W. F. GOODWIN & E. F. ROBERTS.

Mechanism for Converting Reciprocating into Rotary Motion.

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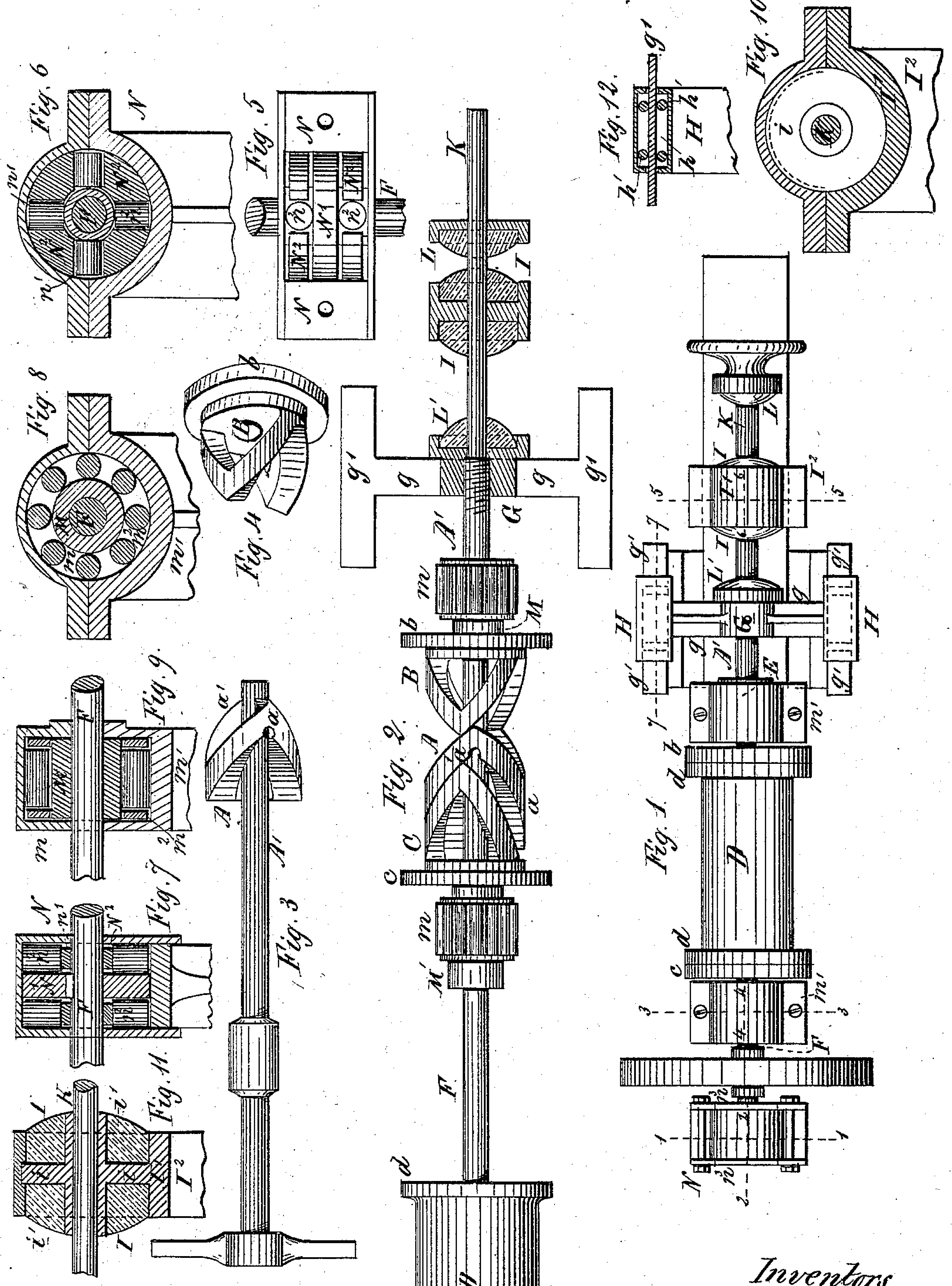

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WILLIAM F. GOODWIN AND EDWARD F. ROBERTS, OF NEW BRUNSWICK, N. J.

IMPROVEMENT IN MECHANISMS FOR CONVERTING RECIPROCATING INTO ROTARY MOTION.

Specification forming part of Letters Patent No. **214,645**, dated April 22, 1879; application filed March 23, 1879.

To all whom it may concern:

Be it known that we, WILLIAM FARR GOODWIN and EDWARD FITZGERALD ROBERTS, both of the city of New Brunswick, in the county of Middlesex and State of New Jersey, have invented a new and useful Mechanism for Transforming Rectilinear Reciprocating Motion into Rotary Motion, of which the following is a specification.

In the accompanying drawings, Figure 1 is a plan view of the apparatus embodying our invention. Fig. 2 is a like view, partly in section, the cylinder and bearings being removed to show the operating mechanism and anti-friction-bearings and lever or cross-head. Fig. 3 is a like view of the driving or reciprocating spiral planes. Fig. 4 is a perspective view of one of the rotating spiral planes. Fig. 5 is a plan view of the bearings which resist the end-thrusts, with the cap or cover removed. Fig. 6 is a section of the same on line 1 1 of Fig. 1. Fig. 7 is a like view on line 2 2 of Fig. 1. Figs. 8 and 9 are transverse and longitudinal sections of the anti-friction-bearings taken, respectively on lines 3 3 and 4 4 of Fig. 1. Figs. 10 and 11 are transverse and longitudinal sections of the stationary buffer-bearing, taken on lines 5 5 and 6 6 of Fig. 1, respectively. Fig. 12 is a section of the anti-friction bearing of the arms of the lever G.

The production of a mechanical movement which will transform rectilinear reciprocating motion into rotary motion without leaving the working parts ineffective during a portion of the time, as is the case with the crank when passing its dead-points, has long been sought, and, as we believe, to the present time without satisfactory result. The object of our invention is to accomplish this long-sought and desirable result in a simple and effective manner.

To alter the position of a cylinder so as to keep the piston-rod at right angles to the crank during the entire stroke is not practicable, and increasing the number of cylinders so as to produce virtually the same result introduces features more objectionable than those of the single cylinder. Nor do the present forms of rotary engines seem to be satisfactory.

Our new movement does about what two cylinders or their pistons would do if they could follow their cranks in their revolutions, because in its movement the power is applied tangentially throughout the stroke, and on opposite sides of the shaft at the same time, which not only implies application of the power to the best advantage, but uniform action as well.

Our new movement is designed to take the place of the ordinary crank, and to do away with the imperfections of that device.

From the beginning of the use of the crank its dead-points and the varyin grapidity of its motion have been thought to be the cause of loss of power and of imperfect action.

Our invention consists, essentially, in the construction and arrangement of the reversed inclined planes in the three pieces A, B, and C, and within the cylinder D, whereby reciprocating is converted into rotary motion; also, in the construction and arrangement of the balanced lever G, together with the cages of anti-friction rollers and their bearings, and also the arrangement of the buffers which serve to cushion the reciprocating parts.

The spirally-inclined planes form acute angles of about forty-five degrees to the axes of rotation.

Upon a circle equal in circumference to two strokes of the power is a wedge of power two, resistance one, to the revolution of the shaft, because four strokes of the power effect one revolution of the shaft instead of two strokes, as is the case with the ordinary crank. At the circumference of the movement, the angle being less than forty-five degrees, and the circle being exactly equal to four strokes of the power, moving equal distance in equal time with the latter, is a wedge of one to one on said circumference, and also of two to one, as against the circle which balances two strokes of power as the balanced crank-circle. The leverage, also, of four strokes of power is as much greater than the circle described by the center of the crank-wrist as four strokes of power is greater than three and one-seventh strokes of the same power. Hence the advantage of our new movement is as two to one or four to two against the balancing-circle or leverage of the crank, and also has an advantage of leverage greater than the circle described by the center of the crank-wrist of six-sevenths of its diameter (or of six-sevenths of one stroke of power) to the revolution.

The principle of the new movement is concentric throughout, the lines of the inclined-plane surfaces all converging to and passing through the axis of rotation, and the corresponding surfaces of the reciprocating wedge acting directly upon both sides of the axis of rotation at the same time, and in lines parallel therewith, as well as with the power, and being secured from rotary motion by a balanced lever. The movement is thus balanced into equilibrium of power and action; hence the minimum of friction and maximum of power ought to result.

When two or more spiral planes are used conjointly upon the same shaft and arranged in the manner as hereinafter described, the leverage may be increased in ratio to the increase of the pitch or length of pitch of said planes.

The advantage of using two spirally-inclined planes instead of one in forming the new movement is threefold, viz:

First. The use of two spirally-inclined planes causes the points of intersection to meet at one-fourth of the length of their pitch, thus forming the power-wedge of four quarter-spirals, two of which are right-hand planes and two left-hand planes, which arrangement lengthens the pitch of said planes to an acute angle and shortens the reciprocal strokes of power, and gives the use of four strokes for each revolution of the shaft instead of two only as with the crank-movement, two of which strokes take place while the crank in its rotation would be passing its centers, or quadrants of opposition to its axis of rotation. Hence by this movement one engine is enabled to perform the work of two similar ordinary engines with crank-movement.

Second. When two planes are used, they wind around their axis of rotation, one upon each side and directly opposite to each other, in such manner that the power acts upon both planes on opposite sides of their axis at the same time. The power, therefore, is balanced upon said axis throughout the stroke and free from lateral pressure upon its axle-bearings.

Third. The joining of the quarter-sections of the spiral planes makes the strength of structure sufficient for all kinds of heavy work, and the oil being held in the cup formed by the junction of said planes upon opposite sides and within the walls of the cylinder is retained upon the surfaces and between the latter, thus affording an unguent and cushion to the working parts.

The same advantageous results could not be obtained with but one plane of each kind—viz., right and left hand spirals—because one thread would bear only upon one side of its shaft at a time, and would therefore be eccentric like the crank and exert lateral pressure upon its axle-bearings; and for the same stroke of power the pitch would be equal in length to two of such strokes and would be one-half shorter and more obtuse than the pitch of the double planes; but were the latter pitch maintained in the single plane, then the stroke would be increased to double that of the double plane movement, and would therefore be objectionable, as the latter movement suits the length of piston-stroke generally approved as the most economical, as longer cylinders waste heat by radiation. Power also would be wasted by lateral pressure, as above stated, and therefore would be objectionable with any kind of power.

More than two spiral planes may be advantageously employed for certain special applications, such as for hoisting-machines, &c.; but two planes, right and left handed, on opposite sides of a shaft equalize the leverage, and place the movement in equilibrium of power and motion, after which no further increasing or reducing of the leverage of the movement would be advantageous.

The first object is thus attained—viz., placing the power tangentially in equilibrium upon opposite sides of the axis of the movement, and thereby causing the power to act uniformly throughout the stroke and revolution, thus getting rid of the dead-points of opposition or resistance inherent to the crank-movement.

The cylinder of the movement may be constructed to serve the purposes of a winding-drum for hoisting and other like purposes.

The new movement is especially adapted to the arbitrary requirements of the direct-acting forces of attraction and repulsion in electro-magnetic motors, because of its uniform power throughout the entire power-stroke and its equilibrium.

We will now proceed to describe the construction of our new mechanical movement and its practical operation, as follows: When the length of stroke and the power are known, a corresponding movement is produced by making a pattern, the spirally-inclined planes of which wind once around in four lengths of stroke, (or eight lengths of a crank suitable for the same stroke.) Two right-handed and two left-handed planes are necessary. The right and left handed planes intersect each other at points one-fourth the length of their pitch, and are formed into one piece, A, which completes the pattern for the casting. The power or reciprocating section A being formed of both the right and left hand inclined planes *a a′*, joined together upon a shaft, A′, presents the surfaces of both sides of the planes *a a′*, facing in opposite directions in lines parallel with said shaft A′, to which they are rigidly connected. Two corresponding sections, B C, are made from or by the same pattern, with flanges *b c* upon their ends, which flanges are bolted to corresponding flanges *d* upon the ends of a cylinder, D, and form the heads of the latter. The sections B C therefore project inwardly toward the center of the cylinder D, with their ends or points of intersection standing directly opposite to each other, leaving just sufficient room between them for the intermediate power or reciprocating section A to move between them from one side to the other. The opposite sides of the sections B C, which form the rotary sections, also form the walls which inclose the reciprocating section A. The latter section is, as above stated, rigidly connected to a shaft, A′, which passes out of the cylinder D through a hole in its center or through a hub, E, in which there is a stuffing-box, which latter serves to pack around the shaft A′ to make the cylinder oil-tight. This shaft A′ is sufficiently strong to transmit its reciprocating motion to the inclined planes of sections B C, and transform said motion, through the medium of said inclined planes of the sections B C, into rotary motion, and through the latter to the shaft F. The outer end of shaft A′ is rigidly attached to a cross-head, G, or balanced lever, which lies in the plane of rotation and at right angles to the shaft A′.

The lever G has its arms *g g* formed like a T, the outer or rectangular branches, *g′ g′*, of which are planed smooth on both sides, and lie at right angles to the lever-arms *g g*, and parallel with the line of power. These arms *g′ g′* reciprocate between anti-friction bearings formed upon the standards H, and which consist of the box or receptacle *h* and the anti-friction rollers *h′*, above and below said arms *g′*, as plainly shown by Fig. 12.

The object of this arrangement of long lever G, working between anti-friction rollers *h′*, being to afford great leverage with little frictional resistance, the whole torsional strain being based upon and resisted by this lever, which serves as the base of the spiral wedge A, the latter being reciprocated by the power which is attached to shaft A′, (in like manner as the plunger-shaft of a direct-acting pump is attached to the piston-rod of a steam-engine,) wedges the rotary sections B C, together with the cylinder D, shaft F, and the driven apparatus, into rotary motion.

I I are rubber buffers or other suitable springs, arranged in suitable boxes *i′ i′*, formed on opposite sides of a central partition, *i*, formed in the bearing I^1 upon the standard I^2. The central partition or collar, *i*, surrounds the power shaft or rod K, which is free to reciprocate in said collar-bearing and buffers. Similar buffers, L L′, are attached to and move with the power-shaft K and shaft A′, the buffer L being rigidly mounted upon shaft K, in rear of bearing I^1, and the buffer L′ being rigidly connected to cross-head or lever G, in front of bearing I^1. The buffers I L L′ serve to receive and return the spent force of the momentum of the reciprocating parts in reversing their motion, and their arrangement is plainly shown in Fig. 1 in full lines, and in Figs. 2, 10, and 11, in section.

M M′, Figs. 1, 2, 8, and 9, are hubs cast upon the heads *b c* of the cylinder C. The former is made sufficiently large to permit the reciprocating shaft to pass through and operate freely within said hub M, while the other, M′, is keyed to the rotating shaft F. These hubs serve to sustain and retain the movement both in action and in place.

To avoid friction, rings of anti-friction rollers *m* are fitted around the hubs M M′, said rollers being located in suitable oil-boxes formed in the bearing-standards or pillow-blocks m^1, upon which the movement and its shafts are mounted. The ends of the hubs M M′ serve also to bear the pressure of the end-thrust of the power, the oil retaining boxes m^2 retaining a copious supply of oil for said end bearings, upon which the end pressure acts.

When the movement is used in any manner whereby the bearings M M′ can be dispensed with, the end-thrust may be resisted by a bearing, N, provided with a box, *n*, within which moves the collar or disk N^1, rigidly keyed to the shaft F. N^2 N^2 are carriers provided with a series of radial slots or recesses, n^1, within which are placed the anti-friction rollers n^2, said carriers being located on opposite sides of the collar N^1, and held in position by the end plates n^3 n^3, which are bolted together, as shown by Fig. 1, against packing to make the box oil-tight, the action of the roller, being partly sliding, requiring oil to relieve the sliding friction,

We disclaim all other arrangements of inclined planes whatsoever which are not shown and described in the several combinations specified in this specification, to which latter we confine our invention inclusively.

Having now described our invention, what we claim, and desire to secure by Letters Patent, is—

1. The within-described mechanical movement, composed of the reversed spiral inclined planes A B C, arranged to operate together in the manner and for the purpose substantially as described.

2. The reversed spirally-inclined planes A B C, arranged within the cylinder D in such manner that the cylinder will serve as an inclosure and support for the movement and to retain oil to the working-surfaces of its spiral planes, in the manner and for the purposes substantially as described.

3. The combination, with the cylinder D, of the reversed inclined planes A B C, arranged to form the heads of said cylinder, substantially as described.

4. The combination of the inclined planes A B C, the flanges *b c* of said planes B C, the cylinder D, and its flanges *d*, and the hubs M M′, constructed and arranged to serve the purpose of a lifting or winding drum, substantially as and for the purposes specified.

5. The lever G, in combination with the reciprocating mechanism of the movement, substantially as and for the purposes specified.

6. In combination with the lever G, the

anti-friction-roller bearings H h h', constructed and arranged to operate substantially as and for the purposes specified.

7. The combination, with the reciprocating parts of the movement and the buffers L L, of the buffers I I, arranged and operating substantially as and for the purpose specified.

8. The combination, with the shaft F and collar or disk N′, of the bearing N, carriers N^2 N^2, rollers n^2, and the end plates n^3 n^3, all arranged and operating substantially as described, for the purpose specified.

9. In combination with the hubs M M′ and cylinder D of the movement, the cages of anti-friction rollers M and their recessed bearings m^1, arranged to operate in the manner and for the purpose substantially as specified.

In witness that we claim the foregoing we have hereunto set our hands and affixed our seals this 22d day of March, A. D. 1879.

WM. FARR GOODWIN. [L. S.]
EDW. F. ROBERTS. [L. S.]

Witnesses:
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