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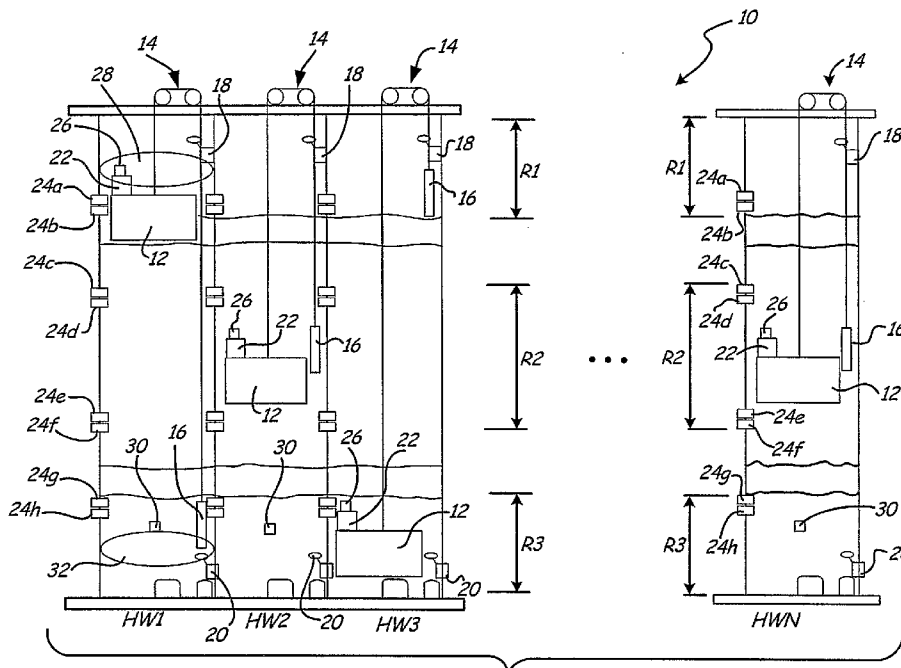
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[Continued on next page]

(54) Title: WARNING SYSTEM FOR MECHANICS IN ELEVATOR HOISTWAYS



(57) Abstract: A warning system for mechanics working in elevator hoistways (HW1, HW2, HW3, HWN) detects elevator cab position within the hoistway and senses the presence of a mechanic on the top of an elevator cab (12) or in the pit at the bottom of the hoistway. A mechanic whose presence has been sensed will receive a warning of approaching danger based on positions of the cab (12) in the hoistway (HW1, HW2, HW3, HWN), as well as cab position within adjacent hoistways, so that the mechanic can notice approaching danger caused by a moving cab (12) or counterweight (16).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WARNING SYSTEM FOR MECHANICS IN ELEVATOR HOISTWAYS

BACKGROUND OF THE INVENTION

The present invention relates to elevator systems, and in particular to a warning system for mechanics performing work in elevator hoistways.

Maintenance and repair of elevator systems can require a mechanic to enter the elevator hoistway. The mechanic may need to work within the pit area at the bottom of a hoistway, or may need to work on top of the elevator cab. Mechanics can be faced with dangerous situations caused by a moving elevator cab and a moving counterweight. For example, a mechanic must avoid a collision with the top of the hoistway when working on top of the cab. A mechanic working on top of the cab must also avoid collision with a passing counterweight for that cab or for a cab in an adjacent hoistway. When working in the pit, the mechanic must avoid a collision with either a cab or a counterweight moving downward into the pit.

BRIEF SUMMARY OF THE INVENTION

The present invention is a system and method that warns mechanics of approaching danger caused by a moving elevator cab or counterweight when the mechanic is either on top of the cab, or in the pit area. The system determines cab position within the hoistway and senses presence of the mechanic either on top of the cab or in the bottom of the hoistway. When a mechanic has been sensed, a voice-based warning is provided to the mechanic of any approaching danger based upon sensed cab position and the location of the mechanic.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram showing an elevator system having multiple hoistways and having cab position and mechanic position sensing used by the warning system of the present invention.

FIG. 2 shows an example of a coded ultrasonic signal used to inform the warning device of the sensed location of the mechanic.

FIG. 3 shows a portable device for providing voice-based warnings to a mechanic working within a hoistway of the elevator system of FIG. 1.

FIG. 4 is a chart illustrating the sensed cab positions and the sensed mechanic positions that result in production of a voice-based warning to the mechanic.

DETAILED DESCRIPTION

FIG. 1 shows elevator system 10 in which the warning system of the invention is implemented. Elevator system 10 has multiple hoistways HW1 through HWN. In FIG. 1, hoistways HW1, HW2, HW3, and HWN are shown.

Each hoistway HW1-HWN includes elevator cab 12, drive system 14, counterweight 16, top limit switch 18, and bottom limit switch 20. When performing maintenance or repairs, a mechanic may enter one of the hoistways HW1-HWN to perform work on top of one of the cabs 12, or in the pit areas at the bottom of hoistways HW1-HWN.

FIG. 1 illustrates three ranges R1, R2, and R3 where hazards can be presented for a mechanic working in hoistways HW1-HWN. Range R1 is at the top of the hoistway, and is an area where a mechanic working on top of cab 12 must avoid contact with the top end of the hoistway. Range R2 is an intermediate area within the hoistway where a mechanic on top of cab 12 must avoid contact with a passing counterweight in that hoistway or an adjacent hoistway. Range R3 defines the pit area at the bottom end of each hoistway. A mechanic working in range R3 must avoid contact with a descending cab 12 or counterweight 16 within a particular hoistway and any adjacent hoistway.

The warning system of the present invention helps a mechanic to avoid these hazards by sensing elevator position within each hoistway HW1-HWN, sensing mechanic position either on top of cab 12 or within the pit area (range R3) of each hoistway, and providing voice-based warning to the mechanic based upon the sensed elevator and mechanic positions. In the embodiment illustrated in FIG. 1, elevator position sensing is accomplished with RFID sensing technology, while mechanic position sensing is achieved using ultrasonic motion detection and ultrasonic signal transmission.

Elevator position sensing in each hoistway HW1-HWN is provided by RFID reader 22 and multiple passive RFID tags 24a-24h. RFID reader 22 is

a low cost, short range (less than 10 cm) RFID reading device carried on cab 12. Each tag 24a-24h has a unique ID which is read by RFID reader 22 as cab 12 passes.

RFID tags 24a-24h are arranged in pairs and are spaced about 20 cm apart from one another. Each pair of RFID tags is at the end of one of the ranges R1-R3. Tags 24a and 24b are at the lower end of range R1. Tags 24c and 24d are located at the upper end of range R2, while tags 24e and 24f are located at the lower end of range R2. Tags 24g and 24h are located at the upper end of range R3.

When cab 12 passes a pair of tags, RFID reader 22 detects the two tags one-by-one. Based on the order in which the two RFID tags are read, RFID reader 22 is able to determine whether cab 12 is entering or leaving a range. Whenever cab 12 is entering one of the ranges R1-R3, RFID reader 22 broadcasts a message through an RF transmitter associated with RFID reader 22. The message transmitted identifies the hoistway HW1-HWN and the range R1-R3 that cab 12 is entering.

The installation of RFID tags 24a-24h in each hoistway is simple. RFID tags 24a-24h can be glued to the wall of each hoistway. RFID reader 22 and tags 24a-24h do not need any fine tuning in positioning.

In addition to the elevator position sensing used as part of the mechanic warning system, RFID tags 24a-24h and RFID reader 22 can also be used for other functions of elevator system 10. For example, RFID tags 24a, 24b, 24g, and 24h and RFID reader 22 can be used alone or in conjunction with additional RFID tags to provide signals used for a normal terminal slowdown device (NTSD) feature and an emergency terminal stopping device (ETSD) feature of elevator system 10. These features are used to stop movement of car 12 when it reaches stopping zones near the top and bottom ends of the hoistway. In addition, the time difference between readings by reader 22 of RFID tags 24a-24h can be used for speed measurement as part of an emergency terminal speed limiting device (ETSLD) feature of elevator system 10. Speed measurement is possible, since the distance between a pair of

tags is known, and the time difference between readings can be measured. The use of RFID tags 24a-24h and RFID reader 22 for additional features of elevator system 10 reduces the effective overall cost per hoistway for the mechanic warning system.

Sensing of mechanic position is performed by ultrasonic motion detection using a pair of ultrasonic transceivers for each hoistway. Cab ultrasonic transceiver 26 is carried on the top of cab 12 and defines cab top sensing zone 28 above cab 12. Pit ultrasonic transceiver 30 is positioned within the pit area (range R3) of each hoistway HW1-HWN, and produces an associated pit sensing zone 32. Ultrasonic transceivers 26 and 30 send out ultrasonic pulses to detect any moving objects within their respective sensing zones 28 and 32. By controlling signal strength and frequency of the ultrasonic pulses from transceivers 26 and 30, the detection zones 28 and 32 can be confined to within the associated hoistway, as illustrated in hoistway HW1 in FIG. 1.

Once ultrasonic transceiver 26 or 30 detects a moving object, it begins sending out a coded message as part of the ultrasonic pulses. This coded signal identifies the transceiver 26 or 30 by hoistway and location. FIG. 2 shows one example of a coded ultrasonic signal, which includes synchronization pulses 32, start code 34, identification code 36 for the ultrasonic transceiver producing the signal, and stop code 38. Transceivers 26 and 30 can continue to detect a moving object even though the ultrasonic signal being generated is in a coded form. If transceiver 26 or 30 cannot detect a moving object, it stops sending out the code, and continues to send out nominal ultrasonic pulses until a moving object is once again sensed. This minimizes ultrasonic interference among the ultrasonic transceivers in the hoistways.

FIG. 3 shows portable warning device 40, which uses cab position information broadcast by RFID readers 22 and mechanic position information received from a nearby ultrasonic transceiver 26 (in the form of the coded ultrasonic signal) to determine whether a voice-based warning should be provided to the mechanic. Portable device 40 is a headset including RF

receiver 42, ultrasonic receiver 44, battery-powered warning circuitry 46, and speaker 48.

RF receiver 42 provides cab position information received from RFID readers 22 carried on cabs 12. The information received indicates the hoistway and the range for the associated cab 12. Ultrasonic receiver 44 receives any incoming ultrasonic pulses, synchronizes itself with the incoming signal, and extracts the unique identification number of the ultrasonic transceiver 26 or 30 producing the detected ultrasound. Once the identification number of ultrasonic transceiver 26 or 30 is known, the position of the mechanic carrying ultrasonic receiver 44 is known to warning device 40.

Based upon the unique number of the adjacent ultrasonic transceiver 26 or 30 and the range and hoistway information received from the RF transmitter, circuitry 46 knows whether it needs to send out a voice-based warning message through headphone/speaker 48. Circuitry 46 includes logic for determining the need for a voice message based upon cab position and mechanic position, and speech synthesizer circuitry for generating the warning message.

FIG. 4 is a chart showing when warning device 40 generates a voice-based warning message based upon cab position and mechanic position. An "X" in the boxes corresponding to a particular cab position (hoistway and range) and a particular mechanic position (hoistway and cab top or pit) indicates that a voice-based warning is generated.

As shown in FIG.4, warning device 40 produces a warning not only based upon location of cab 12 in the same hoistway as the mechanic, but also takes into account position of cabs in adjacent hoistways. For example, if the mechanic is on top of cab 12 in hoistway HW2, a voice-based warning message is generated only when cab 12 enters either range R1 or R2 of hoistway HW2. However, if the mechanic is in the pit of hoistway HW2, a voice-based warning message is generated when the cabs in hoistways HW1, HW2 and HW3 enter either range R1 or range R3. The adjacent hoistways are considered since the mechanic can be injured by an adjacent cab or

counterweight while the mechanic is working within the pit area.

Although portable warning device 40 has been shown as a headset, it can take other forms as well. For example, warning device 40 can be incorporated into a safety helmet. It can also accommodate or be incorporated into ordinary radio communication devices used by mechanics performing elevator repair.

The safety system of the present invention provides enhanced mechanic safety on an automated basis. The mechanic is warned of potential hazards not only from activity within the particular hoistway in which the mechanic is working, but also adjacent hoistways.

The warning messages are specific to a particular mechanic, rather than being broadcast to all workers within the elevator system. Thus, when a warning is received, the mechanic knows that it is intended specifically for him or her.

The warning system has very low material cost in terms of the RFID cab position sensing and the ultrasonic mechanic position sensing. Similarly, the battery powered portable device is relatively low in complexity, and can be incorporated into existing radio communication devices used by mechanics.

Installation cost of the warning system is also low, since RFID tags and the pit area ultrasonic transceivers can be attached to walls, and installation location accuracy is at the centimeter level, rather than higher precision. Maintenance cost is low, since the components in the hoistway do not typically require maintenance.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

CLAIMS:

1. A method of providing warnings to a mechanic working in an elevator hoistway, the method comprising:
 - sensing an elevator cab position within the hoistway;
 - sensing a mechanic position within the hoistway; and
 - providing a voice-based warning to a mechanic whose position is sensed of an approaching danger based on the sensed cab position and sensed mechanic position.
2. The method of claim 1, wherein sensing an elevator cab position comprises:
 - sensing when the cab is within one of a plurality of ranges within the hoistway.
3. The method of claim 2, wherein the plurality of ranges includes at least one of a first range at a top end of the hoistway, a second range where the cab and an associated counterweight pass one another, and a third range at a bottom end of the hoistway.
4. The method of claim 2, and further comprising:
 - transmitting a signal identifying a range in which the cab is present.
5. The method of claim 2, wherein sensing when the cab is within one of a plurality of ranges comprises:
 - reading RFID tags positioned at ends of each of the ranges; and
 - determining what range the cab is in based on the RFID tags read.
6. The method of claim 5, wherein reading RFID tags is performed by an RFID reader carried by the cab.
7. The method of claim 1, wherein sensing a mechanic position comprises:
 - sensing presence of a mechanic within a zone associated with a top of the cab.

8. The method of claim 1, wherein sensing a mechanic position comprises:
sensing presence of a mechanic within a zone associated with a pit area of the hoistway.
9. The method of claim 1, wherein sensing a mechanic position is performed by an ultrasonic motion detector.
10. The method of claim 9, wherein the ultrasonic motion detector transmits a coded ultrasonic signal identifying a location of the ultrasonic motion detector when motion is sensed.
11. The method of claim 1, and further comprising:
transmitting sensed cab position information;
transmitting sensed mechanic position information; and
receiving at a portable warning device carried by the mechanic, the transmitted cab position information and mechanic position information.
12. The method of claim 11, wherein the portable warning device provides the voice-based warning based upon the information received.
13. The method of claim 1, wherein the voice-based warning is based upon sensed cab positions within the hoistway where the mechanic is present and adjacent hoistways.
14. A warning system for a mechanic working on an elevator system including a hoistway and an elevator cab, the warning system comprising:
a cab position sensor;
a mechanic position sensor; and
a portable warning device carried by the mechanic, responsive to cab position information received from the cab position sensor and mechanic position information received from the mechanic position sensor, for generating a voice-based warning signal to the mechanic.

15. The warning system of claim 14, wherein the cab position sensor comprises:

a pair of RFID tags defining a lower end of a first range at a top end of the hoistway;
a pair of RFID tags defining an upper end of a second range of the hoistway where the cab and a counterweight pass;
a pair of RFID tags defining a lower end of the second range;
a pair of RFID tags defining an upper end of a third range at a bottom end of the hoistway; and
an RFID reader carried by the cab that interrogates the RFID tags and transmits an RF signal identifying the hoistway and a current range position of the cab.

16. The warning system of claim 15, wherein the mechanic position sensor comprises:

an ultrasonic transceiver carried by the cab for sensing presence of a mechanic on top of the cab using an ultrasonic signal containing a coded identification of the transceiver; and
an ultrasonic transceiver positioned in the third range for sensing presence of a mechanic at the bottom end of the hoistway using an ultrasonic signal containing a coded identification of the transceiver.

17. The warning system of claim 14, wherein the portable warning device is responsive to an RF signal from the cab position sensor and an ultrasonic signal from the mechanic position sensor.

18. The warning system of claim 14, wherein the portable warning device bases the warning signal on cab positions in the hoistway where the mechanic is sensed and an adjacent hoistway.

19. A method of providing warnings to a mechanic working in an elevator hoistway, the method comprising:

determining an elevator cab position within the hoistway;

sensing presence of a mechanic on top of the cab or in a pit area of the hoistway;

transmitting cab position information and sensed mechanic presence information to a portable warning device carried by the mechanic; and

providing with the portable warning device a voice-based warning to a mechanic whose presence is sensed of an approaching danger based on the cab position information and the sensed mechanic presence information.

20. The method of claim 19, wherein determining an elevator cab position is by reading RFID tags mounted in the hoistway, and wherein sensing position of a mechanic is with an ultrasonic motion detector.

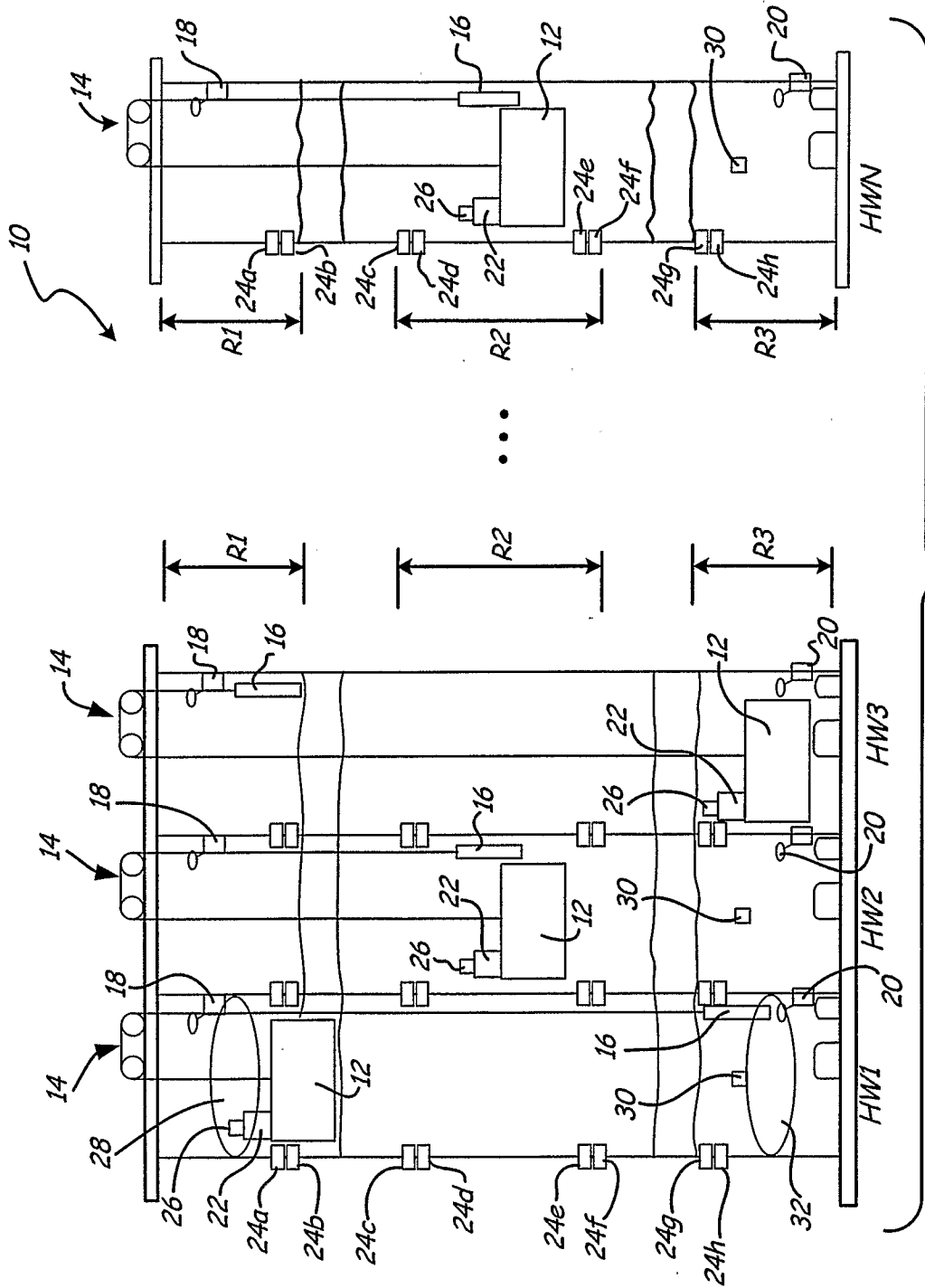


Fig. 1

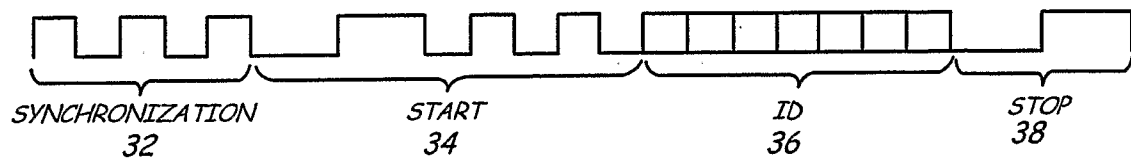


Fig. 2

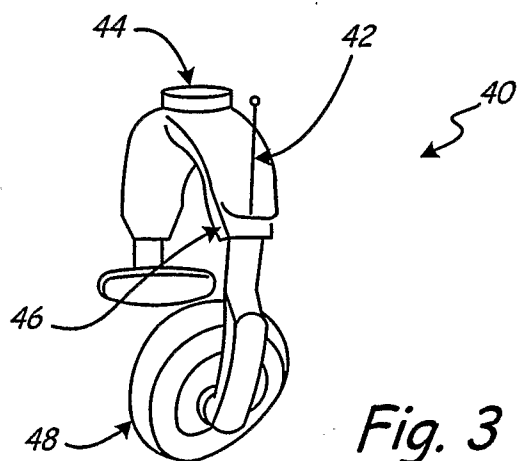


Fig. 3

Cab Position Mechanic position		HW1			HW2			HW3			HWN		
		R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3
HW1	On the cab	X	X										
	In the pit	X		X	X		X						
HW2	On the cab				X	X							
	In the pit	X		X	X		X	X		X			
HW3	On the cab							X	X				
	In the pit				X		X	X		X			
HWN	On the cab										X	X	
	In the pit										X		X

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US5/28153

A. CLASSIFICATION OF SUBJECT MATTER

US: 187/390, 314; IPC(8): G08B 21/0

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)

US: 187/390, 314, 391, 392, 393; IPC(8): G08B 21/0

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)

EAST, MicroPat, IP.com, DialogPro

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 6,202,797 A (Skolnick et al.) 20 March 2001 (20.03.2001), see entire document.	1-4, 7, 8, 11, 12, 13-14, and 18-19 — 9 and 16-17
Y	US 5,283,400 A (Leone et al.) 01 February 1994 (01.02.1994), see Figure 3.	9 and 16-17
A	US 5,347,094 A (Leone et al.) 13 September 1994 (13.09.1994), see entire application.	1-20
A	US 5,476,157 A (Todaro) 19 December 1995 (19.12.1995), see entire document.	1-20
A	US 6,603,398 B2 (Tinone et al.) 5 August 2003 (05.08.2003), see entire document.	1-20
A	US 6,173,814 B1 (Herkel et al.) 16 January 2001 (16.01.2001), see entire document.	1-20
A	US 4,987,402 A (Nykerk) 22 January 1991 (22.01.1991), see entire document.	1-20
A	US 4,897,630 A (Nykerk) 30 January 1990 (30.01.1990), see entire document.	1-20
A	US 6,116,381 A (Jalbert) 12 September 2000 (12.09.2000), see entire document.	1-20

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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