(No Model.) 2 Sheets—Sheet 1.

I. N. BEREZOVSKY.

GEAR CHANGING MECHANISM.

No. 566,963. Patented Sept. 1, 1896.

Fig. 2.

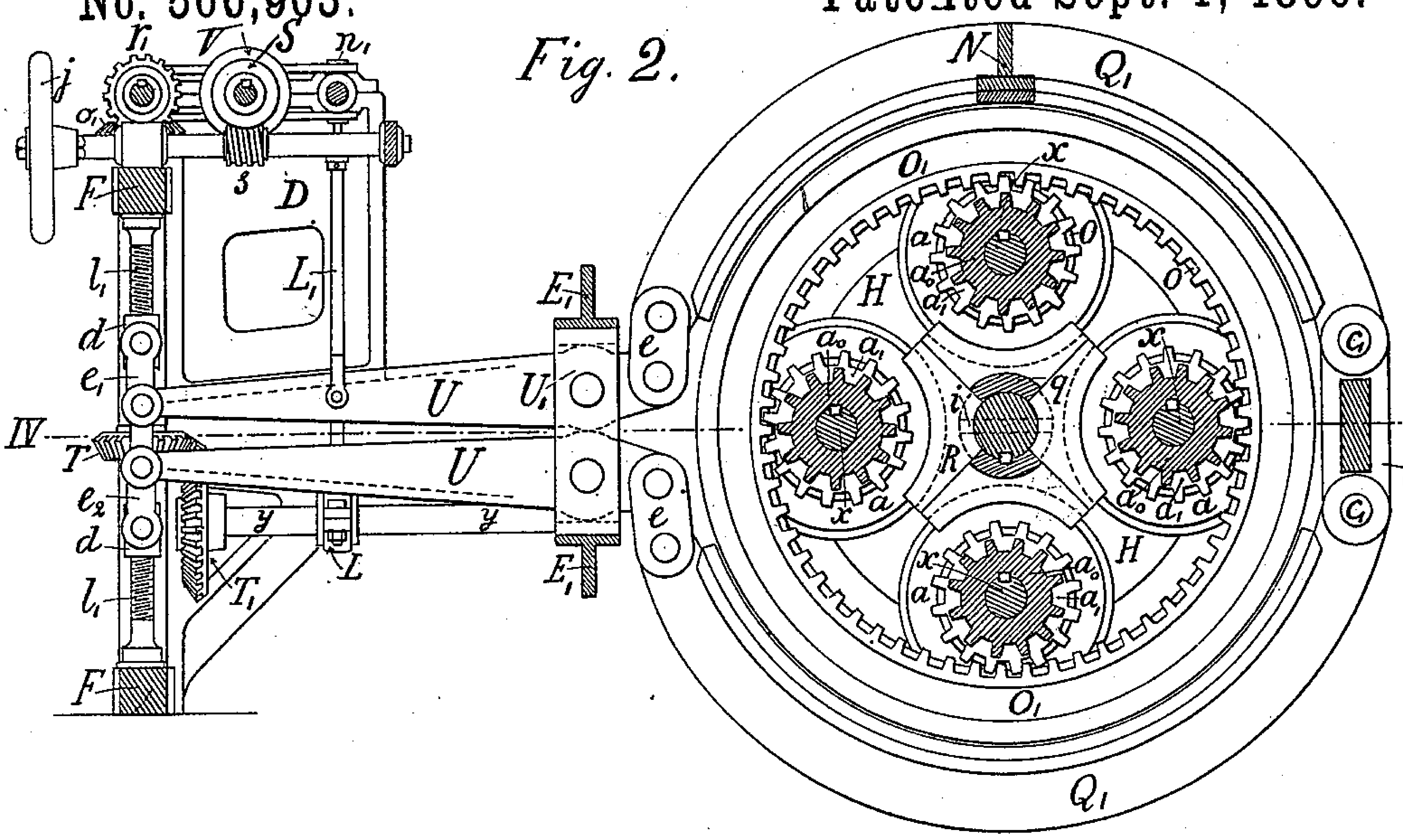
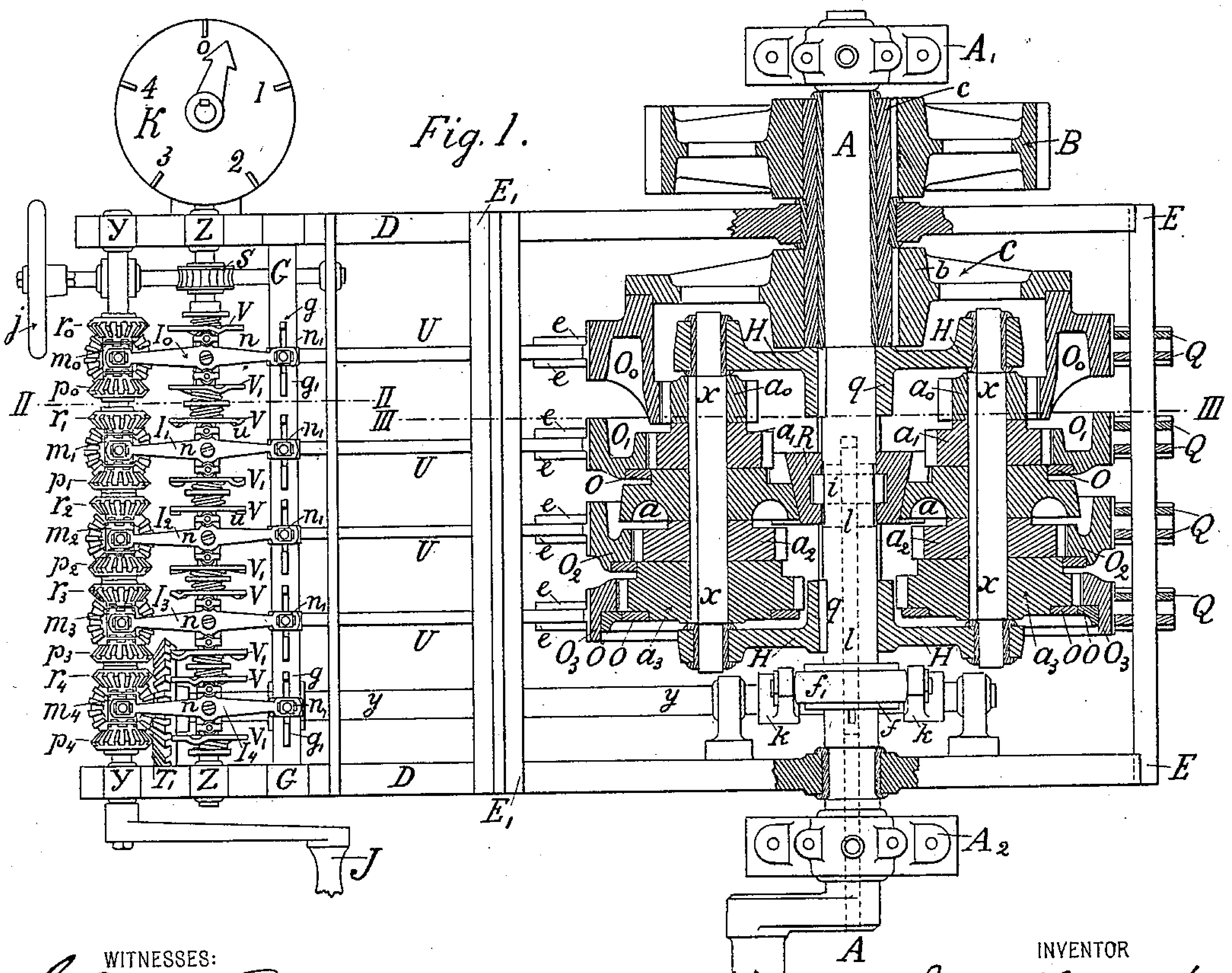


Fig. 1.



WITNESSES:

Charles Bienenfeld.

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INVENTOR

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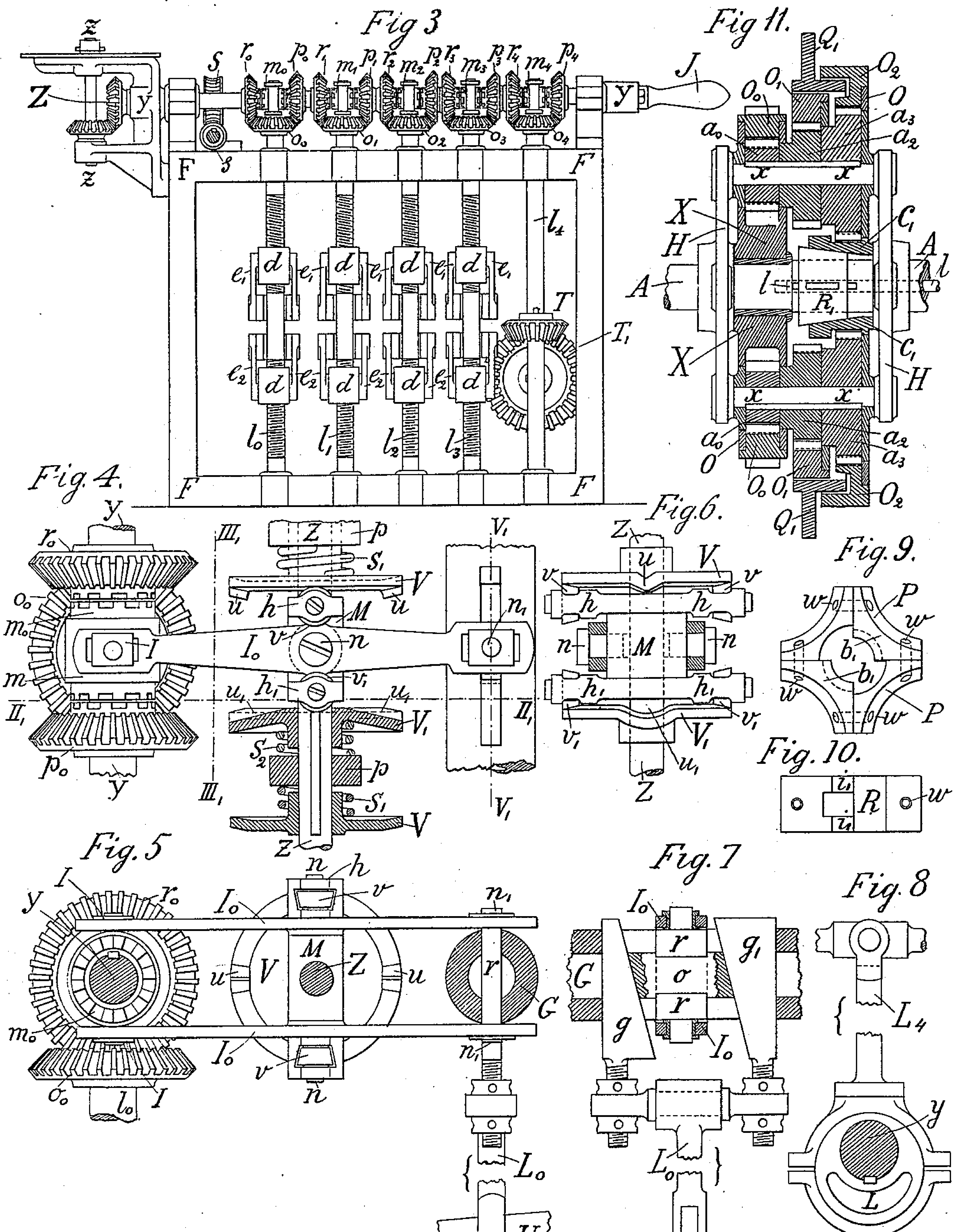

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UNITED STATES PATENT OFFICE.

IVAN N. BEREZOVSKY, OF PHILADELPHIA, PENNSYLVANIA.

GEAR-CHANGING MECHANISM.

SPECIFICATION forming part of Letters Patent No. 566,963, dated September 1, 1896.

Application filed October 2, 1895. Serial No. 564,445. (No model.)

To all whom it may concern:

Be it known that I, IVAN N. BEREZOVSKY, a subject of the Czar of Russia, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and useful Gear-Changing Mechanism, of which the following is a specification.

My invention consists in a mechanism by means of which a rotatory motion may be transmitted from one shaft or wheel to another wheel or shaft in any desirable ratio, varying this ratio between any limits with the same expedience, be the gear in motion or at rest. In the mechanism the driving wheel or shaft may rotate with a fixed unvarying speed, while the driven wheel or shaft varies its speed. The latter may have any number of given velocities from zero, when the motion of the driving wheel or shaft is not transmitted at all to the driven wheel or shaft, up to the highest number of revolutions. I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 represents the top view of the mechanism, its right side being cut by a horizontal plane through shaft A A. Fig. 2 represents a longitudinal vertical section through lines II II III III, and Fig. 3 represents a front view when the hand-wheel j is taken off. Figs. 4 to 10 represent separate parts of the mechanism as it will be particularly explained below. Fig. 11 represents a part of the mechanism, a little modified, in the vertical section along the shaft A A.

A A is a shaft resting on two pillow-blocks A' and A^2 and receiving its rotatory motion from any motive power, directly or indirectly, and transmitting this motion to wheel B. Two disks H H are fixed on the shaft A A, having one common nave q, which has two longitudinal slots, Figs. 1 and 2, in the middle from two diametrically opposite points. The disks H H carry four shafts x x, parallel to shaft A A and having four pinions a^0 a' a^2 a^3, with disks a. All these wheels and disks a are connected into one whole and can rotate with shafts x x. Every four wheels of the sets a^0 a' a^2 a^3, in the same plane, are embraced by toothed rings O^0 O' O^2 O^3, which are in constant gearing with the said wheels. The toothed ring O^0 serves as a rim for wheel C, and has a nave b fixed on sleeve c. The latter is fastened to wheel B by means of a key, so that wheel B and wheel C form one piece. Should one of the rings O' O^2 O^3 be prevented from rotating about shaft A A while shaft A A, with the disks H H, is moving, then will all the four sets of wheels a^0 a' a^2 a^3 rotate, with their shafts imparting their motion to the remaining two rings, and setting in motion wheel C, and consequently also wheel B. The direction and speed of the rotation of wheel B depend on the radii of pinions a^0 a' a^2 a^3 and rings O^0 O' O^2 O^3, and hence will be determined by the formula for epicyclical trains. In annexed figures the radii of these wheels are such that, one of the rings O' O^2 O^3 being fixed, the speed of wheel B will be diminished and will have the same direction as shaft A A. The maximum speed will be given to wheel B when it receives its motion directly from shaft A A, for which purpose all the rings O^0 O' O^2 must move freely, and the sets of wheels a^0 a' a^2 a^3 must be prevented from rotation with their shafts. In the latter case the wheels will drive wheel C without sliding over the teeth of ring O^0, and the whole system of wheels will rotate together with shaft A A as a whole.

To prevent the toothed wheels O^0 O' O^2 O^3 from rotation, the clamp-collars Q^0 Q' Q^2 Q^3, Fig. 2, are used, consisting of semicircular rings able to lock and unlock themselves, preserving their concentricity with the rings O^0 O' O^2 O^3. The fixing of the wheels a^0 a' a^2 a^3 is brought about by friction-clutch R, which, sliding along the shaft A A in the said slots of nave q, is pressed against the disks a and arrests their rotation as well as that of all the sets of wheels on shafts x x.

On shaft A A is fastened on pillows a bed D E E D, which may be turned around shaft A A and fixed in any position. All parts serving to fit the rings and disks a are fastened to this bed.

The above-named semicircular rings of clamps Q^0 Q' Q^2 Q^3 are fastened on one side of shaft A A by means of links to the cross-bar E E of bed D E E D, on which they are set. On the other side of the shaft these rings are connected by means of links e e with the ends of the short arms of levers U U, every two of which are fastened loosely by brackets U', pressed between two cross-bars E' E' of the bed, Fig. 2. Every pair of the long arms of the levers is connected by a pair of links e' e' e^2 e^2 with two nuts of screws l^0 l' l^2 l^3, Figs. 2 and 3, whose threads are right-handed on one half and left-handed on the other. The screws are fastened in frame F F F F, which is fixed to bed D E E D, and they, on turning one side or the other, will bring together or separate the ends of levers U U, as well as the half-rings of the clamps. The latter then turn on either side of line IV V, making the same angle with it. These clamps Q^0 Q' Q^2 Q^3, when pressed together, will produce the fixation of the rings O^0 O' O^2, and, vice versa, when separated will allow the rings to have free motion about shaft A A. The sliding of friction-clutch R is performed by means of rod *l l* (represented on Fig. 1 by a dotted line) inside of shaft A A of forks *k k* on shaft *y y* and of shaft l^4, Fig. 3, connected with shaft *y y* by the bevel-gear T T'. The rod *l l* has across it and on one end a hole holding tight wedge *i*, which passes through a wider hole in shaft A A and is allowed to move in it along the shaft. The wedge is braced by the flanges of friction-clutch R, so that the sliding to and fro of rod *l l* is communicated to the clutch R, and on the end the rod *l l* carries an identical wedge, which is also sliding in a hole of shaft A A and is embraced by ring *f*. The ring *f* has flanges on which there is set a collar f', connected by pins with forks *k k*, Fig. 1, fixed to shaft *y y*. The turning of shaft l^4, Fig. 3, one way or the other is communicated to shaft *y y* and to forks *k k*, which will move the rod *l l* one side or the other with the friction-clutch R and either stop the disks *a* or allow them free rotation accordingly, and so the toothed rings and disks *a* are brought into action by the screws l^0 l' l^2 l^3 and shaft l^4, Figs. 1 and 3, which turning one side effect the fixation of the rings and disks and turning the other allow them free motion. In their turn screws l^0 l' l^2 l^3 and shaft l^4 receive their motion from handle J on shaft Y Y through bevel-gears o^0 o' o^4 p^0 p' p^4 r^0 r' r^4, the first four of which are fixed immovably to screws and shafts l^0 l' l^4 and the last four pairs are set loosely on shaft Y Y and are in constant gearing with the former. The change in the direction of motion of screws l^0 l' l^3 and shaft l^4 is brought about by the sliding to and fro of the jaw-clutch couplings m^0 m' m^4, which are fitted to shaft Y Y by keys and can move along it, catching the right bevel-wheels p' p^2 p^4 for locking the toothed rings O^0 O' O^2 O^3 and disks *a* or the left bevel-wheels r^0 r' r^4 for unlocking the same. Jaw-clutches m^0 m' m^4 move so that it is possible simultaneously to impart the fixing action to only one of the shafts l^0 l' l^4 and at the same time make the other shaft turn in the opposite direction, thus producing the loosening effect.

Suppose the mechanism imparts to wheel B five different velocities, designated by figures 0 1 2 3 4, velocity 0 when wheel B is at rest and velocity 4 signifying its highest speed. The number of variations depend on the number of rings O' O^2. If it be desired to change velocity 2 to velocity 4, it is necessary to connect jaw-clutch m^4 with the bevel-wheel p^4 and the clutch m^2 with bevel-wheel r^2, and then turn handle J. The disks *a* will be locked and the clamp Q^2 will set free ring O^2, but the unlocking of clamp Q^2 will not go on at the next change from velocity 4, say, to velocity 3. At the next change, when jaw-clutch m^4 will be brought in connection with the bevel-wheel r^4, the jaw-clutch m^2 will occupy a neutral position, touching neither wheel p^2 nor r^2. All this is attained by a corresponding change in position of levers I^0 I' I^2 I^3, connected by jaw-clutches m^0 m' m^2 m^3 m^4, which change is brought about by a change in position of two points, the middle *n* and the extreme n' of every lever. Said middle points *n* are brought to the proper position by rotating wheel J, through worm *s*, wheel S, and disks V V', furnished with cams and set on shaft Z Z, and said extreme points n' are moved by connecting-rods L^0 L' L^2 L^3 L^4, with wedges *g g*.

For a better understanding of the action of levers I^0 I' I^2, I have to undertake a detailed description of the mechanism, but preliminary to it let me remark that as a guide for the proper setting of wheel *j* serves indicator K, on which a hand shows the figures indicating the velocities to be imparted to wheel B. This hand is set on a vertical shaft *z z* and is connected with shaft Z Z by two bevel-wheels, Figs. 2 and 3. Every one of levers I^0 I' I^4 is moved in the same way. Therefore, in further description, I will limit myself to the description of the action of lever I^0 only.

Figs. 4, 5, 6, 7, and 8 represent, separately, that part of the mechanism whose object it is to direct the action of lever I^0, whereby Fig. 4 gives the main view of this part; Fig. 5, its vertical section through line II II; Fig. 6, its section through line III III, and Fig. 7 section through line V V. o^0 is a bevel-wheel set on screw l^0; p^0 and r^0, bevel-wheels engaged with the former and sitting loosely on shaft Y Y. m^0 is a jaw-clutch connected with a pair of levers I^0 by ring *m* and two sliding blocks I I, which levers are fastened on either side of parallelopiped M by screws *n n*, around which they can turn. Parallelopiped M is set loosely on shaft Z Z and has two arms *h* and h', one on each side, which arms carry in their turn each a pair of conical rolls *v v* v' v'. These rolls are in constant contact with disks V V, furnished with cams *u u* and grooves u' u'. Disks V V' are fastened by keys and can have only a longitudinal motion along the shaft Z Z. They are pressed against rolls *v v* v' v' by spiral springs s' s^2, resting on rings *p*, immovably fixed to shaft Z Z, so when shaft Z Z is being turned by wheel *j* and worm-gearing *s* S, Figs. 1, 2, and 3, both disks V V' will rotate, and rolls v v' will roll on the conical surface of the disk. When cams u u will be against the rolls v v, the latter will push aside parallelopiped M, and rolls v' v' will come into grooves u' u'. As the points n' n' of the levers I^0 are then immovable, the levers will turn about these points and make jaw-clutch m^0 engage with bevel-wheel p^0, while the spiral spring S' will be compressed. This position of jaw-clutch corresponds with the fixing action of screw l^0. On the further rotation of shaft Z Z the cams u u will stop their action on rolls v v, while rolls v' v' by the action of disk V' will be taken out from their grooves and will push the parallelopiped, with levers I^0, to the opposite side so far that jaw-clutch m^0 will disengage bevel-wheel p^0 and will engage bevel-wheel r^0, the spiral spring S^2 being compressed at that. The latter position of jaw-clutch corresponds with the freeing action of screw l^0. After the unlocking of the ring the connecting-rod L^0, Figs. 2, 5, and 7, will sink and move the wedges g g' in the slots of pipe G, fixed in bed D E E D, Figs. 1, 4, 5, and 7. This will effect the moving aside of pin o, placed in pipe G between the wedges and carrying cotter r, with which the ends n' of levers I^0 are connected, and thus after screw l^0, Figs. 2 and 3, will disengage ring O^0 the levers I^0 will turn about their middle shaft n n, push aside jaw-clutch m^0 from bevel-wheel r^0, and place it in a neutral position between the bevel-wheels p^0 and r^0. The movement of the wedges upward on the locking of the rings will have a tendency to separate jaw-clutch m^0 from bevel-wheel p^0, but the separation will not take place because the action of the spring S' weakening only slightly. The fixation of disk a is attained by the same plan, excepting that the connecting-rod L^4 in this case, instead of being connected with the arm of lever, as in former case, is connected with the eccentric L on shaft y y, Figs. 2 and 8. At the freeing motion of friction-clutch R this eccentric, as in the former case, will sink the connecting-rod L^4, and will in a similar manner move the wedges g g' as well as lever I^4.

Every pair of disks V V' for directing rings and disks a is set on shaft Z Z, so that each pair makes with the two adjacent pairs an angle of one hundred and eighty degrees, divided by the number of variations. In this case the angle will be thirty-six degrees, so that in order to change any velocity to the two adjacent velocities the shaft Z Z must be turned thirty-six degrees. On turning the shaft Z Z one hundred and eighty degrees the cams of every pair of the disks will occupy their previous position. All the jaw-clutches m^0 m', Figs. 1 and 3, will alternately engage and disengage bevel-wheels p^0 p' p^4 r^0 r' r^4, the hand of the indicator describing a full circle, as the velocity ratio of shaft Z Z to shaft z z is two to one. Whatever be at any moment the position of the hand of the indicator, either one only of the rings O^0 O' or disks a may be compressed, but all rings and disks can never be set free simultaneously if handle y has been properly turned.

Let us imagine that all disks and rings, with the exception of one ring, say O^0, are unlocked. Then all connecting-rods L' L^2 will sink, and all jaw-clutches m' m^2, as explained before, will assume a neutral position, and the hand of the indicator will point to "0." If it were now desirable to impart to wheel B any velocity, say 2, it will be necessary to turn wheel j so as to make the hand of the indicator point to "2." Then there will follow, as already explained, a change in position of jaw-clutches m^0 and m^2. The first will engage wheel r^0 and the second wheel p^2. On turning handle J clamp-collar Q^0 will unlock itself and push jaw-clutch m^0 to a neutral position, while clamp-collar Q^2 will lock itself and raise connecting-rod L with its wedges without any effect on jaw-clutch m^2. This position will be retained by the mechanism as long as no other velocity is imparted to wheel B; but if a new velocity is to be imparted to wheel B, then the hand of the indicator having been properly placed, it is necessary to turn the handle J to the side, as in the former case. Should handle J be turned by mistake to the opposite side, wheel B would continue rotating with the previous velocity. If such a mistake should occur before properly placing the hand of the indicator, then all rings and disks will unlock, and the mistake could be corrected by turning handle J the opposite way; but such a mistake can be avoided by setting on shaft Z Z a ratchet-wheel, which would prevent the rotating of shaft Z Z the other way.

Figs. 9 and 10 are separate representations of friction-clutch R. It consists of four pieces connected by screws w. Fig. 10 shows the friction-clutch with its two upper parts removed. The two parts b' b', protruding in, are fitted into two longitudinal slots of nave q, Figs. 1 and 2, and with their flanges i' grasp cotter i of rod l l, described before. By its four conical grooves P the friction-clutch comes in contact with disks a.

To prevent rings O' O^2 from sliding off from the pinions a' a^2, the former as well as the latter are furnished on one of their sides with ring-like flanges of diameters equal to those of their pitch circles, Figs. 1 and 2.

Clamp-collars Q^0 Q' have in their cross-section the view given by letter N on Fig. 2, whereby the lower shaded surface is a section of the brake-shoe.

The mechanism described above in a somewhat modified form is shown on Fig. 11. The toothed ring O^0 may be without the nave, like the rings O' O^2, Fig. 1, and may transmit motion directly by means of a belt, a chain, or teeth. The ring in this case must be furnished on one or both sides with ring-like flanges, their diameters being equal to that of the pitch-circle. On shaft A A is loosely set sheave X, touching the pitch-circle flanges of wheels A^0 and receiving the pressure produced by ring O^0 on wheels a^0. Each pair of the toothed rings $O' O^2 O^3$, Fig. 1, may be rendered immovable by one common clamp, for which purpose, as shown on Fig. 11, the clamp-collar Q′ must have its cross-section of the shape of letter **L**, and one of the pairs of the rings, say O^2, must in cross-section have the shape of the same letter upside down. The clamp-collar Q′ being locked, ring O′ will be compressed. The same clamp-collar Q′ being unlocked, ring Q^2 is rendered immovable. The middle position of the clamp-collar is neutral. Instead of arresting the sets of pinions a^0 a', Fig. 1, by means of disks a and friction-clutch R, Figs. 9 and 10, these pinions may be rendered immovable by a common conical clutch R, Fig. 11, through toothed wheel C′ in constant gearing with one of the series of sets of pinion a^0 a' a^2. The change in position of clutch R is the same as that of the above-described clutch R. Wheel C′ may have pitch-circle flanges. The number of rings O^0 O′ is arbitrary. The number of shafts x x, Figs. 1 and 2, is arbitrary. The greater their number the more compact is the mechanism, as the teeth of wheels $a^0 a'$ and rings O^0 O′ may be made smaller. Arms h h' of the parallelopiped, Figs. 4 and 6, may have either only one roll or even one cam.

For rendering immovable rings O^0 O′ O^2, Figs. 1 and 2, toothed clamps may be used instead of the friction-collars $Q^0 Q' Q^2$. Jaw-clutches m^0 m' m^2, Figs. 1, 3, and 4, may engage conical wheels p^0 p' p^2 r^0 r' r^2 by friction. The internal gearing between the pinions a^0 and the gear-ring O^0, Figs. 1 and 2, may be substituted by external gearing, providing the gear-ring O^0 with external teeth and placing it within the pinions a^0. Then wheel B will have instead of the diminished speed an increased one. In addition to the forward motion of wheel B it is possible to impart to it a backward motion by corresponding change of the radii of rings O^0 O′ O^2 and wheels a^0 a' a^2.

The above mechanism may have various applications in all cases where the velocity ratio of transmission of rotatory motion is to have many variations to be made without arresting the transmission—for example, in connection with an electric-car motor; in transmitting motion from the cranked shaft to the driving-wheel of bicycles; in windmill-motors, which connected with my mechanism will be enabled to work with a very gentle wind; in some agricultural machines, say drills; in many machine-tools with varying motion of parts; in many motors with varying loads, &c., where this mechanism will be of highest service. This mechanism will enable us to use motors fit for normal work only, when a higher number of horse-power be occasionally required of them. This will permit us to use motors of small size and weight and will increase the coefficient of their useful action, as such motors will always work with normal strain and velocity.

I claim—

1. In an epicyclic speed-changing gearing the combination with the bed, D E E D, and the shaft, A A, having disks, H H, fixed thereon which carry two or more shafts, x x, bearing series of pinions, a^0 a' a^2, and disks, a, connected together on each of the shafts, x x, of the internal gear-rings, O^0 O′ O^2, which are in constant gearing with the named pinions being in the same plane and receive their entire support through said pinions primarily from the shaft, A A, the clamp-collars, Q^0 Q′ Q^2, consisting of semicircular rings united with the bed by means of links Q, and adapted to compress the internal gear-rings when the semicircular rings are locked together, the friction-clutch, R, fitted to the shaft, A A, and being able to move itself along the shaft engaging or disengaging with disks, a, the shaft, y y, fastened in the bed, D E E D, by means of pillow-blocks and carrying-forks, k k, in order to move the clutch, R, as it was described above, a shaft, l^4, fastened in the frame, F F F F, of the said bed and connected with the shaft, y y, by a pair of the bevel-gears, T T, the levers, U U, every pair of which is loosely fastened in the middle by brackets, U′, pressed between two cross-bars, E′ E′, of the bed and the short arms of which are connected by means of links, e e, with the said semicircular rings of the clamp-collars, the shafts, l^0 l' l^2, fastened in the frame, F F F F, and provided with threads right and left handed carrying nuts, d d, each of which is connected by a pair of links, e' e' e^2 e^2, with the long arms of the levers, U U, and also the bevel-gears, o^0 o' o^2, fixed on the same shaft, a shaft, Y Y, fastened in the bed and having bevel-gears, p^0 p' p^2 r^0 r' r^2, loosely set thereon and the jaw-clutch couplings, m^0 m' m^2, jointed with the ends of the levers, I^0 I′ I^2, and fitted to the shaft by keys and being able to move along the shaft, for the purpose of catching one or the other of the named bevel-gears, the shaft, Z Z, fastened also in the above-named bed and having parallelopipeds, M, loosely set thereon and jointed with the middle parts of the levers, I^0 I′ I^2, the disks, V V′, fitted movably to the last-called shaft by keys and bearing the spiral springs, S′ S^2, the rings, p, and the screw-wheel, S, fixed on the same shaft, all as and for the purpose explained in the specification, the pipe, G, which is permanently fixed in the above bed and contains the pins, o, placed between the cotters, r, jointed with the ends of the levers, I^0 I′ I^2, and the wedges, g g', in the slots of the pipe which wedges are united by means of the rods, L^0 L′ L^2, with the levers, U U, and with the shaft, y y, as and for the purpose described in the specification, the shaft, x' x' fastened in the bed and having a hand-wheel, j, and the worm, s, in gearing with the wheel, S, and the shaft, z z, of the indicator fastened in the support of the bed and connected with the shaft, Z Z, by a bevel-gearing all said parts combined as set forth.

2. In an epicylic speed-changing gearing

the combination with the bed, D E E D, and the shaft, A A, having disks, H H, fixed thereon which carry two or more shafts, $x\ x$, bearing a series of pinions, $a^0\ a'\ a^2$, and disks, a, connected together on each of the shafts, $x\ x$, of the internal gear-rings, $O^0\ O'\ O^2$, which are in constant gearing with the named pinions in the same place, and are supported and directed in their movement by means of rims at one or both side faces of the internal gear-rings, as well as of the said pinions in circles coincident with the pitch-line of each of them, one of the gear-rings being fixed, the others are removed by the pinions to a rotation around the shaft, A A, as around the axis and the gear-ring, O^0, receives a motion with a certain velocity ratio, the clamp-collars, $Q^0\ Q'\ Q^2$, consisting of semicircular rings which are united with the bed by means of links, Q, and which can turn around the points, $c'\ c'$, embracing the corresponding internal gear-rings without frictional contact when unlocked, and arresting separately either of them when one or the other pair of semicircular rings is pressed together by means set forth, the frictional clutch, R, which is fitted to the shaft, A A, and is only able to move along it engaging or disengaging the disks, a, whereby the named pinions with their shafts, $x\ x$, become immovable or rotate freely relative to the disks, H H, and the means for operating the clamp-collars, $Q^0\ Q'\ Q^2$, and the friction-clutch, R, substantially as and for the purpose explained in the specification all said parts combined as set forth.

3. The combination, with a main shaft, of a disk wheel, mounted on shaft, connected pinions carried by said disk wheel, toothed rings surrounding these pinions, a wheel to which power is to be transmitted, mounted to rotate with the outer of said rings, means for preventing rotation of any one of the rings, and means for preventing rotation of all of the pinions substantially as set forth.

IVAN N. BEREZOVSKY.

In presence of—
CHARLES BIENENFELD,
AARON AVRUTIS.