May 26, 1964 C. G. I. SAHLBERG 3,134,303

LOADING PENDULUM ASSEMBLY FOR AN AUTOMATIC GUN

Filed Feb. 16, 1962 3 Sheets-Sheet 1

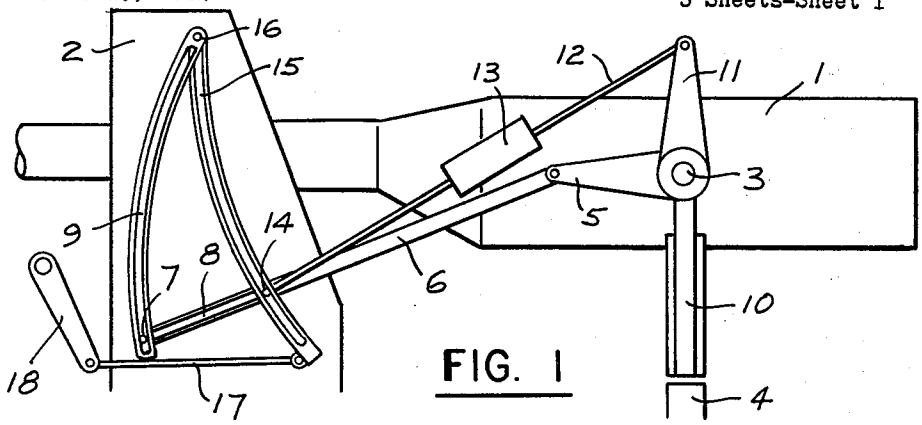

FIG. 1

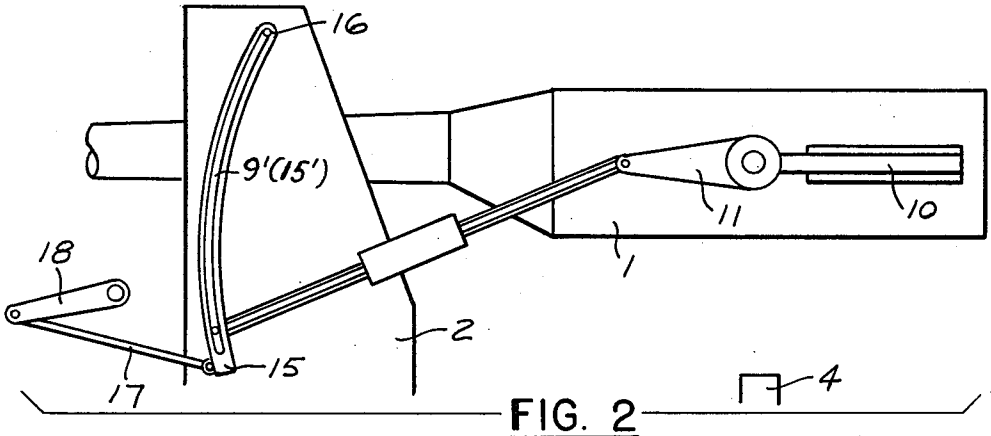

FIG. 2

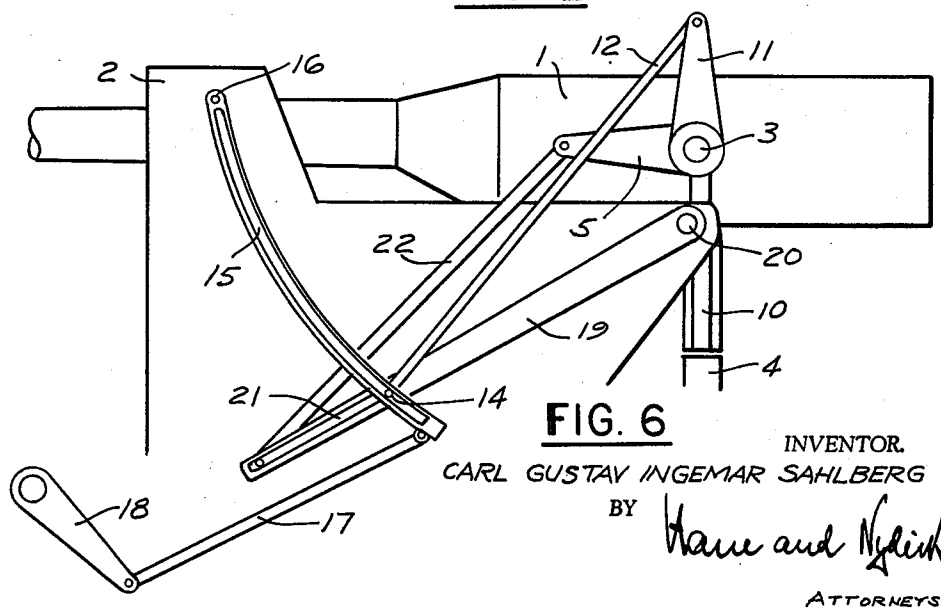

FIG. 6

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FIG. 3

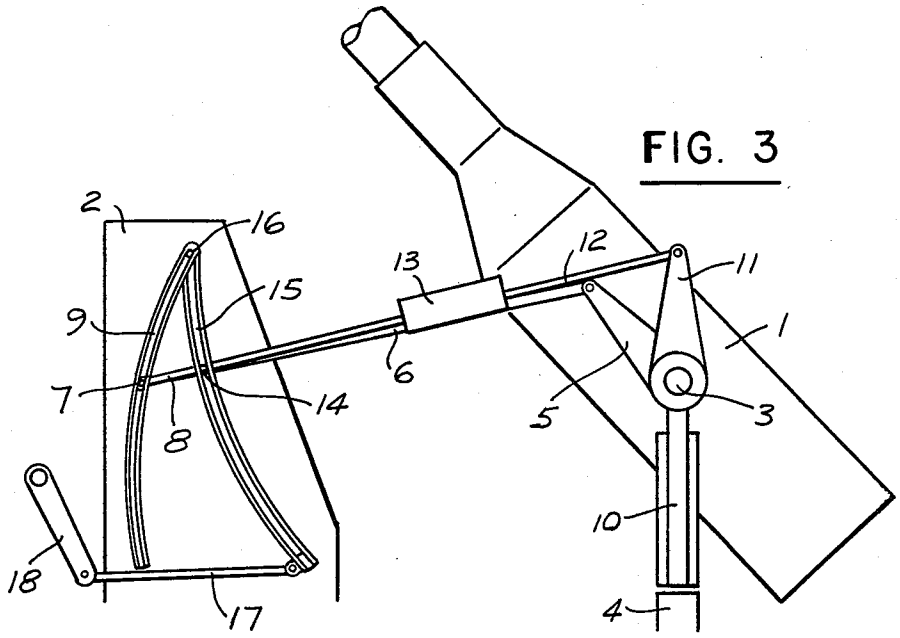
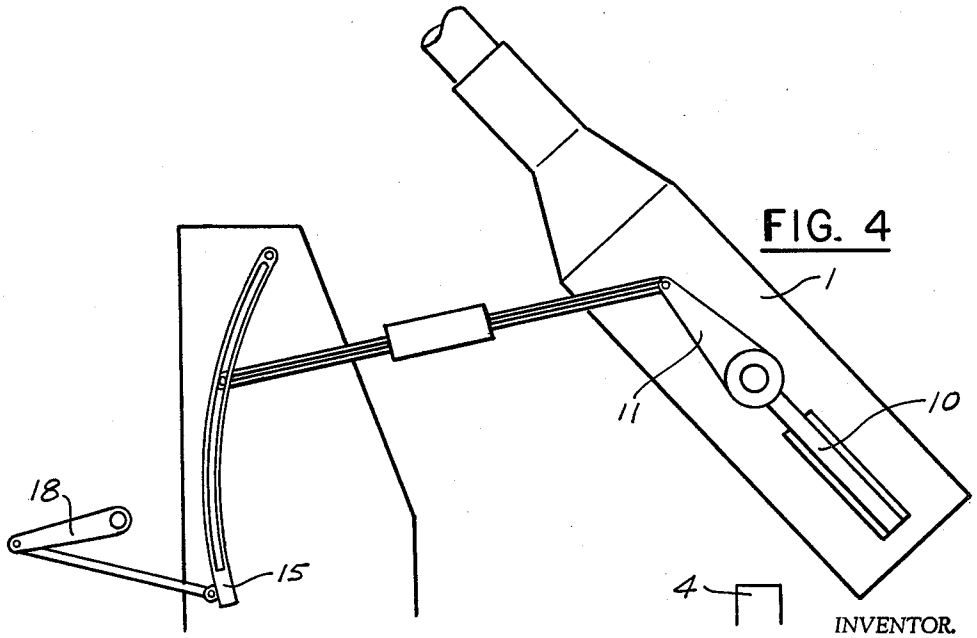


FIG. 4



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LOADING PENDULUM ASSEMBLY FOR AN AUTOMATIC GUN

Filed Feb. 16, 1962 3 Sheets-Sheet 3

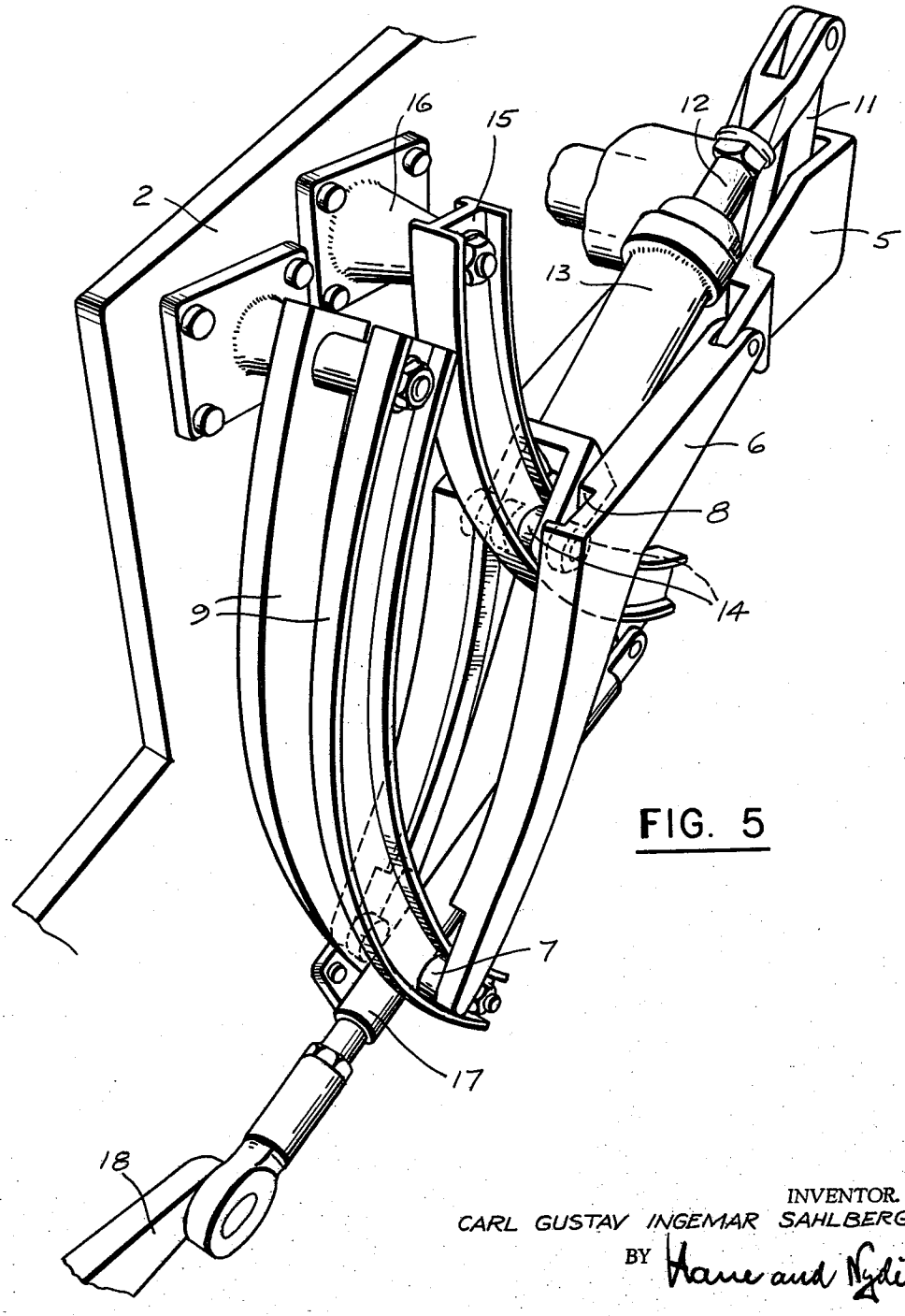

FIG. 5

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3,134,303
LOADING PENDULUM ASSEMBLY FOR AN AUTOMATIC GUN

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4 Claims. (Cl. 89—45)

The present invention relates to installations of automatic guns, and more particularly to automatic guns equipped with a loading pendulum for feeding a round of ammunition from a source of supply such as a hoist to the ramming position.

In guns of the general kind above referred to as heretofore known, the loading pendulum can swing freely between a position fixed in relation to a stationary part of the gun (supply position) and a position fixed in relation to the elevating mass of the gun (ramming position). Due to the high rate of fire of modern automatic guns a loading pendulum of this kind will swing from one position into the other at a high rate of speed and may hence be subjected to severe stresses. It is known to provide two loading pendulums which alternately feed a round of ammunition to the ramming position. The use of two pendulums permits a reduction of the swinging speed of each pendulum but requires an accurate synchronization of the movements of the pendulums.

It is an object of the invention to provide a novel and improved gun installation of the general kind above referred to, in which the amplitude of the swinging movements of the loading pendulum is continuously controlled, whereby the rate of speed of the pendulum and the stresses acting upon the same can be reduced.

A specific object of the invention is to provide a novel and improved gun installation of the general kind above referred to, in which the amplitude of the swinging movements of the pendulum is continuously and automatically controlled in accordance with the elevational position of the elevating mass of the gun (gun barrel) so as to reduce said amplitude proportional to an increasing elevation of the gun barrel.

It is also a specific object of the invention to provide a novel and improved gun installation of the general kind above referred to, in which the swinging movements of the loading pendulum are so controlled that the arc of the pendulum is always limited to a swing from the loading position to the ramming position and vice-versa irrespective of the elevational position of the gun barrel.

A further object of the invention is to provide a novel and improved gun installation of the general kind above referred to which permits elevation or depression of the elevating mass of the gun without change in the position of the loading pendulum which will remain in its ramming or loading position as the case may be, during elevation or depression of the elevating mass.

A loading pendulum assembly according to the invention may be advantageously used for a single pendulum installation and also for synchronization of two alternately operating pendulums.

Other and further objects, features and advantages of the invention will be poinnted out hereinafter and set forth in the appended claims constituting part of the application.

In the accompanying drawing several preferred embodiments of the invention are shown by way of illustration and not by way of limitation.

In the drawing:

FIG. 1 is a diagrammatic view of a gun installation according to the invention showing the loading pendulum in its loading position.

FIG. 2 is a view similar to that of FIG. 1, but showing the loading pendulum in its ramming position.

FIG. 3 is a view similar to that of FIG. 1, but showing the gun barrel elevated from the horizontal position of FIG. 1.

FIG. 4 is a view similar to that of FIG. 2, but showing the gun barrel in elevated opsition.

FIG. 5 is a perspective view of structure of a loading pendulum assembly based upon the principle diagrammatically shown in FIGS. 1 through 4, as usuable in practice and

FIG. 6 is a diagrammatic view of a modification of the pendulum assembly according to FIGS. 1 through 4.

In FIGS. 1 through 6 only those parts of the gun and its mount are indicated that are essential for the understanding of the invention.

Referring first in detail to FIGS. 1 through 4, these figures show part of the elevating mass **1** of the gun and more specifically the recoil jacket and a portion of the barrel of the gun. The non-elevating part of the gun mount is shown at **2**. The recoil jacket **1** is pivotally supported on a trunnion **3**, the mounting for which is not shown. The supply of ammunition is indicated at **4** and may be visualized at the top end of a hoist.

The loading pendulum assembly comprises a lever or a link **5** fixedly supported at one end by recoil jacket **1**, for instance on trunnion **3** for pivotal movement in unison with the recoil jacket. The other end of link **5** is pivotally connected to one end of a guide link **6**, which is formed with a lengthwise guide groove **8** and mounts at its other end a roller **7**. Roller **7** is guided in a circularly curved guide track **9'** formed in a guide link or member **9**, fixedly secured at one end to the non-elevating part **2** of the gun. A loading pendulum **10** is pivotally mounted on the elevating mass **1** of the gun, for instance on trunnion **3**. The pendulum is extended by a link or lever **11** pivotal in unison with the pendulum. Link **11** is pivoted to one end of a driving bar or link **12**. The other end of driving link **12** mounts a roller **14** which is guided in a second curved guide track **15'** formed in a guide member or link **15** and having the same curvature as guide track **9'**. Roller **14** also engages guide track **8** of link **6** and is lengthwise slidable in that guide track. Guide member **15** is pivotal about a pivot pin **16** on the non-elevating part **2** of the gun. The respective ends of guide members **9** and **15** are shown to be in registry in FIGS. 2 and 4. The free end of guide member **15** is pivoted to a drive bar **17** which in turn is hinged to a reciprocatory lever **18** which should be visualized as being driven by suitable power drive means (not shown). Lever **18** is driven by the drive means from the position shown in FIG. 1 to the position in FIG. 2 and vice-versa.

A buffer **13** is interposed in link **12** and serves to absorb joints occurring between roller **14** and driving guide member **15** and also to compensate for possible backlash in the transmission formed by the aforedescribed links and guide members.

The loading pendulum assembly as hereinbefore described, operates as follows:

Let it be assumed that the elevating mass **1** of the gun is in the depressed horizontal position of FIG. 1, that pendulum **10** is in the loading position and loaded with a round of ammunition, and that it is desired to swing the pendulum from the loading position of FIG. 1 into the ramming position of FIG. 2. To effect such swinging of the pendulum, lever **18** is driven in clockwise direction from the position of FIG. 1 into the position of FIG. 2. The driving bar **17** will follow the movement of the lever and accordingly the links and members of the linkage assembly as previously described are displaced from the position of FIG. 1 to the position of FIG. 2. More specifically, curved member **15** will be turned in

clockwise direction taking along with it driving link **12** which is drivingly coupled by lever **11** to pendulum **10** whereby the latter is turned in counter-clockwise direction into the position of FIG. 2. Lever **5** will remain in its position, but roller **14** of link **12** will slide along guide track **8** towards the outer end thereof. The roller will also slide in guide track **15'** toward the free end of said track.

The ratio of transmission is selected in the exemplification according to FIGS. 2 and 4 so that guide members **9** and **15**, links **6** and **12** and levers **5** and **11** are in registry when pendulum **10** is in its ramming position. As is evident, pendulum **10** in FIGS. 1 and 2 must turn through an angle of 90° to reach the ramming position which is the widest angle through which the pendulum must swing in the said position of elevating mass. Accordingly, the displacements relative one to another which the links and members of the linkage assembly must perform are also the greatest possible displacements.

To return pendulum **10** from the position of FIG. 2 into the position of FIG. 1, lever **18** is driven in counter-clockwise direction, that is, from the position of FIG. 2 into the position of FIG. 1. Such movement of the lever compels corresponding movements of all the links and members drivingly coupled therewith as is evident from the previous description.

Driving lever **18** has been described as a reciprocatory lever, but it is also possible to rotate the lever. The drive means for the bar **17** can be an arbitrary one provided it can give the guide member **15** the desired movement between the two positions shown in FIGS. 1 and 2.

Let it now be assumed that it is desired to elevate the recoil jacket **1** from the horizontal position of FIG. 1 into the elevated position of FIG. 3 without movement of pendulum **10** out of its loading position. As is evident from the previous description, elevation of the recoil jacket **1** causes a corresponding turning of lever **5**. The lever forces link **6** pivotally connected to it from the position of FIG. 1 into the position of FIG. 3 and roller **7** of link **6** will ride upwardly in guide track **9'**. The upward movement of link **6** forces link **12** to follow as its roller **14** is guided in guide track **8**. Hence roller **14** will also ride upwardly in guide track **15**. The cylindrical curvature of guide track **15'** is such that its center is the pivot point at which lever **11** and link **12** are joined to each other. Accordingly no turning force acts upon pendulum **10** and the same remains in the loading position when and while the recoil jacket of the gun is elevated.

The same, though reverse action, occurs when the recoil jacket is depressed from the elevated position of FIG. 3 into the horizontal position of FIG. 1.

Similarly, the gun may be elevated from the horizontal position of FIG. 2 into the elevated position of FIG. 4 and vice versa without moving the loading pendulum out of its ramming position. As is shown in FIG. 2, guide tracks **9'** and **15'** are in registry at the beginning of the elevational movement of recoil jacket **1**. Link **6** will be lifted when and while the recoil jacket **1** is elevated, but at the same time it takes along driving link **12** through the same distance due to the coupling between roller **14** of driving link **12** and link **6**. As a result, the lifting movement of link **12** has no effect upon the position of pendulum **10**. Similarly, a depression of recoil jacket **1** from the position of FIG. 4 into the position of FIG. 2 has no effect upon the position of the pendulum.

Let it now be assumed that it is desired to swing pendulum **10** from the loading position of FIG. 3 into the ramming position of FIG. 4. Such movement is again effected by driving lever **18** from the position of FIG. 3 into the position of FIG. 4 in clockwise direction. As is apparent, the arc through which pendulum **10** must turn to reach the ramming position is about half the arc of FIG. 1. While the arc through which lever **18** is turned is the same in FIG. 3 as in FIG. 1, the action of such turning

of lever **18** upon the linkage system is not the same as has been described in connection with FIGS. 1 and 2. Due to the aforedescribed displacement of link **6** and **12** during the elevation of recoil jacket **1**, that is, the ratio of displacement of pendulum **10** relative to lever **18**, the ratio of transmission is correspondingly reduced, as is evident from a comparison of FIGS. 1 and 3 or FIGS. 2 and 4. Hence pendulum **10** will move through the required smaller arc in response to turning of lever **18** through its full arc. Upon completion of the movement of the pendulum into the ramming position all the components of the linkage assembly will occupy the position shown in FIG. 4.

Similarly, the pendulum may be returned from the ramming position of FIG. 4 into the loading position of FIG. 3 when lever **18** is returned from the position of FIG. 4 into the position of FIG. 3.

As is apparent from the previous description, the ratio of transmission which is transmitted from lever **18** to the loading pendulum is continuously controlled in accordance with the elevational position of the gun.

The link **6** need not have the form of a bar but can have the shape of a plate of e.g. triangular form. The track **8** in FIGS. 1–4 is shown straight, but it can have a curved form and a direction which more or less corresponds to the one shown in FIG. 5.

The structure of the loading pendulum assembly of FIG. 5 is evident from the previous description by referring to the corresponding reference numerals. The only difference is that the mountings for guide members **9** and **15** are shown separate as this has been found to be more practical from a manufacturing viewpoint. It may also be noted that in FIG. 5 the guide tracks **9** and **15** are shown double, links **6** and **12** are bifurcated and each mounts two rollers **7** and **14** respectively.

In the arrangement of FIG. 6, the guide member **9** of the proceeding figures is replaced by a link **19** which is pivoted at one end to the non-elevated part of the gun mount at **20**. The other end of link **19** is formed with a guide track **21** in which roller **14** of link **12** is guided lengthwise slidable. The track **21** can also have a curved form and any suitable direction. Link **6** is replaced by a link **22** which at one end is linked to link **19** and at the other end to lever **5**. As a result lever **5** will pull link **22** upwardly when the gun is elevated whereby link **12** is compelled to ride up in guide track **15'** in a manner similar to that described in connection with FIGS. 3 and **4**. The members **15**, **17** and **18** will function as previously described.

It will be obvious that the elevating mass can be depressed from the position shown in FIGS. 1, 2 and 6 and elevated from the position in the said figures to a position above 90°.

While the invention has been described in detail with respect to certain now preferred examples and embodiments of the invention, it will be understood by those skilled in the art after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention, and it is intended, therefore, to cover all such changes and modification in the appended claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A loading pendulum assembly for an elevating automatic gun, said assembly comprising a loading pendulum mounted on the elevating mass of the gun pivotal between a loading position fixed in reference to a stationary part of the gun and a ramming position fixed in reference to the elevational position of the elevating mass of the gun, a drive member with reciprocating movement of predetermined amplitude, and variable ratio transmission means coupling said drive member with said pendulum for pivoting the latter between said positions in response to movement of said drive member, said transmission means comprising a curved first guide

link pivotally mounted on a stationary part of the gun and coupled to said drive member for swinging said first link through an arc of predetermined amplitude corresponding to said movement of the drive member, a second link slidably guided at one end in said first link and pivotally linked at the other end of said pendulum to transmit the movement of the first link to the second link, the position of said one end of the second link in the curved first link in reference to the pivot point thereof controlling the ratio of transmission of said transmission means, and a third link linked at one end to the elevated mass for control by the elevation position thereof and engaging said guided end of the second link to vary the position of said second link in reference to the pivot point thereof in accordance with the elevational position of the elevating mass of the gun, thereby controlling the pivotal movement of said loading pendulum corresponding to the elevational position of the gun.

2. An assembly according to claim 1 wherein said transmission means further comprise a curved fourth link fixedly mounted on a stationary part of the gun, the other end of the third link being slidably guided in said fourth link to vary the position of said guided other end of the third link in accordance with the elevational position of the elevating mass, an intermediate portion of said third link engaging the guided end of the second link to displace said guided end in reference to the first link in accordance with the elevational position of the elevating mass thereby correspondingly changing the ratio of transmission of said transmission means.

3. A loading pendulum assembly for an elevating automatic gun, said assembly comprising a loading pendulum mounted on the elevating mass of the gun pivotal between a loading position fixed in reference to a stationary part of the gun and a ramming position fixed in reference to the elevational position of the elevating mass of the gun, a drive member with reciprocating movement of predetermined amplitude, a first link including a curved guide track pivoted at one end to a stationary part of the gun and coupled at the other end to said drive member for pivoting said link through an arc corresponding to said amplitude of the drive member, a second link engaging at one end said curved guide track slidable along the same, the other end of the second link being coupled to said pendulum for pivoting the same corresponding to the pivotal movement of the first link, the position of the end of the second link guided in the curved guide track of the first link controlling the extent of the pivotal movement imparted to the pendulum by a pivotal movement of the first link in response to a movement of the drive member, a third link coupled at one end to said elevating mass for displacement of said third link in accordance with the elevational position of the elevating mass,

and a fourth link including a curved guide track fixedly secured to a stationary part of the gun, the other end of said third link slidably engaging the guide track of said fourth link for displacement along said track, an intermediate portion of the third link forming a guide track, the guided end of the second link slidably engaging said guide track to position said second link in the curved guide track of the first link in accordance with the angular position of the pendulum thereby controlling the extent of the pivotal movement of the pendulum in response to a movement of the drive member.

4. A loading pendulum assembly for an elevating automatic gun, said assembly comprising a loading pendulum mounted on the elevating mass of the gun pivotal between a loading position fixed in reference to a stationary part of the gun and a ramming position fixed in reference to the elevational position of the elevating mass of the gun, a drive member with reciprocating movement of predetermined amplitude, a first link including a curved guide track pivoted at one end to a stationary part of the gun and coupled at the other end to said drive member for pivoting said link through an arc corresponding to said amplitude of the drive member, a second link engaging at one end said curved guide track slidable along the same, the other end of the second link being coupled to said pendulum for pivoting the same corresponding to the pivotal movement of the first link, the position of the end of the second link guided in the curved guide track of the first link controlling the extent of the pivotal movement imparted to the pendulum by a pivotal movement of the first link in response to a movement of the drive member, a third link pivoted on one end to a stationary part of the gun, said third link including a guide track slidably engaged by the guided end of the second link to displace said guided end in both the guide track of the first link and the guide track of the third link in accordance with the pivotal position of the third link, and a fourth link pivoted at one end to said elevating mass for pivotal movement of the fourth link in accordance with the elevational position of the elevating mass, the other end of the fourth link being pivoted to said third link to position the guided end of the second link in accordance with the angular position of the elevating mass thereby controlling the extent of the pivotal movement of the pendulum in response to a movement of the drive member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,655,079 Aldrin et al. ---------- Oct. 13, 1953

FOREIGN PATENTS

136,692 Sweden ---------- July 22, 1952
329,878 Germany ---------- Dec. 1, 1920