame to produce an augmenting counterbalancing torque about the hinge axis which is sinusoidally related to the angle between the door and the frame, the sum of the partial and augmenting counterbalancing torques

-14-

substantially counterbalancing the door throughout an arc of motion between the open and the closed positions.

21. A door assembly according to claim 20 wherein the first counterbalancing means includes a first torque rod and the second counterbalancing means includes a second torque rod, the first and second torque rods twisting in opposite directions as the door swings from the open to the closed position.
22. An augmenting counterbalancing assembly for a partially counterbalanced door hinged to a frame comprising:
- 10        an augmenting torque rod adapted for fixed connection at one end to the frame and rotating connection at the other end to the frame; and
- 15        a cam adapted for connection to the door, the cam having a cam surface which twists the augmenting torque rod from a first minimum twist angle to a maximum twist angle and back to a second minimum twist angle as the door swings from an open position through an intermediate position to a closed position.
23. An augmenting counterbalancing assembly according to claim 22 wherein the torque rod twists in the opposite direction from the door as the door swings from the open to the closed position.
- 20



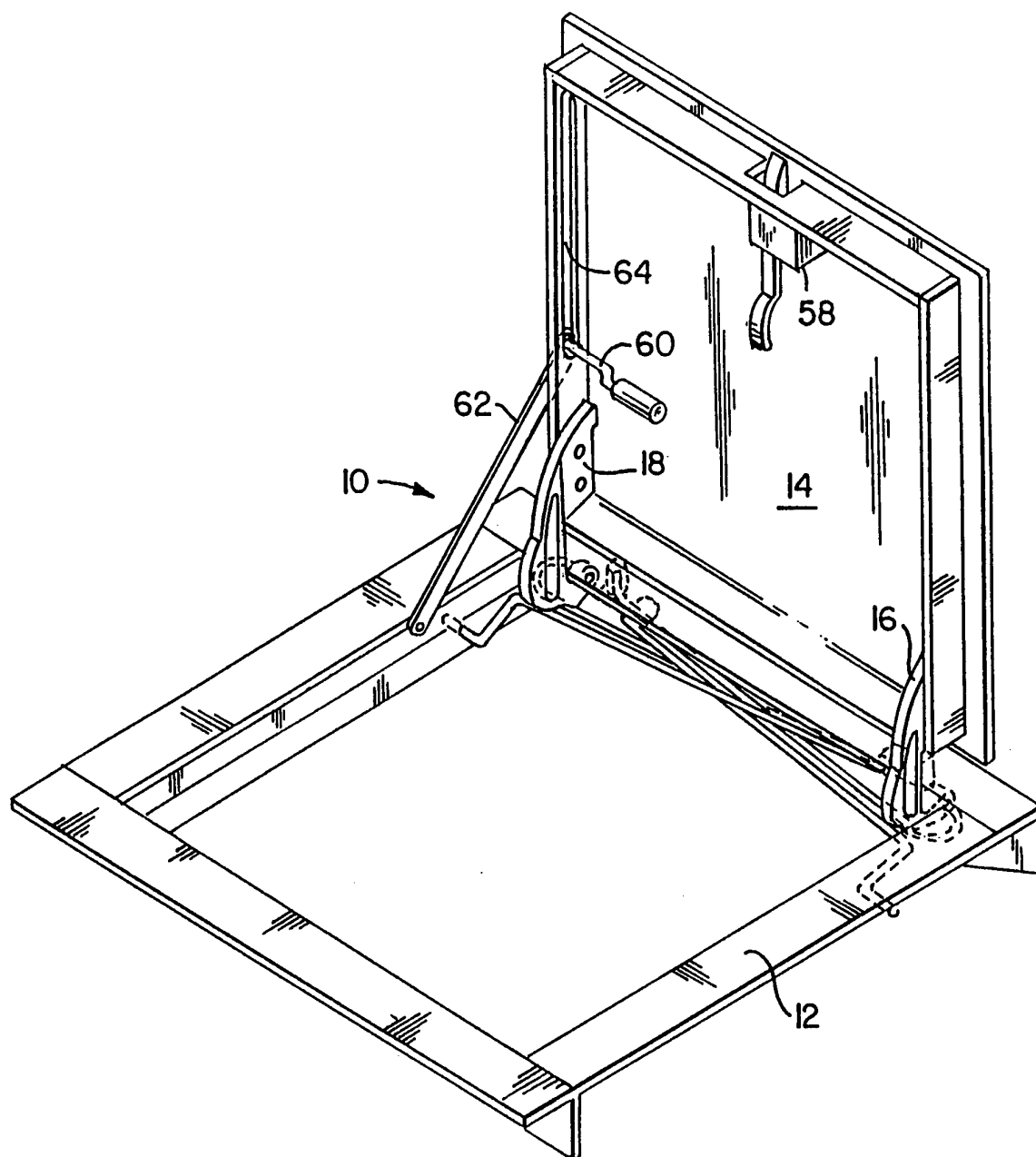


FIG. 1

FIG. 2

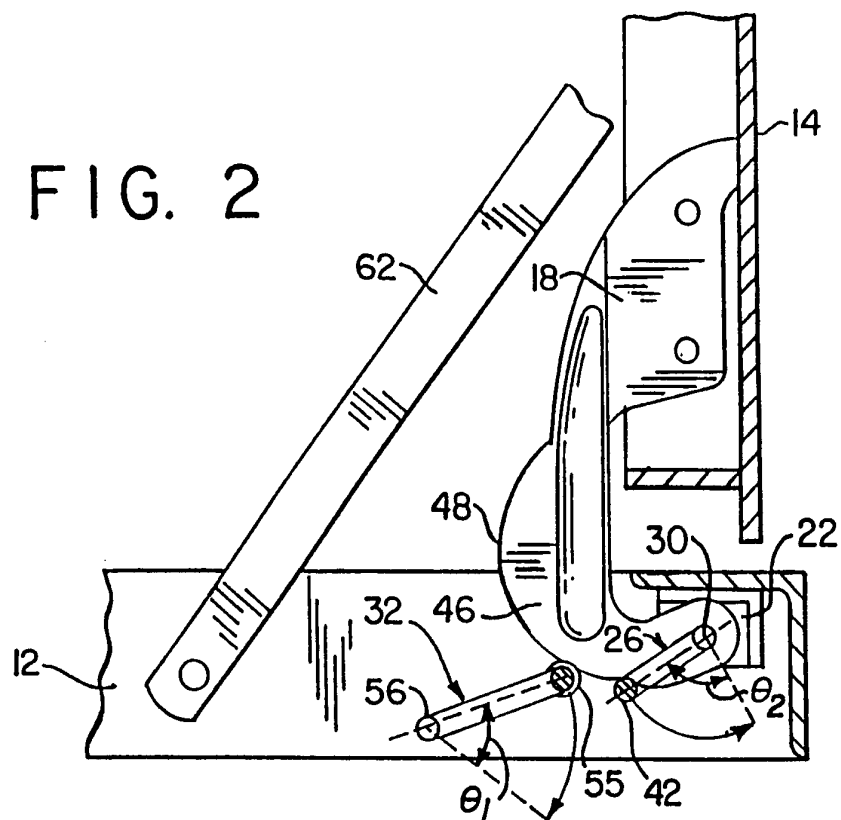
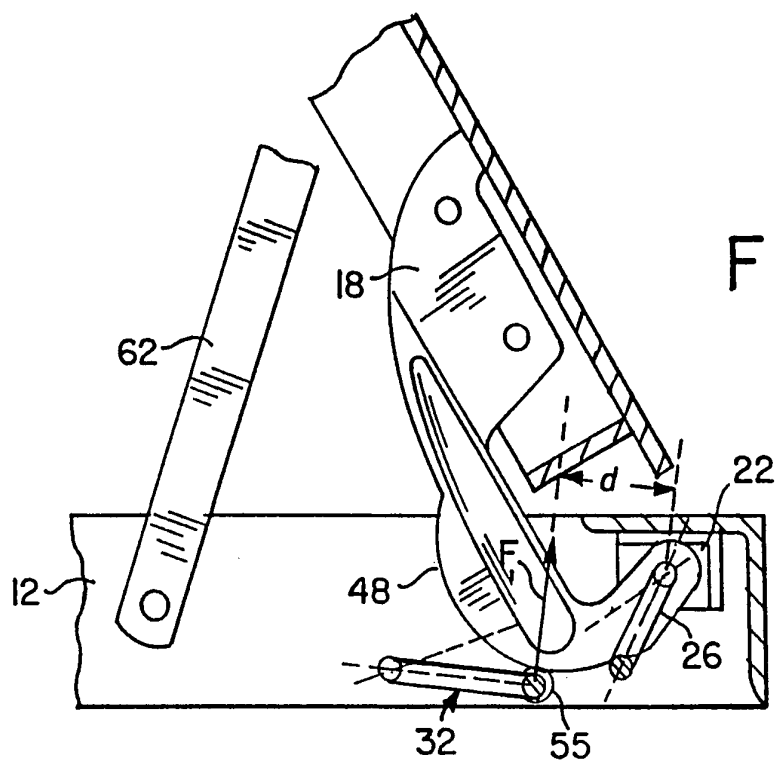
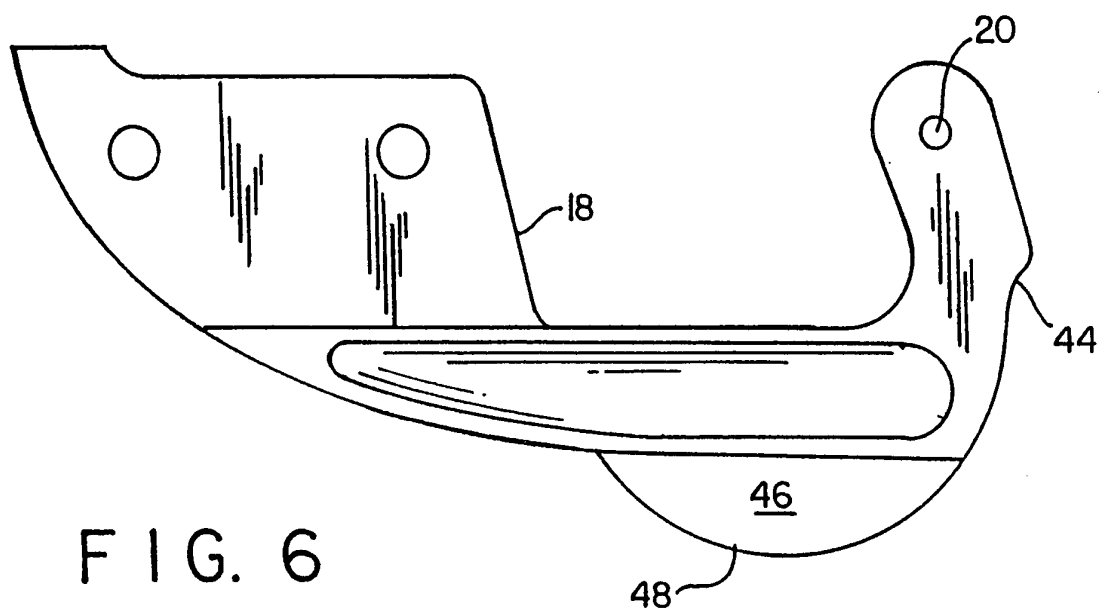
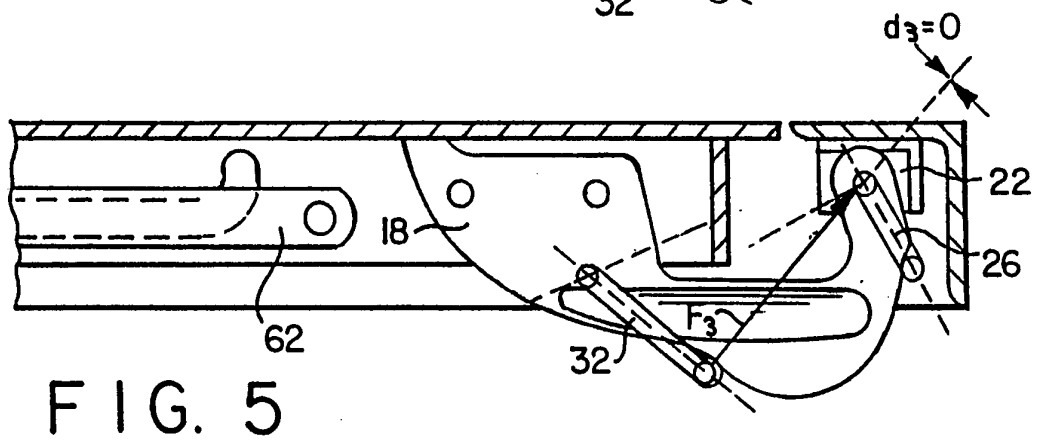
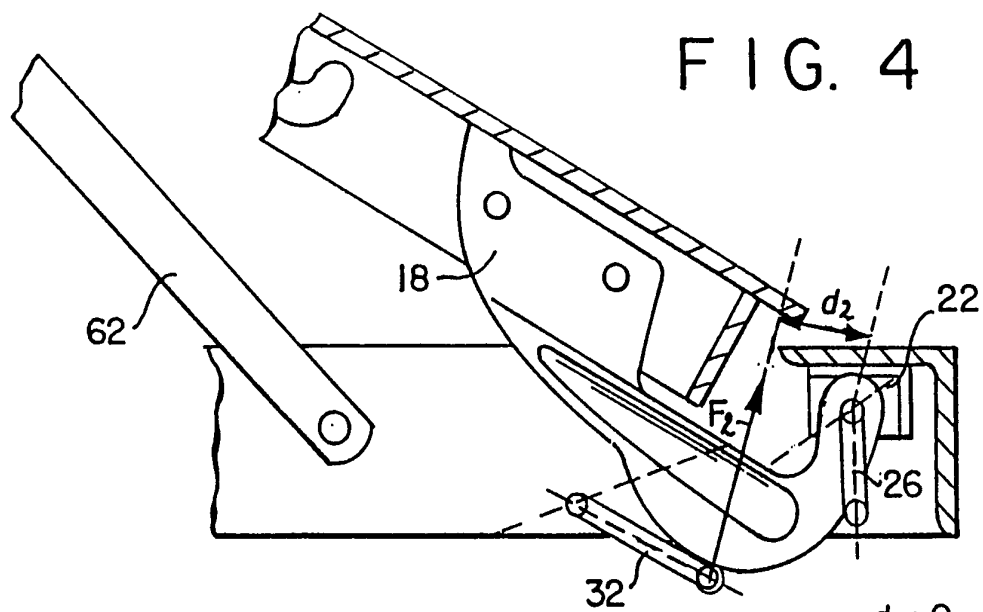
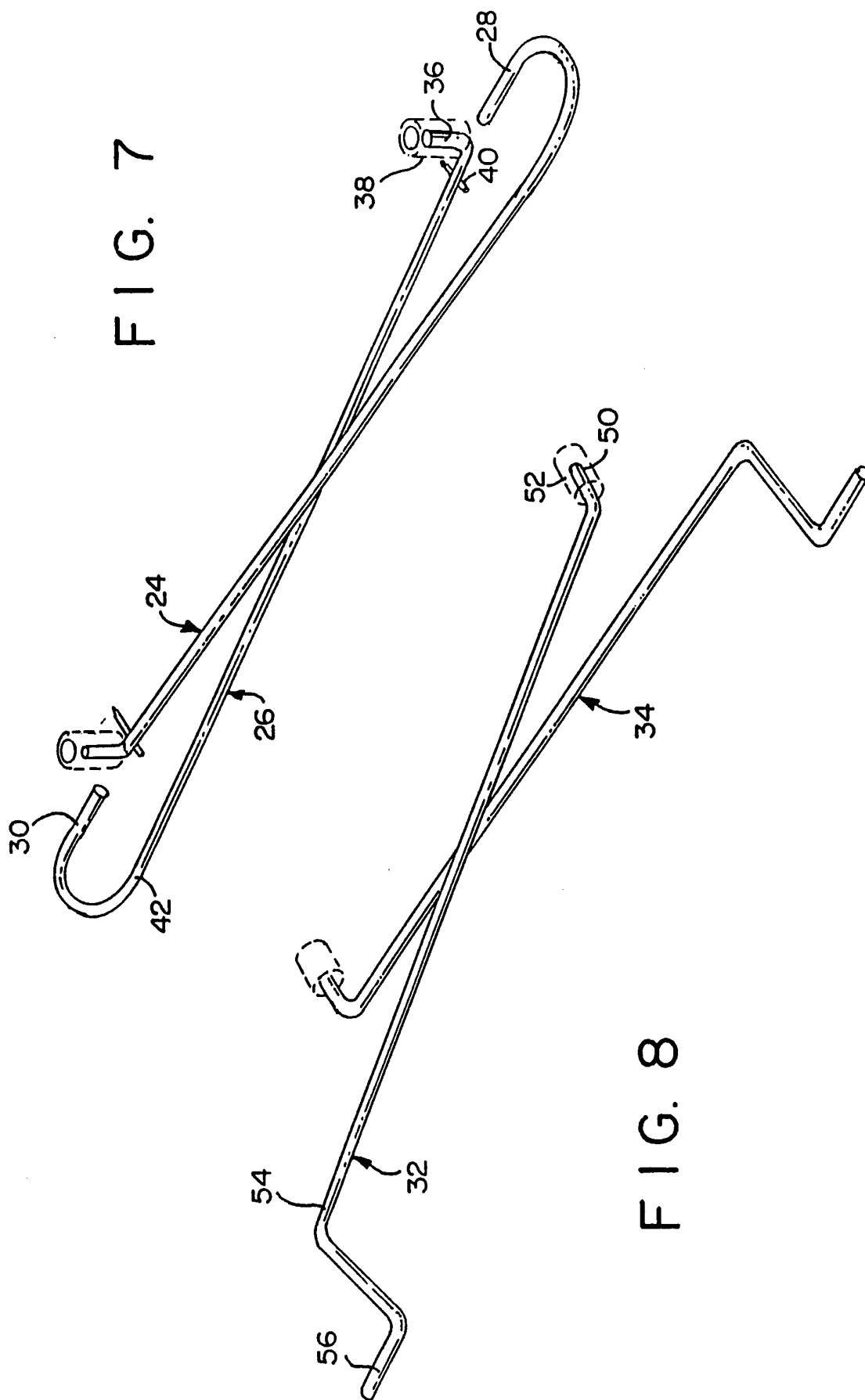


FIG. 3







## INTERNATIONAL SEARCH REPORT

national application No.  
PCT/US93/10141

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(5) :E05F 1/10, 1/08

US CL :49/386; 16/308

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)

U.S. : 49/366, 367, 379, 386; 16/298, 299, 308; 267/154

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 practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4,873,791 (Lyons, Sr.) 17 October 1989, see entire document.	1-2
X	US, A, 2,783,495 (Vigmostad) 05 March 1957, see entire document.	22-23
A	US, A, 3,516,210 (Jentoft et al) 23 June 1970, see entire document.	1-23
A	US, A, 4,133,074 (Schack) 09 January 1979, see entire document.	1-23
A	US, A, 4,291,501 (Steinberg et al) 29 September 1981, see entire document.	1-23
A	US, A, 4,419,789 (Matsui et al) 13 December 1983, see entire document.	1-23

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be part of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Z" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 11 JANUARY 1994	Date of mailing of the international search report 26 JAN 1994
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. NOT APPLICABLE	Authorized officer <i>my means</i> JERRY REDMAN Telephone No. (703) 308-2168