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A METHOD FOR THE TARGET HOMING OF A PROJECTILE
AND DEVICES FOR CARRYING OUT THE METHOD

The invention concerns improvements in or relating to the target homing of a projectile and devices for carrying out the method.

It is known to provide means for the end-phase steering of artillery projectiles (see the article by Peter J. Geogre in "WEHRTECHNIK" 3/79, pages 19, 22, 24-27) which are fired in a caseless manner and without self-propulsion so that projectiles initially describe a purely ballistic trajectory which is afforded by the propellant-charge number (e.g. the launching speed) and the weapon barrel elevation.

15 The realisation underlying the invention is that the conventional end-phase steering and target approach path resulting from a range extending linearly controlled flight path (which latter follows on the ballistic apogee for increasing the range of the projectile) leads to an angle of impact on the target object which is unfavourable with respect to the effect of the entrained war or combat charge.

In recognition of these factors, the problem underlying the invention is to ensure a more favourable angle of impact on the target without any material impairment of the range.

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In accordance with the present invention there is provided a method of homing-in on a target of a projectile, such as an artillery projectile, which is self-steering in its flight end phase along a flat flight path, such as a range extending glide path at a small angle of inclination, from which a target search and target homing is effected, characterised in that, after acquisition of the target object that is to be homed in on, initially the flat flight path is still maintained, before, upon further shortening of the distance of the target object, a pitch-angle control for transition from the flight path into a

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steeper target approach is effected, for which transition a determination is made on board the projectile of the point in time of reaching the theoretical point of impact by the projectile, and from which determination upon target acquisition there is calculated on board the projectile, the delay timespan for transient maintenance for the flat flight path, up to the time instant of the leaving the flat flight path by pitch-angle change-over into the the target approach path, for the more effective steeper target approach to the target object.

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The present invention also provides a device, for causing a direction-change of a projectile which self-controls its flight end phase in a programme-controlled manner and which is equipped with a target search mechanism, with regulating and control mechanisms and with control surfaces for a flat range extending flight path and then for the steering the projectile into a steeper target approach path, characterised in that in the device a navigation computer is connected subsequent to a store, for storing information which is input prior to the commencement of the flat flight path, the navigation computer having a flight-path extrapolation computer mechanism, into which also a target search mechanism is connected to enable said computer to determine a time delay of the pitch angle change instant relative to a target acquisition instant, whilst maintaining the flat flight path, and which provides inputs to a flight-cycle time control circuit for thereafter controlling the projectile steering surfaces for pitch angle change into the target approach path.

Thus, it is not immediately upon acquisition of the target object to be combatted that the linearly controlled flight path is superceded by a target tracking flight path, but the point in time of the target homing is delayed to maintain the linear flight path, in order then to over-control into a flight phase having an enlarged angle of pitch and thus to attack the target object considerably more steeply and thus more effectively.

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Since the linear flight path is guaranteed by a pre-programmed automatic control on board the projectile and the target approach path is guaranteed by a target search mechanism on board the projectile, the delay timespan between acquisition of the target object and change of the angle of pitch has to be ascertained from the actual flight dynamics of the projectile, namely it has to be extrapolated with respect to the theoretical end point of the linearly descending flight path, and to do so it is also necessary to take into account the initial ballistic flight path, afforded by firing, prior to entry into the linearly controlled flight path, on board the projectile. It is known to in-put manually on the projectile that is to be fired (prior to introduction thereof into the weapon barrel) characteristic values regarding the barrel elevation and propellant-charge number, or to put-in directly the range, calculable from these parameters and the preset linearly-flat flight path, to the theoretical path end point. However, this is complicated and, particularly under combat conditions, is extremely fraught with error.

Therefore there arises in connection with, as well as independently of, the problem concerning the angle of attack on the target, another problem of ascertaining on board the missile, without the need for a manual data input regarding the firing factors, the ballistic trajectory or the actual initial flight path of the fired projectile.

In order to avoid this further problem, the method in accordance with the invention preferably includes determining characteristic data of a ballistic firing flight path of the projectile, by measuring on board the projectile, during and after the firing thereof from a weapon barrel, the muzzle velocity and the timespan between firing and apogee passage of the projectile; and the device of the invention preferably includes means for making such measurements, which in relation to preset ballistic characteristic values of the projectile, represent a measure of the firing propellant-charge number and the firing elevation angle, and thus a determination the ballistic firing flight path of the projectile. Such means may comprise a device for

the input of the characteristic values of a ballistic firing flight into the store of a navigation computer on board a projectile which is self-steering along a flat end-phase flight path, such as for carrying out the method as mentioned hereinbefore, characterised in that provided on board the projectile is a time measuring circuit for measuring the timespan which elapses between the exit of two sensors, offset relative to one another by a specific distance along the projectile, from the muzzle of a firing weapon barrel, and connected to which circuit, to permit determination of the apogee timespan, is an apogee detector, so that items of information which are dependent upon these timespans, are transmitted as the ballistic firing characteristic values into the store. Reference is made to our co-pending Application No. 8614991 (A2177213) which is divided from the present application.

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This solution to the further problem stems from the realisation that the purely ballistic trajectory or flight path, can be determined not solely from the firing barrel elevation and propellant-charge number, i.e. from data specific to the gun, but can also be determined specifically from the muzzle velocity and apogee instant, in other words from actual flight derived data. This flight derived data can be ascertained on board the projectile itself, from which data therefore the sought flight-path information can be made available on board the projectile, without having to in-put manually information specific to the gun.

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The invention includes a ballistic starting and after apogee steering in a flat flight path for target search projectile comprising means to detect or ascertain measurements of the velocity of the projectile at the moment of discharge of the projectile from a weapon barrel and the moment at which the missile reaches apogee; means to store information relating to the ballistic or aerodynamic characteristics of the projectile; means to detect a target; means to derive from said measurements and information a time period to theoretical termination of the flat range extending flat flight or glide path at a given angle to the horizontal, and a time delay period

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from the time point of detection of the target; and means to utilise said delay period to maintain the projectile upon said flat flight or glide path until said delay period elapses before causing the projectile to be tilted to a target approach path inclined at a greater angle to the horizontal.

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An embodiment of the invention is described, by way of example, with reference to the accompanying simplified diagrammatic drawings, wherein:-

FIGURE 1 shows the entire flight path of a projectile over the path covered above ground;

FIGURE 2 shows, in a detail representation enlarged as compared with FIGURE 1, the flight end phase beginning with onset of the target search phase;

FIGURE 3 shows a block schematic diagram of essential functional elements for control of the projectile during in the flight end phase represented with FIGURE 2; and

FIGURE 4 shows a block schematic diagram of a device for an on-board ascertainment of the ballistic firing flight path of the projectile for obtaining information for control of the end-phase represented in with FIGURE 2.

The projectile 21 sketched in FIGURE 1 represents a caseless artillery shell which is equipped with control circuits and control

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means for an end-phase steering and with a built-in target search mechanism for increasing the accuracy of fire.

The projectile 21 is fired from a weapon barrel 22. A purely ballistic firing flight path 23 and therewith the orientation of the projectile 21 relative to the horizontal results from the elevation w_1 of the weapon barrel 22 at the firing point z_1 , taking into account factors such as the flow geometry of the projectile 21 and the control fins being swung out, as shown, immediately after the firing; and from the firing or muzzle velocity v_1 of the projectile 21. The latter in turn is determined by the number N (in other words the quantity) of the firing propellant charges which are arranged and ignited, for the initial acceleration of the projectile 21, behind the projectile in the weapon barrel 22. For a purely ballistic flight path 23 there would thus emerge a ballistic point of impact z_3 .

To achieve a greater combat range, the projectile 21 is steered into a non-ballistic range extending linearly-flat flight path 25. For this, after flying through the apogee 26 of the height h_2 above the location z_2 , flight stabilisation and control measures are initiated in a programme-controlled manner by means of the control surfaces 24, and lift wings 27 (see FIGURE 2) are run out (deployed). From the stored advance data for the automatic control along the flat flight path 25 and the firing derived ballistic flight data there would result an advanced point of impact z_{11} of the projectile 21 in a correspondingly further remote target zone.

The projectile is steered out of the ballistic flight path 23 so that the inclination w_{25} (FIGURE 2) of the approximately linear flight path 25 amounts typically to 20° relative to the horizontal. From this, in the advanced target point of impact z_{11} an impact path angle w_{11} of the order of magnitude of also 20° would result, which would however represent an unfavourable attack effective angle with respect to the combat charge in the projectile 21. Therefore there is effected an approach the target object 28 to be combatted in the actual target point z_8 with a target approach path 29, made steeper

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relative to the flat flight path 25, at an actual target path angle w_8 which is at least twice as large as the impact path angle w_{11} in the case of the uninfluenced flat flight path 25, and preferably lies in the order of magnitude of 45° , whereby to greatly improve the effectiveness of the combat charge in the projectile 21 upon the target object 28 to be attacked.

The so-called flight end-phase begins with the falling below of a pre-programmed target search height h_4 , which is preset in accordance with the target search and target tracking mechanism 30 incorporated into the projectile 21 and in the case of a millimetre-wave radar target search mechanism 30 the height is for example of the order of 650 m to 700 m, whereupon the target search mechanism 30 (FIGURE 3) is switched on. Because constructional reasons restrict the angle of pitch relative to the flight angle of the projectile 21, and because of the, somewhat steeper, inclination of the flat flight path 25 downwards, there results a target-acquisition limiting angle w_6 of, for example, 35° (FIGURE 2); which is why from the position of the search start location z_4 only target objects 28 can be acquired which lie beyond the nearest acquisition point z_6 . Potential target objects beyond the advanced point of impact z_{11} of the flat flight path 25 cannot as a rule be attacked from this, because that would require a reversal of direction (decrease in inclination) of the flight path angle w_{25} , which would as a rule be impermissible because it would apply high accelerative forces to the projectile which could affect the mechanical stability of the projectile 21 and the mechanisms incorporated therein.

If the intended target object 28 were to be attacked directly, upon being acquired by the target search mechanism 30, by target tracking homing of the projectile, a target tracking path 31 would occur which would indeed deviate downwards from the flat flight path 25, but would still yield a too small and therefore unfavourable impact path angle w_{31} for effective attack.

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In the present embodiment, provision is made to control the

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projectile 21, even after acquisition of the intended target object 28, in such a way that, whilst its yaw direction is immediately changed at the target acquisition point 25 towards the direction of the target object 28, the projectile continues to follow the actual flat flight path 25 so that its inclination is maintained.

A delayed point in time t_7 , for a change of angle of pitch for the derivation from the flat flight path 25, is ascertained in accordance with the proximity to the target object 28, taking into account the theoretical end flight time as far as the linearly advanced point of impact z_{11} of the flat flight path 25 and the target approach path 29 striven for, on board the projectile 21 as a delay or residual flight timespan t_5 to t_7 . At the point in time t_7 then initially the target tracking and the regulation for the previous maintenance of the projectile path inclination w_{25} are transiently interrupted and a non-controlled change to a steeper angle of pitch undertaken; whereupon the flight attitude regulation is again put into operation in accordance with this more steeply preset path impact angle w_8 , in conjunction with target tracking, switched on again, by means of the target search mechanism 30.

For these flight phases, shown in FIGURE 2 as height/path diagrams, for attacking the target object 28 at an optimum target-path impact angle w_8 , provided on board the projectile 21 is a time control circuit 32 (FIGURE 3). [In FIGURES 3 and 4 lines are denoted by the reference characters accorded to the specific information referred to hereinafter, for the sake of brevity.] The circuit 32 determines the function of the time t and thus, from the known data of the ballistic and the flat flight paths 23 to 25, the point in time t_4 , so that, as the limiting height h_4 for the commencement of the target search is fallen below, the target search mechanism 30 is thus put into operation. Upon target acquisition at the point in time t_5 , the target search mechanism 30 provides follow-up control information regarding the horizontal target displacement 33 and the vertical target displacement 34, in each case related to the instantaneous spatial orientation of the projectile 21 in its situation relative to

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the flat flight path 25. The horizontal target displacement information 33 serves immediately as control information for a yaw target follow-up regulator 35. A simple flight-path extrapolation calculating mechanism 36, determines the point-in-time t_7 for the initiation of the pitch manoeuvre from the flat flight path 25, which manoeuvre, as mentioned, is intended to be left for the transition into the steeper target approach path 29.

After receipt of the point-in-time information t_7 from the mechanism 36, the time control circuit 32 supplies, upon occurrence of the point in time t_7 , to pitch regulation mechanism 37 an item of information to cause the pitch control system to be initially interrupted for the change into the steeper target approach path 29, and, after renewed achievement of a stable flight state, to put the regulation mechanism 37 into operation again, but now taking into account the new path-direction desired value w_8 and the follow-up control by the target search mechanism 30 which is likewise interrupted or switched off and on again. By appropriate control of the adjusting members for the control surfaces 24 from the yaw target follow-up regulator 35 and the pitch regulation mechanism 37 there is effected an end-phase steering in accordance with the target approach path 29 up to impact at the target point z_8 .

For the characteristic values of the actual data regarding the initially ballistic flight path 23 and the following flat flight path 25, for determining the point in time t_7 of the pitch angle change, as well as for the determining, derived from the path data, of the point in time t_4 for the beginning of the flight end-phase target search, a store 38 is provided. Into this there are in-put prior to the firing point in time t_1 (FIGURE 1) - or immediately afterwards and at any rate prior to the transition into the flat flight path 25 after reaching of the apogee point in time t_2 - the firing data which determine the ballistic flight path 23 of the projectile 21 and which correspond to the elevation angle w_1 and the muzzle velocity v_1 of the projectile 21. Together with projectile-typical characteristic values preset in the store 38 there can thus be determined by a navigation

computer 54 the height/time flight path picture (as is shown in FIGURE 1 and FIGURE 2 (taking into account the time coordinates t over the location z), after which the described search and control procedures can be triggered by the time control circuit 32.

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The actual elevation and velocity data w_1 , v_1 , or the range z_1 to z_{11} calculable therefrom, are set customarily by means of externally accessible adjusting elements on the projectile 21, that is to be fired, prior to loading thereof into the weapon barrel 22 in accordance with the inclination w_1 thereof and in accordance with the propellant charges that are to be supplied. This handling is, however, very prone to non-reproducible false settings or inputs, particularly under combat factors.

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In this embodiment, provision is made for determining this initial data, decisive for the flight paths 23 to 25, and thus for the time course of the control interventions from the time control circuit 32, without the need for a manual setting, immediately after the firing of the projectile 21, on board the projectile 21 and for feeding the data into the store 38.

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In the projectile walling 40 are two exit sensors 41, 42 which respond to the leaving of the weapon barrel 22 through the muzzle thereof, to ascertain the muzzle or exit velocity v_1 . The sensors 41, 42 are offset mutually by a specific extent 39 in the direction of the velocity vector and thus in the longitudinal direction of the projectile 21. The sensors 41, 42 may be opto-electronic pick-ups which respond to the jump in the ambient brightness upon exit from the weapon barrel 22, or preferably simply coil arrangements which supply exit signals t_{41} , t_{42} as a result of the field change at the weapon barrel muzzle.

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Upon or in consequence of firing of the projectile 21 in the weapon barrel 22, a power source 44 is activated, for example by control from an acceleration sensor 45. The power source 44 can, for example, be an activatable battery, the electrochemical components of

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which are now brought into action with one another, or be a thermoelectrical or pizelectrical generator which, by reason of the temperature difference behind and in front of the rearward end of the projectile 21 or respectively the initial acceleration thereof, supplies electrical power into the signal processing circuit (in accordance with FIGURE 3 and FIGURE 4). What is crucial is the fact that upon exit from the weapon barrel 22 in any event already the electrical power is available to meet the needs a time measuring circuit 43 (for example a counting circuit for equidistant or regular timing impulses) in order to ascertain the timespan t_{41} to t_{42} . Since the installation distance 39 is preset constructively, in other words is known, it is sufficient, for the ascertainment of the firing velocity v_1 from that timespan t_{41} to t_{42} , to provide, instead of a computer, a table- or reference correlation or decoding store 47. Connected subsequent to this there could be an appropriate translation matrix 48 by means of which the velocity information would be expressed as propellant-charge number #, as is more customary, in the case of artillery, than the numerical value regarding the firing velocity v_1 of the projectile 21.

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A time-dependent or path-dependent determination of the ballistic flight path 23, can be made from the necessary knowledge of the muzzle velocity v_1 together with knowledge of the firing elevation w_1 ; and the latter would indeed be determinable by measuring techniques from the actual factors pertaining upon the firing of the gun, but this information is needed on board the fired projectile 21 in order, as described in connection with FIGURE 3, to determine the end point 11 and to derive therefrom the point in time for the control procedures for a delayed and thereby steeper target approach path 29. It is proposed herein to make a determination of the purely ballistic flight path 23 from the muzzle velocity v_1 of the projectile 21 in combination with the point in time t_2 of the passage thereof through the apogee 26, by means of an apogee detector 49 provided on board the projectile 21. The apogee detector may comprise a pressure sensor 50 which supplies a signal regarding the derivative trend in pressure with respect to time during the first time period derived from the

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flight path height h ; or/and of an acceleration sensor 51 which supplies, as output signal, directly an item of acceleration information or else the second temporal derivation of the height course of the ballistic flight path 23. Connected subsequent to these sensors 50 or/and 51 is at least one zero indicator 52 which supplies a signal (t_2) to the time measuring circuit 43 when the ballistic flight path 23 (FIGURE 1) passes in the apogee 26 through its height maximum over the time t or respectively over the path z .

10 The timespan t_1 (respectively with sufficient accuracy t_{41} or t_{42}) to t_2 thus represents the second necessary characteristic value for determining the theoretical course of the purely ballistic flight path 23. Together with the already ascertained velocity information in corresponding the actual propellant-charge number $\#$, thus by way of a further reference table or decoding matrix 53 on board the projectile 21 the associated value of the firing elevation w_1 can be ascertained, or the matrix input information can be evaluated directly for the path determination.

20 These items of information (v_1 , t_2) (which correspond to the decisive characteristic data (w_1 , $\#$) for the describing of the ballistic flight path 23) are, as explained in connection with FIGURE 3, stored immediately in the store 38, in order to determine therefrom, by way of a navigation computer 54, the theoretical impact point-in-time or instant t_{11} of the projectile 21 in the advanced path end point z_{11} . From this impact instant t_{11} , occurring only upon absence of the target acquisition, then by means of the calculating mechanism 36, on board the projectile 21, as explained in connection with FIGURE 2 and FIGURE 3, it is extrapolated what delay timespan t_5 to t_7 after target acquisition (t_5 over z_5) up to the delayed pitch angle change is to be preset in order then to initiate the target approach path 29 (which provides the considerably improved steeper impact path angle w_8) from the control circuit 32.

35 These point-in-time ascertainties and flight path transitions are ensurable, with comparatively slight cost, in an exceedingly exact

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and reproducible manner on board the projectile 21, as an apogee detector 49 (FIGURE 4) is present on board the projectile 21 for the combination of the flight paths 23 and 25. This is because the apogee 26 of the ballistic firing flight path (which the projectile leaves only after the apogee) extends transiently horizontally; and because the flight attitude of the projectile 21 upon passage through the apogee 26 is practically horizontal or in any event divergent only by a slight (and in this respect preset, or known) flight angle-of-incidence relative to the horizontal. Therefore, the apogee instant t_2 , the instantaneous orientation of the projectile 21 in space can be accepted as a horizontal reference position for the function of the pitch regulation mechanism 37 (for control of the projectile along the paths 25 and 29), for example by resetting or zeroing a gyroscopically-stabilised position reference system and of a pitch speed integrator, as taken into account symbolically in FIGURE 3 by a pitch-position reference transmitter 55. The end-phase steering control, crucial for the accuracy of fire, along the flat path 25 is thus effected in an exceedingly precise manner, because previously, namely immediately prior to leaving the ballistic firing path 23, the pitch reference value, crucial for the path angle $w_{25/11}$, has been obtained from the actual flight factors of the projectile 21 itself.

The invention generally provides methods and means to produce a more favourably effective target approach path 29 and for removing the need for error-prone firing-date inputs into the driveless projectile 21 that is to be fired from a weapon barrel 22 and which changes in a self-controlled manner from a ballistic firing flight path with linking flat flight path 25 into an end-phase flight path from which a located target object 28 is homed in on. For this, a change point in time t_7 for a pitch angle change out of the flat end-phase flight path 25 is delayed relative to the target acquisition point in time t_6 , whilst the projectile 21 is still moving in accordance with the preset flat flight path 25, so that only upon the change point in time is the projectile turned to the more steeply extending target approach path 29. To determine the optimised change point in time t_7 in relation to the approach to the located target object 28, a theoretical impact

point in time z_{11} of the flat flight path 25, taking into account the ballistic firing flight path 23, is computed on board the projectile 21; for this the actual ballistic firing flight path 23 is ascertained from the timespans t_{41} to t_{42} , for the exit velocity v_1 of the projectile 21 from the weapon barrel 22, and from the time t_1 or t_{41} up to time t_2 of passage through the apogee 26 which are measured on board the projectile. Additionally, by measuring the apogee, the build-up of a positional reference for the path control is made possible.

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CLAIMS

1. A method of homing-in on a target of a projectile, such as an artillery projectile, which is self-steering in its flight end phase along a flat flight path, such as a range extending glide path at a small angle of inclination, from which a target search and target homing is effected, characterised in that, after acquisition of the target object that is to be homed in on, initially the flat flight path is still maintained, before, upon further shortening of the distance of the target object, a pitch-angle control for transition from the flight path into a steeper target approach path is effected, for which transition a determination is made on board the projectile of the point in time of reaching the theoretical point of impact by the projectile, and from which determination upon target acquisition there is calculated on board the projectile, the delay timespan for transient maintenance for the flat flight path, up to the time instant of the leaving the flat flight path by pitch-angle change-over into the target approach path, for the more effective steeper target approach to the target object.

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2. A method as claimed in Claim 1, characterised in that, to obtain ballistic path information for said determination, values, characteristic of the launching velocity and the launching elevation for the ballistic flight path of the projectile, are determined on board the projectile during and after launching of the projectile.

3. A method as claimed in Claim 2, characterised in that the time instant of the apogee passage of the projectile is measured or determined on board the projectile to provide ballistic path information previous to transition to the flat path.

4. A method as claimed in Claim 2 or 3, characterised in that, to obtain ballistic flight path information, on board the projectile upon or after launching thereof an evaluation of acceleration measuring

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signals is undertaken.

5. A method as claimed in any one of Claims 2 to 4, characterised in that to provide ballistic path information, the launching velocity of the projectile is determined by measuring a timespan between the instants at which two points, at a specific distance from one another along the projectile, emerge from a barrel of a weapon as the projectile leaves the barrel.
6. A method as claimed in any one of Claims 2 to 5, characterised in that to provide ballistic path information the launching elevation of the projectile is determined by measuring the timespan which elapses between an instant of the propulsion of the projectile in the weapon barrel and the time instant when the ballistic launching flight path of the projectile passes through its height maximum.
7. A device, for causing a direction-change of a projectile which self-controls its flight end phase in a programme-controlled manner and which is equipped with a target search mechanism, with regulating and control mechanisms and with control surfaces for a flat range extending flight path and then for the steering the projectile into a steeper target approach path, characterised in that in the device a navigation computer is connected subsequent to a store, for storing information which is input prior to the commencement of the flat flight path, the navigation computer having a flight-path extrapolation computer mechanism, to which also a target search mechanism is connected to enable said computer to determine a time delay of the pitch angle change instant relative to a target acquisition instant, whilst maintaining the flat flight path, and which computer provides inputs to a flight-cycle time control circuit for thereafter controlling the projectile steering surfaces for pitch angle change into the target approach path.
8. A device as claimed in Claim 7 characterised in that the device is provided with a time measuring circuit for measuring a timespan which elapses between the emergence of two sensors, mutually offset by



a defined distance along the projectile, from the muzzle of a launching weapon barrel, which circuit is connected to a measuring circuit, for determining the apogee timespan, to provide information dependent upon these timespans which information provides a ballistic launching path characteristic data values and is transmitted into the store.

9. A device as claimed in Claim 8, characterised in that the device is arranged to receive an input from an acceleration sensor of the projectile.

10. A device as claimed in Claim 8 or 9, characterised in that a pitch-position reference transmitter is provided, which upon apogee passage transfers an item of horizontal reference information into a pitch regulating mechanism of the device.

11. A projectile incorporating a control system which is constructed or arranged to perform the method claimed in any one of Claims 1 to 6.

12. A projectile incorporating a device as claimed in Claim 7, 8, 9 or 10.

13. A ballistic starting and after apogee steering in a flat flight path for target search projectile comprising means to detect or ascertain measurements of the velocity of the projectile at the moment of discharge of the projectile from a weapon barrel and the moment at which the missile reaches apogee; means to store information relating to the ballistic or aerodynamic characteristics of the projectile; means to detect a target; means to derive from said measurements and information a time period to theoretical termination of the flat range extending flat flight or glide path at a given angle to the horizontal, and a time delay period from the time point of detection of the target; and means to utilise said delay period to maintain the projectile upon said flat flight or glide path until said delay period elapses before causing the projectile to be tilted to a target approach path inclined at a greater angle to the horizontal.



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14. A projectile as claimed in Claim 13 wherein said means to detect a target is negated temporarily at the end of said delay period.

15. A projectile as claimed in Claim 12, 13 or 14 wherein said angle of the target approach path is at least twice the angle of the range extending flat flight or glide path.

16. A projectile which is adapted to perform the method of control substantially as hereinbefore described with reference to FIGURE 2 or FIGURES 1 and 2; or which includes control means substantially as hereinbefore described with reference to FIGURE 3 or FIGURES 3 and 4 of the accompanying drawings.

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