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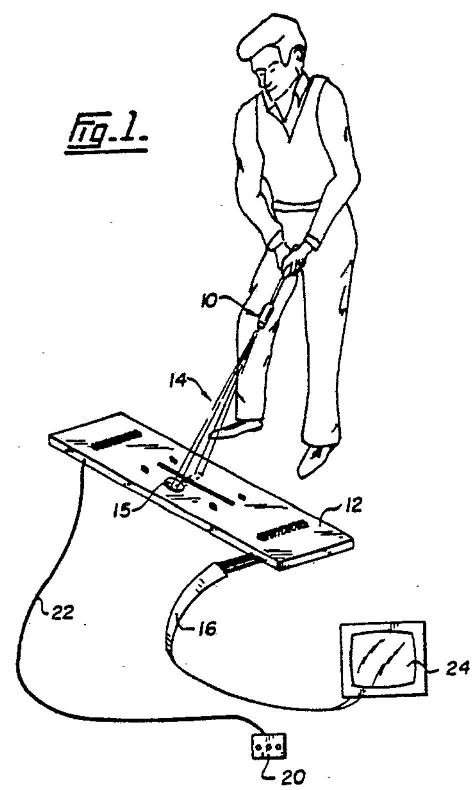
(54) Golf practice apparatus.

(57) Apparatus for the practicing of golf swings has a club member (10) to be swung by a user in simulation of the swinging of a golf club, the club member (10) having a simulated golf club handgrip and a source of radiation for providing a beam (14) extending from one end of the club member (10) in the longitudinal direction of the club member, the beam having a flat leading side. Sensors responsive to the radiation for sensing the swinging of the club member (10) are disposed in a predetermined array in the vicinity of a simulated golf ball impact location for providing sensor signals in response to the passage of the beam over the array. The sensor signals are processed for providing first signals corresponding to the direction of travel of the beam, second signals corresponding to the speed of travel of the beam and third signals corresponding to the orientation of the beam. The first, second and third signals are employed for computing a golf ball flight and providing corresponding output signals to a monitor (24) for providing a visual representation of the flight of the golf ball.

Fig. 1.



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GOLF PRACTICE APPARATUS

The present invention relates to apparatus for the practicing of golf swings and, more particularly, to apparatus which provides the user with a visual display of the result of a golf swing by the user.

As will be readily appreciated by golfers, much of the difficulty in playing golf in a successful manner is involved in ensuring that the orientation of the golf club head is exactly correct at the instant of impact of the club head against the ball.

Consequently, many golfers spend much time practicing their golf swings with different types of golf club. However, such practicing cannot be performed, for example, in a room of a normal household, because most houses and apartments have ceilings which are only eight feet high and a full swing with a wood or iron golf club would therefore produce holes and other damage to the ceilings of such rooms. Furthermore, a wide-open space is required in order to avoid damage to the contents of the room, and it has been estimated that an area of at least fifteen feet by twelve feet of open space would be required to enable a golfer to swing a driver comfortably. A still further danger is the risk of damage to the surface of the floor, because of the absolute necessity of contact of the golf club with the floor. In this connection, golfers will appreciate that, on a golf course, it is necessary to remove a small divot during a swing in order to achieve correct flight of the ball. Even if the contents of a room could be displaced to provide sufficient space for a full swing, and if a protective covering could be placed on the floor, it is nevertheless not feasible, without great expense and difficulty, to raise the ceilings of most rooms to avoid damage.

Previous attempts have been made to provide apparatus for facilitating the practicing of golf swings.

For example, United States Patent 4,137,566, issued January 13, 1987 to Steven L. Haas et al, disclosed an apparatus and method for analyzing a golf swing and displaying the results in which light sources are attached to appropriate locations on the golfer himself or on a golf club, the light from these light sources being detected by electro-optical sensors having different fields of view encompassing the golfer and the golf club during at least a portion of the golf swing. The outputs of the sensors are electronically processed to provide alpha-numeric or graphic data for display. However, as will be immediately apparent from the above remarks, the disadvantage of this prior apparatus and method is that they require the user to swing a golf club, which as explained above is impractical in many rooms.

Another prior art golf swing practicing apparatus is shown in United States Patent 4,254,956, issued March 10, 1981 to Thomas L. Rusnak, which discloses apparatus for photoelectrically sensing the time and position of a golf club head at selected stations along a practice swing. Corresponding characteristics of the swing and the resulting ball flight are computed electrically and displayed to the player. However, once again, this prior apparatus has the disadvantage that it requires the use of a real golf club or, at least, a simulated golf club having the same dimensions as a real golf club.

United States Patent 4,306,722, issued December 22, 1981 to Thomas L. Rusnak disclosed golf swing training apparatus in which the passage of the head of a golf club is detected during swinging of the club head past sensing devices located near the floor. However, this prior device also completely fails to avoid the disadvantages of swinging a full-length golf club.

In United States Patent 4,542,906, issued September 24, 1985 to Akio Takase et al, there is disclosed a computer-aided golf training device which detects movement of a golf ball immediately after the ball has been impacted by a club head. Consequently, this prior apparatus again requires the use of a golf club and, further, has the disadvantage that it requires a ball to be struck and thereby put into flight, which would increase even further the space required.

In United States Patent 2,080,608, issued May 18, 1937 to E. S. Hannaford, there is disclosed a golf game improver which employs a practice stick, weighted so as to give the same feel as a golf club when swing and incorporating means for projecting a beam of light from one end of the stick. No means are provided for detecting or sensing this beam of light, which is merely used to project a spot of light onto a mat so as to trace across the mat, when the stick is swung in simulation of a golf swing. By visually observing the trace, the user can form some rough judgement of the correctness of his swing, but no means are provided for accurately sensing, recording, measuring or reproducing the swing.

It is, accordingly, an object of the present invention to provide a novel and improved apparatus for the practicing of golf swings which avoids the use of a golf club but senses the correctness or otherwise of the swings.

To that end, the present invention provides an elongate member, which is swung by a user in simulation of the swinging of a golf club and which projects a beam of radiation from one end thereof, the beam being detected by sensors to provide signals which are electronically processed to provide a visual display corresponding to the swing.

In particular, according to the invention there is provided apparatus for the practicing of golf swings, comprising an elongate member to be swung by a user in simulation of the swinging of a golf club, the elongate member comprising a simulated golf club hand grip, a source of radiation and means for forming the radiation into a beam extending from one end of the elongate member in the longitudinal direction of the elongate member. A plurality of sensor means are disposed in a predetermined array for providing sensor signals in response to the passage of the beam over the array during the swinging of the elongate member. Means are provided for processing the sensor signals to produce output signals corresponding to the motion of the elongate member, and visual display means responsive to the output signals provide a visual representation corresponding to the output signals.

The visual representation may, for example, take the form of a picture illustrating the flight of a golf ball, the flight varying in dependence on various characteristics of the swinging of the elongate member.

By thus employing detection of the beam during the swing, instead of detecting motion of a golf club head, the elongate member may have a length substantially less than that of a golf club, thus avoiding the space requirements for the swinging of a golf club.

In a preferred embodiment of the invention, the array of sensor means is supported on the floor, beneath the path of travel of the elongate member during the swinging of the elongate member, and in the vicinity of a simulated golf ball impact location. The sensor means comprise groups of sensors which are differently arranged for sensing the direction of movement of the beam through the impact location, the timing of the beam during the passage of the beam over the array and the inclination of the beam as the beam passes through the impact location.

The invention will be more readily understood from the following description of a preferred embodiment thereof given, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a view in perspective of a golf swing practice apparatus embodying the present invention while in use by a golfer;

Figure 1A shows a diagrammatic end view of a housing forming part of the apparatus of Figure 1;

Figure 2 shows a view in side elevation of a club forming part of the apparatus of Figure 1;

Figure 2A shows a more detailed view, partially broken away in longitudinal cross-section, of the club of Figure 2;

Figure 3 shows a view in elevation of a diaphragm forming part of the optical system of the club of Figure 2;

Figure 4 diagrammatically illustrates an array of light sensors included in the apparatus of Figure 1;

Figure 4A shows a modification of Figure 41 Figure 5 shows a block diagram of the electronic components of the apparatus of Figure 1;

Figure 6 shows a flow chart illustrating the operation of the components shown in Figure 5;

Figure 7 shows a more detailed block diagram of the fast sensor array of Figure 5;

Figure 8 shows a circuit diagram of an end bank light sensor circuit included in the end bank sensor array of Figure 5, and associated components; and

Figure 9 and 10 show circuit diagrams of two of the light sensors incorporated in the fast sensor array of Figure 5, together with associated components.

Referring now to Figure 1 of the accompanying drawings, the golf swing practice apparatus illustrated therein comprises a simulated golf club in the form of an elongate club member indicated generally by reference numeral 10, which has a length approximately one-half of the length of a conventional golf club and which, as illustrated in Figure 1, is swung by the user of the apparatus in simulation of the swinging of a golf club.

The apparatus further includes a shallow, elongate housing 12 of rectangular shape, which is placed on the floor while the apparatus is in use and which, as described in greater detail below, incorporates an array of light detectors for detecting a light beam, indicated generally by reference numeral 14, which extends from one end of the club member 10 in the longitudinal direction of the club member 10, the arrangement being such that the light beam 14 sweeps along at least a portion of the upper surface of the shallow rectangular housing 12 during the simulated golf swing.

The housing 10 is also provided with a sonar transducer 15, which is a commercially available sonar transducer manufactured by Polaroid Corporation and the purpose of which is to sense the height of the lower end of the club member 10 for measuring the height of the imaginary golf club head at an appropriate location during the swing.

As can be seen from Figures 1 and 1A, the sonar transducer 15 is offset from the centre of the top of the housing 12 and is tilted towards the user.

By measuring the height of the club member 10, as the light beam 14 passes through a "strike point" on the housing 12, it can be determined whether the imaginary club head has passed over, and thus missed, the position of an imaginary ball or whether the club member 10 has been swung too low.

The shallow rectangular housing 12 is connected by a cable 16 to a monitor 24 for providing the user of the apparatus with a visual display of the results of his simulated golf swings. A control switch unit 20 is connected by means of a cable 22 to the housing 12 for providing user input into the apparatus, as described in greater detail below.

Referring now to Figures 2 and 2A, it will be seen that the club member 10 comprises a tubular metal shaft 26 provided at one end thereof with a simulated golf club hand grip 28 and, at the other end thereof, with a club head indicated generally by reference numeral 30.

The club head 30 comprises an elongate housing 32 formed at one end thereof with an end closure 34, which is in threaded engagement with the corresponding end of the housing 32 and formed with a cylindrical opening 35 for receiving an end 27 of the shaft 26, the end 27 being adjustable secured by a grub screw 29 in threaded engagement with the end closure 34.

The housing 32 contains a light source in the form of a light bulb 36 provided with a reflector 33. A pair of condensing lenses 37 and 38 are provided for redirecting the light from the light bulb 36 through a mask or diaphragm 39, which is described in greater detail below with reference to Figure 3, and a focussing lens 40 to form the beam 14.

The lenses 37 and 38 are held apart in a cylindrical bore 41 in the housing 32 by a cylindrical spacer 42, and threaded retainer rings 43 and 44 are screwed into an internal thread 45 in the housing 32 to retain the diaphragm 39, the lenses 37 and 38 and the spacer 42 in position in the housing 32.

The focussing lens 40 is secured in a sleeve 46 by a retainer ring 47 in threaded engagement with an internal thread 48 in the sleeve 46. An external thread 49 on the sleeve 46 is in threaded engagement with the internal thread 45 of the housing 32. The sleeve 46 has at one end a cylindrical peripheral projection 50, the periphery of which is knurled to facilitate manual rotation of the sleeve 46 relative to the housing 32 for axially displacing the focussing lens 40 and thereby focussing the beam 14.

The housing 32 is formed with an integral auxiliary housing 51, which serves to contain a pair of batteries 52 for energizing the light bulb 36. The batteries 52 are retained in the auxiliary housing 51 by means of a closure 53 in snap-in engagement with the auxiliary housing 51. Manually actuatable switch 54 (Figure 2) serves, when closed, for completing a circuit through the light bulb 36 and the batteries 50 illuminating the light bulb 36 to produce the light beam 14.

The diaphragm 39 comprises a disc of transparent material, e.g. glass, provided with an opaque coating. As shown in Figure 3, this coating comprises an outer portion 70, and is formed with a central rectangular opening 71, within which there is a substantially smaller, rectangular opaque portion 72. Consequently, as will be readily apparent, the light which is transmitted by the condensing lenses 37 and 38 through the diaphragm 39 is formed so that the light beam 14 is of rectangular cross-section and, at its middle, has a dark spot or portion 74 (Figure 4), i.e. a light-free portion, which is of rectangular shape and which corresponds to the opaque portion 72 of the diaphragm, this dark portion of the beam cross-section being surrounded by an illuminated area or portion 75 of rectangular shape.

The planar or flat leading side of the light beam 14, which forms the leading edge 76 of the rectangular illuminated area 75, and the dark spot or portion 74 are sensed by an array of light sensors in the housing 12 in order to determine the direction, speed and orientation of the light beam 14 as the club member 10 is swung to move the light beam 14 through an imaginary golf ball impact location on the housing 12, as described in greater detail below.

This array of light sensors, which comprise phototransistors, is illustrated in Figure 4 of the drawings, which shows two flat, horizontal, vertically spaced support boards 80 and 81, which are mounted in the housing 12.

On the upper support board 64 there is shown the above-described area 75 of light which is projected on to the upper board 80 by the light beam 14. The array of light sensors comprises, firstly, two parallel rows or end banks, indicated generally by reference numerals 82 and 84, of light sensors 86, the rows 82 and 84 being spaced apart in the longitudinal direction of the board 80, which is indicated by arrow A, with the rows 82 and 84 extending transversely of the direction A.

In the present embodiment of the invention, each of the rows or end banks 82 and 84 comprises twenty-four sensors 86. However, the number of sensors is not critical and may be varied depending upon the particular type of sensor employed and the dimensions of the sensor array as a whole.

As the light beam 14 sweeps across the end banks 82 and 84 in succession, the rectangular illuminated area 75 and the rectangular dark spot 74 cause some of the light sensors of each end bank 82 and 84 to be successively energized, de-energized, energized again and, finally, again de-energized. It is the first of these de-energizations, corresponding to the passage of the dark spot 74 over the light sensors, which is detected to indicate the passage of the axis of the light beam 14 over the rows 82 and 84. Also, the individual light sensors 86 of each row or end bank 82 and 84 are constantly monitored in succession, and the light sensors, in each row, which respond to the dark spot 74 are used to indicate the presence of the dark spot 74. These light sensors thus provide an indication of the direction of the path of movement of the light beam 14 across the board 80 and, thus, through the location of impact of the light beam with an imaginary golf ball. The location of this imaginary golf ball is indicated by a disk 87 painted on the top of the housing 12 in a colour, e.g. white, which contrasts with the colour, e.g. green, of the remainder of the housing 12 to indicate to the user where he should aim his swing.

The board 80 is formed, at a central portion thereof, with a longitudinal slot 88, which allows a portion of the light beam 14 to pass downwardly through the board 80, and an array of four light sensors 90a, 90b, 90c and 90d are spaced apart at opposite sides of and longitudinally of the slot 88.

Two parallel sensor rows, indicated generally by reference numerals 92 and 94, each comprising eight light sensors 96, are mounted on the lower board 81, and are spaced apart longitudinally along the board 81 beneath the slot 88, the rows 92 and 94 extending transversely of the longitudinal direction A. More particularly, these two rows 92 and 94 are positioned to intercept the above-mentioned portion of the light beam 14 which passes downwardly through the slot 88.

The light sensors 90a - 90d are employed to detect the timing of the travel of the planar front or leading side of the light beam 14 during the passage of the light beam 14 through the imaginary golf ball impact location represented by the disk 87.

In addition, the light sensors 96 are employed to sense the angle of the light beam during the passage of the light beam through the imaginary golf ball impact location, i.e. the inclination of the longitudinal axis of the club 10.

More particularly, considering for a moment only the four sensors 90a - 90d, as the leading edge 76 of the illuminated area 75 sweeps in succession over these sensors, they will be energized at successive time intervals which vary in dependence, firstly, on the direction of travel of the light beam 14 relative to the housing 12 and, secondly, on the orientation of the illuminated area on the board 80.

Consequently, these four light sensor 90a - 90d are insufficient to distinguish variations of those time intervals resulting from differences in the direction of travel of the light beam from those variations resulting from differences in the orientation of the illuminated area 75.

However, these differences can be distinguished from one another by also taking with account the timing and location of the beam portion which passes downwardly through the slot.

This beam portion is so narrow as to illuminate only one sensor in row 92 and one sensor in row 94.

Which of the sensors 96 of each row is illuminated depends on the direction of the longitudinal axis of the beam 14 and, thus, that of the club 10, assuming that those two axes are co-incident.

Consequently, by detecting the timings of the energization not only of the four sensors 90a - 90d but also those of the two illuminated sensors 96, and by also taking into account the direction of travel of the beam, as detected by the end bank sensors, the spatial orientation, i.e. the three-dimensional orientation of the plane of the leading side of the light beam 14 can be determined by the processing of the sensor signals, and also the speed of travel of the light beam can be measured.

In Figure 4A, parts which correspond to those shown in Figure 4 have, for convenience, been indicated by the same reference numerals.

However, the sensor array of Figure 4A differs from that of Figure 4 in that, instead of having the sensor rows 92 and 94 mounted on the board 81 at a spacing below the board 80, in this case a corresponding pair of sensors rows, indicated by reference numerals 92a and 94a, are mounted in a downwardly facing fashion on the underside of the board 80 and the board 81 of Figure 4 is replaced by a board 81a which is closer to the board 80. The board 81a is provided with a mirrored upper surface 97 for reflecting upwardly onto the sensor array comprising the sensor rows 92a and 94a the portion of the light beam 14 which passes downwardly through the slot 88.

Referring now to the block diagram of the apparatus shown in Figure 5 of the drawings, a central processing unit CPU 100 is connected to the control switch unit 20, which comprises three manually operable switches for providing user input into the CPU 100.

The CPU 100 is also provided with input data from an end bank sensor array 104, which incorporates the two rows or end banks 82 and 84 of light sensors 86, and a fast sensor array 106, which incorporates the light sensors 90a - 90d and 96.

A system memory 108 is connected to the CPU 100 and serves to store program data for controlling the operation of the apparatus.

The CPU 100 outputs a signal to a graphics control circuit 110 which, in response to data from the CPU 100 and to data stored in a graphics memory 112, provides a display on the screen of the monitor 24.

More particularly, the switch unit 20 may be employed by the user, at the beginning of a game, to provide appropriate input into the CPU 100 for selecting, for example, which of the eighteen holes of a golf course he wishes to play. Graphics data relating to this hole is then transferred from the system memory 108 to the graphics memory 112. Also, the switch unit 102 may, for example, be employed for presetting parameters such as wind speed, the speed of the green on which a game is to be played, etc.

When the user then swings the club 10 so as to cause the light beam 14 to sweep across the sensor array in the housing 12, the direction and orientation of the light bean 14, and thus of the club member 10, as the light beam passes through the simulated golf ball impact location, are sensed as described above and corresponding data is fed from the end bank sensor array 104 and the fast sensor array 106 to the CPU 100.

More particularly, at the beginning of the sensing of a golf swing, the sensors 86 of rows 82 and 84, represented as the end bank sensor array 104 in Figure 5, is checked for the presence of a signal from any of the end bank sensors 86, as indicated in the flow chart of Figure 6. In response to detection of such a signal, the end bank sensors 86 are monitored to determine which of them first detects the dark spot 74, as described above, and the fast sensors, i.e. the fast sensor array 106 comprising the fast sensors 90a - 90d and 96, are set up so that the timings of the energization of those sensors can be detected. Under control of the data stored in the system memory 108, the CPU 100 then computes the trajectory or flight of an imaginary golf ball and outputs corresponding flight data to the graphics control 110.

The graphic control 110 combines the flight data with data relating to the golf course obtained from the graphics memory 112 to provide on the screen of the monitor 24 a graphical representation of a hole of the golf course with, superimposed thereon, the trajectory or flight of the imaginary golf ball. Thus, the user can observe on the screen of the monitor 24 a graphical display of the results of his swing.

A sonar ranging module 115 is connected to the CPU 100 and to the sonar transducer 15, and is a commercially available product manufactured by Texas Instruments Incorporated, of Dallas, Texas, and identified as Type SN 28827. In operation, the CPU 100 sends a pulse to the sonar ranging module 115 to initiate the transmission of a sonar signal by the transducer 15. The sonar ranging module 115 also monitors the transducer 15 and, in response to an echo signal from the latter, outputs a corresponding signal to the CPU 100, which then determines the time lapse between the sonar transducer transmission and echo signal transmission as a measurement of the height of the club member 10.

The sonar signal from the transducer 15 is confined to an angle of approximately fifteen degrees, which is wide enough to record a variety of swings and narrow enough to avoid most spurious signals from objects other than the club member 10.

The height measurement thus determined by the CPU 100 is displayed on the monitor 24.

The CPU 100 also provides an output to a speaker unit 116, for providing an audio signal. More particularly, the speaker unit 116 is operated by the CPU 100 to provide an audio signal corresponding to the sound of a golf club striking golf ball as the light beam 14 passes through the imaginary golf ball impact location. Also, the speaker unit 116 is controlled so as to provide appropriate sound signals when, for example, the imaginary flight of the golf ball lands in water.

Referring now to Figure 7, which illustrates in block diagram form the fast sensor array 106 comprising the sensors 90a - 90d and the rows of sensors 92 and 94 shown in Figure 4, there are shown sensor circuits 120a and 120h and 121a - 121h.

The sensor circuits 120a - 120h each comprise one of the sensors 96 of the sensor row 92 (or 92a) with associated circuitry, and the sensors 121a - 121h each comprise one of the sensors 96 of the sensor row 94 (or 94a) with associated circuitry, as will be described in greater detail below.

The sensor circuits 120a - 120h and 121a - 121h are corrected to a common input conductor 123, to which a DAC voltage is applied.

Figure 7 also shows two circuits 122a and 122b connected to the outputs of the sensor circuits 120a and 121a, respectively, for processing the output of these circuits, and four sensor circuits 124a - 124d, which each comprise a respective one of the sensors 90a - 90d and associated components, as described in greater detail below with reference to Figure 9A.

The sensor circuits 120a - 120h each have an output connected to the circuit 122a and the sensor circuits 121a -121h each have an output connected to the circuit 122b.

In addition, the sensor circuits 120a - 120h and 121a - 121h also each have an output connected by a conductor 126 to the CPU 100.

The outputs of circuits 122a, 122b and 124a 124d are connected to respective latches 127 of an 8-bit counter 128, the output which is connected by conductor 130 to a 16-bit counter in the CPU 100.

The sensor circuits will now be descended in greater detail with reference to Figures 8, 9 and 10.

Figure 8 shows a sensor circuit incorporating one of the end bank sensors 86, each of which has a similar circuit. The sensor 86 shown in Figure 8 is implemented as an infra-red phototransistor Tr1 which, when energized, provides a voltage at the output of an operational amplifier OA1. A voltage divider comprising resistors r1 and r2 is used to reduce this voltage, the reduced voltage being applied by conductor 132 to a digital input circuit 133, implemented as an 8255 chip, which is one of a pair of such circuits respectively connected to the end banks 82 and 84.

The DAC voltage from conductor 123 and a resistor r3 are employed to compensate the phototransistor Tr1 when there is ambient infra-red radiation, by providing a current to null the output of the operational amplifier OA1.

A diode D1 is provided to protect the input of the digital input circuit 133. This is required since, when the circuit is compensating for infra-red and if the ambient infra-red then disappears, the output of the operational amplifier OA1 would be driven negative and, therefore, so would the input of the digital input circuit if the diode D1 were not present.

The digital input circuit is polled by the CPU100 to determine the status of the end bank sensors 86.

Figure 9 shows one of the sensor circuits 124a -124d of the sensors 90a - 90d, the remainder of which are similar to that shown in Figure 9. In this case, the light sensor, e.g. sensor 90a, comprises a phototransistor Tr2, which produces an A.C. pulse at the output of an operational amplifier OA2, which is coupled to transistor Tr3, which controls an operational amplifier OA3, the output voltage of which is applied through a diode D3 to the conductor 136, in the case of one of the circuits 120a - 120h, or 138, in the case of one of the circuits 121a - 121h. The output voltage of the operational amplifier OA3 is reduced by a voltage divider comprising resistors r8 and r9 and applied to the respective conductor 126, which is connected to a respective port of one of a pair of digital input circuits 140, 142, (Figure 7) which are implemented as 8255 chips and serve as inputs to the CPU 100.

When the phototransistor Tr3 is energized, it provides a signal through the respective conductor 126 to the respective part of the digital input circuit 140 or 142 by which the CPU 100 determines which of the phototransistors Tr3, i.e. which of the light sensors 96, has been illuminated by the portion of the light beam passing through the slot 88. As described above, this data is employed in the computation of the orientation of the longitudinal axis of the club 10.

Also, the same phototransistor Tr3, through its conductor 136 or 138 and its associated circuit 122a or 122b, and through the corresponding latch 127, latches the timer 128.

Likewise, when one of the four sensors 90a 90d is energized, its sensor circuit 124a - 124d, through the corresponding latch 127, latches the timer 128.

The timer 128 is an 8-bit counter, and is connected to a 16-bit counter in the CPU 100.

With this arrangement, the timings of the illuminations of the sensors 96 and 90a - 90d are latched in hardware and can be retrieved during the interrupt service routine of the CPU 100 to enable the timings for these sensors to be measured accurately, and a 24 bit time resolution is employed, at 0.5 microseconds, to provide an interval of 8 seconds. This accuracy directly determines the accuracy of the measurements as a function of velocity of the light beam.

Claims

1. Apparatus for the practicing of golf swings, comprising an elongate member to be swung by a user in simulation of the swinging of a golf club, the elongate member comprising a simulated golf club handgrip, a source of radiation and means for forming radiation from the radiation source into a beam extending from one end of the elongate member in the longitudinal direction of the elongate member, characterized by a plurality of sensor means responsive to the radiation and disposed in a predetermined array for producing sensor signals in response to the passage of the beam over the array during the swinging of the elongate member; means for processing the sensor signals to produce output signals corresponding to the speed and orientation of the elongate member; and visual display means responsive to the output signals for providing a visual representation corresponding to the output signals.

2. Apparatus as claimed in claim 1, characterized by means for supporting the array of sensor means in the vicinity of as imaginary golf ball impact location disposed beneath the path of travel of the elongate member during the swinging of the elongate member.

3. Apparatus as claimed in claim 2, characterized in that the supporting means comprise means for supporting the sensor means array on a floor.

4. Apparatus as claimed in claim 1, characterized in that the means for forming the beam comprise means for imparting a planar shape to a leading side of the beam, the processing means including means responsive to passage of the beam leading side over the predetermined array for

detecting the three-dimensional orientation of the beam leading side relative to the predetermined array.

5. Apparatus as claimed in claim 4, characterized in that the means for forming the beam further comprise means for forming a radiation-free zone within the beam, the processing means including means responsive to passage of the radiation-free zone over the predetermined array for detecting the direction of travel of the beam over the predetermined array.

6. Apparatus as claimed in claim 1, characterized in that the plurality of sensor means comprise first sensor means for sensing the direction of movement of the beam through a simulated golf ball impact location, second sensor means for sensing the timing of the light beam during the passage of the beam over the predetermined array and third sensor means for sensing the inclination of the beam as the beam passes through the simulated golf ball impact location.

7. Apparatus as claimed in claim 1, characterized in that the plurality of sensor means comprise first and second rows of sensors arranged with the first row parallel to and laterally spaced from the second row for sensing the direction of movement of the beam through a simulated golf ball impact location.

8. Apparatus as claimed in claim 1, characterized in that the predetermined array of sensor means comprises first and second rows of sensors arranged with the first row parallel to and laterally spaced from the second row, means providing an opaque covering over the first and second rows for shielding the first and second rows from the beam, and means defining in the opaque covering a slot extending transversely of the first and second rows for allowing radiation from the beam to reach portions of the first and second rows, depending upon the inclination of the beam.

9. Apparatus as claimed in claim 8, characterized in that the plurality of sensor means comprise first and second rows of sensors arranged with the first row parallel to and laterally spaced from the second row for sensing the direction of movement of the beam through a simulated golf ball impact location.

10. Apparatus as claimed in claim 1, characterized in that the plurality of sensor means comprise a group of sensors mutually spaced in an array for sensing the timing of the beam.

11. Apparatus as claimed in claim 1, characterized in that the visual display means comprise memory means for storing data relating to a graphical display of portions of a golf course, and means responsive to the graphical display data and the output signals for displaying a graphical representation of the golf course portions and of a golf ball flight corresponding to the output signals, with the flight superimposed on the golf course portions.

12. Apparatus as claimed in claim 1, characterized in that the processing means includes means responsive to the motion of the elongate member for outputting sound control signals, the apparatus including means for generating sound in response to the sound control signals.

13. Apparatus as claimed in claim 11, characterized in that the processing means includes means responsive to the motion of the elongate member and to the graphical display data for outputting sound control signals, the apparatus including means for generating sound in response to the sound control signals.

14. Apparatus as claimed in claim 1, characterized by means for sensing the height of the club member during passage of the beam over the array.

15. Apparatus as claimed in claim 14, characterized in that the height sensing means comprise transducer means for transmitting a sonar signal and detecting an echo of said sonar signal.

16. Apparatus for the practicing of golf swings, comprising a club member to be swung by a user in simulation of the swinging of a golf club, the club member having a simulated golf club handgrip, a source of radiation, and means for forming the radiation into a beam extending from one end of the club member in the longitudinal direction of the club member and with the beam having a flat leading side, characterized by sensor means responsive to the radiation for sensing the swinging of the club member, the sensor means being disposed in a predetermined array in the vicinity of a simulated golf ball impact location for providing sensor signals in response to the passage of the beam over the array, means responsive to the sensor signals for providing first signals corresponding to the direction of travel of the beam through the location, second signals corresponding to the speed of travel of the beam through the location and third signals corresponding to the three-dimensional orientation of the beam leading side during passage thereof through the location, means responsive to the first, second and third signals for computing a golf ball flight and providing output signals corresponding to the flight, and visual display means responsive to the output signals for providing a visual representation of the flight.

17. Apparatus as claimed in claim 16, characterized in that the visual display means comprise means for displaying a graphical representation of the flight.

18. Apparatus as claimed in claim 17, characterized by means for storing data representing a graphical display of portions of a golf course, the visual display means comprising means for graphically displaying the flight representation superimposed on the golf course portions.

19. Apparatus as claimed in claims 16, characterized in that the sensor means comprise two sets of sensors arranged with the sets spaced apart along the direction of the path of travel of the beam through the location and with the sensors of each set distributed across the path for sensing the direction, the sensor signal responsive means including means responsive to the two sets of sensors for providing the first signals.

20. Apparatus as claimed in claim 16, characterized in that the sensor means comprise individual sensors spaced apart in the vicinity of the location for sensing the speed of travel of the beam, the sensor signal responsive means including means responsive to the sensors for providing the second signal.

21. Apparatus as claimed in claim 16, characterized in that the sensor means comprise a mask which is opaque to the radiation, first and second sets of sensors located above and below, respectively, the opaque mask and means defining an elongate opening in the mask through which radiation from the beam can reach the sensors below the mask, the sensor signal responsive means comprising means responsive to the first and second sets of sensors for providing the third signals.

22. Apparatus as claimed in claim 16, characterized in that the sensor means comprise a mask which is opaque to the radiation; first and second sets of sensors located above and below, respectively, the opaque mask, means defining an elongate opening in the mask through which a portion of the beam can pass downwardly through the mask and means below the mask for reflecting the beam portion upwardly to the second set of sensors, the sensor signal responsive means comprising means responsive to the first and second sets of sensors for providing the third signals.

23. Apparatus as claimed in claim 16, characterized in that the sensor means comprise first and second sets of sensors arranged with the first set spaced from the second set in the direction of the path of travel of the beam through the location and with the sensors of each of the sets distributed across the path for sensing the direction;
the sensor signal responsive means including means responsive to the first and second sets of sensors for providing the first signals;
the sensor means further comprising a mask opaque to the radiation, third and fourth sets of sensors disposed, respectively, above and below the mask and means defining an elongate opening in the mask through which a portion of the beam can reach the fourth set of sensors, depending on the orientation of the beam;
the fourth set being arranged in two mutually spaced, parallel rows extending transversely of the direction; and
the sensor signal responsive means including means responsive to the third set of sensors for providing the second signals and means responsive to the third and fourth sets of sensors for providing the third signals.

24. Apparatus as claimed in claim 16, characterized by means for sensing the height of the club member during passage of the beam over the array.

25. Apparatus as claimed in claim 24, characterized in that the height sensing means comprise transducer means for transmitting a sonar signal and detecting an echo of said sonar signal.

Fig.1.

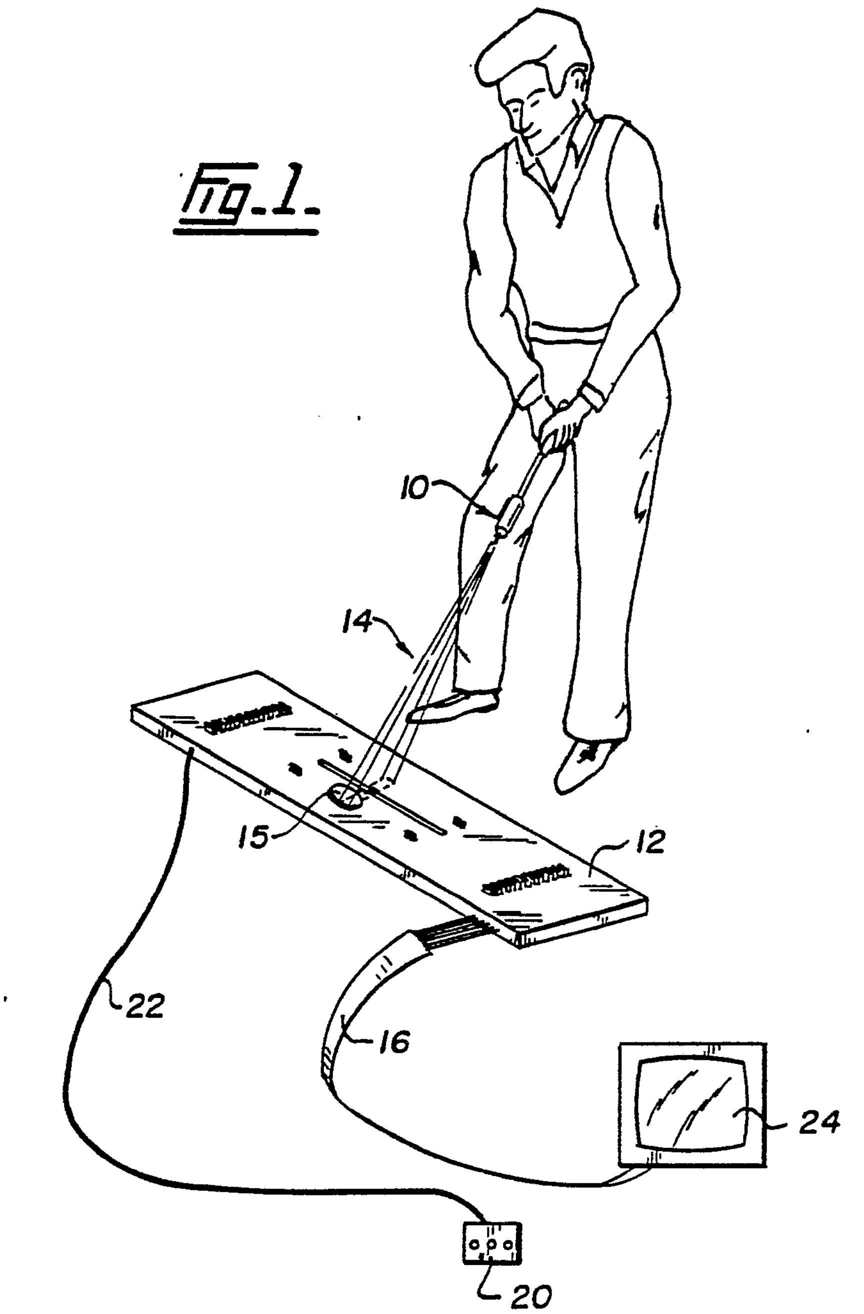
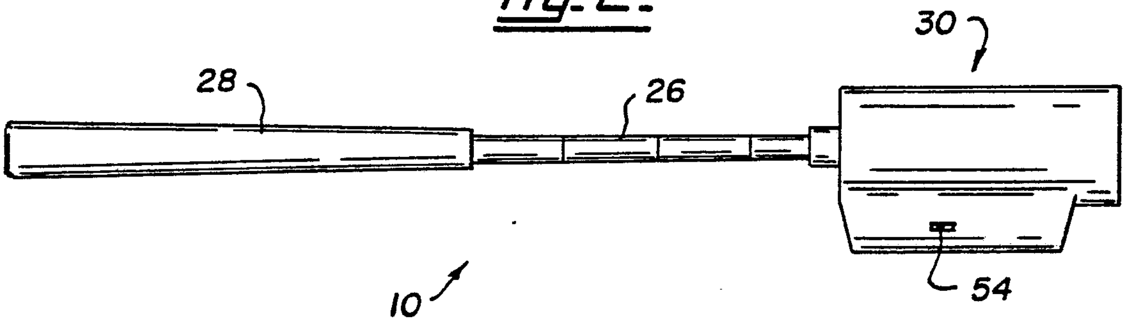


Fig.2.



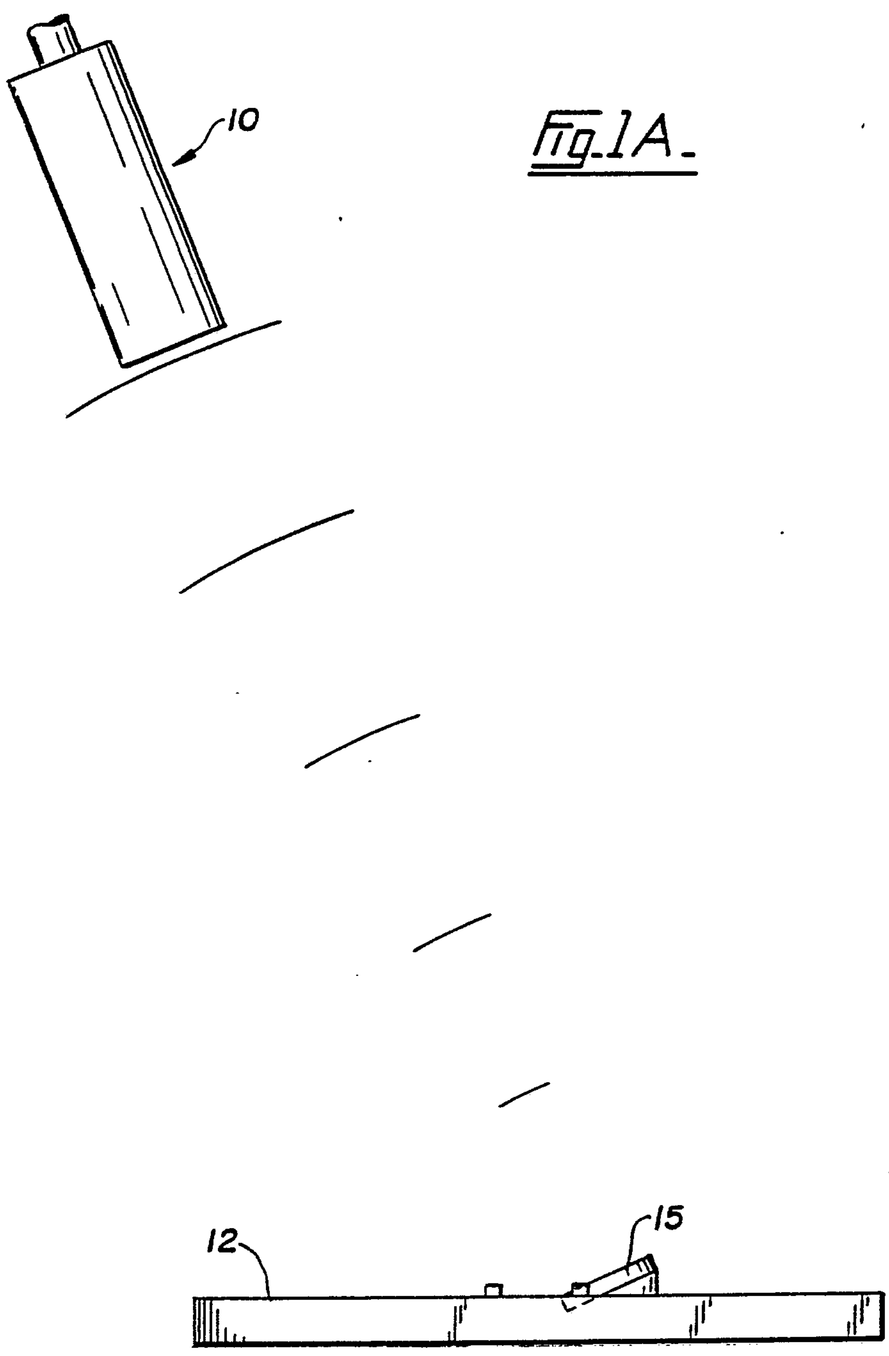


Fig. 1A.

Fig. 2A.

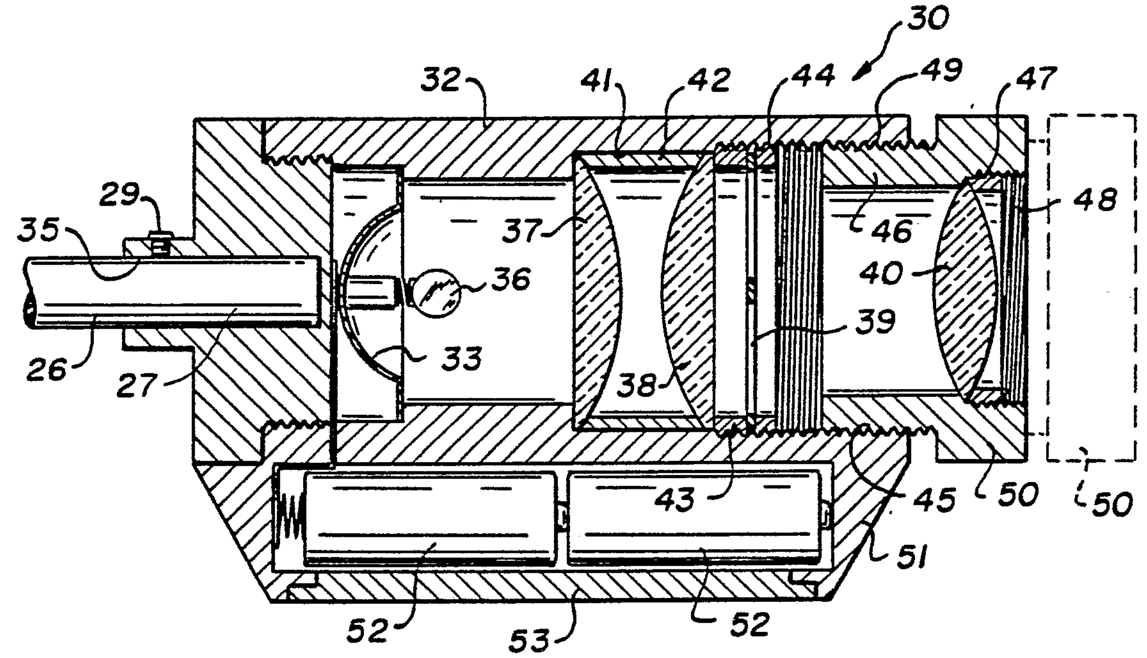

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Fig. 3.

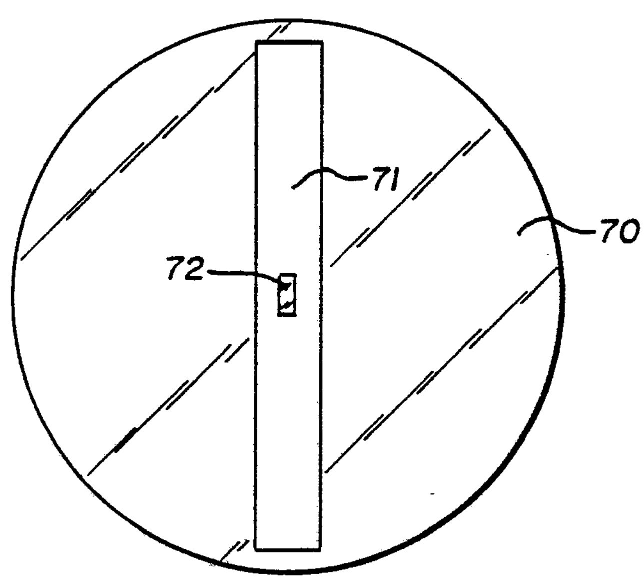
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Fig. 4.

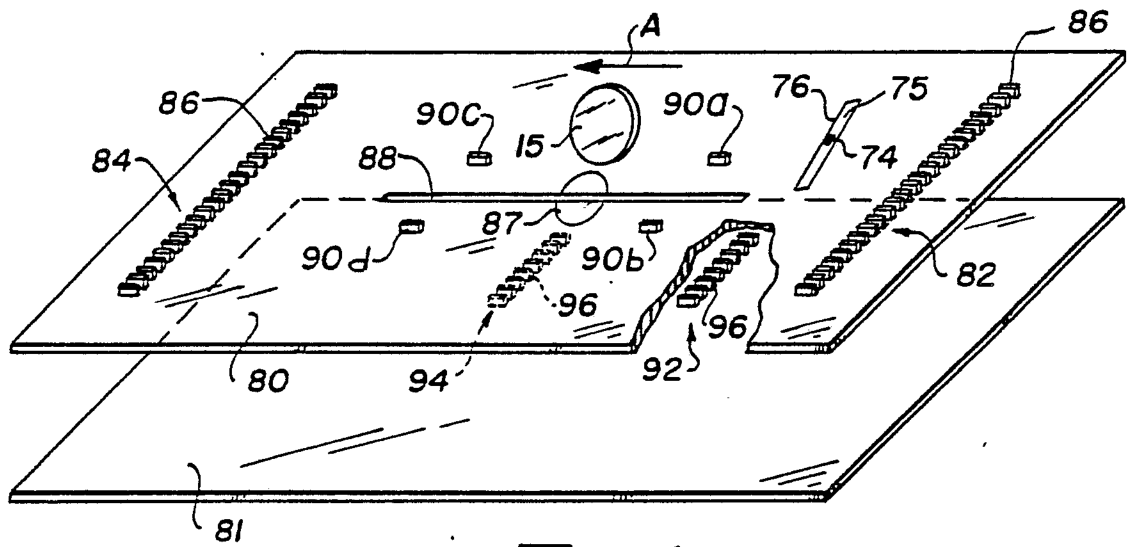


Fig. 4A.

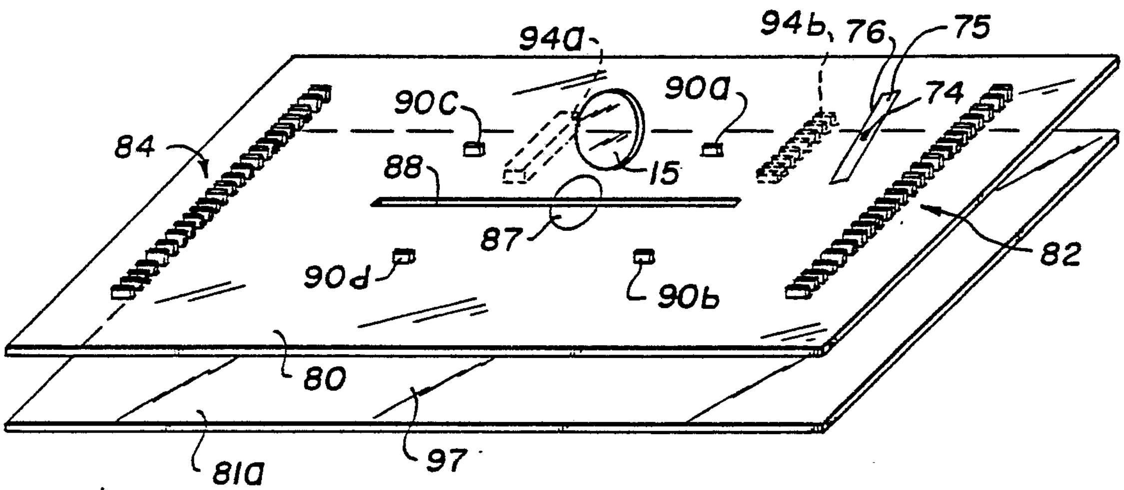
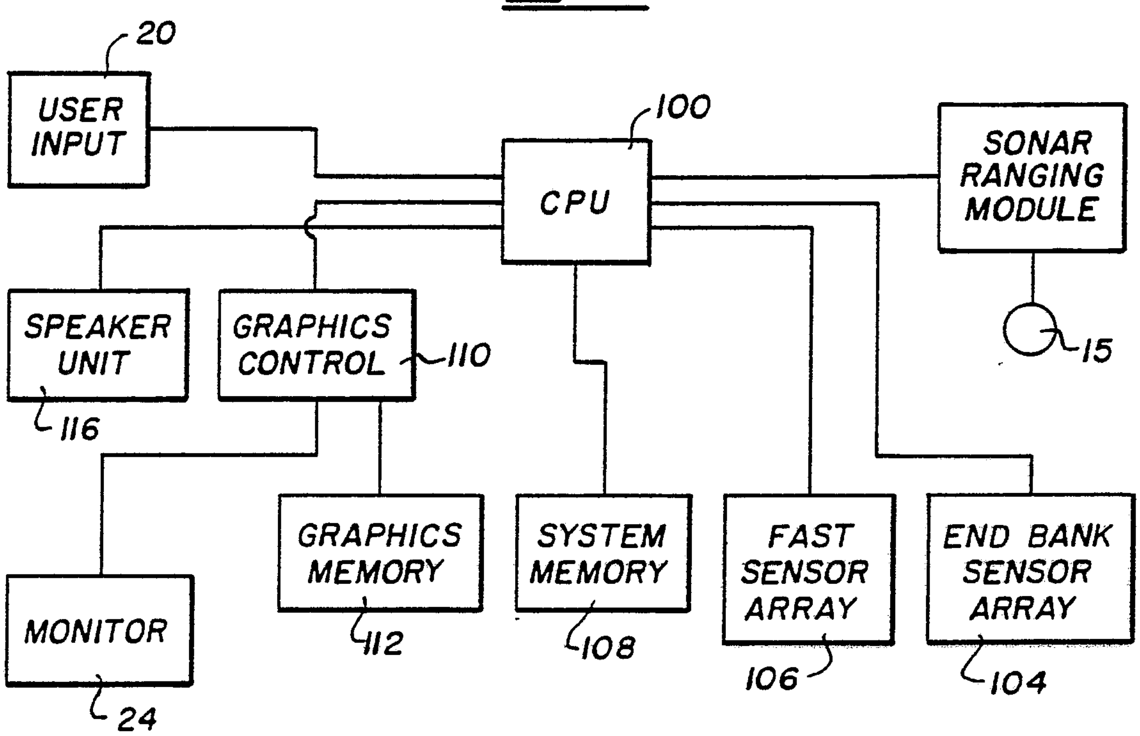
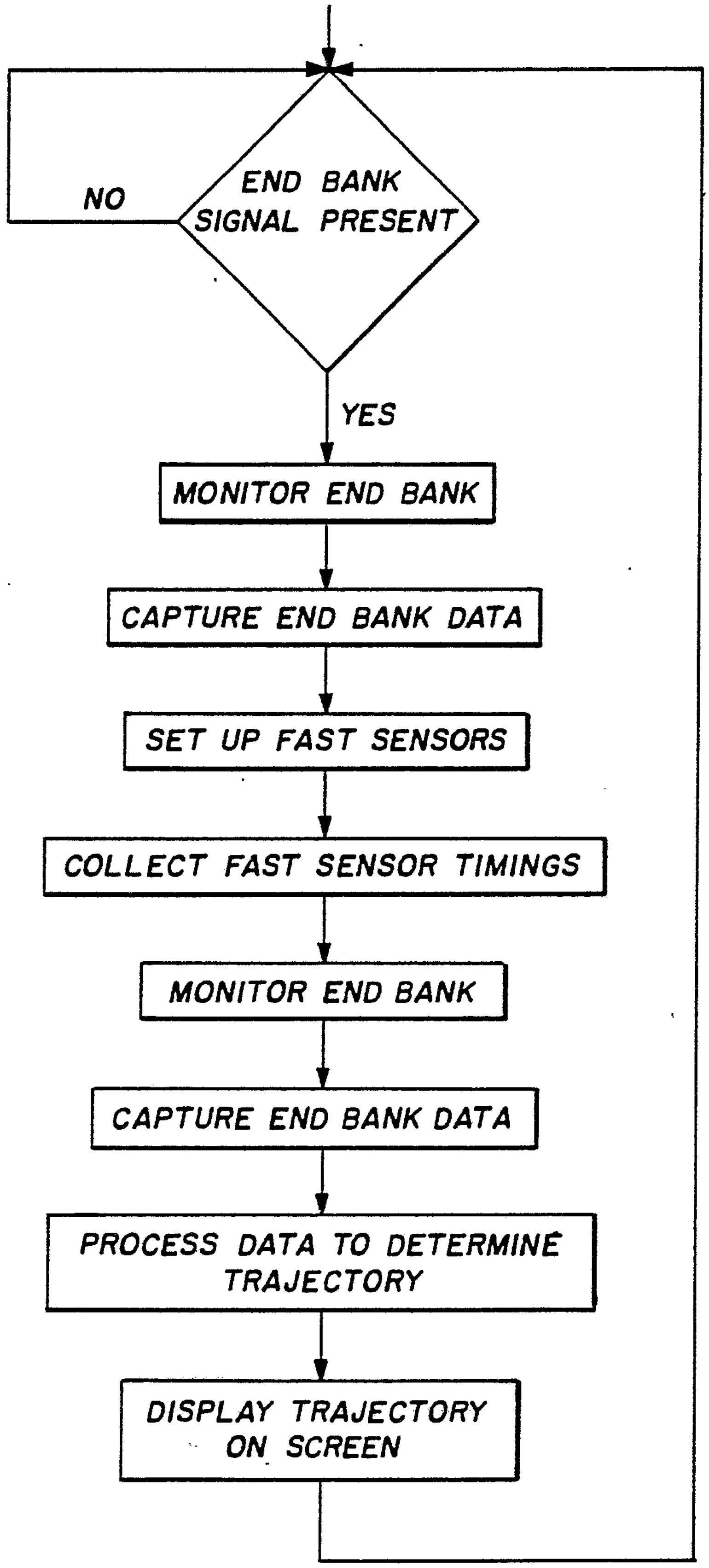


Fig. 5.

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SET UP FAST SENSORS
COLLECT FAST SENSOR TIMINGS
MONITOR END BANK
CAPTURE END BANK DATA
PROCESS DATA TO DETERMINE TRAJECTORY
DISPLAY TRAJECTORY ON SCREEN

Fig.6.

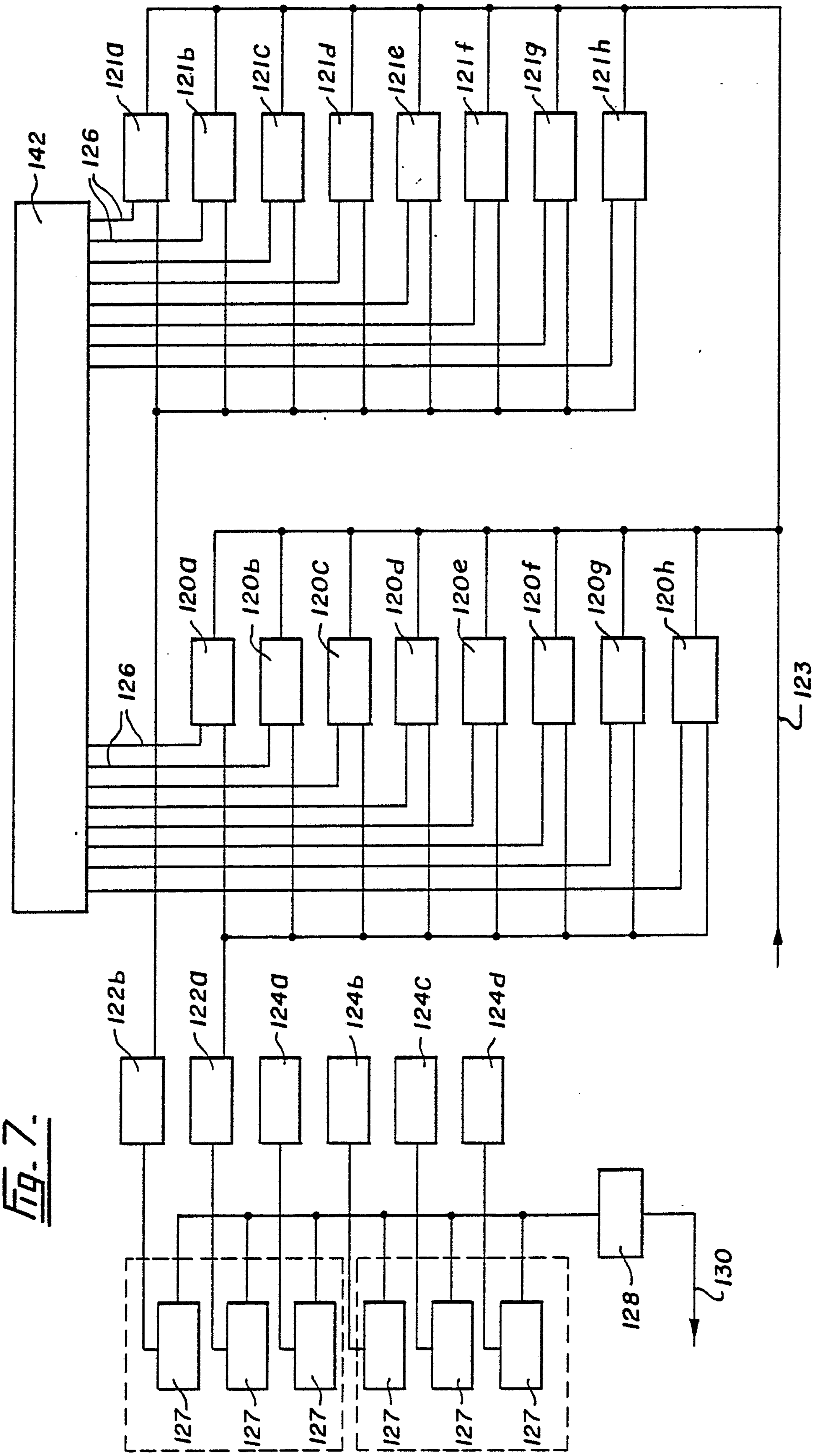
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Fig. 7.

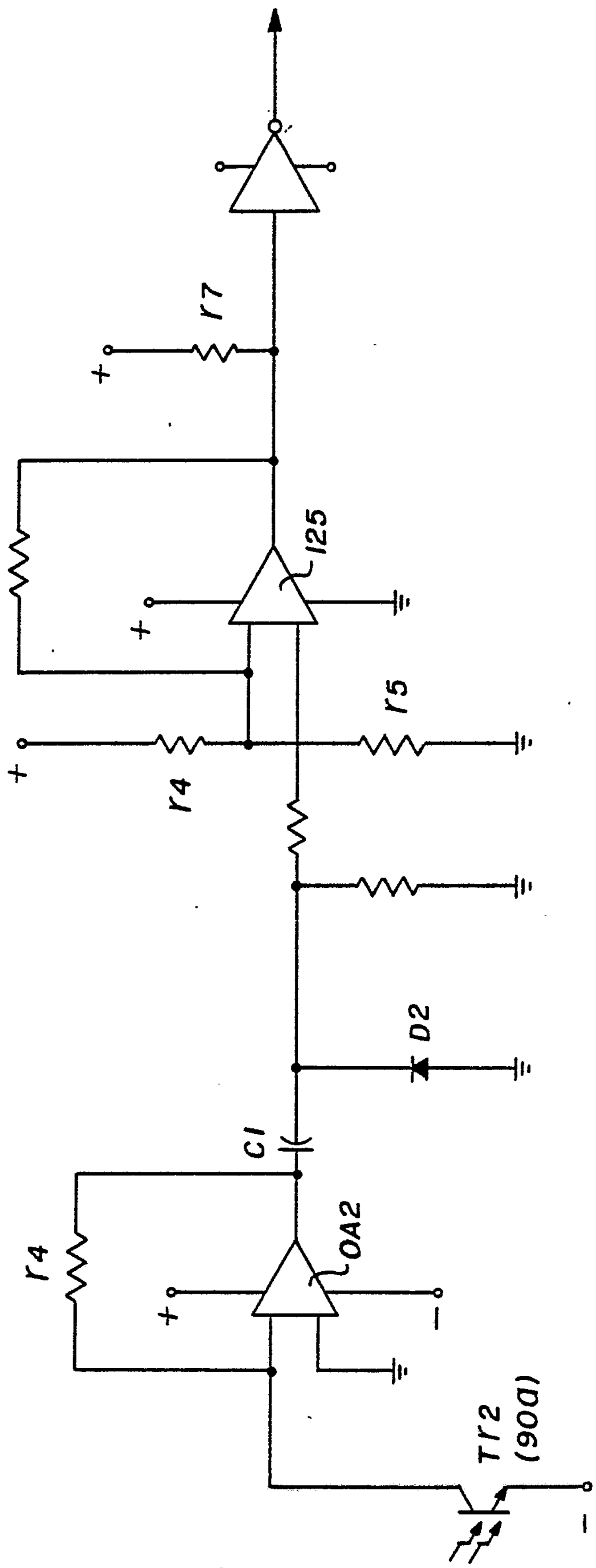

Fig. 9.

Fig. 8.

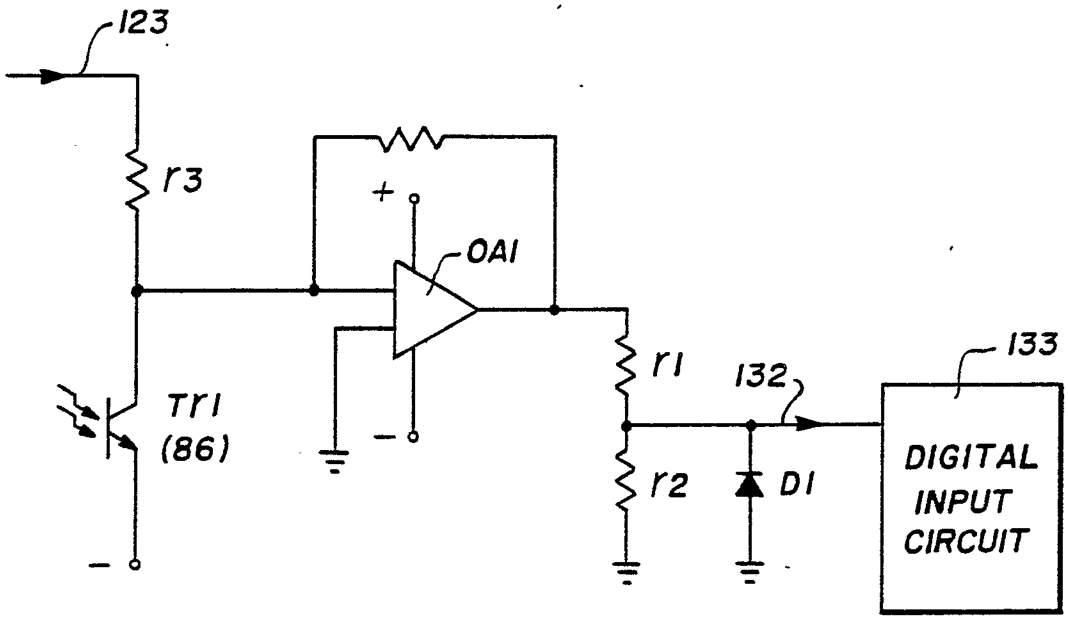
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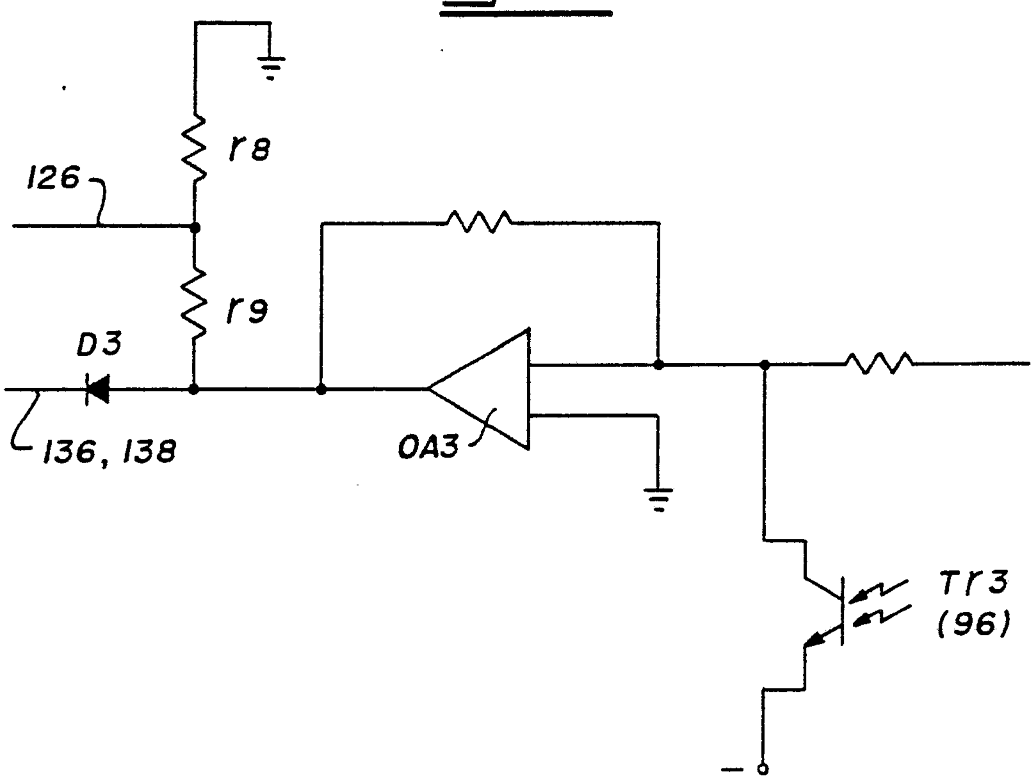
Fig. 10.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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 3756

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X Y	GB-A-2 091 111 (TREDINNICK) * Page 2, lines 51-66,80-95,115-117; page 3, lines 64-83; figures 1-3,6 *	1-3,6-7,10,14 11,16-19,24	A 63 B 69/36
A,D	US-A-2 080 608 (HANNAFORD) * Figures 1-3; page 2, left-hand column, lines 3-31 *	1,16	
Y	US-A-4 429 880 (CHEN et al.) * Figures 1,3-4; column 4, lines 22-51; column 5, lines 13-17 *	11,16-19,24	
A	GB-A-2 115 704 (MIYAMAE) * Figures 1-3; page 2, lines 24-78 *	4-5	
A,D	US-A-4 254 956 (RUSNAK) * Figures 1,3-4; abstract; column 11, line 64 - column 12, line 9 *	1,6-7,10,14,24	**TECHNICAL FIELDS SEARCHED (Int. Cl.4)**
A	GB-A-2 154 146 (ESSEX) * Abstract *	11,16-18	A 63 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24-07-1989	JONES T.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document