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Patented Feb. 25, 1902.

C. C. PROTHEROE.
RECIPROCATING ENGINE.

(Application filed Nov. 9, 1899.)

(No Model.)

2 Sheets—Sheet 1.

Fig. 3.

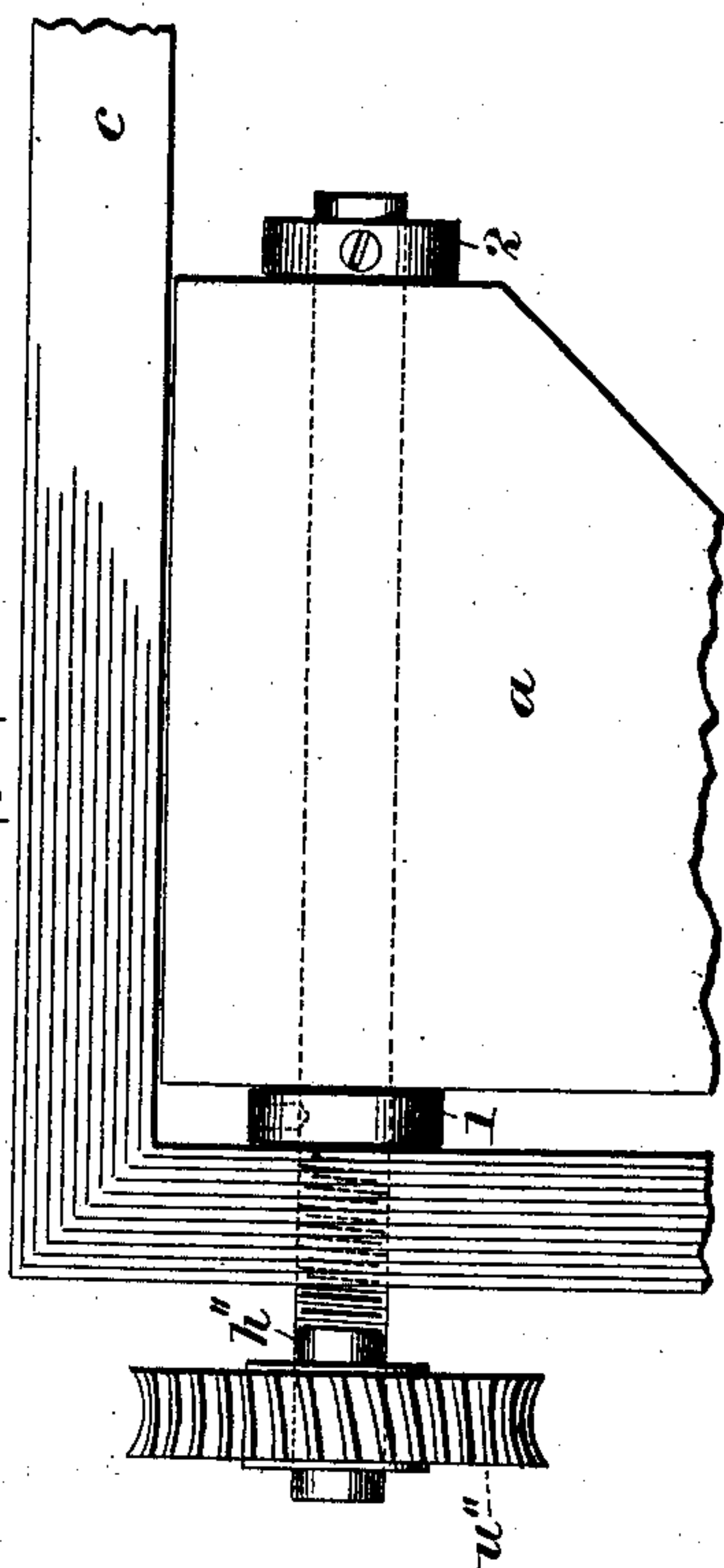
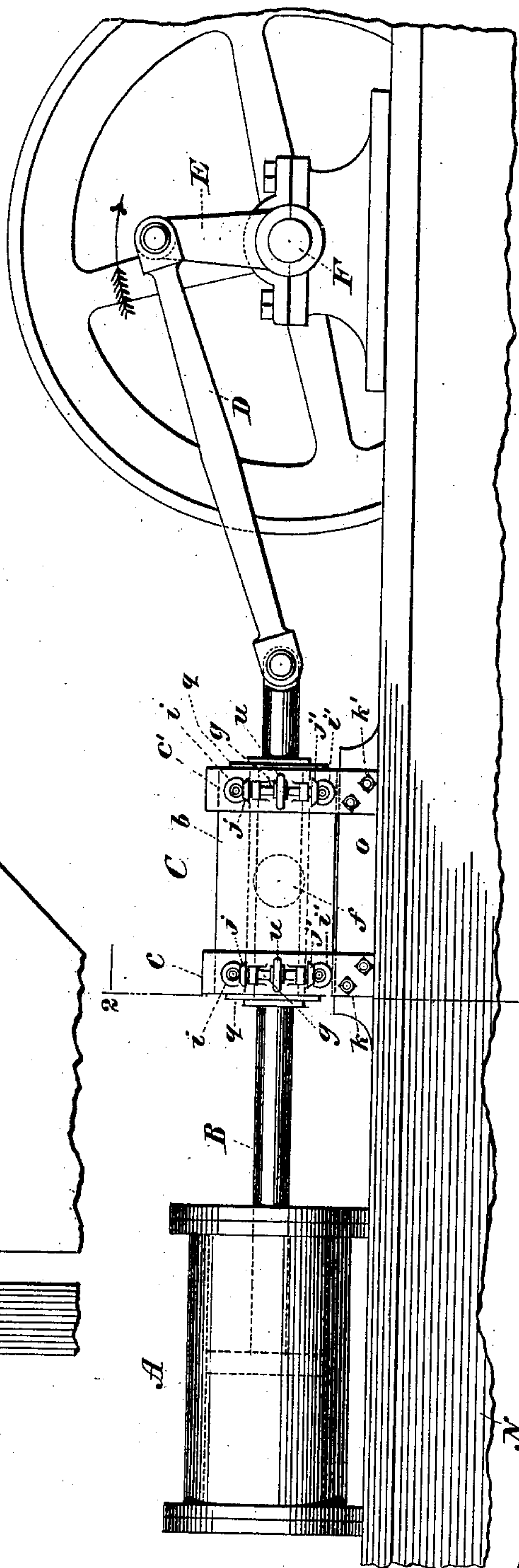


Fig. 1.



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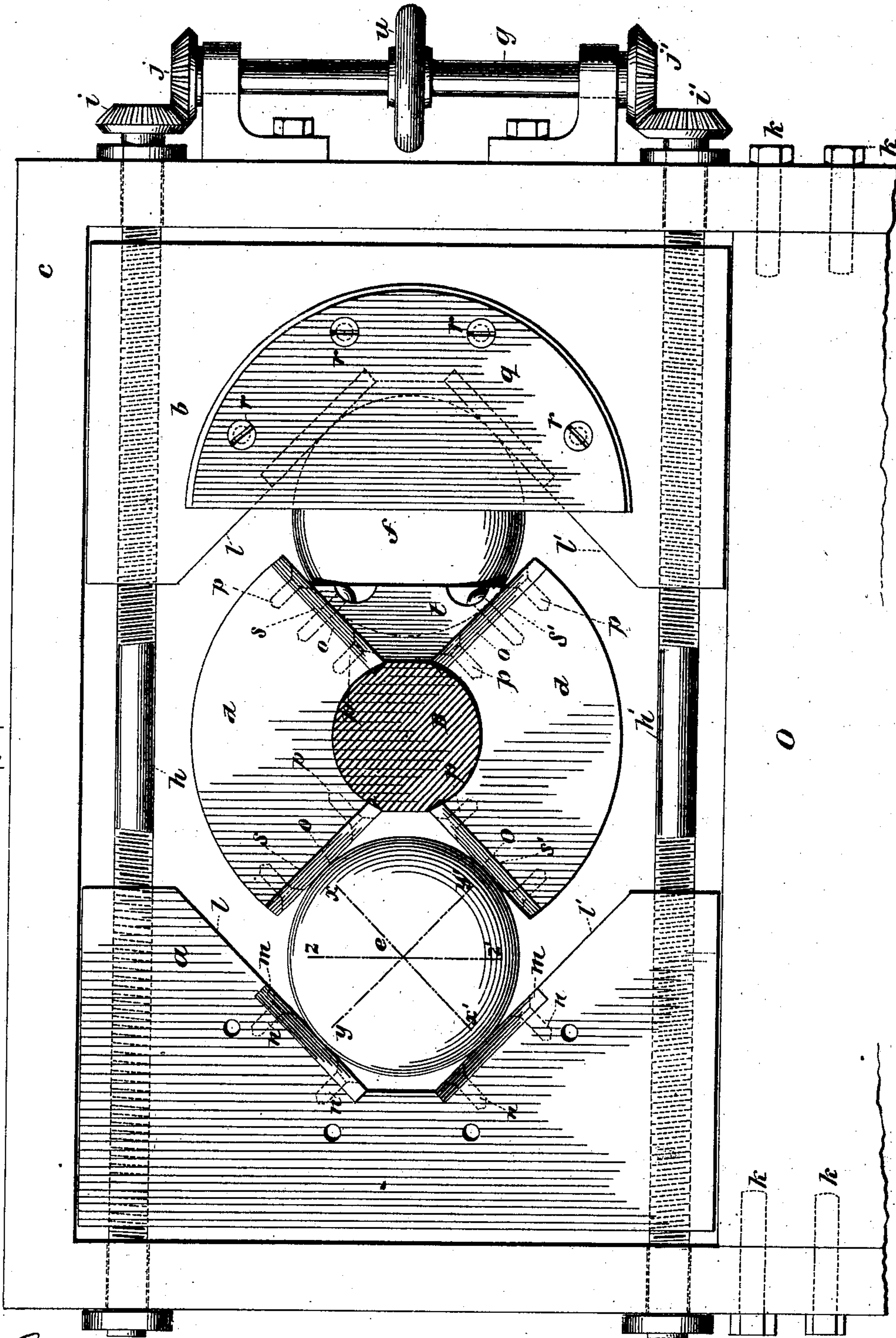
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2 Sheets—Sheet 2.

Fig. 2.



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RECIPROCATING ENGINE.

SPECIFICATION forming part of Letters Patent No. 694,076, dated February 25, 1902.

Application filed November 9, 1899. Serial No. 736,394. (No model.)

To all whom it may concern:

Be it known that I, CHARLES C. PROTHEROE, of Richmond Hill, borough of Queens, city and State of New York, have invented certain new and useful Improvements in Reciprocating Engines, of which the annexed is a specification.

My invention consists in combining with the reciprocating piston-rod of a reciprocating engine a ball-bearing, such ball-bearing consisting of two or more balls which, in combination with the cylinder, support and guide the piston-rod in its reciprocating movements and at the same time serve to reduce friction at the cross-head, of guideways in the piston-rod and supporting the balls of my bearing in contact with the piston-rod, wherein plane surfaces only contact with the balls, and, further, of means for adjusting the position of the balls simultaneously and uniformly with reference to the longitudinal axis of the reciprocating member and in the various other combinations set forth in the claims.

In the accompanying drawings, Figure 1 is a vertical section showing my ball-bearing slide in combination with the piston-rod of a horizontal reciprocating engine. Fig. 2 is a transverse section of the ball-bearing through the line 2 2 of Fig. 1, showing one form of adjusting-screws; and Fig. 3 shows another form of adjusting-screws with their collars.

Similar characters of reference indicate like parts.

A represents the engine-cylinder, B the piston-rod, C the cross-head with ball-bearing slide, D the pitman, E the crank, and F the crank-shaft, which may be of the usual and ordinary construction.

Upon the engine-bed N is the raised platform O, of suitable width and length to serve as a support for the ball-bearing slide. This platform O may form a part of bed N, or it may be secured thereto or supported by other suitable means.

I provide two guideways *a* and *b*, which rest upon the platform O, as shown. These guideways are retained by inverted-U-shaped holders *c c'*, one at each end of the guideways *a* and *b*, Fig. 1, and they serve to hold the guideways firmly against the platform O. The holders *c c'* are secured to the platform O by set-screws *k k* and *k' k'* or by any suitable

means. The guideways *a* and *b* are thus permitted a motion toward and away from each other, while at the same time firmly seated upon platform O. Other suitable means may be employed to seat the guideways which will permit of the desired movement. The piston-rod B is enlarged at *d*, as shown, where it passes between the guideways *a* and *b*, and its longitudinal axis is substantially parallel thereto.

In each guideway *a* and *b* is cut a groove formed by the plane faces *l* and *l'*, respectively. These faces are inclined at about ninety degrees to each other, respectively, and they are each inclined at about forty-five degrees to the surface of platform O, as shown. They extend the entire length of their respective guideways. In the enlarged part *d* of piston-rod B are cut similar grooves, one upon each side, as shown, formed by the plane faces *s* and *s'*, respectively, the planes of which are each parallel to the longitudinal axis of the piston-rod. These grooves each extend the entire length of the part *d*. They are upon opposite sides of the piston-rod, as shown, and when retained in position, as hereinafter described, by the balls *e* and *f* plane faces *l* and *s'* will be at all times substantially parallel to each other as piston-rod B reciprocates, as will also plane faces *l'* and *s*. Two balls *e* and *f*, preferably of hardened steel, are placed between the faces, as shown in Fig. 2. Thus faces *l l' s s'* at one side of piston B retain ball *e* and corresponding faces *l l' s s'* at the other side retain ball *f*. By such construction each ball bears against four plane surfaces. These four bearing-points are substantially in a vertical plane ninety degrees, or thereabout, removed from each other, respectively, as shown.

h h' are right and left threaded screws retained by collars on the sides of each of the holders *c c'*, as shown, and geared together by bevel-gears *i i' j j'* and shaft *g*, suitably supported on one side of holders *c c'*, Fig. 2. The shaft *g* is also provided with a hand-wheel *u*. Right and left threaded screws *h h'* pass through guideways *a* and *b*, which are threaded to receive them. It will be obvious that by turning hand-wheel *u* through the gear connection screws *h h'*, acting together, will cause guideways *a b* to approach or recede

from each other as desired and that faces l and l' of the guideways will advance balls e and f radially toward the longitudinal axis of piston-rod B. The advance of the balls toward the longitudinal axis of the piston by the mutual approach of the guideways at each end thereof above described will be uniform and will furnish ready adjustment for the ball-bearing, while aiding to retain the accurate adjustment of the piston-rod and also prevent the rotation of the piston-rod.

In Fig. 2 is shown plate q at the end of the guideway b . This has been removed from guideway a to show internal construction. I secure such a stop-plate as q at each end of each guideway a and b to prevent the escape of either ball e or f from its guideways. Obviously stop q may be constructed in various shapes and secured to the guideways a or b in different modes. The construction here shown is simple and aids in the assembling of parts. Set-screws r hold plate q in place. The plate q may be secured in position after the balls have been placed between their respective guideways. In Fig. 2 are also shown stops t , secured at the end of the right-hand groove in the piston-rod, as shown. This stop has been removed from the left-hand groove in that figure to show internal construction. I place such a stop as t at each end of each groove of the piston-rod. They serve to compel the assembling of the balls in substantially the same plane transversely to the path of the piston-rod at each end of each stroke, as hereinafter described. Obviously they may be of various shapes and secured to the piston-rod in different modes. They are arranged to pass freely between the guideways a and b with their stops q , as shown.

Instead of enlarging the piston-rod where it passes between the guideways in constructing the grooves formed by faces s and s' these grooves may be cut into the rod itself.

The operation of the device is as follows: In Fig. 1 I have shown the engine at mid-stroke, with crank-arm E at the highest point of elevation moving over from left to right, as shown by the arrow. In Fig. 2 I have drawn the dotted broken lines xx' , yy' , and zz' , each passing through the center of ball e , to represent the several axes upon which that ball may be caused to revolve in the operation of the device, as hereinafter described. It will be obvious that with a horizontal engine such as here shown the piston-rod B rests by its weight in a direction vertically downward upon both balls e and f and that in the absence of other forces operating to alter this condition as the piston-rod reciprocates balls e and f will be rolled by faces s of the piston against faces l' of the guideways a and b , and they will thus be in contact with and roll along both faces, and that the ball e , for instance, will therefore be caused to revolve substantially upon the line yy' as an axis. So long as the preponderance of pressure in the operation of the engine is verti-

cally downward substantially this same condition will continue. Thus the distance traveled by ball e , for instance, at the point of contact with face s will be substantially the same as the distance traveled by the opposite point of that ball in contact with face l' . By this means substantially no slipping of ball e is permitted. Should the preponderance of pressure be at any time in the operation of the engine vertically upward from any cause, it will be obvious that balls e and f will be rolled by faces s' of the piston-rod against faces l of the guideways, thus revolving substantially on the line xx' as an axis, and there will again be substantially an absence of slipping of the ball in its contact with either face. Should now the force generated in the operation of the device result in a preponderance of pressure in either direction laterally, then it will be obvious that ball e , for instance, should the lateral pressure bear against that ball, would be rolled by faces s and s' against faces l and l' substantially upon the line zz' as an axis and that the distances traveled by ball e at its points of contact with faces s and s' will be substantially the same as the distances traveled by the opposite points of that ball in contact with faces l and l' , and there will be again substantially an absence of slipping of the ball in its contact with all four faces. Where, as just described, a preponderance of pressure is exerted upon the ball e , ball f will be partially relieved from pressure and may be found to be loose and to lag behind. This loose ball will then be rolled or slid along by one of the stops t of the piston-rod as it reciprocates in order that the balls may be found in substantially the same plane transversely to the longitudinal axis of the piston-rod at each end of each stroke thereof. By this means the balls are always ready in position to begin a new stroke at the termination of the preceding stroke. If now in the position shown in Fig. 1 the pressure upon the balls be either vertically downward or upward, as the piston-rod advances from mid-stroke to the end of its stroke it will roll the balls e and f toward the right-hand end of the guideways. If, however, the pressure be lateral upon either ball, as the piston-rod advances that ball which receives the pressure will be rolled positively by the piston-rod to the right-hand end of its guideways and the loose ball will be positively pushed or slid by the stop t of the piston-rod also to the right-hand end of its guideways, where they meet stops q . Again, on the stroke from right to left, whether the pressure be upward, downward, or lateral, the balls will be rolled from the right toward the left along the guideways by the positive action of the piston-rod or by stops t to the left-hand end of their guideways, where they again meet stops q . The path of each ball is about one-half the length of the stroke of the piston-rod. The length of the guideways, as well as the length of the enlarged part d of the piston-

rod, is therefore to be arranged in view of the path of the ball and of its diameter, and I find that the better construction is one which provides sufficient length in guideways *a* and *b* that the balls may be rolled in each direction without being brought into actual contact with stops *q* at either end thereof. By proper use of adjusting-screws *h h'* practically all slipping of the balls in their contact either with the piston-rod or with guideways *a b* may be prevented and rolling friction provided to receive pressures at the cross-head substantially at all times. In combination with the cylinder my ball-bearing slide supports the piston-rod in its movements. Obviously more than two balls may be used in the device surrounding the piston-rod and provided with their respective guideways in the piston-rod and for the support of each ball, and these guideways may each be provided with plane surfaces for contact with the balls.

In Fig. 3 I show another means of adjustment whereby the pressure of each ball against the piston-rod is independently regulated. In that figure, *h''* is an adjusting-screw, shown at the upper side of one end of guideway *a*. It is to be understood that two such screws are placed at each side of inverted-U-shaped holders *c* and *c'* at top and bottom, respectively. They are threaded in part where they pass through the holders *c c'*, which latter are threaded to receive them, and they are smooth where they pass through guideways *a* or *b*. Two collars 1 and 2 are secured at the ends of the smooth part of each adjusting-screw externally guideways *a* and *b*, respectively, and in close proximity thereto. They serve to compel the motion of guideway *a* or *b* toward or away from the piston-rod when the set-screws are turned. *w'* is a hand-wheel placed at the end of each screw to enable them to be turned readily. Thus it will be obvious that either end of either guideway *a* or *b* may be adjusted nearer to or farther from the piston-rod and the pressure of ball *e* or *f* regulated. The proper adjustment of piston-rod may also thus be regulated.

In Fig. 2 are shown in section plates *m*, secured by set-screws *n* to faces *l* and *l'* of guideways *a* and *b*, respectively. Plates *m*, preferably of hardened steel, are placed in the position shown between the hardened ball and the softer material of the guideways to receive any impact of the balls and to afford greater resistance to wear and tear, thereby tending to preserve proper alinement of the parts. They extend throughout the length of faces *l l'*, respectively, and are of uniform width and thickness. Secured by set-screws *p* to faces *s* and *s'*, respectively, of piston-rod B are similar hardened plates *o*. Plates *o* extend throughout the length of faces *s s'*, respectively. These latter serve the same purpose as plates *m*, above described. Either may be renewed when de-

sired. Any other means may be employed to preserve the surfaces of faces *l, l', s,* and *s'* which will accomplish the desired object. 70

The device may obviously be applied to other reciprocating rods provided with such support as is afforded by the cylinder-head for the piston-rod. One of the advantages of the device is the reduction of friction. 75

I claim—

1. The combination with the cylinder of a reciprocating engine and its piston-rod of a ball-bearing for said piston-rod, means actuated by said piston-rod and constructed and operating to positively move the balls of said bearing over a path of definite extent corresponding to that of the path of said piston-rod, means for independently regulating the pressure between each of the balls of said bearing and said piston-rod, and means operated by said piston-rod for converting the reciprocating motion thereof into rotary motion, substantially as described. 80

2. The combination with the cylinder of a reciprocating engine and its piston-rod of a ball-bearing for said piston-rod, means for simultaneously and uniformly adjusting the pressure between the balls of said bearing and said piston-rod and means operated by said piston-rod for converting the reciprocating motion thereof into rotary motion, substantially as described. 85

3. The combination with the cylinder of a reciprocating engine and its piston-rod of balls in contact with said piston-rod, ways or guides respectively supporting said balls in said contact, means for simultaneously and uniformly adjusting said ways or guides nearer to or farther from said piston-rod, a pitman connected to said piston-rod and a crank-arm and crank-shaft connected to and adapted to be operated by said pitman, substantially as described. 90

4. The combination with the cylinder of a reciprocating engine and its piston-rod of balls in contact with said piston-rod, ways or guides borne by said piston-rod receiving said balls, means supporting said balls in said contact, means for independently regulating the pressure between each of said balls and said piston-rod, means actuated by said piston-rod and constructed and operating to positively move the balls of said bearing over a path of definite extent corresponding to that of the path of said piston-rod and means operated by said piston-rod for converting the reciprocating motion thereof into rotary motion, substantially as described. 95

5. The combination with the cylinder of a reciprocating engine and its piston-rod of balls in contact with said piston-rod, ways or guides borne by said piston-rod receiving said balls, ways or guides respectively supporting said balls in said contact, means for adjusting said last-named ways or guides nearer to or farther from said piston-rod and means operated by said piston-rod, means actuated by said piston-rod and constructed and operating to 100

positively move the balls of said bearing over a path of definite extent corresponding to that of the path of said piston-rod for converting the reciprocating motion thereof into rotary motion, substantially as described.

6. The combination with the cylinder of a reciprocating engine and its piston-rod of balls in contact with said piston-rod, ways or guides substantially parallel to the path of and borne by said piston-rod receiving said balls, ways or guides respectively supporting said balls in said contact, means for simultaneously and uniformly adjusting said last-named ways or guides nearer to or farther from said piston-rod, means actuated by said piston-rod and constructed and operating to positively move the balls of said bearing over a path of definite extent corresponding to that of the path of said piston-rod and means operated by said piston-rod for converting the reciprocating motion thereof into rotary motion, substantially as described.

7. The combination with the cylinder of a reciprocating engine and its piston-rod of ways or guides borne by said piston-rod, plane surfaces parallel to the path of reciprocation of said piston-rod on the ways or guides thereof for contact with the balls, balls in contact therewith, means supporting said balls in said contact and means operated by said piston-rod, means actuated by said piston-rod and constructed and operating to positively move the balls of said bearing over a path of definite extent corresponding to that of the path of said piston-rod for converting the reciprocating motion thereof into rotary motion, substantially as described.

8. The combination with the cylinder of a reciprocating engine and its piston-rod of ways or guides borne by said piston-rod, plane surfaces parallel to the path of reciprocation of said piston-rod on the ways or guides there-

of for contact with the balls, balls in contact therewith, ways or guides respectively supporting said balls in said contact, plane surfaces on said last-named ways or guides substantially parallel to the path of reciprocation of the piston-rod for contact with said balls, means for adjusting said last-named ways or guides nearer to or farther from said piston-rod and means operated by said piston-rod for converting the reciprocating motion thereof into rotary motion, substantially as described.

9. The combination with the cylinder of a reciprocating engine and its piston-rod, ways or guides borne by said piston-rod, plane surfaces parallel to the path of reciprocation of said piston-rod on said ways or guides for contact with the balls, balls in contact therewith, ways or guides respectively supporting said balls in said contact, plane surfaces on said last-named ways substantially parallel to the path of reciprocation of said piston-rod for contact with said balls, means for simultaneously and uniformly adjusting said last-named ways nearer to or farther from said piston-rod and means operated by said piston-rod for converting the reciprocating motion thereof into rotary motion, substantially as described.

10. The combination with the cylinder of a reciprocating engine and its piston-rod B, of faces s, s' , plates o, o' , secured thereon, ball e , faces l, l' , plates m, m , secured thereon, guideway a , means sustaining said guideway in supporting said ball against said rod and means of adjusting said guideway nearer to or farther from said rod, substantially as and for the purposes described.

CHAS. C. PROTHEROE.

Witnesses:

JOHN TOBIN,
JAMES G. K. LEE.