No. 693,702. Patented Feb. 18, 1902.

H. H. GRENFELL.

ELEVATING AND SIGHT ADJUSTING GEAR FOR ORDNANCE.

(Application filed July 15, 1901.)

(No Model.) 5 Sheets—Sheet 1.

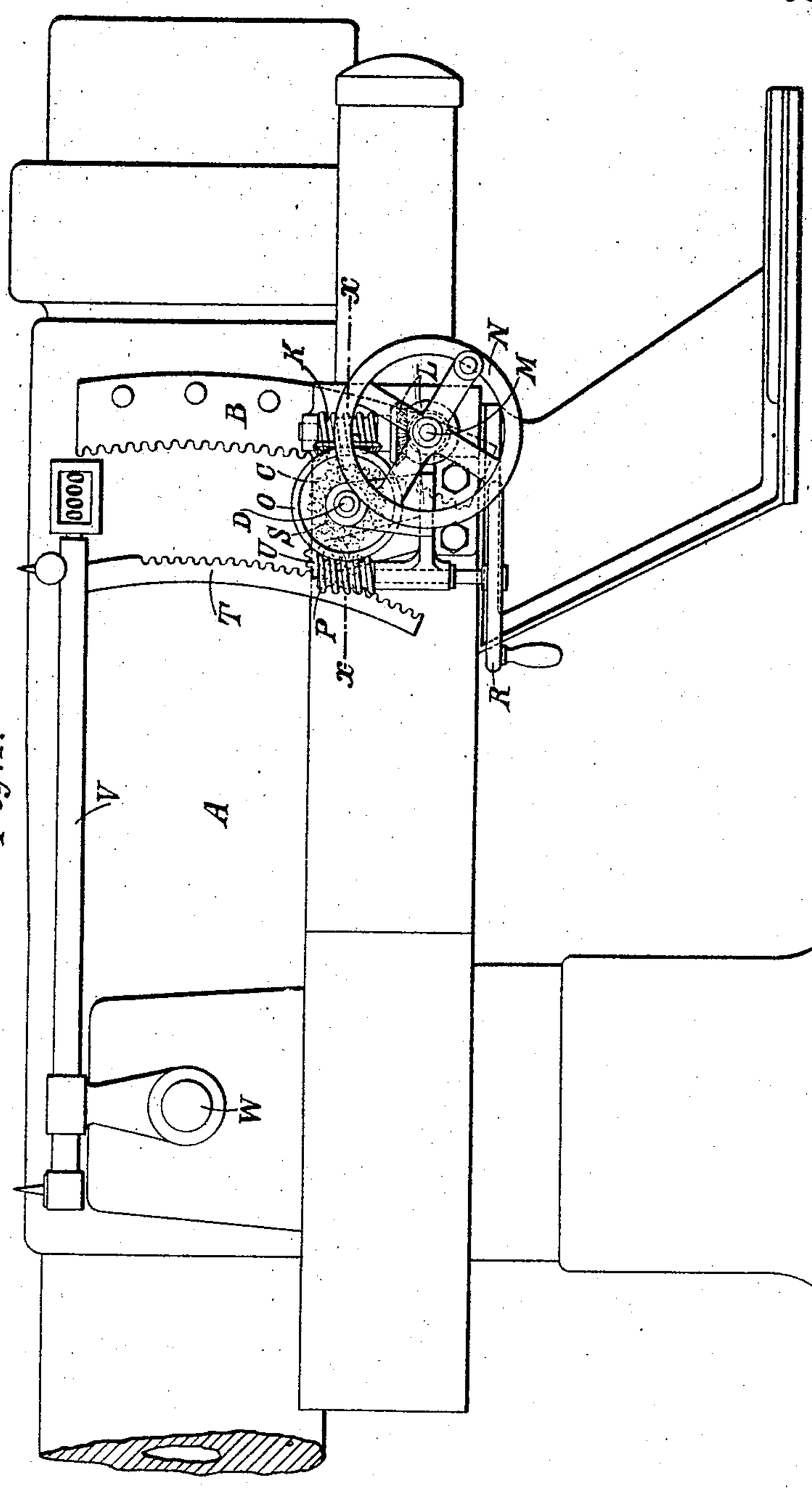

Fig. 1.

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Fig. 2.

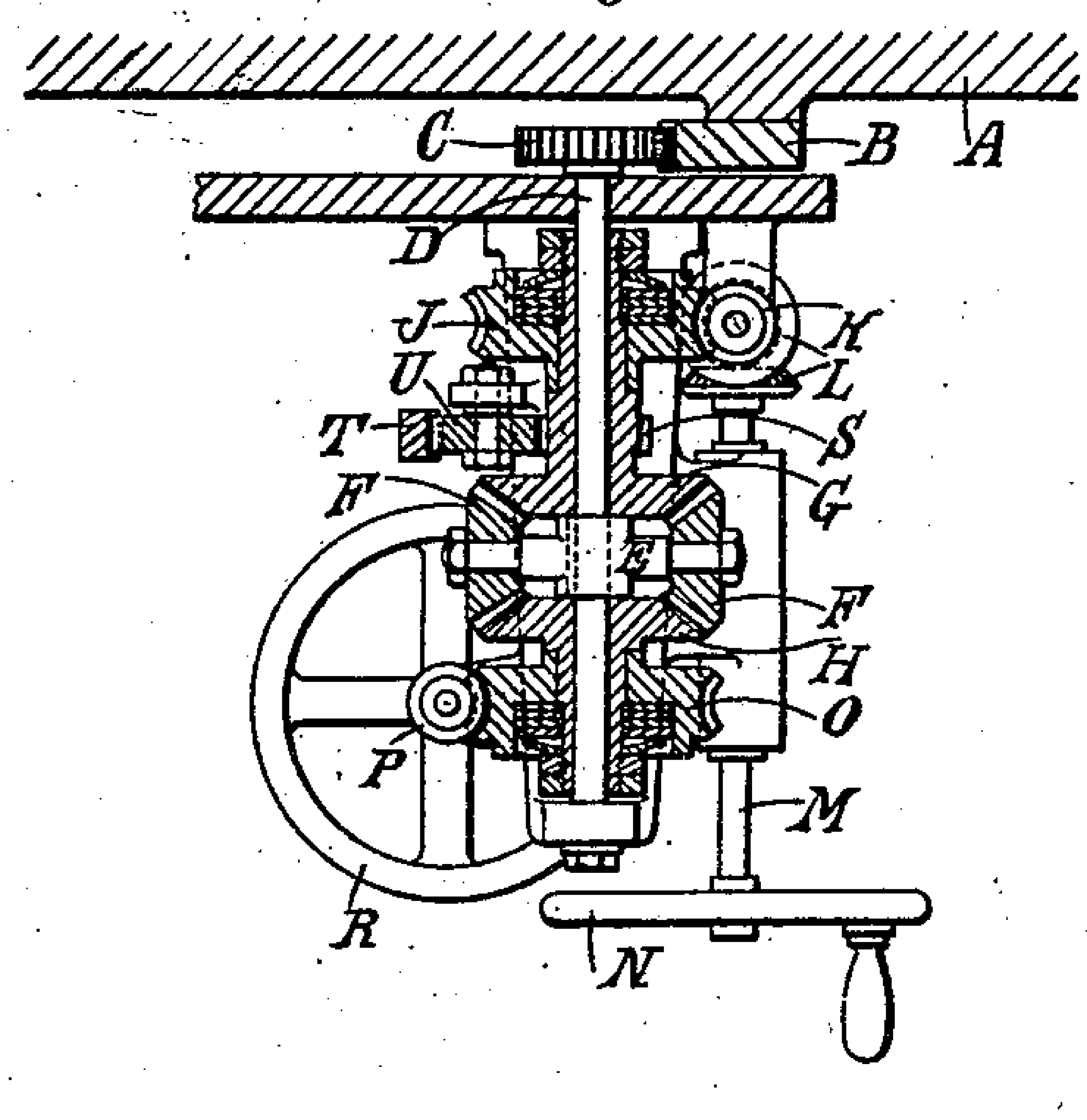

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Fig. 4.

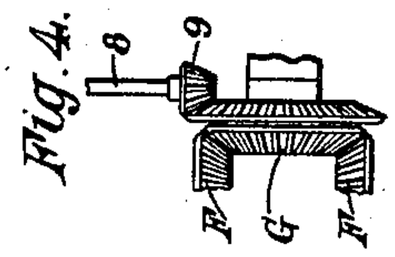
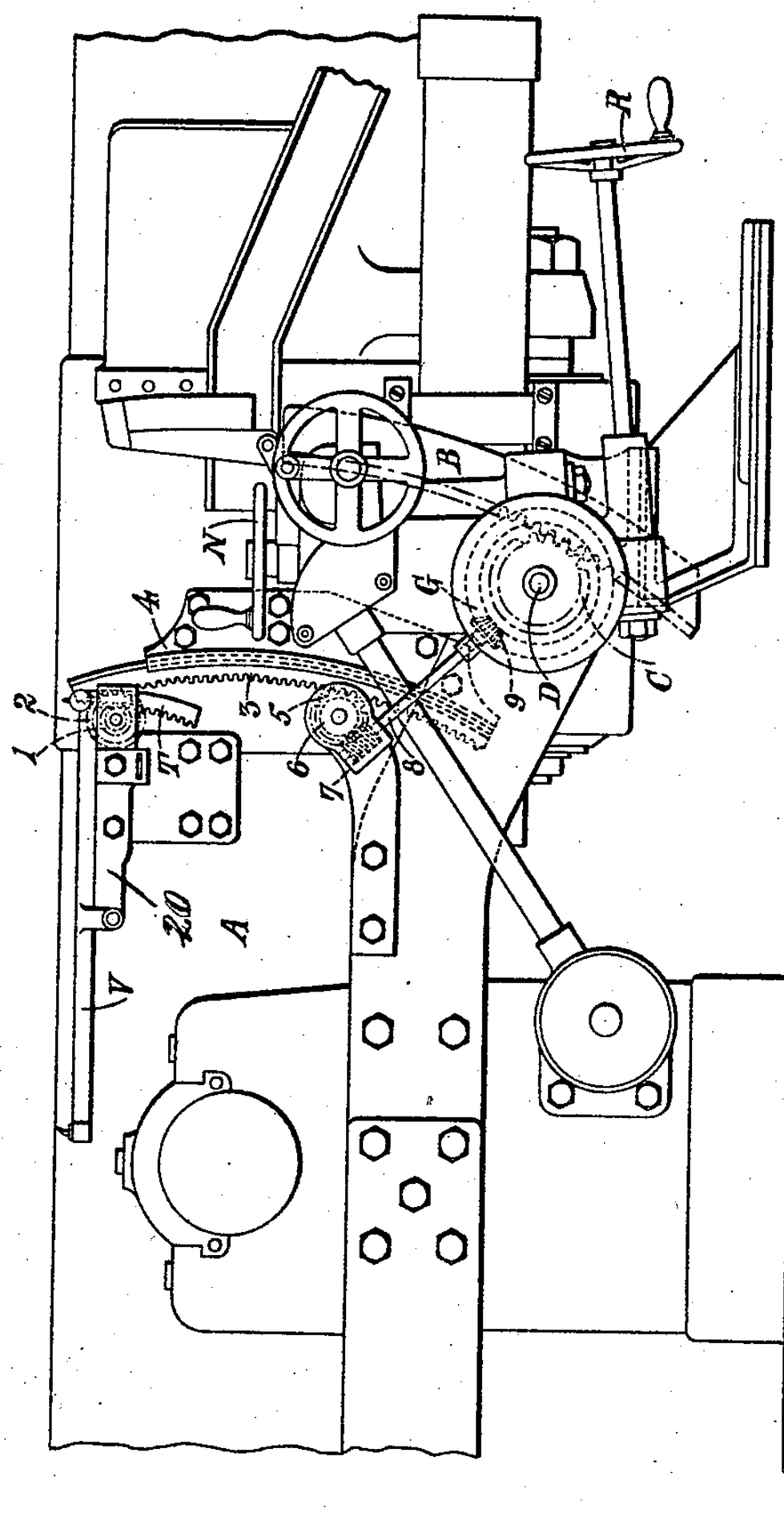


Fig. 3.



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(No Model.)

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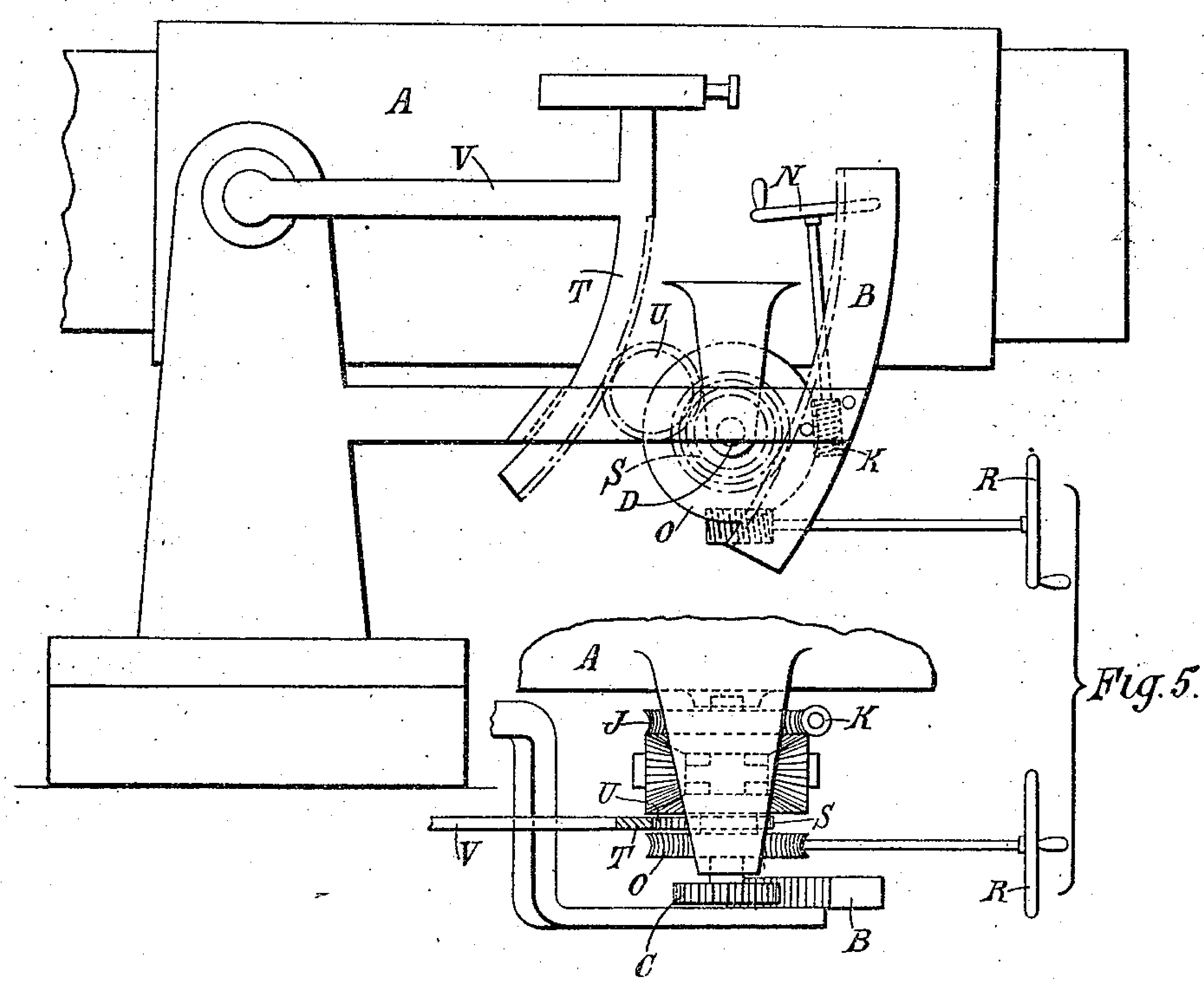

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(No Model.) 5 Sheets—Sheet 5.

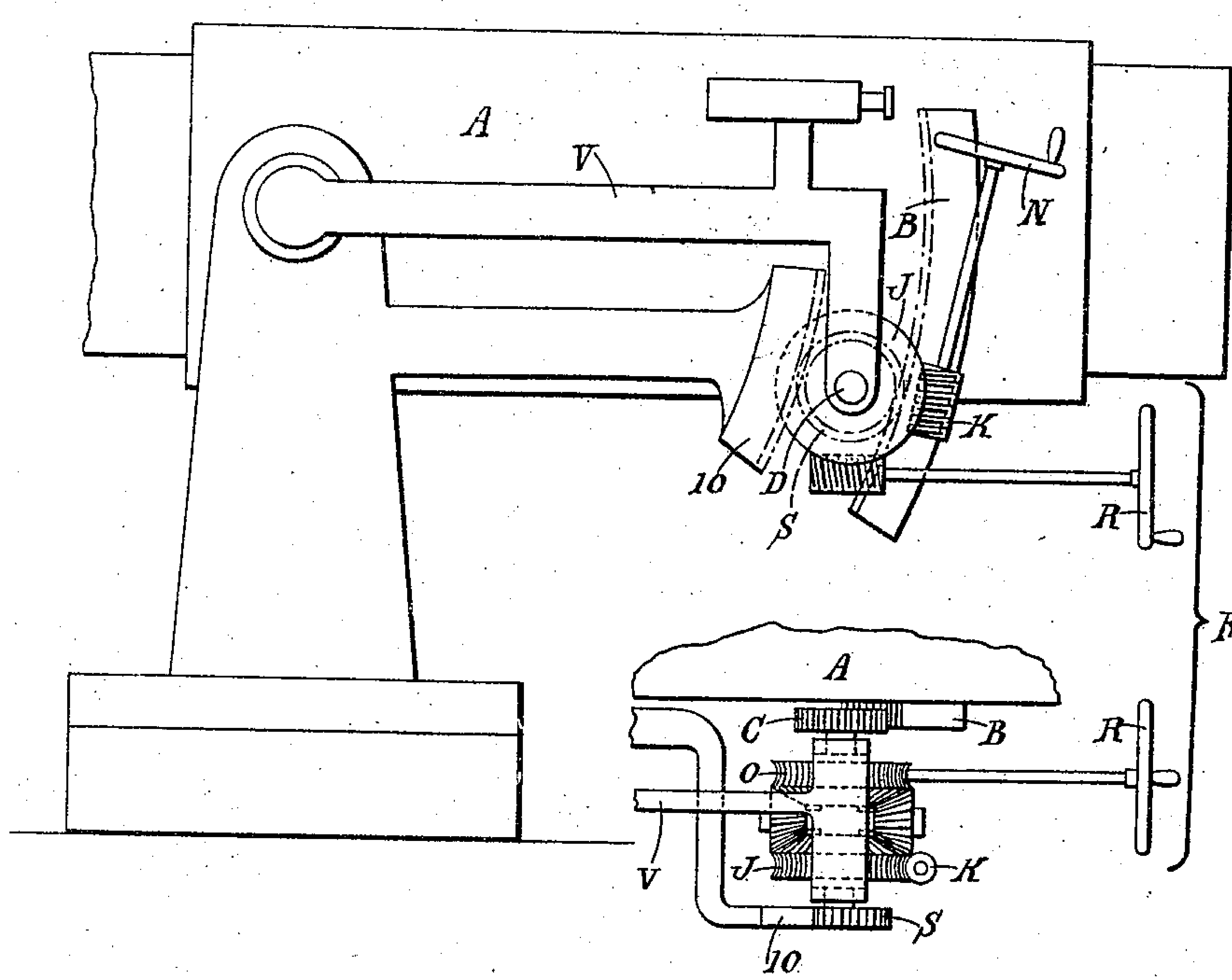

Fig. 6.

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UNITED STATES PATENT OFFICE.

HUBERT H. GRENFELL, OF HANTS, ENGLAND.

ELEVATING AND SIGHT-ADJUSTING GEAR FOR ORDNANCE.

SPECIFICATION forming part of Letters Patent No. 693,702, dated February 18, 1902.

Application filed July 15, 1901. Serial No. 68,396. (No model.)

To all whom it may concern:

Be it known that I, HUBERT HENRY GRENFELL, a subject of the King of Great Britain, residing at Hants, England, have invented certain new and useful Improvements in Elevating and Sight-Adjusting Gear for Ordnance, of which the following is a specification.

To insure the maximum of accuracy combined with rapidity in the fire of naval ordnance, the attention of the captain of the gun should be concentrated on the sole duty of discharging it as soon as his sights come in line with the object to be fired at. This being in itself a difficult and delicate task, demanding his undivided attention, any improvement in the direction of removing causes likely to disturb the captain is of the utmost importance, and any arrangements by which the other duties he is at present charged with and which distract his attention from his chief and all-important duty are removed tend directly to increase the accuracy and rapidity of his fire. With the arrangements heretofore in use in addition to firing his gun at the correct instant the captain of the gun has to alter his sights for every change of range (and the range under modern conditions of high speed at sea is in a state of continuous change) and also to conduct both the elevating and training of his gun. These are three distinct and separate operations, requiring the working of three different hand-wheels in three different places with one hand, the other hand having to be kept continuously on the firing-key, and since the captain's eye should never leave the sights he has to feel for the elevating and training hand-wheels. When, however, he is adjusting his sights his eye must necessarily be taken off the object, after which he has again to find his object and bring his gun to bear on it.

Now by my invention not only can the captain or firer keep his eye continuously along the sights, but whatever alterations is being made in the adjustment for change of range the rear sight does not move from his eye, and the alinement is therefore not altered. Moreover, as the operations for these changes are conducted by means of my improved gear independently of the firer it follows that he may keep his eye continuously along the sights while having one hand on the firing-key and the other on the elevating-wheel, neither hand being required to be moved from these positions.

By my invention I provide gear for adjusting the sights for range so constructed and arranged that the said gear operates to turn the gun with respect to the sights instead of, as heretofore, turning the sights with respect to the gun, so that the line of sight is not disturbed when making the change for range. This constitutes the chief feature of my invention. Further, I combine with this range-gear the gear for elevating and depressing the gun to bring the same to bear on the object to be fired at. Although these gears are combined and both operate to elevate and depress the gun, yet they work independently of each other and are controlled by separate hand-wheels, one of which is worked by the captain of the gun's crew, who has his eye applied to the sights, and the other of which—viz., that for effecting the adjustment for range—is worked by another member of the crew. The hand-wheels may be worked simultaneously as well as at different times, and in the former case they produce on the gun an aggregate or differential effect according to their direction of movement. The combination of the two gears is in some cases effected by a differential train of wheels, which constitutes another important feature of my invention. The sight-bar is pivoted in some cases at the trunnion and in others not at the trunnion, and in the latter case the motion of the actuating-gear is transmitted to the sights by means of a sliding arc.

In the accompanying drawings, which illustrate various modes of carrying my invention into practice, Figure 1 is a side elevation of a portion of a gun and of its mounting, showing my gear applied thereto. Fig. 2 is a section on the line *x x*, Fig. 1. Fig. 3 is a side elevation illustrating a modification hereinafter described. Fig. 4 illustrates a detail of construction of the differential train of wheels. Figs. 5 and 6 are diagrammatic representations in side elevation and plan of modifications hereinafter described.

Like characters of reference denote corresponding parts in the several figures.

Referring to Figs. 1 and 2, A is the gun. B is

the elevating-arc. C is the elevating-pinion, mounted on a shaft D, carried by fixed bearings on the mounting. On said shaft is arranged a differential gear, comprising a cross-arm E, fixed on the shaft D and carrying a pair of bevel-wheels F F, gearing with driving-wheels G H, attached to sleeves mounted loosely on the shaft. On the sleeve of the wheel G is mounted a worm-wheel J, adapted to be locked to said sleeve by a suitable friction device. To this worm-wheel is geared a worm K, which is driven through wheels L and shaft M by a hand-wheel N under the control of the captain of the gun for bringing the gun to bear on the object to be fired at without altering the sights relatively to the gun. On the sleeve of the wheel H is mounted a worm-wheel O, adapted to be locked to said sleeve by another friction device.

P is a worm gearing with the worm-wheel O and driven by a hand-wheel R under the control of a member of the gun's crew for adjusting the gun for range. The power of the hand-wheel gears above described may be arranged to suit any requirements.

S is a pinion fixed on the sleeve of the wheel G and gearing through an intermediate pinion U with a curved rack T, attached to the sight-bar V, which is pivoted on the trunnion W of the gun or about the same axis as the trunnion, the center of curvature of the rack T being the center of the trunnion. The velocity ratio of the pinion S and rack T is the same as that of the pinion C and elevating-arc B.

To elevate or depress the gun without altering the sight-bar relatively to the gun, the captain turns his wheel N in the required direction, thus turning the corresponding driving-wheel G of the differential gear, which imparts a rotary motion to the radial bevel-wheels F F of said gear. As the opposite driving-wheel H of the differential gear is meanwhile held fast by the worm P, the driving-wheel G causes the radial wheels F to roll on the stationary wheel H, thus turning the elevating-shaft D, the angular motion imparted to said shaft being half that of the driving-wheel G and in the same direction. The gun is thus elevated or depressed, as the case may be. At the same time by the pinion S above described the curved rack T is elevated or depressed with the gun, and the general result, therefore, is that the gun and sight are raised or lowered through the same angle without altering the adjustment of the sight-bar—*i. e.*, its relative position to the axis of the gun.

To alter the adjustment of the sights for an increase or decrease of range, the hand-wheel R, controlling the driving-wheel H of the differential gear, is turned in the required direction and a corresponding motion is given to the elevating-pinion C, the radial wheels F F in this case rolling on the driving-wheel G. This wheel G being held stationary by the worm K, no motion is given to the curved rack T, and consequently the gun turns, while the sight-bar remains stationary. It will be seen, therefore, that the very important advantage is gained of adjusting the gun for any alteration of range without disturbing the "line of sight"—that is to say, if the sight was prior to the change accurately "on" the object it will remain "on" during the change and be found "on" at its completion. Consequently the position of the eye of the firer remains the same during the adjustment.

To alter the adjustment of the sights for a variation in the range and at the same time to alter the elevation of the gun to bring the same on the object to be fired at, both hand-wheels N and R are worked simultaneously. The speed of both operations is entirely dependent on the speed with which the wheels are turned, and the motion of the gun is the sum or the difference of the motions imparted by the separate gears. No matter in which direction each wheel is being turned the power necessary for any given speed of adjustment is constant, the movement of one wheel having no effect on the power necessary to move the other. With gearing heretofore in use in such a case—*i. e.*, the range being altered while the gun is being relaid—either the relaying has to be stopped for the adjustment of the sights and the gun relaid subsequently or the gun is laid, the sights adjusted, and then the gun is relaid. With my new method of gearing the operation becomes a single one, and either motion may cease before the other without affecting the completion of the movement.

In the modification illustrated in Figs. 3 and 4 the sight-bar instead of being pivoted on the trunnion is pivoted on a bar 20, carried by the gun-cradle, and its curved rack T gears with a pinion 1, carried by the cradle and fixed to turn with a pinion 2, which gears with a curved rack 3, mounted with a capability of sliding in a curved guide 4, fixed to the cradle. The center of curvature of the rack 3 and of its guide is the trunnion of the cradle. 5 is another pinion geared to the rack 3 and fixed to rotate with a worm-wheel 6, gearing with a worm 7, fixed on a shaft 8, that is driven through a bevel-pinion 9 from bevel-teeth on the back of the wheel G of the differential train. The movements of the wheel G are thus conveyed to the curved rack 3 and thence to the sight-bar. The ratio of the radius of the elevating-arc B to that of the elevating-pinion C is the same as that of the curved rack 3 to its pinion 5 and also as that of the segmental rack T on the sight-bar to its pinion 2. Moreover, the gearing is so proportioned that the two pinions 2 and 5 rotate at the same speed as the elevating-pinion C. When the adjustment is being made for range, the wheel G, as in the first arrangement described, is held stationary, and consequently the rack 3 is locked, while the guide 4 moves with the cradle. The pinion 2 also moves with the

cradle, and consequently rolls on the stationary rack 3, thereby turning the sight-bar relatively to the gun-cradle through the same angle as that through which the cradle moves, but in the opposite direction. The angle of the sight-bar therefore remains constant during the change for range. On the other hand, when the wheel G is rotated by the turning of the captain's hand-wheel the gun-cradle and sight-bar turn in unison.

The connection of the gear with the gun and sight-bar can be varied in many ways, as illustrated, for example, in the diagrammatic views, Figs. 5 to 11.

In Fig. 5 the elevating-arc B is fixed to the mounting and the elevating and sight-adjusting gear is carried by the cradle.

In Fig. 6 the elevating-arc B is fixed to the cradle, as in the first-described arrangement; but the shaft D of the elevating and sight-adjusting gear is connected directly to the sight-bar, and the pinion S on the sleeve of the differential train is geared to a curved rack 10, fixed to the mounting.

The principal cause of a slow rate of fire in large guns is found in the constant relaying of the gun, demanded by the conditions of modern naval warfare, and the advantages are obvious of a system of gear by which the speed of carrying out these frequent alterations in laying the gun is largely increased and whereby the radical fault of the firer having frequently to remove his eye from his sights is entirely obviated. As an example, take the case of two ships passing at a high rate of speed. Assuming that the gun is loaded and laid on the extreme bow bearing, as soon as the enemy comes into view from the gun the captain of the gun alines the sights and fires. If the ship is steady, he need not touch the elevating-wheel again while the enemy is in view, although his sights are being constantly adjusted for change of distance. Similarly, if the ship is rolling and the amplitude of her roll is approximately uniform his first alinement is again sufficient throughout the whole run, and his whole attention can be devoted to firing his gun whenever the sights "roll on" or come in line with the object. It is evident that this is the only way to attain a maximum of accuracy and rapidity of fire.

What I claim is—

1. The combination with a gun and its mounting of pivoted sights, elevating-gear controlling said sights and gun together, other elevating-gear controlling the gun alone, an epicyclic train connecting these two gears, and means for actuating said train from either end, substantially as described.

2. The combination with a gun and its mounting of pivoted sights, two sets of gears for controlling the elevation of the gun and sights, hand-wheels for actuating said gears, and an epicyclic train of wheels connecting said gears, whereby they can be operated separately or together, substantially as described.

3. The combination with a gun and its mounting of pivoted sights, two sets of gears for controlling the elevation of the gun and sights, means for actuating said gears, an epicyclic train connecting said gears, a worm and worm-wheel at each end of the epicyclic train whereby as either worm is operated the train rolls on the corresponding stationary terminal gear so that the train may be operated from either end alone, or from both ends simultaneously, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

H. H. GRENFELL.

Witnesses:
GEO. HARRISON,
ALEXANDER W. ALLEN.