(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 687 809 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
23.08.2017 Bulletin 2017/34

(51) Int Cl.:
F41G 7/26 *(2006.01)*

(21) Application number: **12176984.8**

(22) Date of filing: **18.07.2012**

(54) Missile guidance

Raketenlenkung

Guidage de missile

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(43) Date of publication of application:
22.01.2014 Bulletin 2014/04

(73) Proprietor: **Thales Holdings UK Plc**
Addlestone, Near Weybridge, Surrey KT15 2NX (GB)

(72) Inventor: **Yu, Wai**
Belfast BT6 9HB (GB)

(74) Representative: **Round, Edward Mark**
Marks & Clerk LLP
90 Long Acre
London WC2E 9RA (GB)

(56) References cited:
GB-A- 1 517 794
GB-A- 2 345 952
US-A- 4 174 818
US-A- 5 056 736

EP 2 687 809 B1

Description

[0001] The present invention relates to missile guidance, and particularly to laser assisted missile guidance.

[0002] Missile guidance using lasers has been known for some considerable time. For example, UK Patent 1517794 discloses the general principle that laser missile guidance can be implemented.

[0003] A laser beam riding missile guidance system typically comprises a guidance laser operable to generate an intermittently projected laser beam which is directed to form a Laser Information Field (LIF). In general terms, a LIF is a divergent projection of a laser beam, describing a volume which is, in cross section relative to the direction of projection, substantially rectangular. The LIF is formed by scanning and sweeping a laser beam across (azimuth) and down (elevation) with respect to a general projection direction.

[0004] By modulating an information signal bearing positional data on to the laser beam forming the LIF, a missile with a suitable detector in its rear face can determine its position relative the bounds of the LIF, from the received positional data. If the missile has suitable guidance mechanisms, it can alter its trajectory to maintain a particular position relative the LIF, or use the LIF as a means of steering towards a target. In one example, the positional data is used by a missile to detect the displacement of its trajectory from a centre line of the LIF (in the beam projection direction) and to make suitable adjustments to its flight control in order to bring itself to the centre of the LIF. The reader will appreciate that standard control techniques can be used to achieve this, and such is beyond the scope of this disclosure.

[0005] A problem with existing implementations is that there is no continuing communications link from a launch platform to a missile, once a missile has been launched from its canister. Missile parameters, such as the fuse setting of the missile (i.e. when the operator of the missile desires an explosive element of the missile to activate), have to be set before firing and cannot be changed thereafter.

[0006] The LIF as described above also only provides a static positional reference frame, as it is essentially merely a two dimensional grid of laser pulses. A missile fired in such a reference frame calculates its azimuth and elevation displacement (i.e. its pitch and yaw), with regard to the LIF, by detecting spacing between laser pulses defining grid lines in the LIF. US Patent 5,056,736 discloses a similar laser beam-riding missile guidance system wherein a coded information scanning pattern is interlaced with the guidance scanning pattern. Existing implementations, such as that described above, have no facility to enable a missile to detect roll of the launch platform from which the LIF is projected, and thus the orientation of the LIF itself. Thus, the extent to which a positional decoding is correct depends on the launch platform remaining substantially horizontal with respect to the ground. If the launch platform is subject to roll, then this will distort the reference frame provided by the LIF.

[0007] In a system such as described above, including a launch platform not mounted on the ground, and so is subject to roll, then means for stabilising this roll is often provided. This is evident in the case of a launch platform on a ship. This can be a mechanical roll stabilisation device. It may also be possible to include roll stabilisation in a large aircraft.

[0008] However, on smaller installations, such as on a helicopter or an unmanned airborne vehicle (UAV), roll stabilisation can be difficult to achieve. This is due to the size and weight of roll stabilisation devices, and the capacity of a smaller vehicle to accommodate large mechanical devices of such nature. Further, in such installations, there may be severe constraints on the mass and size of supplied additional equipment, both in terms of space and also payload.

[0009] Moreover, the capability of any roll stabilisation device to eliminate the effect of roll on a LIF generator will inevitably be limited. This applies to the range of rotational displacement (roll) which might arise, or the rate of change of roll of such a launch platform. This can be such that the range and rate of change of roll can exceed the capability of a practical roll stabilisation device, particularly if the launch platform is itself relatively small (and thus more susceptible to external atmospheric and hydrostatic forces) and manoeuvrable.

[0010] Accordingly, rather than rely on the ability of a launch platform to stabilise roll, or to compensate for it, an aspect of the invention provides an approach which involves detecting roll, and conveying information describing detected roll to a missile during flight. This is done using a system which otherwise would be used for guidance of the missile.

[0011] An aspect of the invention involves implementation of a laser based missile guidance system which does not rely on moving a guidance laser beam to compensate for roll, but rather to project, to an intended recipient, information to enable the recipient projectile to compensate for roll at the launch platform, and thus to counter the effect of roll on the guidance laser beam.

[0012] An aspect of the invention provides a missile launch platform operable to establish wireless communication with a missile launched therefrom, the platform comprising roll measurement means operable to determine roll of said platform with respect to a reference frame, and roll information communication means operable to emit a signal towards a launched missile, the signal bearing roll information describing roll of said platform relative to said reference frame.

[0013] The roll information may comprise roll angle information. The roll measurement means may comprise a sensor on the launch platform operable to measure roll angle. The roll measurement means may comprise roll information encoding means operable to encode roll information prior to emission. The roll information encoding means may be operable to encode roll information into a piece of digital information. In one embodiment, a piece of digital information comprises a binary code. The binary code may comprise a six bit binary word.

[0014] The roll information may be linearly quantised into the binary information.

[0015] The launch platform may comprise laser emission means operable to emit a laser beam suitable for bearing information, the laser beam being suitable for detection by a launched missile. The laser emission means may be operable to emit one or more positional laser pulse trains intended to impart positional information to a launched missile on which said laser beam is incident. The launch platform may be configured to impose said signal bearing roll information on said laser beam.

[0016] Another aspect of the invention comprises a missile comprising a laser beam detector operable to detect a laser beam incident thereon and to resolve an information bearing signal therefrom, a signal processor operable to extract, from a received signal, position information and roll information, and a missile flight controller operable in accordance with extracted position information and roll information to control flight of said missile.

[0017] Further aspects, features and advantages of the invention will become apparent from the following description of a particular embodiment thereof, with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram of a missile guidance beam generator in accordance with an embodiment of the invention;

Figure 2 is a schematic cross section of a laser guidance beam emitted by the generator of figure 1, over a period of one sweep from top to bottom for a laser diode V and from left to right for a laser diode H;

Figure 3 is a timing diagram of pulses emitted by the generator in pursuit of emission of the laser guidance beam of figure 2, in an example in the field of the embodiment of the invention;

Figure 4 is a timing diagram of pulses emitted by the generator in pursuit of emission of the laser guidance beam of figure 2, in accordance with an embodiment of the invention;

Figure 5 is a schematic diagram of a missile for use with the embodiment illustrated in figure 1; and

Figure 6 is a schematic diagram of architecture of the missile of figure 5.

[0018] Referring to figure 1, a missile guidance beam generator 10 is shown schematically in figure 1, but the reader will understand that it will comprise an outer casing suitably adapted to be affixed to a barrel of a launcher, by conventional means.

[0019] The generator 10 is operable to generate a Laser Information Field (LIF). While the structure by which this is delivered will be described in due course, the reader will benefit from a functional description also.

[0020] As a missile is primed for launch, its guidance circuitry is synchronised with the beam generation apparatus 10. The LIF is projected by the generator 10, such that a receiver of the missile synchronises with the LIF. Through this, the missile can gather information about its position relative to the intended trajectory defined by the projected LIF, and make any adjustments to its flight control apparatus that might be required in order to maintain that trajectory.

[0021] The manner in which this is implemented in accordance with the specific embodiment will now be described with reference to figure 1. The generator 10 comprises two laser diodes 22, 24 each assigned to generation of laser light in response to control signals from a controller 30. In use, the missile guidance beam generator 10 will be affixed to a barrel of a launcher of a missile adapted to receive laser light projected from the generator 10, or to a land platform. A roll sensor 32 provides a signal to the controller 30, for the insertion of roll information into the stream of pulses generated by the laser diodes 22, 24 as will be described in due course.

[0022] Each laser diode 22, 24 is configured to correspond to lines of a LIF, such as that illustrated in figure 2, extending in one direction. Thus, the laser diode 22 is denoted "laser diode H" (horizontal) and laser diode 24 is denoted "laser diode V" (vertical) in figure 1. Laser diode 22 is responsible for the generation of the horizontal lines of the LIF, and laser diode 24 is responsible for the generation of the vertical lines of the LIF.

[0023] Each line of the LIF is created by the scanning action of a LIF generator 26. This takes, as an input, pulses of light generated by the laser diodes 22, 24. It scans this light across the field of projection intended to be imparted with the LIF and then passes the scanned light to beam angle optics 28 for conditioning of the beam of light for output.

[0024] The light generated by each diode is emitted in the form of pulses. For signalling reasons, light is emitted, by each diode, in sequences of two pulses. Each combination of two pulses is known as a doublet. The doublets are spaced in time, by a predetermined delay, so that a receiver, furnished with information as to the delays used, can detect the presence of a doublet and thus the presence of light of the LIF. From knowledge of the expected arrangement of doublets across a scanned LIF, a missile in receipt of light from the generator 10 can determine its position relative to an intended trajectory and make any necessary adjustments to its flight path. Accordingly, the LIF can be thought of as being the projection, across time and space, of pulses encoding positional information, from which a suitably configured receiver can determine its position relative to the path defined by the LIF.

[0025] Figure 3 illustrates an example emission of light pulses by the generator 10, over time. This arrangement is conventional, and exemplary of the field of the invention, but not part of the invention per se.

[0026] In the upper line, pulses of light emanating from the laser diode 22, governing pitch of the missile, are illustrated. In the lower line, a pulse train from the laser diode 24 is illustrated, from which a suitable receiver can determine yaw from an ideal trajectory.

[0027] A pitch doublet is indicated in the upper line, denoted pulses P1 and P2. The doublet is emitted periodically, with a period T_{IPI}. The time between P1 and P2 is also predetermined, denoted P in figure 3. The pitch doublet is validated by pitch validity detection windows c, d, e, at times t_c, t_d, and t_e after the first pitch doublet pulse P1. A receiver, intended to detect the presence of a pitch doublet, will validate a pitch doublet by the absence of pulses to these windows. Times t_c, t_d, and t_e are predetermined, and known to the receiver. Presence of pulses at these times will cause the receiver to reject detected pulses as instances of pulses P1 and P2.

[0028] Assuming that pulses c, d and e are not detected, P1 and P2 are detected. The spacing in time between P1 and P2 and the following pair of P1 and P2 (T_{IPI}) is encoded, and defines the position of the receiver in the pitch direction. Spacing between the two pairs of pulses varies with pitch.

[0029] The receiver synchronises to the time of receipt of P1. A predetermined time (P-Y) after transmission of P1, the laser diode 24 dedicated to emission of yaw doublets is energised, and issues a pair of pulses Y1 and Y2, spaced apart by a time Y which varies in the yaw direction swept across the LIF. By this, the receiver can detect its yaw. The yaw pulses Y1, Y2 are validated by the determination that no pulses are detected in yaw validation windows a, b, e, f, at respective times t_a, t_b, t_e and t_f after the emission of pulse Y1. It should be noted that the use of the notation t_e to describe the position of yaw validation window e does not imply that yaw validation window e is positioned at the same time lapse after lead pulse Y1 as the spacing of pitch validation pulse e after P1.

[0030] The pitch and yaw pulses, are positioned so as to limit the possibility of the laser diodes being overheated, or otherwise being subject to deleterious consequences as a result of over-use. They are also positioned so as to provide, as far as possible, uniquely identifiable time periods between pulses, so that pulses can be distinguished by the receiver.

[0031] Figure 4 shows the same arrangement of pulses as in Figure 3, with the additional imposition of roll information pulses. These are in positions, taking further account of the need not to exceed the duty cycles of the two laser diodes 22, 24.

[0032] A first roll pulse R_0 is positioned directly after the first pitch validation window c. If emitted, it is emitted by the yaw laser diode 24.

[0033] A second roll pulse R_1 is positioned directly after the first roll pulse R_0, and before the second pitch validation window d. If emitted, it is emitted by the pitch laser diode 22.

[0034] A third roll pulse R_2 is positioned directly after the second pitch validation window d and before the third pitch validation window e. If emitted, it is emitted by the yaw laser diode 24.

[0035] A fourth roll pulse R_3 is positioned directly after the third pitch validation window e and before the first yaw pulse Y1. If emitted, it is emitted by the pitch laser diode 22.

[0036] A fifth roll pulse R_4 is positioned after the second yaw pulse Y2 and before the third yaw validation window e. If emitted, it is emitted by the pitch laser diode 22.

[0037] A sixth roll pulse R_5 is positioned directly after the fifth roll pulse R_4, again before the third pitch validation window e. If emitted, it is emitted by the yaw laser diode 24.

[0038] The positions of these pulses does not interfere with the framework illustrated in figure 3. That is, none of the pulses coincides with the validation windows, and so no false invalidation of doublets should arise as a result of inclusion of these pulses. Thus, backwards compatibility of the arrangement of figure 4 with the arrangement of figure 3 (expected by missiles not configured for use with an embodiment of the present invention) is preserved.

[0039] These pulses are selectively emitted by the LIF generator 10, in the described and illustrated positions. The six-bit binary word $R_5R_4R_3R_2R_1R_0$ (where R_0 is the least significant bit) denoted by the presence or absence of the respective pulses in the emitted (and detected) pulse train convey binary encoded information to the receiver concerning roll of the launch platform on which the LIF generator 10 is mounted. That way, the receiver can make adjustments to its interpretation of the spacings, in time, between the pitch doublet pairs of P1 and P2, and between the yaw doublet pairs of Y1 and Y2, to determine its pitch and yaw on the desired trajectory.

[0040] In this embodiment, the presence of a roll pulse conveys a "1" value of the respective bit, and the absence thereof conveys a "0" value. The reader will appreciate that an arrangement in which the opposite holds true could equally be implemented.

[0041] The six-bit binary number encodes the range of roll angle which the launch platform can be expected to experience. In this embodiment, with 64 possible symbols available for use, a roll angle range of $\pm 45°$ is encoded. Given that, for operational needs, resolution to 2° may be sufficient, the full range of possible roll angles can be encoded using 46 symbols. This leaves 18 unused symbols. One of these symbols will be 000000 which is reserved as it consists of the absence of all roll information pulses (which might occur for numerous operational reasons).

[0042] Thus, 17 symbols can be used for other purposes. These symbols could be used to convey other information, or operational commands, a facility not available previously. For example, symbols could be assigned to a command to change a missile parameter, to provide updated course information, fuse settings, or to order the missile to leave the missile guidance system.

[0043] The symbols could be employed as single word commands, or could equally be assembled into an instruction set comprising sequences of words.

[0044] A LIF is constructed by scanning the light emitted by the two lasers across a defined and constrained space. The laser diode emissions are scanned across, left to right and top to bottom, which forms a forward sweep, then right to left and bottom to top, which forms a backward sweep. A forward sweep and backward sweep constitute a scan cycle.

[0045] A LIF comprises a number, X, of doublets and (X-1) inter pulse intervals (IPI). A doublet is formed by two laser pulses, such as P1 and P2 for pitch, as per the above example. An IPI is the spacing between two doublets.

[0046] Thus, Figures 3 and 4 illustrate, for each diode, a time interval commensurate with a doublet projection and an IPI.

[0047] The present embodiment implements a requirement for the roll pulse information to be consistent over the full extent of two sweeps, thus over a full scan back and forth. Thus, redundancy will be imparted, which can be used to error check the roll pulse information. This is because noise could arise at a single roll pulse position, which would erroneously convey a "1" value where a "0" value would actually have been intended. This error could have serious consequences if left unchecked.

[0048] The present embodiment employs a bit inversion scheme. Thus, while the information conveyed in a first scan sweep may be "010101", that in the subsequent scan sweep will be "101010". The received words can then be compared, on a bitwise basis, for instance using an XOR operator. In that case, if the XOR operator detects identity of any of the bits, then an error is detected. The data will then be disregarded.

[0049] Figure 5 illustrates a schematic diagram showing a missile for use with the above described embodiment. Figure 6 shows a schematic diagram of a controller in that missile. As shown in figure 5, the missile 50 comprises a generally tubular body with a conical nose portion and a tail. In the tail, a detector 52 is positioned, operable to detect laser light of the frequency adopted by the laser diodes 22, 24. The detector passes signals corresponding to detected laser light to a controller 54, which controls attitude of canards 60 which provide aerodynamic control surfaces for use in controlling flight of the missile. A fuse 56 provides ignition of ordnance 60. The fuse 56 is under the control of the controller 54, which might have other detection means to enable ignition to be controlled relative to position, altitude, or any other external condition.

[0050] Figure 6 shows operation of the missile. In essence, figure 6 shows a functional architecture of the controller 54, in response to pulses detected by the detector 52. Such pulses are fed to a LIF decoding unit 102 which decodes LIF pulses in accordance with established techniques. Roll pulses are detected and the information conveyed therein is loaded into a roll pulse register 106. The roll pulse information is passed to a roll pulse decoder 108 which acts, in accordance with the encoding scheme used to encode the roll angle, to detect whether a roll angle is stored in the conveyed information, or if, in accordance with a predefined instruction set, an instruction is being conveyed.

[0051] In response to this, relevant information is sent to a missile dynamics controller 104. This may be a compensatory signal intended to correct a roll, or to correct interpretation of the LIF data which may be distorted by roll. It may also be to override LIF control of the missile, in view of an instruction, for example, to leave the trajectory and to follow an alternative trajectory. Missile dynamics control signals are sent by the missile dynamics controller 104 to the canards 60.

[0052] Advantages associated with features of the presently described embodiment are numerous. In particular, the intention is that the presently described arrangement is to be compatible with existing missile communication. It is expected to impart greater robustness and reliability to the issue of missile guidance and communication, and to offer relatively high resolution guidance. Further, by using different information signalling techniques than were hitherto appreciated, it is expected that greater information capacity will ensue.

[0053] Backwards compatibility is achieved because the additional laser pulses, as previously described, are positioned in the LIF emission such that there is no interference with the position decoding, itself provided by existing LIF pulses. There is no interference with the position decoding carried out by LIF guided missiles, and so the present arrangement can be used by LIF guided missiles which have not been reconfigured by an arrangement in accordance with the described embodiment - a "legacy" system of such type would not be affected by the additional roll pulses.

[0054] The presently described embodiment takes account of the various advantages of digital technology in its implementation. This is exemplified by the encoding of the roll information in binary form. Detecting and decoding of binary information is generally straightforward and not prone to error. An error checking mechanism is employed, in the described embodiment, which provides an additional layer of robustness to the inherent advantages of digital communication. This can take account of any data corruption which might arise, for instance as the result of noise or interference. Update of roll information is aligned, in the described embodiment, with position update information, and thus a position update can be corrected by the latest received roll information.

[0055] Resolution, of a device in accordance with the described embodiment, can be relatively high, in comparison with existing devices. This is because the number of bits in the binary code determines the number of different combinations that is available. The range of roll that can be produced by a launch platform needs to be encoded into the binary code, and so the number of combinations available in the binary code will define the resolution across that range. For envisaged purposes, a resolution of 2 degrees is considered sufficient, and the proposed binary code is capable of delivering this resolution.

[0056] Besides conveying roll data to the missile, the described embodiment could also be further adapted to transmit other messages to the missile, such as a command to the missile to stay on course without further laser guidance, to change its deployment configuration such as fuse settings, to activate other on-board navigation systems, and so on. The disclosure need not be read as being limited to any particular implementation. This enables much greater control over a missile than was previously considered possible. In the above disclosure, it is envisaged that words of the binary code are fixed in length, but the reader will appreciate that words could be concatenated to represent data requiring a longer bit string. Thus, the capacity of the embodiment to convey information is not limited to the length of the word defined in the particular embodiment.

Claims

1. A missile guidance apparatus comprising laser beam projection means (10) configured to project a laser beam comprising a scanned projection of laser beam pulses, the laser beam projection means (10) being further configured to project first laser beam pulses (P1, P2) scanned in a first direction, substantially orthogonal to a beam projection direction, tracing grid lines in said first direction wherein the first laser beam pulses comprise sequences of two pulses spaced in time by a first predetermined delay; and second laser beam pulses (Y1, Y2) scanned in a second direction, substantially orthogonal to the first direction and to the beam projection direction, tracing grid lines in said second direction wherein the second laser beam pulses comprise sequences of two pulses spaced in time by a second predetermined delay;
   wherein the laser beam projection means (10) is further configured to selectively project third laser beam pulses (a, b, c, d, e, f), at positions in time interposed between said first laser beam pulses and said second laser beam pulses, so that said third laser beam pulses do not interfere with said first and second laser beam pulses;
   wherein the missile guidance apparatus further includes a means (30) configured to impose information describing roll of a missile launch platform or a communication signal on the laser beam by encoding said third laser beam pulses with said information for use by a missile projected from said launch platform.

2. Apparatus in accordance with claim 1 wherein said third laser beam pulse positions constitute a binary word, the presence or absence of third laser pulses at said positions encoding a value of said binary word.

3. Apparatus in accordance with claim 2 wherein said binary word can have a range of values, at least a subset of said values corresponding to possible roll positions of said launch platform, for imparting a roll position to said projected missile.

4. Apparatus in accordance with claim 3 wherein a further subset of said values correspond to command signals, for communication of a command signal to said receiver.

5. Apparatus in accordance with any preceding claim wherein at least one of said positions of said third laser beam pulses is interposed in said first laser beam pulses.

6. Apparatus in accordance with any preceding claim wherein at least one of said positions of said third laser beam pulses is interposed in said second laser beam pulses.

7. A missile (50) comprising a guidance system receptive to a laser guidance beam projected by an apparatus in accordance with any preceding claim, comprising: a receiver (52) configured to detect laser light pulses so emitted, and a controller (54) configured to control flight of said missile (50), the controller (54) being further configured to:

   detect first pulses by detecting sequences of two pulses spaced in time by a first predetermined delay,
   detect second pulses by detecting sequences of two pulses spaced in time by a second predetermined delay,
   detect third pulses at position in time interposed between said first laser beam pulses and said second laser beam pulses, and to
   determine, from said detected third pulses, either emitted information concerning a roll position of said missile guidance apparatus or a command by way of said third pulses.

8. A missile in accordance with claim 7 and configured to process detected first and second pulses on the basis of roll information communicated thereto in said third pulses, to correct pitch and yaw information conveyed in said first and second pulses with respect to said roll information.

Patentansprüche

1. Lenkvorrichtung für einen Lenkflugkörper, ein Laserstrahl-Projektionsmittel (10) umfassend, konfiguriert zum

Projizieren eines Laserstrahls, der eine abgetastete Projektion von Laserstrahlpulsen umfasst, wobei das Laserstrahl-Projektionsmittel (10) außerdem dazu konfiguriert ist, in einer ersten Richtung abgetastete erste Laserstrahlpulse (P1, P2) zu projizieren, im Wesentlichen orthogonal zu einer Strahlprojektionsrichtung, wobei Gitterzeilen in der ersten Richtung nachgezeichnet werden, worin die ersten Laserstrahlpulse Sequenzen von zwei Pulsen umfassen, die durch eine erste vorgegebene Verzögerung einen zeitlichen Abstand haben; und

zweite Laserstrahlpulse (Y1, Y2), in einer zweiten Richtung abgetastet, im Wesentlichen orthogonal zur ersten Richtung und zur Strahlprojektionsrichtung, wobei Gitterzeilen in der zweiten Richtung nachgezeichnet werden, worin die zweiten Laserstrahlpulse Sequenzen von zwei Pulsen umfassen, die durch eine zweite vorgegebene Verzögerung einen zeitlichen Abstand haben;

worin das Laserstrahl-Projektionsmittel (10) außerdem dazu konfiguriert ist, dritte Laserstrahlpulse (a, b, c, d, e, f) selektiv an Positionen zu projizieren, die zeitlich zwischen den ersten Laserstrahlpulsen und den zweiten Laserstrahlpulsen positioniert sind, sodass die dritten Laserstrahlpulse die ersten und zweiten Laserstrahlpulse nicht stören;

worin die Lenkvorrichtung für einen Lenkflugkörper außerdem ein Mittel (30) einschließt, das zum Festlegen von Information konfiguriert ist, die Rollbewegung einer Lenkflugkörper-Abschussplattform beschreibt oder ein Kommunikationssignal auf dem Laserstrahl durch Codieren der dritten Laserstrahlpulse mit der Information zur Verwendung durch einen Lenkflugkörper, der von der Abschussplattform projiziert wird.

2. Vorrichtung nach Anspruch 1, worin die dritten Laserstrahl-Pulspositionen ein binäres Wort bilden, wobei die Anwesenheit oder Abwesenheit von dritten Laserpulsen an den Positionen einen Wert des binären Wortes codieren.

3. Vorrichtung nach Anspruch 2, worin das binäre Wort einen Bereich von Werten haben kann, wobei mindestens eine Teilmenge der Werte möglichen Rollbewegungspositionen der Abschussplattform entspricht, um dem projizierten Lenkflugkörper eine Rollbewegungsposition zu erteilen.

4. Vorrichtung nach Anspruch 3, worin eine weitere Teilmenge der Werte Befehlssignalen zur Kommunikation eines Befehlssignals an den Empfänger entspricht.

5. Vorrichtung nach einem vorhergehenden Anspruch, worin mindestens eine der Positionen der dritten Laserstrahlpulse zwischen den ersten Laserstrahlpulsen positioniert ist.

6. Vorrichtung nach einem vorhergehenden Anspruch, worin mindestens eine der Positionen der dritten Laserstrahlpulse zwischen den zweiten Laserstrahlpulsen positioniert ist.

7. Lenkflugkörper (50),
ein Lenksystem umfassend, das für einen Laserlenkstrahl aufnahmefähig ist, der von einer Vorrichtung nach einem vorhergehenden Anspruch projiziert wird, Folgendes umfassend:

> einen Empfänger (52), konfiguriert zum Detektieren von so emittierten Laserlichtpulsen, und
> einen Controller (54), konfiguriert zum Steuern des Flugs des Lenkflugkörpers (50), wobei der Controller (54) außerdem konfiguriert ist zum:
>
> > Detektieren von ersten Pulsen durch Detektieren von Sequenzen zweier Pulse, die durch eine erste vorgegebene Verzögerung mit zeitlichem Abstand angeordnet sind,
> > Detektieren von zweiten Pulsen durch Detektieren von Sequenzen zweier Pulse, die durch eine zweite vorgegebene Verzögerung mit zeitlichem Abstand angeordnet sind,
> > Detektieren von dritten Pulsen an einer Position, die zeitlich zwischen den ersten Laserstrahlpulsen und den zweiten Laserstrahlpulsen positioniert ist, und um
> > aus den detektierten dritten Pulsen entweder emittierte Information bestimmen, die eine Rollbewegungsposition der Lenkflugkörper-Lenkvorrichtung oder einen Befehl durch die dritten Pulse betrifft.

8. Lenkflugkörper nach Anspruch 7 und konfiguriert zum Verarbeiten von detektierten ersten und zweiten Pulsen auf der Basis von Rollbewegungsinformation, die in den dritten Pulsen dorthin kommuniziert wird, um in den ersten und zweiten Pulsen mitgeteilte Stampf- und Gier-Information mit Bezug auf die Rollbewegungsinformation zu korrigieren.

Revendications

1. Appareil de guidage de missile comprenant un moyen de projection de faisceau laser (10) qui est configuré de manière à :

> projeter un faisceau laser qui comprend une projection balayée d'impulsions de faisceau laser,

le moyen de projection de faisceau laser (10) étant en outre configuré de manière à projeter :

des premières impulsions de faisceau laser (P1, P2) qui sont balayées dans une première direction qui est sensiblement orthogonale à une direction de projection de faisceau, en suivant des lignes de grille dans ladite première direction, dans lequel les premières impulsions de faisceau laser comprennent des séquences de deux impulsions qui sont espacées temporellement par un premier retard prédéterminé ; et
des deuxièmes impulsions de faisceau laser (Y1, Y2) qui sont balayées dans une seconde direction qui est sensiblement orthogonale à la première direction ainsi qu'à la direction de projection de faisceau, en suivant des lignes de grille dans ladite seconde direction, dans lequel les deuxièmes impulsions de faisceau laser comprennent des séquences de deux impulsions qui sont espacées temporellement par un second retard prédéterminé ; dans lequel :

le moyen de projection de faisceau laser (10) est en outre configuré de manière à projeter de manière sélective des troisièmes impulsions de faisceau laser (a, b, c, d ,e ,f) en des positions qui sont interposées temporellement entre lesdites premières impulsions de faisceau laser et lesdites deuxièmes impulsions de faisceau laser, de telle sorte que lesdites troisièmes impulsions de faisceau laser n'interfèrent ni avec lesdites premières impulsions de faisceau laser, ni avec lesdites deuxièmes impulsions de faisceau laser ; dans lequel :

l'appareil de guidage de missile inclut en outre un moyen (30) qui est configuré de manière à appliquer une information qui décrit le roulis d'une plate-forme de lancement de missile ou un signal de communication sur le faisceau laser en codant lesdites troisièmes impulsions de faisceau laser avec ladite information en vue d'une utilisation par un missile qui est projeté depuis ladite plate-forme de lancement.

2. Appareil selon la revendication 1, dans lequel les positions desdites troisièmes impulsions de faisceau laser constituent un mot binaire, la présence ou l'absence de troisièmes impulsions laser au niveau desdites positions codant une valeur dudit mot binaire.

3. Appareil selon la revendication 2, dans lequel ledit mot binaire peut présenter une plage de valeurs, au moins un sous-jeu desdites valeurs correspondant à des positions de roulis possibles de ladite plateforme de lancement, pour imprimer une position de roulis audit missile projeté.

4. Appareil selon la revendication 3, dans lequel un autre sous-jeu desdites valeurs correspond à des signaux de commande, pour une communication d'un signal de commande audit récepteur.

5. Appareil selon l'une quelconque des revendications précédentes, dans lequel au moins l'une desdites positions desdites troisièmes impulsions de faisceau laser est interposée dans lesdites premières impulsions de faisceau laser.

6. Appareil selon l'une quelconque des revendications précédentes, dans lequel au moins l'une desdites positions desdites troisièmes impulsions de faisceau laser est interposée dans lesdites deuxièmes impulsions de faisceau laser.

7. Missile (50) comprenant un système de guidage qui est sensible à un faisceau de guidage laser qui est projeté par un appareil selon l'une quelconque des revendications précédentes, comprenant :

un récepteur (52) qui est configuré de manière à détecter des impulsions de lumière laser ainsi émises ; et
un contrôleur (54) qui est configuré de manière à commander le vol dudit missile (50), le contrôleur (54) étant en outre configuré de manière à :

détecter des premières impulsions en détectant des séquences de deux impulsions qui sont espacées temporellement par un premier retard prédéterminé ;
détecter des deuxièmes impulsions en détectant des séquences de deux impulsions qui sont espacées temporellement par un second retard prédéterminé ;
détecter des troisièmes impulsions en une position qui est interposée temporellement entre lesdites premières impulsions de faisceau laser et lesdites deuxièmes impulsions de faisceau laser ; et de manière à :

déterminer, à partir desdites troisièmes impulsions détectées, si une information émise concerne une position de roulis dudit appareil de guidage de missile ou une commande au moyen desdites troisièmes impulsions.

8. Missile selon la revendication 7 et configuré de manière à traiter des premières et deuxièmes impulsions détectées sur la base d'une information de roulis qui lui est communiquée dans lesdites troisièmes impulsions, de manière à corriger une information de tangage et de lacet qui est convoyée dans lesdites premières et deuxièmes impulsions en relation avec ladite information de roulis.

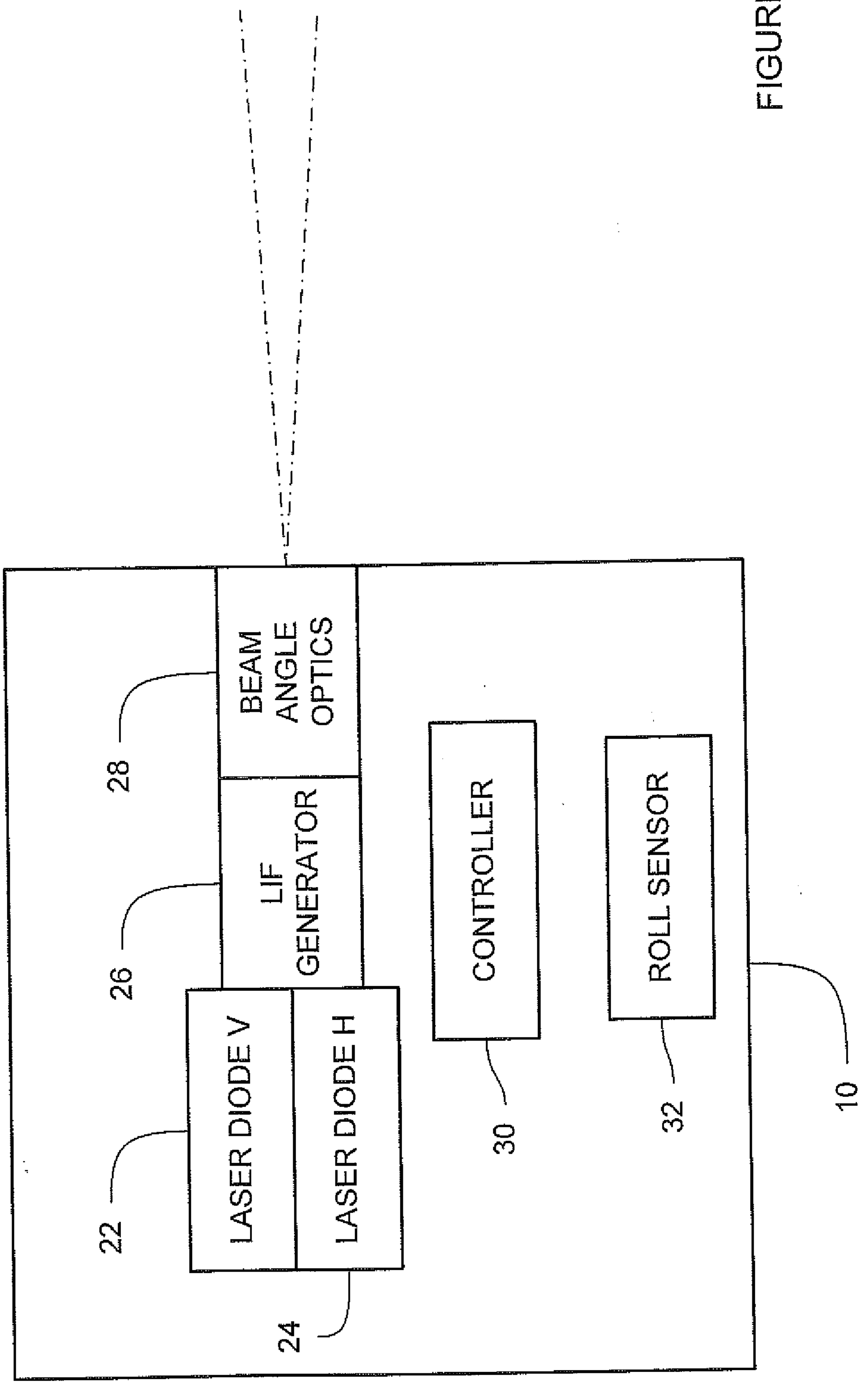
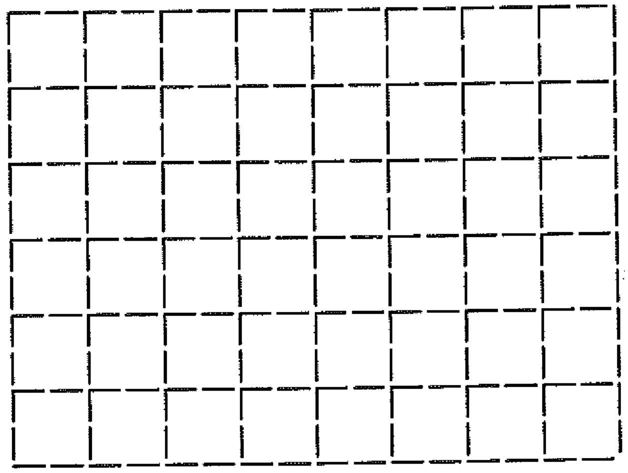

BEAM
ANGLE
OPTICS
LIF
GENERATOR
LASER DIODE V
LASER DIODE H
CONTROLLER
ROLL SENSOR
28
26
22
24
30
32
10

FIGURE 1



—— PITCH DOUBLET

| YAW DOUBLET

FIGURE 2

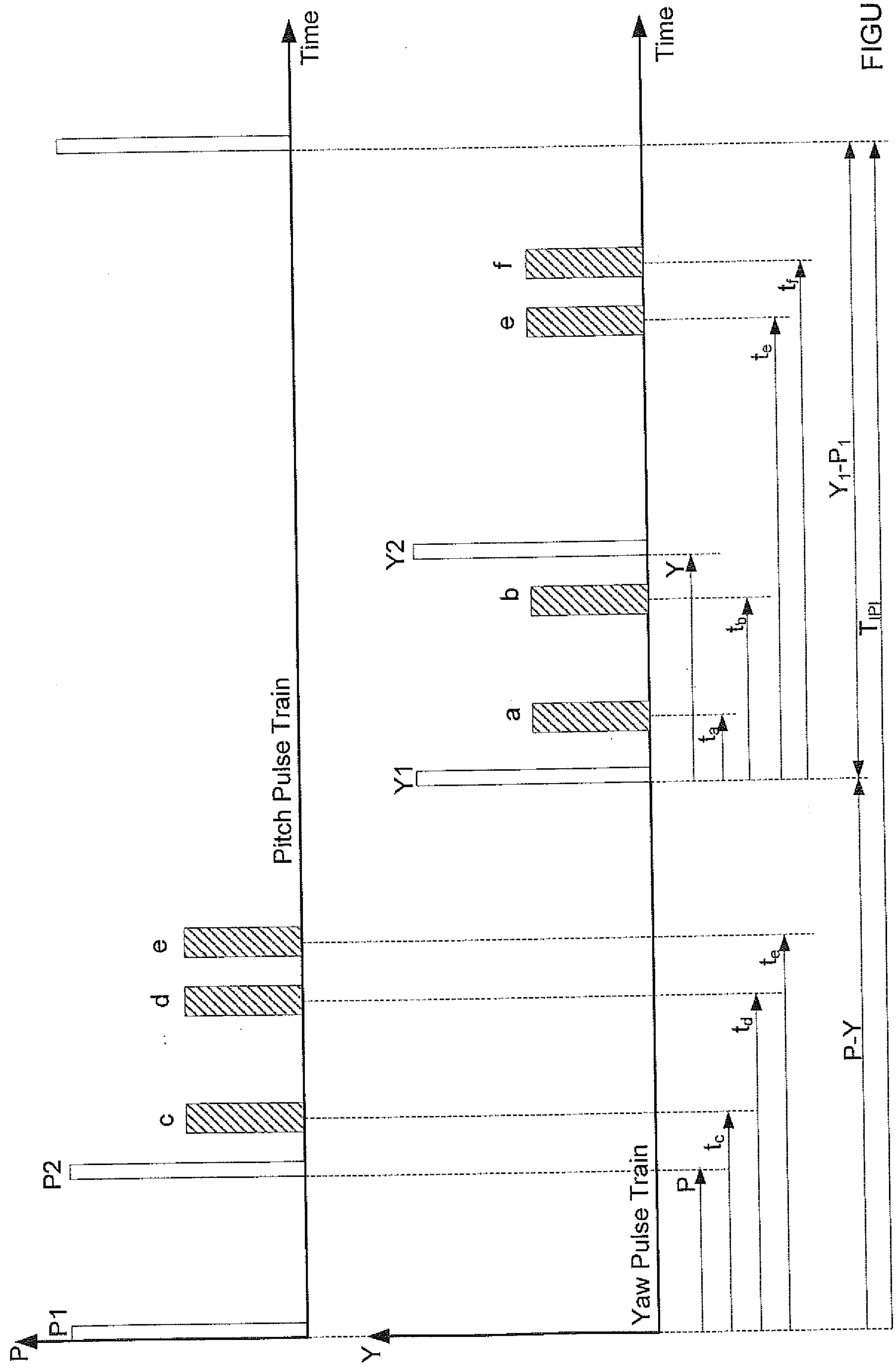

Time
Time
Pitch Pulse Train
Yaw Pulse Train
P
Y
P1
P2
c
d
e
Y1
a
b
Y2
e
f
t_a
t_b
t_c
t_d
t_e
t_f
P_Y
Y_1-P_1
T_{IPI}

FIGURE 3

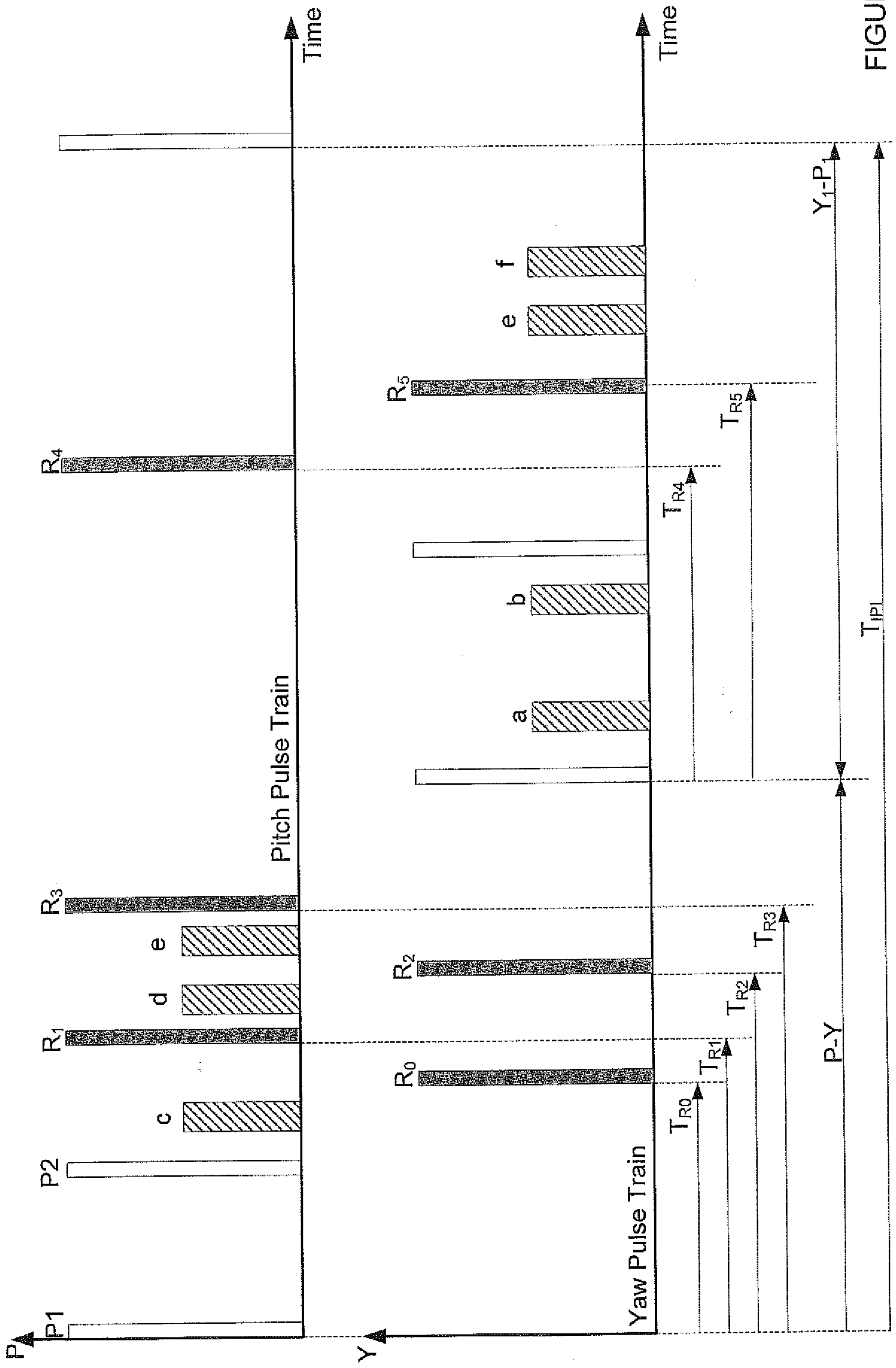
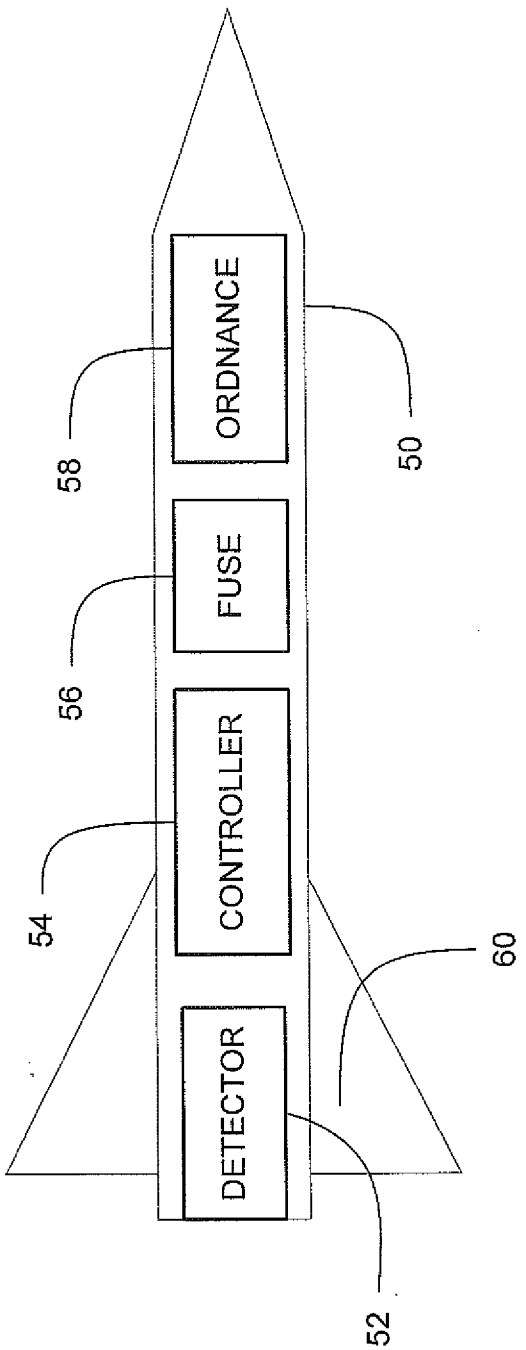

P
Y
Time
Time
Pitch Pulse Train
Yaw Pulse Train
P1
P2
c
R1
d
e
R3
R4
R0
R2
a
b
R5
e
f
TR0
TR1
TR2
TR3
TR4
TR5
P-Y
Y1-P1
TIPI

FIGURE 4

FIGURE 5



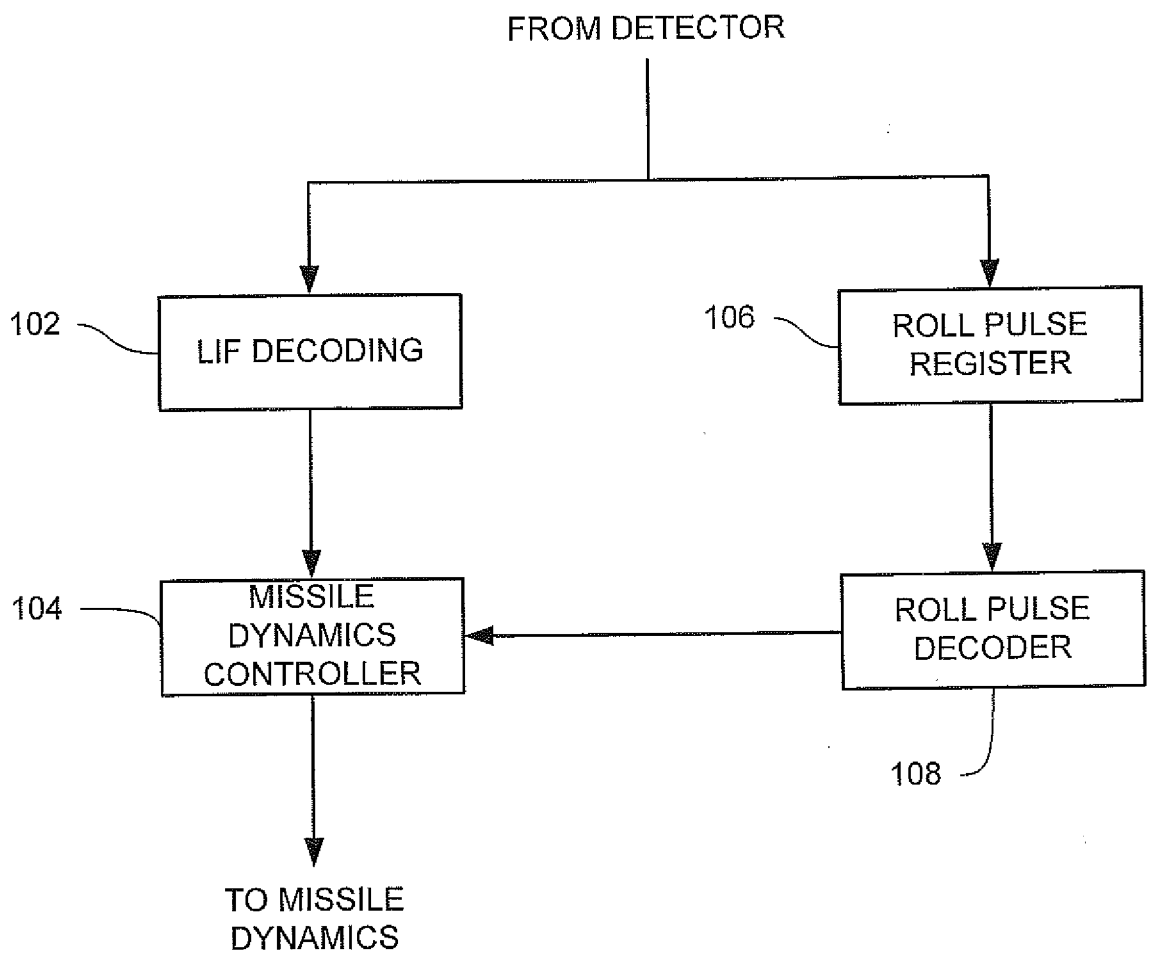

FROM DETECTOR
102
LIF DECODING
106
ROLL PULSE REGISTER
104
MISSILE DYNAMICS CONTROLLER
ROLL PULSE DECODER
108
TO MISSILE DYNAMICS

FIGURE 6

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- GB 1517794 A **[0002]**
- US 5056736 A **[0006]**