To enable gunners to raise and lower rapidly and easily automatic cannons, a necessity which is particularly important in anti-aircraft guns, the weapon needs to be in perfect balance irrespective of its angular elevation. It is, however, not always possible to build gun mountings in such a way that the centre of the pivot coincides with the weapon's centre of gravity, especially when there is no room available as in very small armoured cupolas. Generally, the rear part of a vertically pivoted gun is heavier than its front portion since the rear portion includes cradle and mount, feed mechanism, cushioning device. Of all the known means devised to produce a balance of weights, counterweights are not usable, especially in vehicle-mounted weapons, because of the additional weight which constitutes an extra load on the vehicle. As common spring mounts produce tensions varying heavily with lengths of travel, they can not steady the gun in its various angular positions.

The inventor found a solution to this problem and points out a way enabling the gun to be brought to an equipoise in any angular position between -10 and +80 without the use of any laying gear. Because only if there is no laying gear, the gun can be readily adjusted by hand to any desired elevation. To make manual adjustment effortless, perfect balance over the entire adjusting range is essential.

The inventor uses very simple means to solve this problem in that he provides for a tension spring acting on a roller chain secured to a rotatable segment rotatable simultaneously with a vertically pivoted gun, the chain rolling off the toothed segment. Various points on the periphery of the segment vary in distance from the pivot, these distances being so selected as to ensure perfect balance of the gun at any elevation. The radius of every single point on the periphery of the segment corresponds with both the spring tension and the unbalance of the gun in this particular position.

One embodiment of the invention is illustrated in the drawings. FIG. 1 shows the gun in its horizontal position, FIG. 2 in its elevated position, FIG. 3 shows segmented, chain and tension spring with the gun in its horizontal position on an enlarged scale, FIG. 4 shows the same item represented in FIG. 3 with the gun in its elevated position.

With the gun 1 being raised or lowered, the toothed segment 2 rotates likewise, this segment being secured to the pivot carrying the gun. One end of the roller chain 4 is secured to the segment 2 in such a way that the chain can roll off this segment. The other end of the roller chain 4 is secured to the tension spring 5 which, in turn, is suspended from a cross bar 6 mounted within the armoured cupola. A change in elevation of the gun 1 results in a variation of the travel of the tension spring 5, different rates of spring tension acting on segment 2 over roller chain 4 and, thus, different forces acting on different radii. The arrangement provides that a small pull is exerted on a long radius and a large pull on a small radius in such a manner that in every position of the gun, throughout its entire range of adjustment, a momentum of rotation is produced which keeps the gun in its state of equilibrium.

**Operation**

Considering FIGS. 1 and 3, the gun 1 when disposed in the horizontal position is subject to a predetermined tension or torque determined by the effective length of the gear segment 2, i.e. the distance the end of the chain 4 connected to the spring 5 is spaced from the center of the pivot 3. As the gun is pivoted from the position of FIGS. 1 and 3 to that of FIGS. 2 and 4, the effective length mentioned above gets shorter and at the same time more tension is applied to the spring 5. Thus at any given point or tooth on the gear segment 2 the balancing force is maintained substantially constant due to the changing tension and effective length of the gear segment.

1 claim:

1. A balancing system for a gun vertically pivoted upon a horizontal axis of rotation at a point outside the center of gravity of said gun, and counterbalance means operatively connected to said gun at said horizontal axis of rotation, said counterbalance means comprising a tension spring anchored at one end and extending toward said gun, a gear segment rotatable in unison with said gun about said horizontal axis of rotation, said gear segment including a toothed section offset on an eccentric arc from said axis of rotation and each tooth providing a plurality of differently disposed lever arms, and a connecting member secured at one end to said tension spring and connected at said other end to one end of said toothed section, said connecting member including portions progressively engageable with said lever arms from said one end of said toothed section whereby pivoted movement of the gun about its horizontal axis of rotation progressively changes the effective torque imposed on said gear segment to balance said gun at different elevations about said axis of rotation.

2. The structure of claim 1; said gear segment being fixed to and depending from said gun at the axis of rotation thereof, said connecting member comprising a link chain progressively engageable with one or all of the teeth on said segment.

**References Cited** in the file of this patent

**UNITED STATES PATENTS**

2,408,110 Thresh  September 24, 1946
2,564,360 Hammel et al.  August 14, 1951

**FOREIGN PATENTS**

730,707 France  May 17, 1932
863,886 France  January 6, 1941
586,981 Great Britain  April 9, 1957