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ARTILLERY INSTALLATIONS FOR FIRING ON MOVING TARGETS

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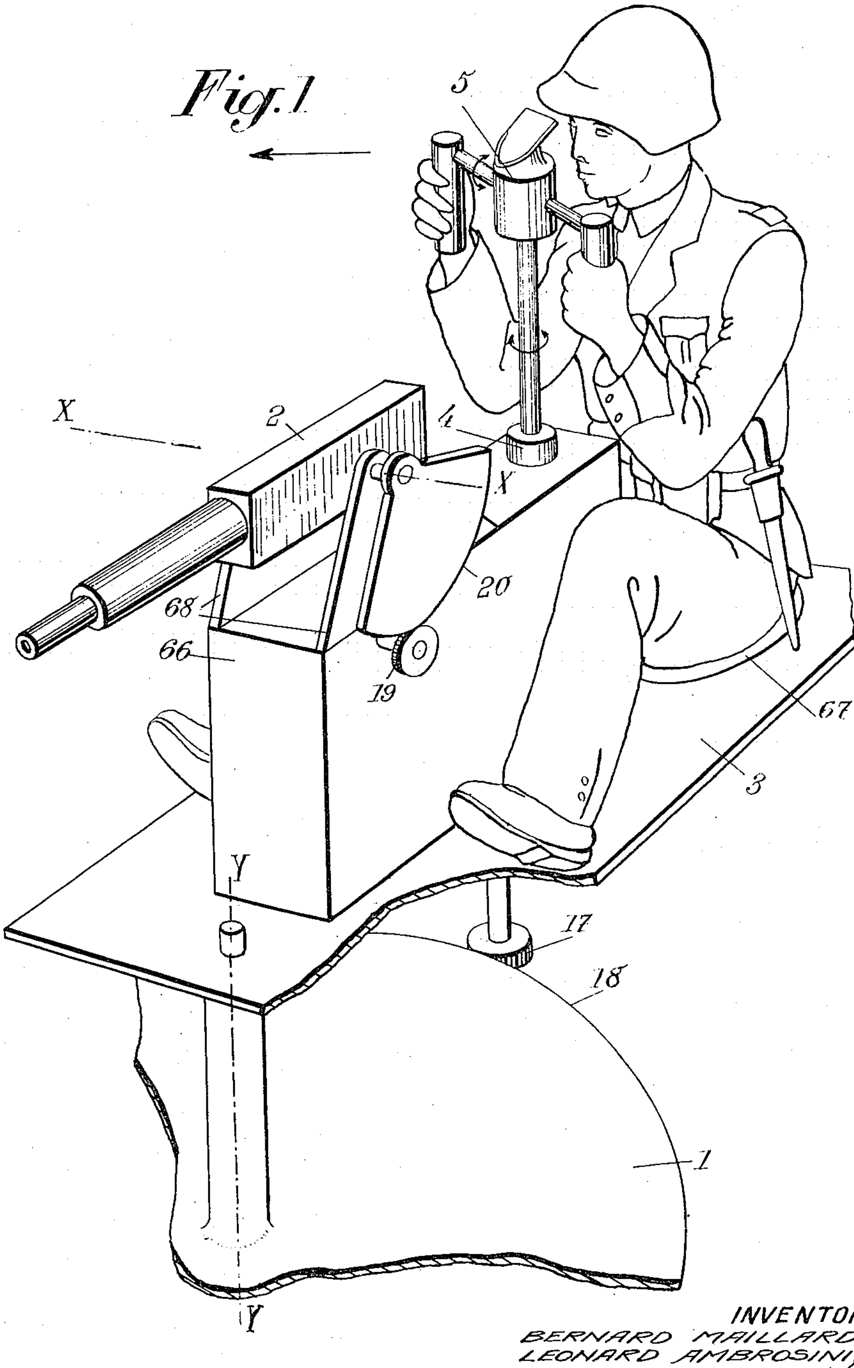
Fig. 1



INVENTORS
BERNARD MAILLARD,
LEONARD AMBROSINI,
BY
Robert B Larson
ATTORNEY

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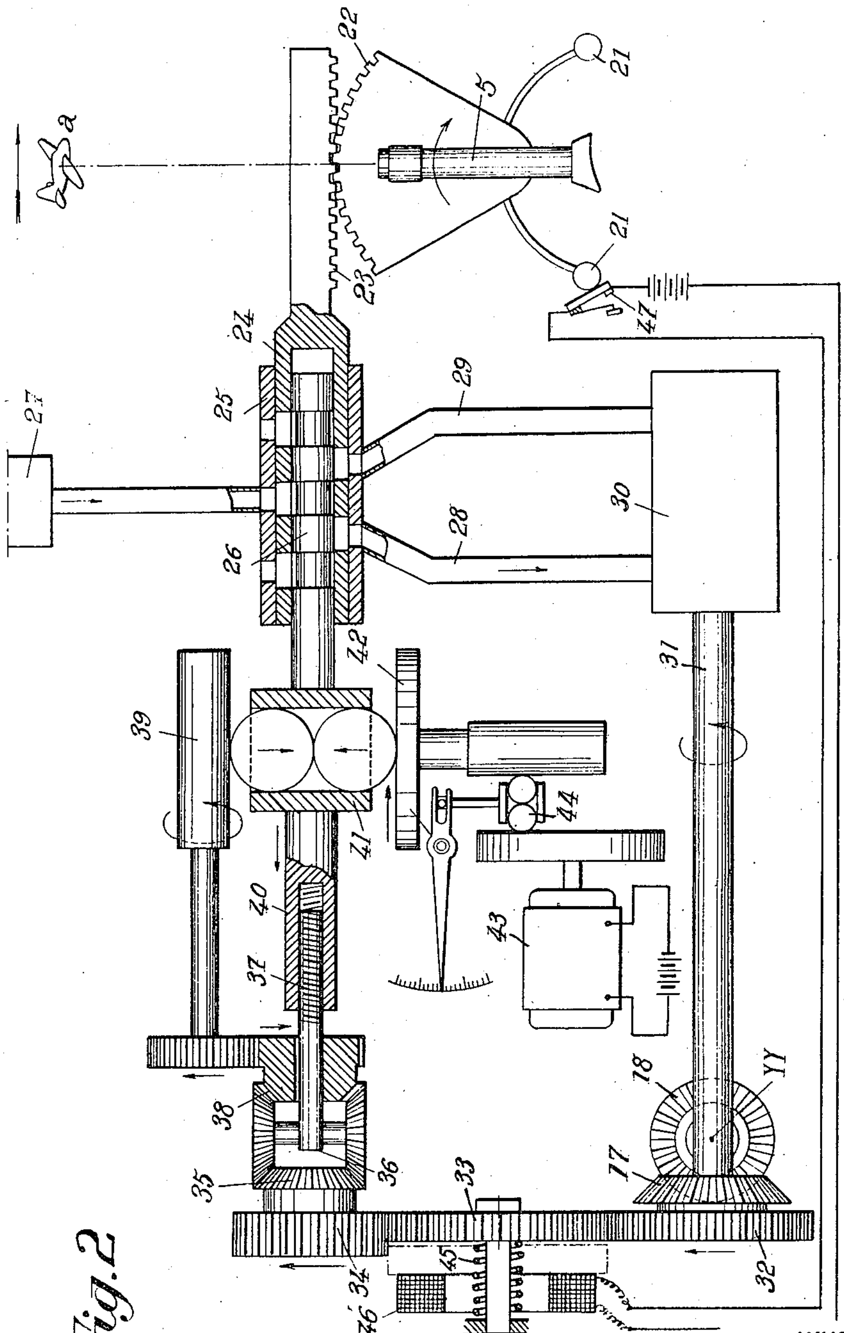
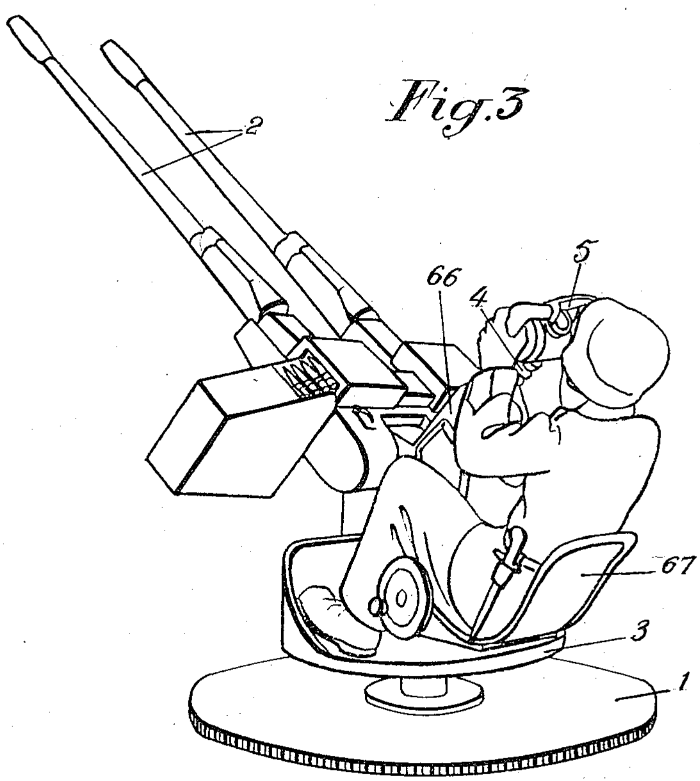


Fig. 2

INVENTORS
BERNARD MAILLARD,
LEONARD AMBROSINI,
BY
Robert B. Larson
ATTORNEY

Fig. 3



INVENTORS
BERNARD MAILLARD,
LEONARD AMBROSINI,
BY
Robert B Larson
ATTORNEY

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ARTILLERY INSTALLATIONS FOR FIRING ON MOVING TARGETS

Bernard Maillard and Leonard Ambrosini, Geneva, Switzerland, assignors to Society "Brevets Aero-Mecaniques," S. A., Geneva, Switzerland, a society of the Confederation of Switzerland

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4 Claims. (Cl. 89—41)

The present invention relates to artillery installations for firing on moving targets, in particular for anti-aircraft firing, including at least one gun movable with respect to a base or stand with both elevating and traversing displacements effected by pivoting about corresponding respective axes.

The chief object of the present invention is to provide an installation of this kind which is better adapted to meet the requirements of practice than those existing at the present time.

The artillery installation according to the invention comprises a movable sighting device having an optical axis fixed with respect thereto, this sighting device being movably supported so that the layer can move it with respect to the gun to maintain its optical axis on the target, a servo-mechanism interconnecting the movable sighting device, the gun and the gun-stand in such manner that, when the layer tends to track a target with said sighting device, an angular interconnection complying with a predetermined law is maintained between said sighting device optical axis and the line of fire of the gun in response to displacements imparted by the layer to the sighting device, and this installation is characterized by the fact that it comprises means for enabling the layer to choose at will between a limited number and preferably two different laws of interrelation between the displacements of the sighting device optical axis and the line of fire of the gun.

Other features of the present invention will become apparent in the course of the following description of some specific embodiments thereof with reference to the accompanying drawings, given merely by way of example, and in which:

Fig. 1 diagrammatically shows, in perspective view with parts cut away, an artillery installation according to the invention.

Fig. 2 diagrammatically shows, in top plan view with parts in section, a hydraulic mechanism for use in such an installation.

Fig. 3 is a perspective view showing another embodiment of the installation according to the invention.

In the following description, it will be supposed that the invention is applied to the construction of antiaircraft gun installations, with the movable sighting device carried by the same support as the gun.

On a base or stand **1** resting on the ground or on a suitable platform, there is mounted an automatic gun **2** arranged to have elevating displacements by pivoting about a normally horizontal axis X—X (Fig. 1) with respect to a frame **3** pivotable (for traversing displacements) with respect to stand **1** about an axis Y—Y (Fig. 1) which is normally vertical.

A sighting device **5** is movably mounted on a support **4** directly or indirectly connected to the gun stand **1** so that the layer can freely move this device with respect to the gun, at least within an angular zone of substantial

value (at least 10° approximately on either side of the line of fire of the gun and preferably about 30°).

This sighting device has an optical axis which is fixed with respect thereto, whereby the layer can, by moving the sighting device, bring and maintain the optical axis thereof on the target.

According to a first embodiment of the invention, support **4** has the same traversing displacements as the gun.

For this purpose, as shown by Figs. 1 and 3, support **4** is fixed with respect to frame **3** which participates in the traversing displacements of the gun but not in the elevating displacements thereof.

Sighting device **5** is pivoted to support **4** about two axes, one horizontal and the other located in a vertical plane parallel to the line of fire of the gun.

In the construction of Fig. 1, this second mentioned axis is vertical and fixed with respect to frame **3**.

Thus, a universal connection is provided between device **5** and its support **4**.

A servo-mechanism is provided between the sighting device **5**, the gun **2** and the gun stand **1** so that when the layer tends to track the target there is established, between the optical axis of the sighting device and the line of fire of the gun, in response to the displacements imparted by the layer to the sighting device, an angular interrelation complying with a predetermined law and the layer can choose at will between a limited number (for instance two) of such laws, to adopt at any time that which is the best adapted to the firing conditions.

Fig. 2 shows such a servo-mechanism, arranged to enable the layer to choose between the two following laws: on the one hand, a first law, hereinafter called "automatic servo-sighting law," constantly maintaining between the sighting device optical axis and the line of fire of the gun a predetermined angle called "lead angle" depending upon at least one of the characteristics of movement of the target; and, on the other hand, a second law, hereinafter called "servo-control law," causing the gun to move in the same direction as sighting device **5** with an angular velocity the higher as said device **5** is making a greater angle with its neutral position.

This servo-mechanism, when it works according to the automatic servo-sighting law, is of the tachometric type, that is to say such that the angular velocity of displacement of the sighting line is the only element taken in consideration for determining the interconnection between the sighting device, the gun and the gun stand. Of course, this servo-mechanism, which is shown only diagrammatically, might advantageously be completed by many supplementary mechanisms, known in themselves, for improving accuracy.

It is known that a tachometric sighting device may include, as essential element, either an electric tachometer, or a mechanical variator, or a gyroscope, or many other apparatus. In the following description, it will be supposed that this element is a mechanical variator.

The sighting device **5** (a telescope or the like) movable by means of handles **21** about an axis parallel to axis Y—Y or coinciding therewith, is rigid with a toothed sector **22** meshing with a rack **23** integral with the sliding sleeve **24** of a valve system. This sleeve **24** slides in an outer casing **25** and it accommodates a rod **26** slidable therein.

Casing **25**, sleeve **24** and rod **26** are provided with passages, arranged as shown by Fig. 2, such that a liquid, supplied from a source **27** of liquid under pressure, passes toward either of two conduits **28**, **29**, according to sleeve **24** and rod **26** are moved with respect to each other in one direction or the other from a neutral relative position for which any flow is cut off.

Conduits **28** and **29** are connected to a hydraulic motor

30 such that, when liquid is fed thereto through one of these conduits, this motor runs in a given direction whereas it runs in the opposed direction when it is fed through the other of these conduits, exhaust of said liquid taking place through that of said two conduits 28, 29 which is not fed with liquid under pressure.

The shaft 31 of the hydraulic motor 30, which is carried by the gun frame 3, is connected, on the one hand, through a pinion 17, with a toothed wheel 18 the axis of which is Y—Y (see also Fig. 1) fixed in position with respect to the gun stand, and on the other hand, through a gear train 32, 33, 34, with one of the sun-wheels of an epicycloidal gear the planet-wheel carrier 36 of which rotates together with a screw 37 and the other sun-wheel 38 of which is driven in rotation by the cylinder 39 of a conventional ball speed variator.

Screw 37 is engaged in a threaded sleeve 40 rigid with the cage 41 of the speed variator and also with the above mentioned rod 26, said sleeve 40 being guided in such manner that it can slide axially but is prevented from rotating about its axis.

The balls of the speed variator, held in cage 41, are interposed between the above mentioned cylinder 39 and a disc 42 driven in rotation by a motor 43 which will first be supposed to be running at uniform speed.

This system works in the following manner when operating according to the first mentioned law (the directions of rotation being those indicated by the arrows of Fig. 2).

When, starting from the position of rest, for which the sighting line and the line of fire are located in the same vertical plane (or possibly in parallel planes), the layer moves the telescope angularly in the clockwise direction to track a target moving in the direction of arrow *a*, sleeve 24 slides toward the right and liquid under pressure is fed to the motor through conduit 28. The motor then runs in the direction indicated by the arrow marked on shaft 31 and, as toothed wheel 18 is fixed in position, the frame of the gun is driven in rotation in the clockwise direction.

Simultaneously, the sun-wheel 35 is driven in the direction of the arrow and, as sun-wheel 38 is stationary, the planet-wheel carrier 36 rotates in a direction such that cage 41 and rod 26 are moved toward the left due to the action of screw 37 on sleeve 40.

The disc 42 of the speed variator being supposed to rotate in the direction of the arrow, the displacement toward the left of the balls takes place until they impart to cylinder 39 a speed such that the speed of sun-wheel 38 becomes equal and opposed to that of sun-wheel 35, which stops the translatory movement of cage 41.

It should be noted that, at this time, the amplitude of the displacement of said cage 41 corresponds to the value of the angular velocity of frame 3.

A traversing movement in the clockwise direction will then take place, such movement being more rapid than that of the sighting line until, while the layer is keeping the sighting line on the target, the platform 3 has moved relatively to the sighting line through an angle sufficient to bring the line of fire of the gun ahead of the sighting line by the desired angle. This movement of the platform 3 relative to the sighting line moves the rod 26 to the right relative to the sleeve 24, thus reducing the rate of flow of liquid through the conduit 28, the rod 26 and sleeve 24 tending always to assume a balance position at which the flow of liquid is just sufficient to move the platform 3 at the same rate as the sighting line.

Supposing, by way of example, that the target is describing a circle at a uniform rate about the artillery installation, it will be understood that the lead angle will then remain constant. On the contrary, this lead angle will increase if the angular velocity of displacement of the target increases and it will decrease if this angular velocity decreases.

When the telescope is stopped in fixed position in space, all the parts return to their relative positions shown by Fig. 2, and in particular sleeve 24 and rod 26 will return to their neutral relative position and the line of sighting and line of fire will be again parallel.

Of course, instead of taking into account, to determine the lead angle, only the angular velocity of displacement of the target, other apparatus incorporating other factors (and well known in the art) might be used to get nearer to the theoretical lead angle. For instance, with the apparatus above described, the distance of the target (determined through telemetric or radar means) might be taken into account by modifying in accordance with this distance the rotation speed of variator disc 42 (which is kept constant if, as above supposed, only the angular velocity of the target is to be taken into consideration). A ball variator 44 responsive to variations of the distance of the target would further increase the speed of rotation of disc 42 when the distance of the target increases and vice versa.

Mechanisms of the kind of that above described with reference to Fig. 2 have the advantage that they do not leave to the appreciation of the layer the determination of the lead angle, the layer having only to keep the line of sighting upon the target.

However, these apparatus require an extensive training of the layer.

Supposing for instance that the layer, starting from the position of rest, for which the optical axis of the sighting device and the line of fire are parallel, wishes quickly to bring said optical axis onto a target located on the right hand side of the line of fire and which moves with respect to the gun in the clockwise direction, he moves device 5 in this direction while, initially, the gun is lagging behind.

It is then the function of the servo-mechanism to make up for this lag and to bring the line of fire ahead of the neutral position so as finally to give it the correct lead angle ahead of the sighting line.

Whereas control of the sighting line is performed by the layer with natural reflexes, the fact that said layer, if his seat is carried by frame 3, undergoes the same angular displacements as the gun and is alternately moved on either side of the sighting line is somewhat disturbing.

According to our invention, this drawback is obviated since, as above stated, the installation is provided with means enabling the operator to choose at will, among a limited number (for instance two) of laws of operation of the servo-mechanism.

In the case above mentioned, where the two laws are, respectively, an automatic servo-sighting law and a servo-control law, the layer will obviously choose the second mentioned one in order to bring the sighting line from rest onto a given target, or to shift from one target to another, since with this law the drawback above described does not exist. Then, for firing, he will adopt the first law (automatic servo-sighting).

In order to enable the mechanism above described with reference to Fig. 2 to act according to the servo-control law, this mechanism includes means for uncoupling shaft 31 and sun-wheel 35.

For this purpose, the intermediate pinion 33 of the gear train 32—33—34 is slidable axially against the action of a spring 45. A fixed electromagnet 46 may, when energized, pull this pinion 33 out of engagement with pinion 32, while leaving it in mesh with pinion 34, which is then held stationary. A switch 47, for instance carried by one of the handles 21, enables the layer to energize this electromagnet when he wishes to do so.

Thus, when switch 21 is closed, the gun follows the movements of part 5 angularly without any lead angle. This is due to the fact that, if the switch 21 is closed before a gun-laying operation is commenced, the rod 26 is not moved from its neutral position, whereas, if the switch is closed during a gun-laying operation, the rod 26 is brought back into neutral position, piston 35, coupled with pinion 33, being stopped, whereas pinion 38 keeps being driven by cylinder **39** until both pinions **35** and **38** are stationary due to the fact that rod **26** is returned to its neutral position by the rotation of the screw threads **37** (for which neutral position no movement is imparted to cylinder **39** by the balls). The lead angle will be restored when switch **47** is opened.

The arrangements above described are adapted to control traversing displacements of the gun. Of course analogous arrangements may be used in each case to control elevating displacements, a pinion **19** (Fig. 1) corresponding to pinion **17**, then driving, for instance, a toothed sector **20** (corresponding to wheel **18**).

The whole of these two mechanisms (made for instance according to the construction of Fig. 2) will be preferably enclosed in at least one casing **66** which may be supported by frame **3** (Figs. 1 and 3).

In the construction of Fig. 1, frame **3** supports the layer's seat **67**. To this frame are also secured the supports **68** with respect to which the gun pivots about axis X—X, the casing **66** of the servo-mechanisms and the support **4** of the sighting device.

The same arrangement is used in the construction of Fig. 3 which relates to a construction according to which the second axis of pivoting of device **5** with respect to support **4** (which axis is located in a vertical plane parallel to the line of fire of the gun) is perpendicular both to the line of sight of said device and to the first (horizontal) axis about which the sighting device **5** is pivoted to support **4**, this second axis being therefore movable angularly at the same time as the sighting line with respect to said first axis.

It should be noted that one of the two inter-relation laws to be chosen by the layer might merely be one keeping the line of fire of the gun substantially parallel to the line of sight of device **5**. Such a law might be used alternately with an automatic servo-sighting law.

It should be further noted that when reference is made to a first and second servo-mechanism, it does not necessarily indicate that the two servo-mechanisms are wholly distinct. These mechanisms may have parts in common as is the case for the embodiment shown in Fig. 2.

Of course, the invention is applicable not only to guns proper but to all equivalent firearms, such as machine-guns, rocket launching devices, and so on.

What we claim is:

1. An artillery installation for firing on moving targets and in particular on aircraft, which comprises, in combination, a gun stand, a frame pivotally mounted on said gun stand about a given axis, a gun carried by said frame to participate in the pivoting displacements thereof with respect to said gun stand about said axis, a support fixed with respect to said frame, a sighting device pivotally mounted on said support about an axis parallel to said first mentioned axis, a toothed sector rotatable together with said sighting device about said second mentioned axis, a rack slidable in said frame in mesh with said toothed sector, a cylindrical casing fixed with respect to said frame and in line with said rack, a sleeve rigid with said rack slidable in cooperating engagement in said casing, a slide valve rod slidable in said sleeve, a source of liquid under pressure and a hydraulic motor carried by said frame, said casing, said sleeve and said slide valve rod being provided with passages for distribution of a liquid under pressure, conduit means between at least one of said passages of said casing and said source of liquid under pressure and between at least two of said passages of said casing and said motor for operating said motor in one direction or the other, or not at all, according to the respective relative positions of said sleeve and said slide valve rod with respect to said casing, a shaft driven by said motor, gear means interposed between said shaft and said gun stand for moving said frame with respect to said gun stand in response to the operation of said motor, an epicycloidal gear having two sun-wheels journalled with respect to said frame, two planet-wheels in mesh with said sun-wheels, a planet-wheel carrier, the axis of rotation of said planet-wheel carrier and of said sun-wheels being in line with the axis of said slide valve rod, a gear train for coupling with said motor shaft one of said sun-wheels, a screw rigid with said planet-wheel carrier extending in the direction of the axis of rotation thereof, said slide valve rod being provided with a coaxial threaded hole having threads in cooperating engagement with the threads of said screw, said slide valve rod being guided in said frame so as to be slidable axially with respect thereto but to be prevented from rotating about its axis, a speed variator including a disc journalled in said frame about an axis at right angles to the axis of said slide valve rod, a constant speed motor, transmission means between said last mentioned motor and said disc for rotating said disc with respect to said frame, a cylinder journalled in said frame about an axis parallel to that of said slide valve rod, gear means for coupling said cylinder in rotation with the second sun-wheel, a tubular cage carried by said slide valve rod with its axis at right angles to that of said cylinder, said cage being interposed between said cylinder and said disc, cooperating balls guided in said cage and bearing upon said cylinder and said disc respectively, clutch means between the shaft of said hydraulic motor and said first mentioned sun-wheel for cutting off the transmission between said motor and said sun-wheel, and manual control means for operating said clutch means.

2. An artillery installation according to claim 1, in which said transmission means between said constant speed motor and said disc include a speed variator adjustable in response to variations of the distance of the target to increase the speed of rotation of said disc when this distance increases.

3. An artillery installation for firing on moving targets, in particular for anti-aircraft firing, which comprises, in combination, a gun stand, at least one gun movably supported by said gun stand so that it can be moved with respect thereto with at least traversing displacements about a normally vertical axis, a sighting device having its optical axis fixed with respect thereto and movable with respect to said gun about a normally vertical axis so that the gun layer can bring and maintain said optical axis on a target, a servo-mechanism interposed between said gun, said gun stand and said sighting device for pivoting said gun with respect to said gun stand about said first mentioned axis in response to pivoting displacements of said sighting device about said second mentioned axis to keep the axis of said gun constantly ahead of the axis of said sighting device with a lead angle the greater as said sighting device is being pivoted faster, a second servo-mechanism interposed between said gun, said gun stand and said sighting device for pivoting said gun with respect to said gun stand about said first mentioned vertical axis in response to pivoting displacements of said sighting device about said second mentioned vertical axis to move said gun axis with a given relation to the movement of the sighting device axis different from that maintained by said first mentioned servo-mechanism, and manually operative means for bringing either of said servo-mechanisms into operation and simultaneously bringing the other one out of action.

4. An artillery installation for firing on moving targets, in particular for anti-aircraft firing, which comprises, in combination, a gun stand, at least one gun movably supported by said gun stand so that it can be moved with respect thereto with at least traversing displacements about a normally vertical axis, a sighting device having its optical axis fired with respect thereto and movable with respect to said gun about a normally vertical axis so that the gun layer can bring and maintain said optical axis on a target, a servo-mechanism interposed between said gun, said gun stand and said sighting device for pivoting said gun with respect to said gun stand about said first mentioned axis in response to pivoting displace-

ments of said sighting device about said second mentioned axis to keep the axis of said gun constantly ahead of the axis of said sighting device with a lead angle the greater as said sighting device is being pivoted faster, a second servo-mechanism interposed between said gun, said gun stand and said sighting device for pivoting said gun with respect to said gun stand about said first mentioned vertical axis in response to pivoting displacements of said sighting device about said second mentioned vertical axis to move said gun axis to tend to make it parallel to said sighting device axis, and manually operative means for bringing either of said servo-mechanisms into operation and simultaneously bringing the other one out of action.

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