

Feb. 13, 1940.

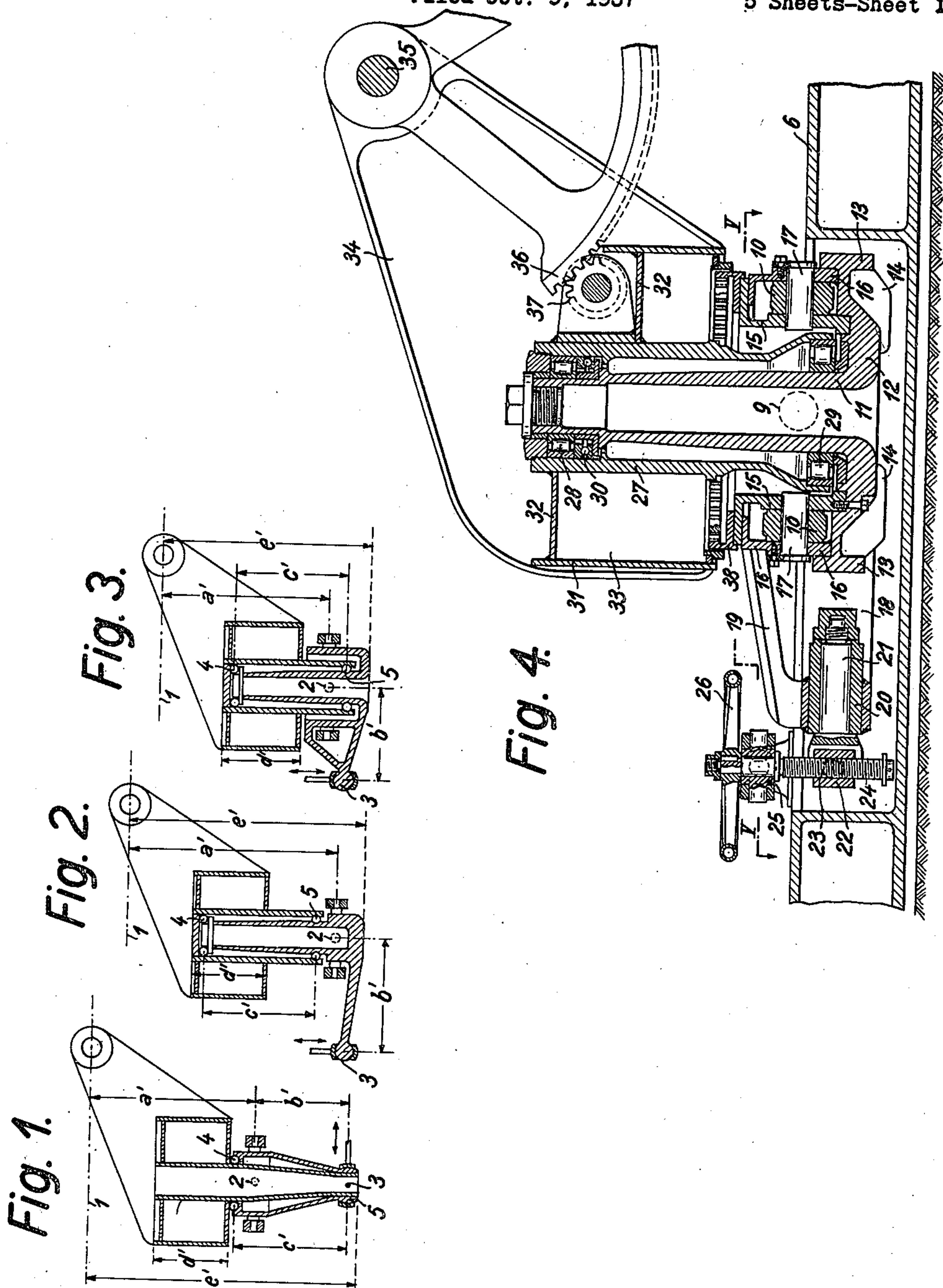
E. NUDING

2,190,332

PIVOT GUN

Filed Oct. 9, 1937

5 Sheets-Sheet 1



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Fig. 5.

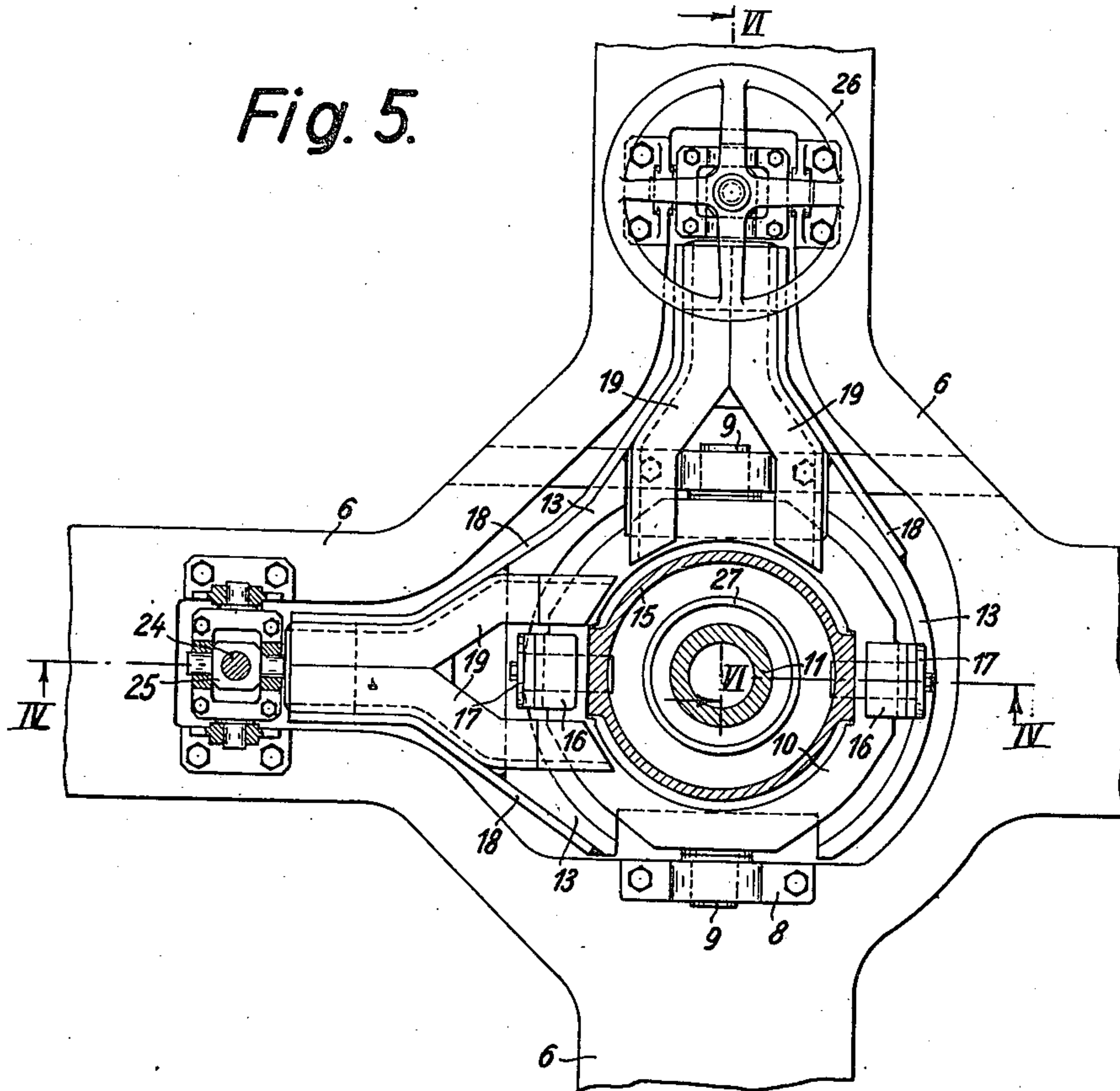
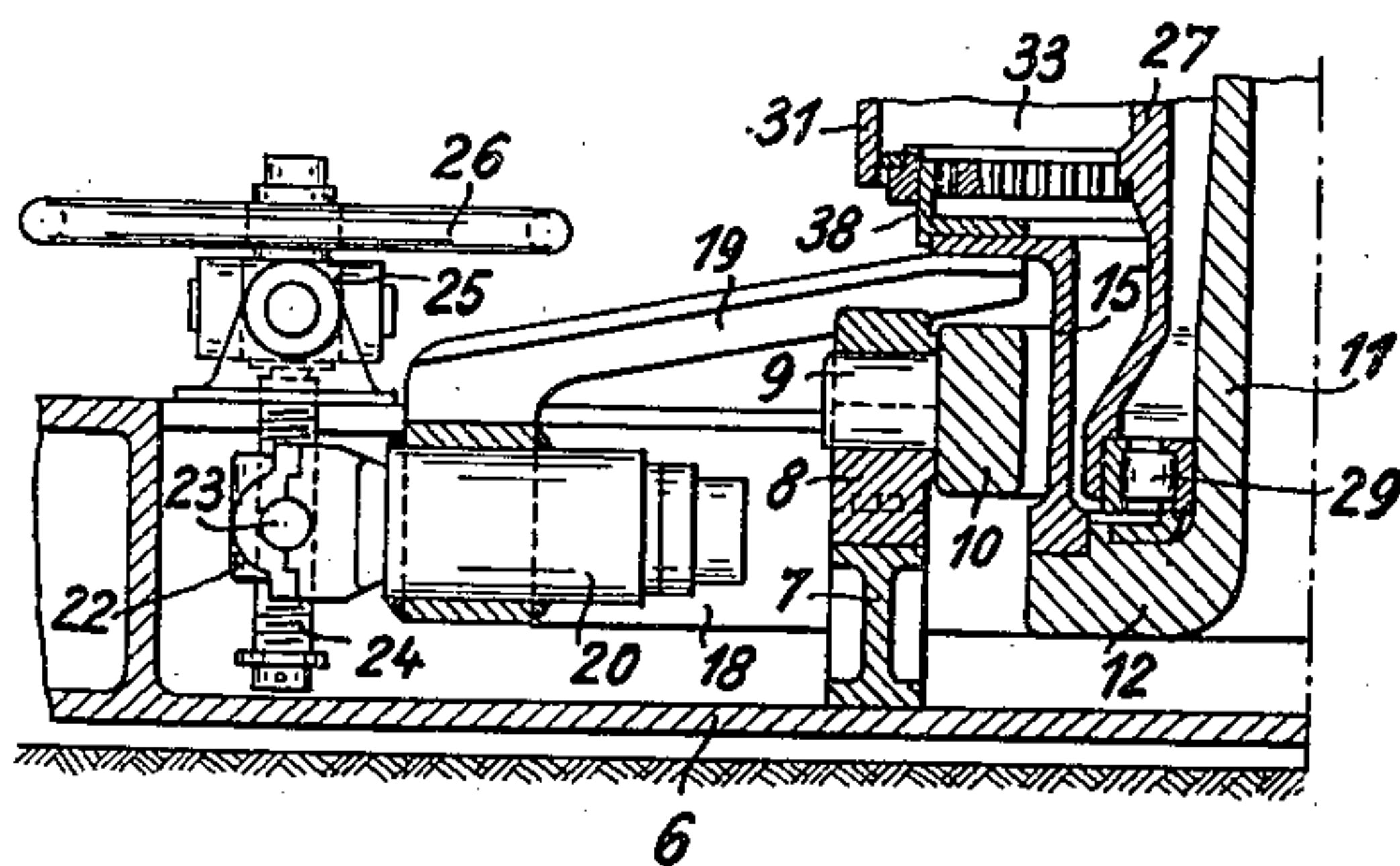


Fig. 6.



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Fig. 7.

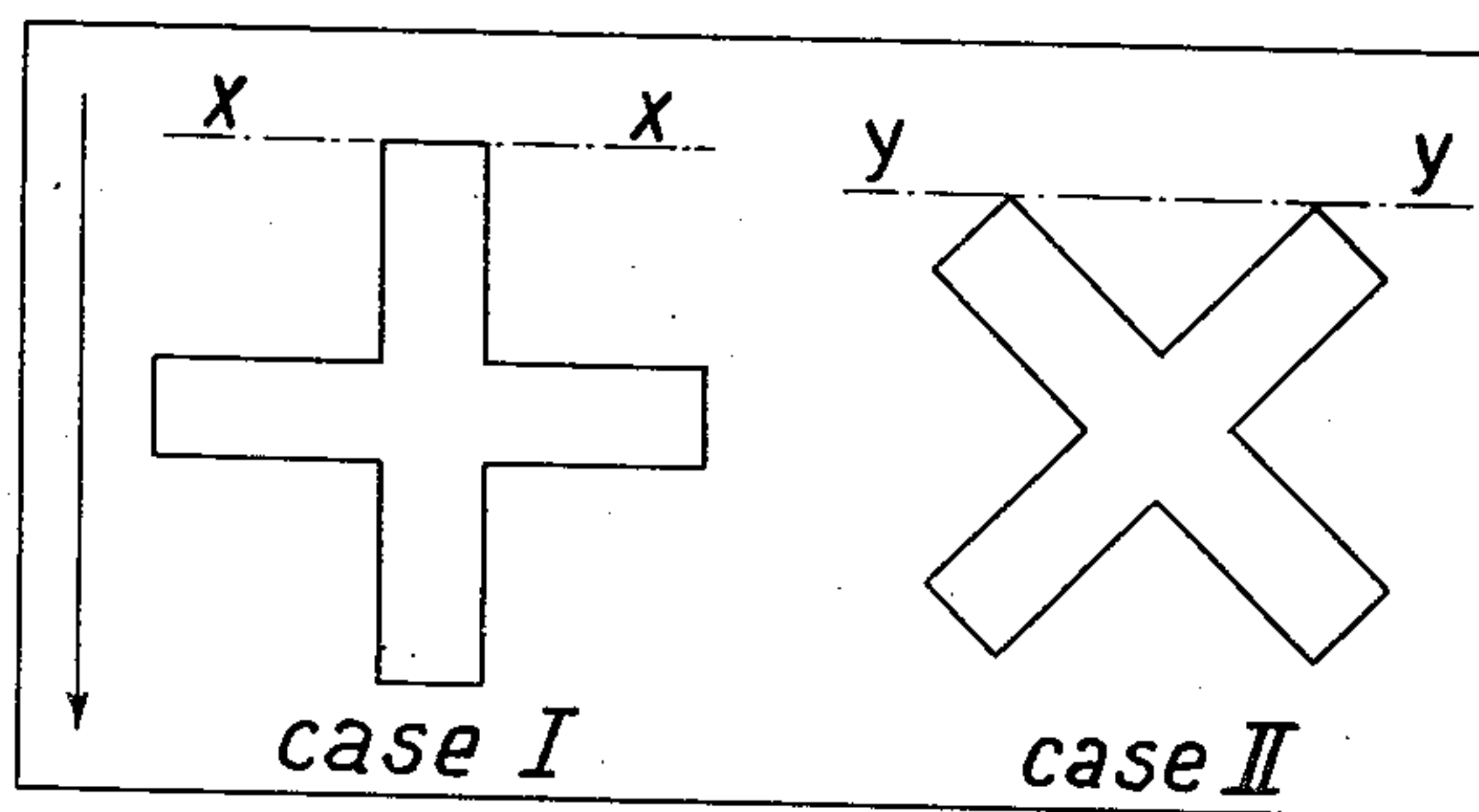


Fig. 8.

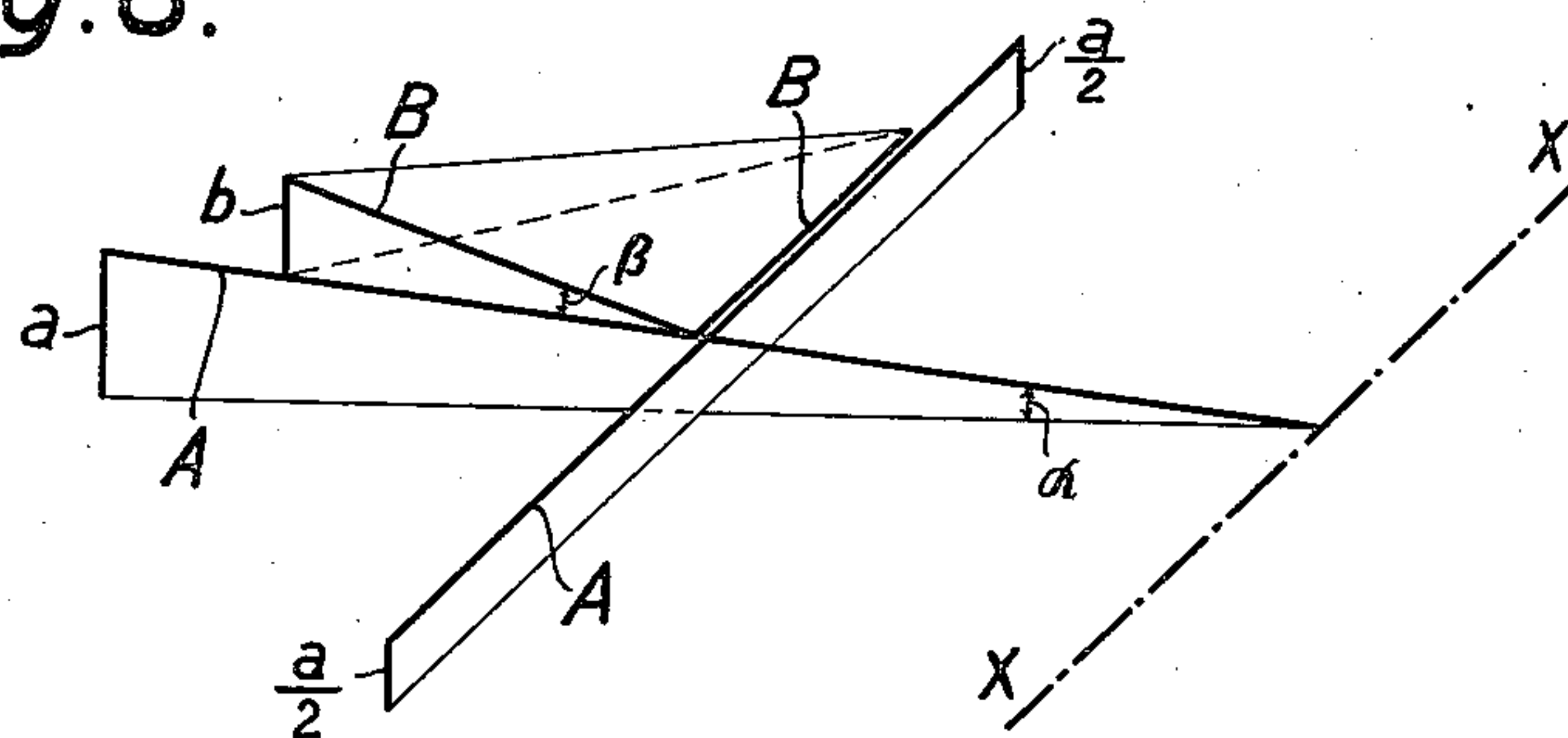
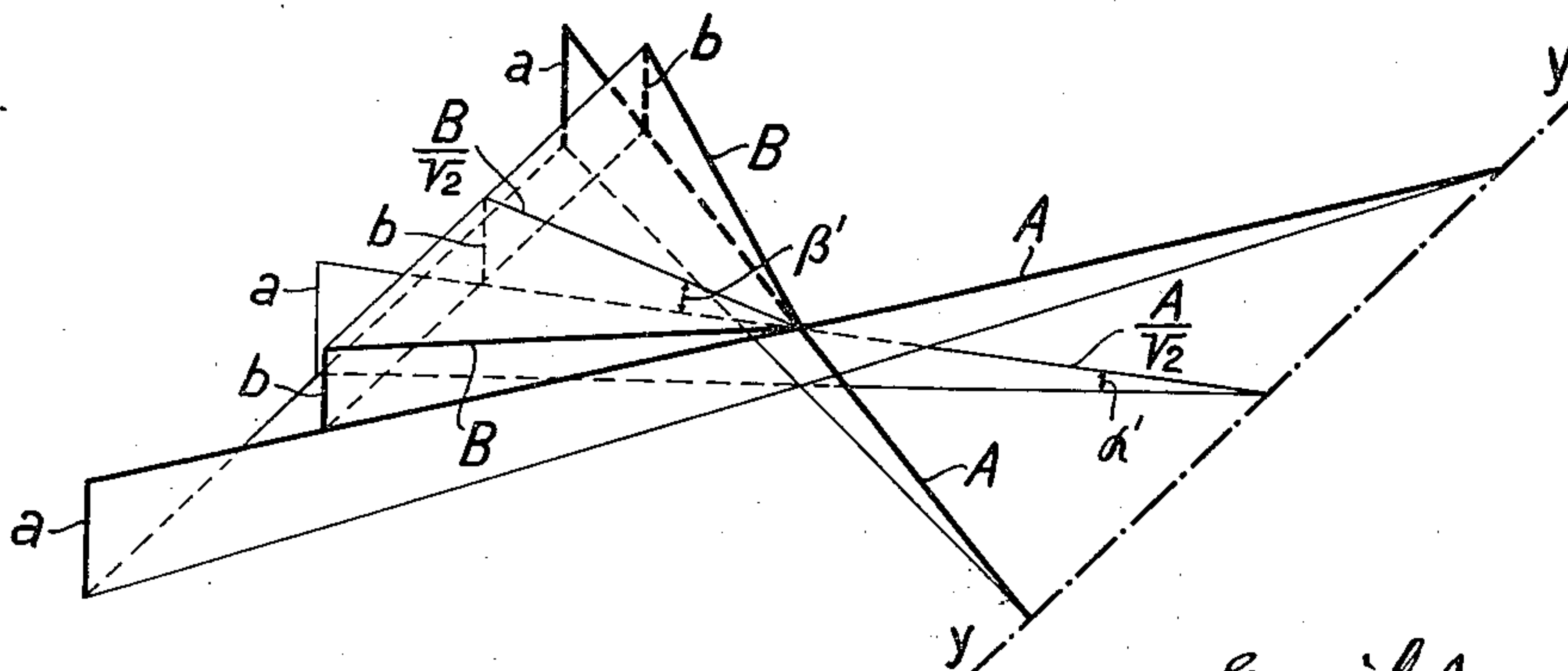


Fig. 9.



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Fig. 10.

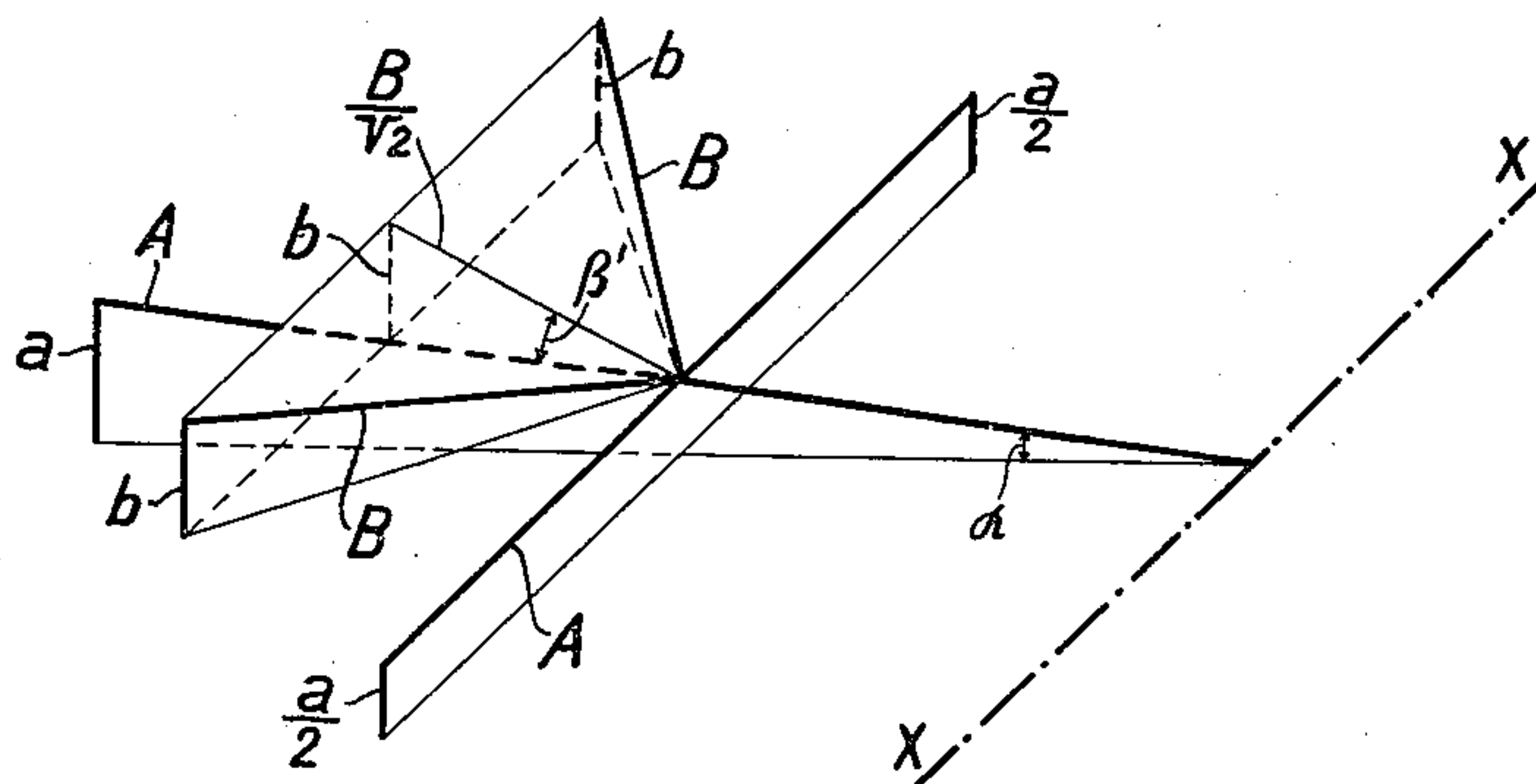
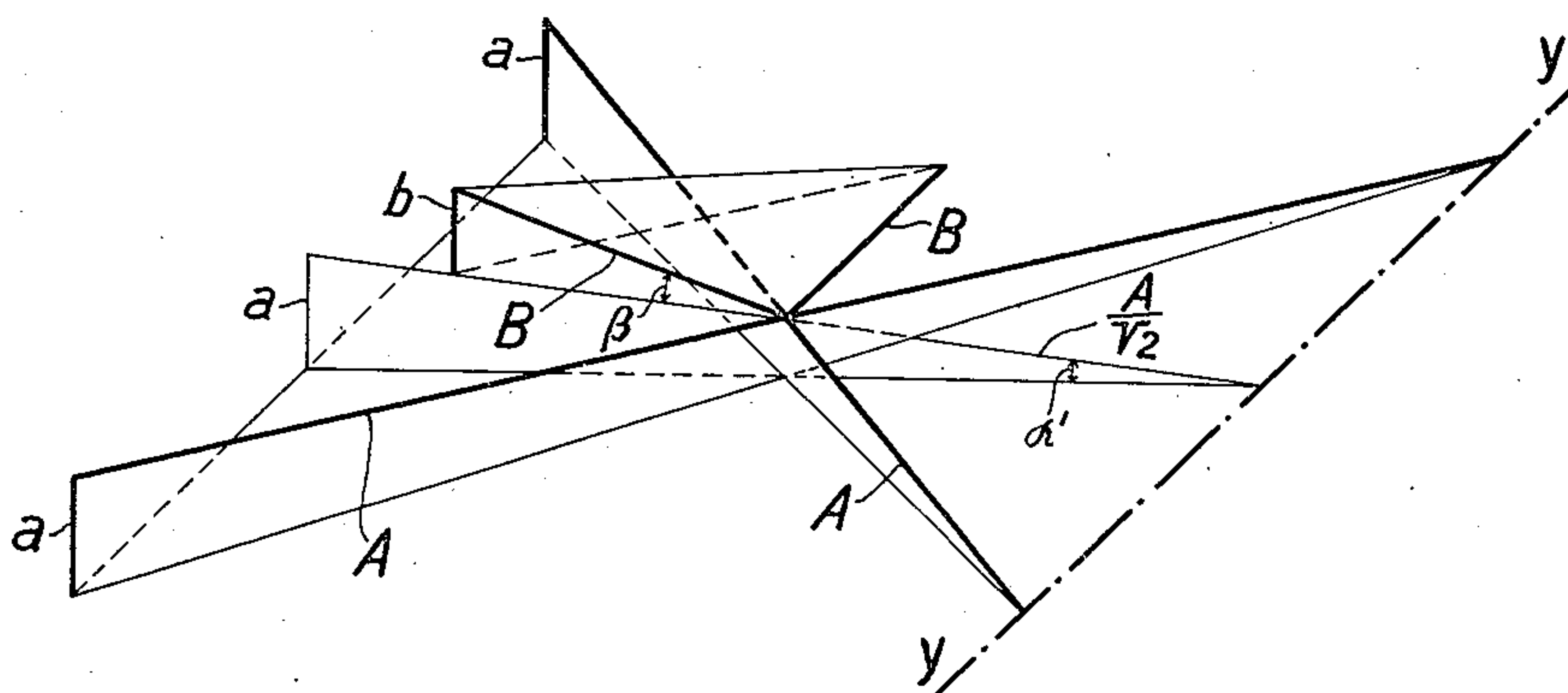


Fig. 11.



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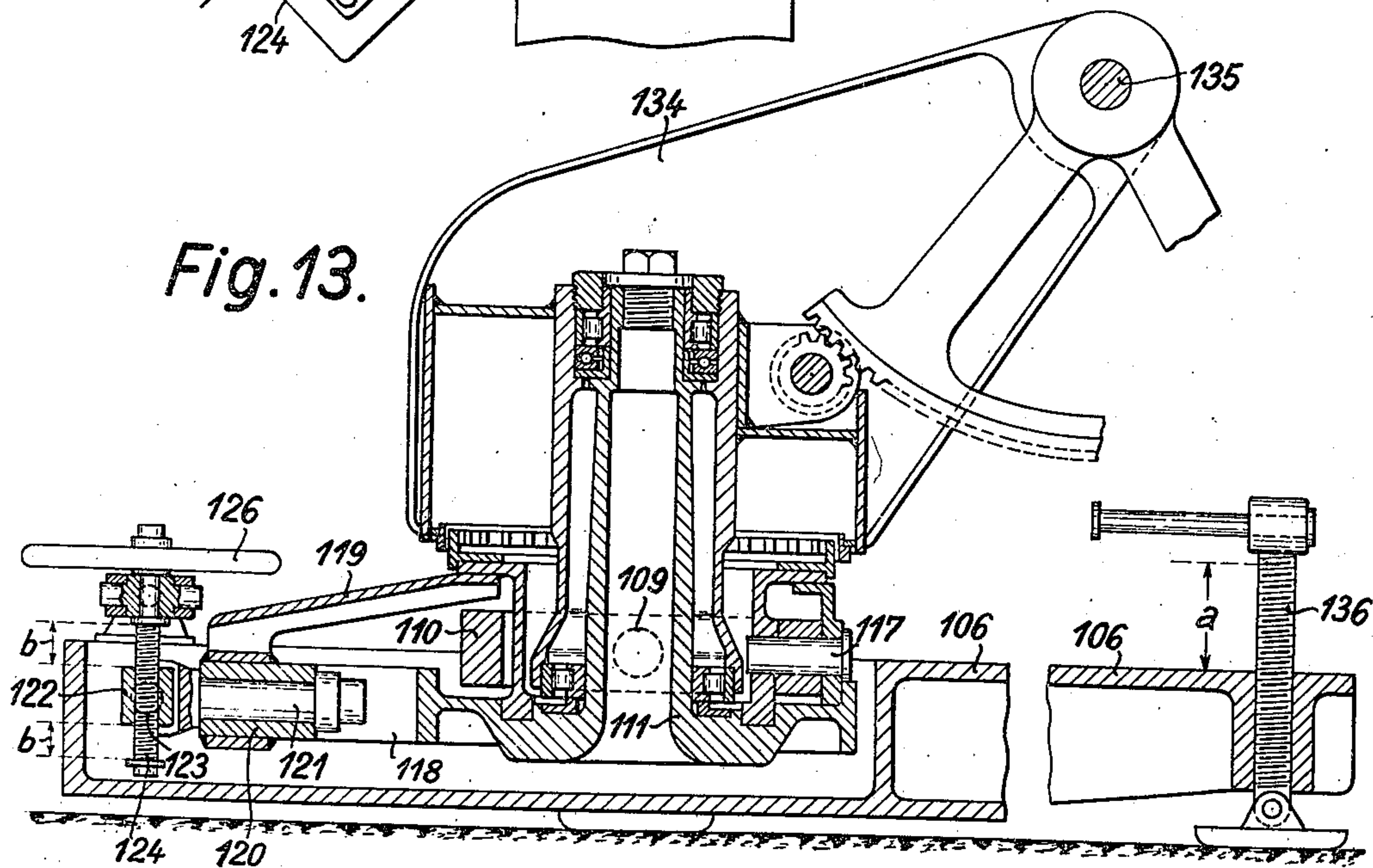
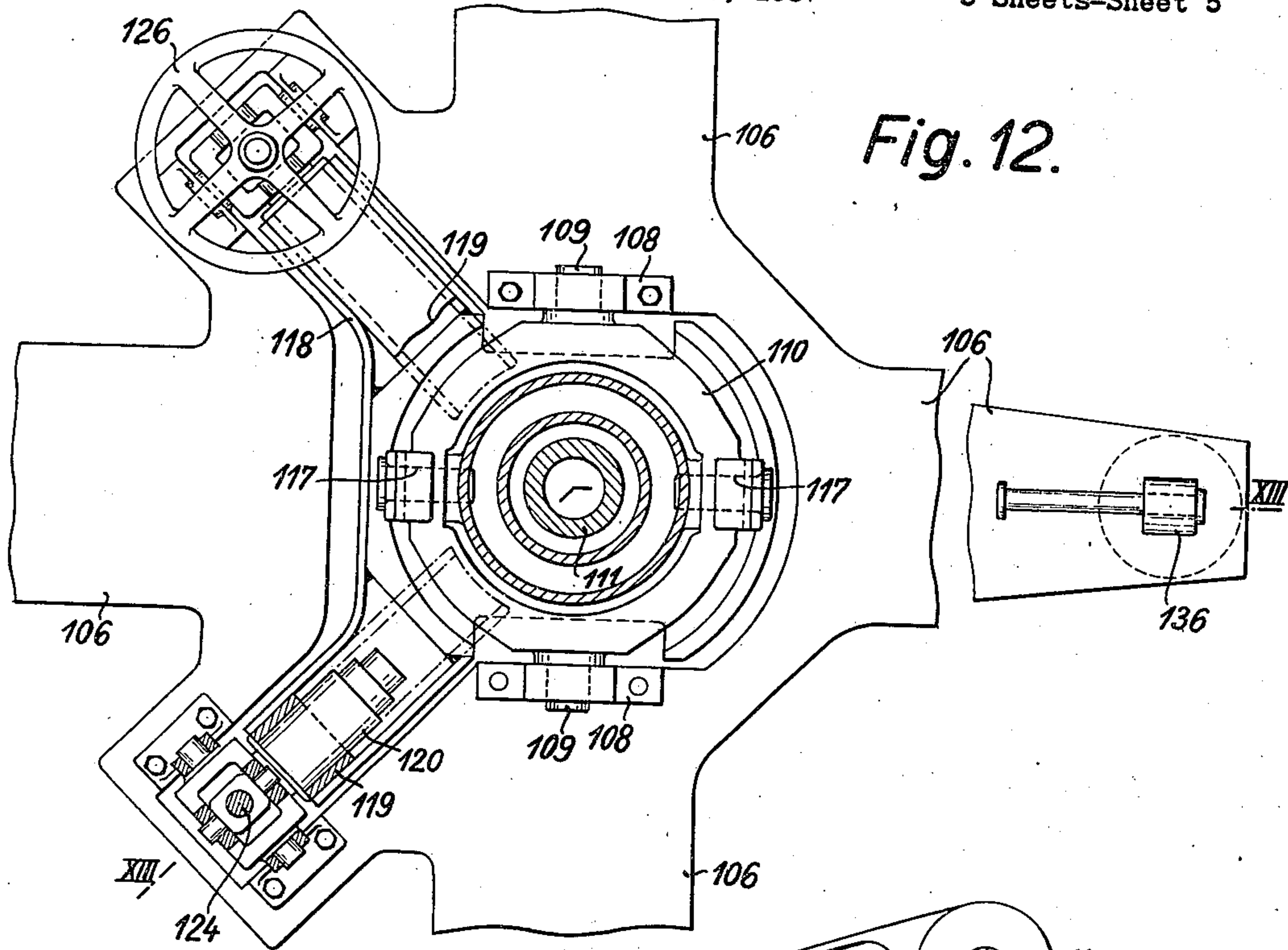
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PIVOT GUN

Filed Oct. 9, 1937

5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,190,332

PIVOT GUN

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Application October 9, 1937, Serial No. 168,149
In Germany October 21, 1936

8 Claims. (Cl. 89—40)

The present invention relates to a pivot gun in which the pivot carrying the upper carriage can be given an inclination relatively to the lower carriage, in order to adjust the pivot vertically in space.

In known guns of this class the upper carriage is rigidly connected to a pivot which from above projects into a pivot housing mounted on the lower carriage, the pivot being supported in the housing through the intermediary of a ball or Cardan joint. The lower end of the pivot, further, is adjustably mounted on the lower carriage. This construction suffers from the drawback of having a very great firing height.

The object of the present invention is a pivot gun, which has a notably smaller firing height and thus greater stability. This object is obtained by connecting the upper carriage to a sleeve which is mounted for rotation on a pivot, the latter, preferably near its lower extremity, being suspended from the lower carriage by means of a Cardan joint or the like and being provided at its lower extremity with lateral arms rigidly fixed to it and adjustably connected to the lower carriage.

The invention further provides that in any position of the lower carriage on the ground, which carriage advantageously is constructed as a cruciform carriage, the required angle of inclination to be given to the pivot is adjusted by means of shortest possible screw spindles, by displacing said lateral rigid sleeve arms by an angle relatively to two adjacent legs of the cruciform lower carriage, preferably by an angle of 45 degrees.

In order that the invention may be clearly understood and readily carried into effect, two embodiments of the same are illustrated by way of example in the accompanying drawings, in which

Figure 1 shows schematically the structure of a pivot gun carriage, with adjusting mechanism for the upper carriage, of the known type, whilst

Figures 2 and 3 show schematically two different structures of carriage according to the invention.

Figure 4 is a vertical section on line IV—IV, Figure 5, of a carriage forming the first embodiment corresponding to the structure according to Figure 3,

Figure 5 is a top view, partly in horizontal section on the line V—V of Figure 4,

Figure 6 is a vertical section on the line VI—VI of Figure 5,

Figure 7 is an illustration serving to disclose

the second embodiment and showing schematically two different positions of the cross carriage on the ground,

Figures 8 and 9 are perspective schematic views of the carriage of the first embodiment, in the two positions shown in Figure 7,

Figures 10 and 11 are perspective schematic views of the carriage according to the second embodiment, in the two positions of Figure 7,

Figure 12 is a top view, partly in section, of the carriage of the second embodiment, and

Figure 13 is a vertical section on the line XIII—XIII of Figure 12.

It may be seen from the schematic Figures 1 to 3, how the firing height e' of a gun is reduced by an arrangement according to the invention, without increasing the stresses acting upon the mechanism serving to adjust the carriage, and without changing, especially shortening, the bearing length of the pivotal upper carriage support necessary for a firm support of the upper carriage. The stress on the adjusting mechanism by the braking forces occurring upon the recoil of the gun barrel depends on the ratio of the distance a' of the axis 1 of the gun barrel from the point of suspension (Cardan joint) 2 of the parts adjustable relatively to the lower carriage, to the distance b' of this point of suspension 2 from the point of application 3 of the rotary adjusting mechanism. In the carriage structure according to Figure 2 the distance a' , true, is somewhat greater than in Figure 1, owing to the angular arrangement, however, the lever arm b' can be enlarged here to the same extent, without causing an increase of the firing height. It will be noted that the firing height e' in Figure 2 is lower than in Figure 1. By the special construction of the pivot according to Figure 3, however, the distance a' is notably reduced when compared with Figure 2 and thus the firing height e' is still further reduced.

For an exact positioning of the upper carriage on the lower carriage, owing to the play due to unavoidable clearance in the bearings, the long distance c' between the two bearings 4 and 5 is of importance. Furthermore, the height d' , which is available for the attachment of the walls of the upper carriage to the pivot or the sleeve, is important for the inner rigidity of the upper carriage. Both of these constructional items are chosen alike in all three schematic examples.

Constructional details of a carriage constructed according to modification, Figure 3 of the invention, are shown in Figures 4 to 6. In these figures, 6 denotes the lower, cruciform carriage

on which, by means of traverses 7, Figure 6, and bearings 8, the trunnions 9 of a Cardan ring 10 are supported. The pivotal column 11 on which the gun is slued has at its lower end an external flange 12 which is provided with axially-directed extensions 13, see Figure 4, and stiffening ribs 14. The flange 12 has fixed to it a short tubular piece 15, outwardly flanged at its upper end, and two angle irons 16, all of which elements together form the bearings on ring 10 for the two other trunnions 17, disposed 90° apart from trunnions 9 and by which pivotal column 11 is journaled in the Cardan ring 10. The pivot column 11 has further rigidly attached to it two radially extending arms which include an angle of 90° and are formed by vertical sheet metal plates 18 welded to the periphery of extensions 13 and by rigid angle iron braces 19 to the upper portion of tubular piece 15. These arms 18, 19 thus form each a fork, the two prongs of which are fixed to the column above and below the Cardan journal 9, 17, respectively. The walls 18 and angle irons 19 of each arm jointly support at their outer ends a sleeve 20, the sleeve of each arm having journaled in it a stud 21. This stud has a bifurcated outer end within which is supported on horizontal pivots 23 a threaded nut block 22. A threaded adjusting spindle 24 passes through the nut block 22 and is mounted in its turn for rotation in a block 25 Cardanically but non-shiftable suspended from the lower carriage. At the top the spindle 24 carries a hand wheel 26.

The upper carriage is mounted on the pivot 11 by means of a sleeve 27 and two antifriction bearings 28 and 29. A ball thrust bearing 30, further, takes up the weight of the upper carriage and of all parts carried by the latter. The upper carriage comprises a box 31 which by means of horizontal plates 32 and vertical plates 33 is connected to the sleeve 27. This box carries lateral carriage walls 34 on which are provided the bearings for the horizontal gun trunnions 35. The elevating gear of the gun is marked by the toothed arc 36 and pinion 37. Lateral training is effected by an internally toothed wheel 38 fixed on the flanged portion of tubular piece 15 and in mesh with a pinion (not shown) mounted on the upper carriage.

The tubular shape of the piece 15 which carries the Cardan journals 17 results in the possibility of a particularly rigid mounting of the adjusting arms 18, 19. The bifurcated form of these arms, see Figure 4, further notably increases their resistance to bending.

The hereinbefore described carriage constructed according to the invention shows, when compared with the known type of carriage, the further advantage, that the diameter of the internally toothed wheel 38 of the training mechanism can be made very large without interfering in any way with other parts of the carriage. The power for operating the carriage upon training, therefore, can be kept small.

In the following will now be described the second embodiment.

For better comprehension of the nature of the improvements obtained by this modification, the conditions prevailing in the embodiment just described, in which the axes of the legs 6 of the lower carriage coincide in the top view with those of the adjusting arms 18, 19, (Figures 8 and 9), may be compared in the following with the conditions prevailing in the modification represented in Figures 12 and 13, in which the axes of the legs of the lower carriage are displaced 45 de-

grees relatively to those of the adjusting arms (Figures 10 and 11).

It should be stated first, that there are two limit positions which a cruciform carriage can take on the ground. These two limit positions are illustrated in Figure 7, in which the ground is represented by a rectangle in which an arrow indicates the direction of the inclination of the ground. In the position denoted by "Case I" one axis of the legs of the lower carriage extends in the direction of the inclination while the other axis is normal thereto. In "Case II" both axes of the carriage legs are displaced 45 degrees relatively to the inclination direction of the ground. The axis about which the cross carriage can be turned relatively to the ground, in order to partly or wholly compensate the inclined position of the carriage is denoted in "Case I" by X—X, in "Case II" by Y—Y.

These two foregoing cases are investigated in the following for each of two embodiments, Figure 8 showing Case I and Figure 9 showing Case II for the first embodiment, whilst in Figure 10 is represented Case I and in Figure 11 Case II for the second embodiment. In these figures A, A denote the axes of the legs of the lower carriage and B, B the axes of the adjusting arms. The legs can be lifted (or lowered) in known manner each by the amount a by means of screw jacks provided on their outer extremity and the adjusting arms can be lifted (or lowered) from their middle position each by the amount b , by screw spindles, such as 24 in Figures 4 and 6 and 124 in Figure 13.

Case I in connection with the first embodiment will be considered first by reference to Figure 8. In this case turning of the carriage about the axis X—X is obtained by that leg which extends in the direction of the inclination, being lifted by the amount a , while the legs extending transversely of the former are lifted each by the amount

$$\frac{a}{2}$$

Therefrom results an inclined position of the plane of the legs relatively to the ground, the angle of which position can be calculated from tang

$$\alpha = \frac{a}{A}$$

Since very small angles always are dealt with in the present investigations, the angle itself is put in the following everywhere instead of the tangent. Thus the inclination is in Case I:

$$\alpha = \frac{a}{A}$$

In Case II, Figure 9, in which, when the carriage is to be turned about the axis Y—Y, the legs remote from this axis have to be lifted each by the amount a , the inclination α' , however, is greater, because to the same opposite cathetus a belongs now the adjacent cathetus

$$\frac{A}{\sqrt{2}}$$

the inclination thus assumes the value

$$\alpha' = \frac{a\sqrt{2}}{A}$$

The maximum inclination (α') that can be obtained with the given amount a thus does not lie, generally spoken, in the direction of the legs, as in Case I, but between the legs.

The same considerations apply also to the adjusting operation of the arms B, B. The inclined position obtainable by the amount b relatively to the plane of the legs is, in the direction of the adjusting arms:

$$\beta = \frac{b}{B}$$

in Figure 8, and is in the midst between the arms

$$\beta' = \frac{b}{B'} = \frac{b\sqrt{2}}{B} = \beta\sqrt{2}$$

in Figure 9.

Since in the first embodiment according to Figures 8 and 9 the axes of the legs A and those of the adjusting arms B coincide, seen in the top view, also the minimum values of the inclined positions obtained by adjusting the legs and by adjusting the adjusting arms ($\alpha + \beta$ in the direction of the legs in Case I, Figure 8) as well as the maximum values

$$(\alpha' + \beta' = \alpha\sqrt{2} + \beta\sqrt{2})$$

in the midst between the legs in Case II, Figure 9) coincide also. In other words, a greater inclination of the ground can be compensated with the first embodiment and with the carriage in the position of Case II, than with the position of Case I.

In the second embodiment, Figures 10 and 11, an angle α can be compensated, with the carriage in the position of Case I, by the carriage legs, and by the adjusting the arms an angle

$$\beta' = \beta\sqrt{2} \text{ together } \alpha + \beta\sqrt{2}$$

If the values of a and b are equal in both cases, thus a greater inclination of the ground can be compensated in the second embodiment with the carriage in the position of Case I than in the first embodiment.

Conditions are converse in Case II, Figure 11. In this case we can compensate with the second embodiment an angle

$$\alpha' = \alpha\sqrt{2}$$

by the carriage legs, but by the adjusting arms, only the angle β , together

$$\alpha\sqrt{2} + \beta$$

The inclination of the ground which can be compensated in Case II thus is smaller than with the first embodiment.

Now it is of importance in practice to provide that a determined limit value of the inclination of the ground can be compensated at any rate, for instance a limit value prescribed by the user, no matter in which position the carriage may be relatively to the ground, that is in the position of Case I, Case II or in an intermediate position. This limit value which is obtained at any rate by the amounts a and b , is $\alpha + \beta$ in the first embodiment,

$$\alpha + \beta\sqrt{2} \text{ or } \alpha\sqrt{2} + \beta$$

in the second embodiment. That means, that without alteration of the values a and b in the second embodiment the limit value is higher or that a determined limit value can be obtained by lower values of a and b (in practice a low value of b is dealt with), than in the first embodiment.

The screw spindles of the adjusting gear which determine the value b therefore can have a shorter operating length in the second embodiment than in the first one.

This second embodiment is illustrated in detail in Figures 12 and 13. It differs from the

first-described embodiment merely by the adjusting arms being angularly displaced relatively to the legs of the lower carriage. The latter is denoted by 106 and is formed again as a cruciform base comprising four legs. On the carriage 106 is mounted by means of bearings 108 and trunnions 109 the Cardan ring 110 in which the pivotal column 111 rests on trunnions 117. The column 111 has fixed to it two adjusting arms 118, 119 which include an angle of 90° and, seen from above, Figure 12, extend by 45° displaced relatively to the axes of the legs of the lower carriage. By sleeves 120 and studs 121 journaled therein, the arms 118, 119 are connected to nuts 122 adapted to turn on horizontal trunnions 123, see Figure 13. The nuts 122 in their turn are in engagement with screw spindles 124 which are Cardanically suspended from the lower carriage and are adapted to be actuated by hand wheels 126, all in the same manner as shown in and described with reference to Figures 4 and 5.

On the pivot column 111 is mounted, similar to Figure 4, through the intermediary of suitable antifriction bearings, the upper carriage 134, in which rest the horizontal trunnions 135 of the cradle (not shown) carrying the gun barrel. The free ends of the legs 106 of the carriage can be lifted and lowered in known manner by screw jacks 136.

What I claim and desire to secure by Letters Patent is:

1. In a gun carriage structure of the class described, a lower carriage and an upper carriage, a pivotal column Cardanically mounted at its lower end on said lower carriage, a supporting element connected with said upper carriage and disposed to surround and rotate on said column, two upwardly projecting lugs fixed at the lower end of said column and surrounding the lower part of said supporting element and carrying one pair of the journals of the Cardan mounting, two angularly-spaced radial arms attached to the lower end of said column, and means for adjustably connecting said arms to said lower carriage.

2. In a gun carriage structure of the class described, a lower carriage and an upper carriage, a pivotal column Cardanically mounted at its lower end on said lower carriage, a sleeve provided on said upper carriage and disposed to engage over and rotate on said column, an upwardly projecting annular element rigidly attached to the lower end of said column, said element surrounding the lower part of said sleeve and carrying one pair of the journals of said Cardan mounting, two angularly-spaced radial arms attached to the lower end of said column, and means for adjustably connecting said arms to said lower carriage.

3. In a gun carriage structure of the class described, a lower carriage and an upper carriage, a pivotal column Cardanically mounted at its lower end on said lower carriage, a sleeve provided on said upper carriage and disposed to engage over and rotate on said column, a training gear interposed between said upper carriage and said column for controlling the rotation of said carriage, an upwardly projecting annular element rigidly attached to the lower end of said column, said element surrounding the lower part of said sleeve and carrying one pair of the journals of said Cardan mounting and a toothed ring forming part of said training gear, two angularly-spaced radial arms attached to the lower end of said column, and means for adjustably connecting said arms to said lower carriage.

4. In a gun carriage structure of the class described, a lower carriage and an upper carriage, a pivotal column Cardanically mounted at its lower end on said lower carriage, a sleeve provided on said upper carriage and disposed to engage over and rotate on said column, two angularly-spaced radial arms attached to the lower end of said column, and means for adjustably connecting said arms to said lower carriage, each of said arms having bifurcated inner ends attached to said column, two of the journals of said Cardan mounting being arranged each between the points of attachment of said bifurcated ends of one of said arms to said column.
5. In a gun carriage structure of the class described, a lower carriage and an upper carriage, a pivotal column Cardanically mounted at its lower end on said lower carriage, a sleeve provided on said upper carriage and disposed to engage over and rotate on said column, an upwardly projecting annular element rigidly attached to the lower end of said column and surrounding the lower part of said sleeve and carrying one pair of the journals of said Cardan mounting, two angularly-spaced radial arms attached to said annular element, each of said arms consisting of two parts having bifurcated inner ends fixed to said annular elements, each journal of a pair of journals of said Cardan mounting being arranged between the four points of attachment of the bifurcated ends of one of said arms to said annular element, and means for adjustably connecting the outer ends of said arms to said lower carriage.
6. In a gun carriage structure of the class described, a cruciform lower carriage, means on the legs thereof for leveling said carriage with respect to the ground, an upper carriage, a pivotal column Cardanically mounted at its lower end on said lower carriage, a sleeve provided on said upper carriage and disposed to engage over and rotate on said column, two angularly-spaced radial arms attached to the lower end of said col-

umn, and means for adjustably connecting said arms to said lower carriage, each between two of the legs thereof.

7. In a gun carriage structure of the class described, a cruciform lower carriage, means on the legs of said lower carriage for leveling it with respect to the ground, an upper carriage, a pivotal column Cardanically mounted at its lower end on said lower carriage, a sleeve provided on said upper carriage and disposed to engage over and rotate on said column, two upwardly projecting lugs rigidly attached to the lower end of said column, said lugs surrounding the lower part of said sleeve and carrying one pair of journals of the Cardan mounting, two angularly-spaced and inwardly bifurcated radial arms attached to said lugs, each of said arms consisting of two arm elements having bifurcated inner ends fixed to said lugs, two of the journals of said Cardan mounting being arranged each between the four points of attachment of the bifurcated ends of one of said arms, the outer ends of said arms having means for adjustably connecting them to said lower carriage, each arm between two of the legs thereof, so as to form angles of 45° therewith.

8. In a gun carriage structure of the class described, a lower carriage and an upper carriage, a pivotal column and means for universally pivotally supporting said column at its lower end on said lower carriage to permit said column to tilt in all directions, a supporting element connected with said upper carriage and surrounding said column, said element having means disposed near its upper end and means disposed at its lower end and not higher than said column pivot means for rotatably supporting it by said column, and two angularly-spaced radial arms rigidly attached to the lower end of said column, and means for adjustably connecting said arms to said lower carriage to tilt said column a desired angle in any direction relatively to said lower carriage.

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