No. 675,669. Patented June 4, 1901.

O. NORLING.

CHANGE SPEED GEAR.

(Application filed Mar. 8, 1900.)

(No Model.) 4 Sheets—Sheet 1.

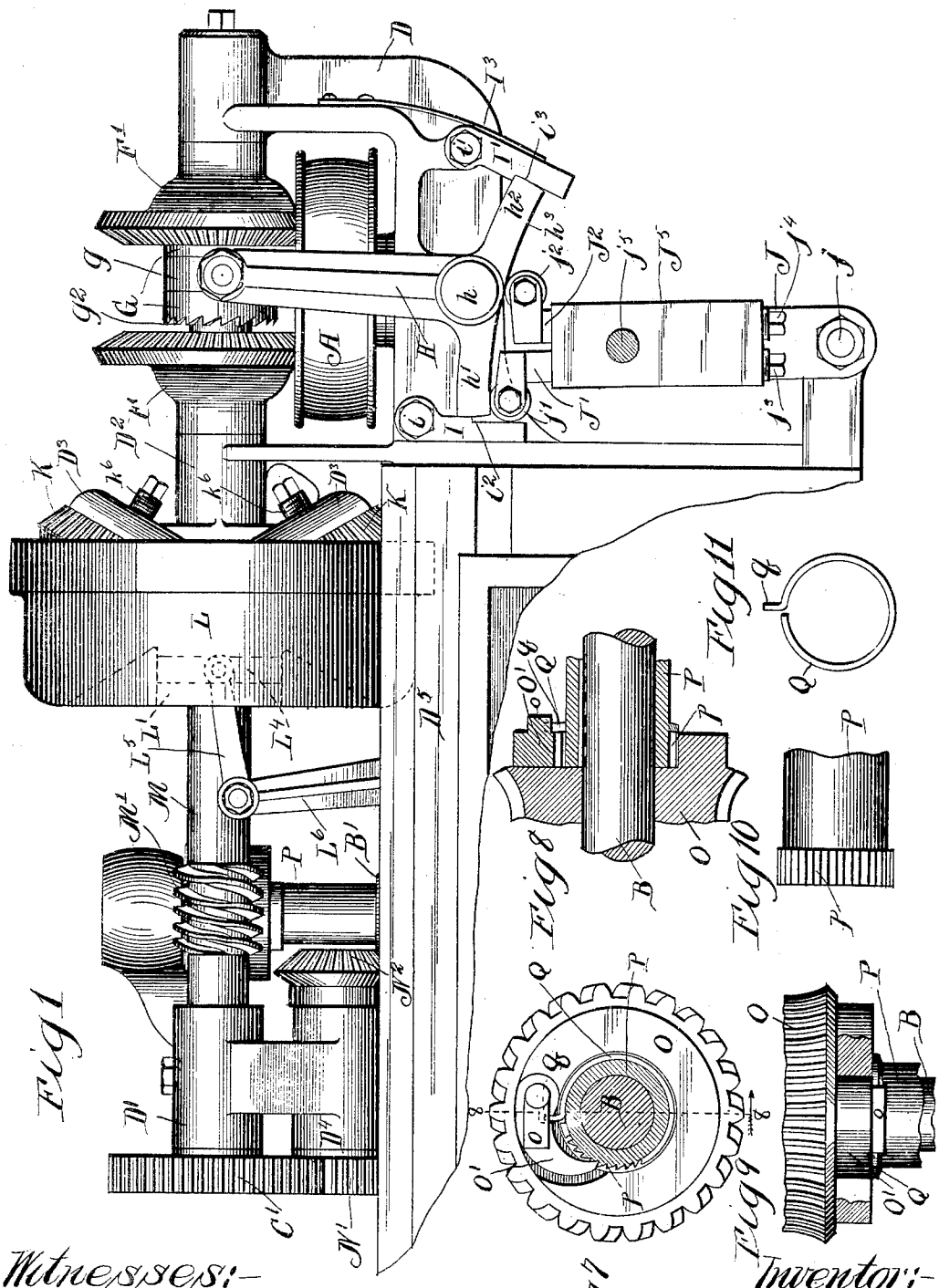


Fig 1

Fig 8

Fig 10

Fig 11

Fig 9

Witnesses:-
Carl H. Crawford
William L. Hall.

Inventor:-
Oscar Norling
by Poole & Brown his Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C

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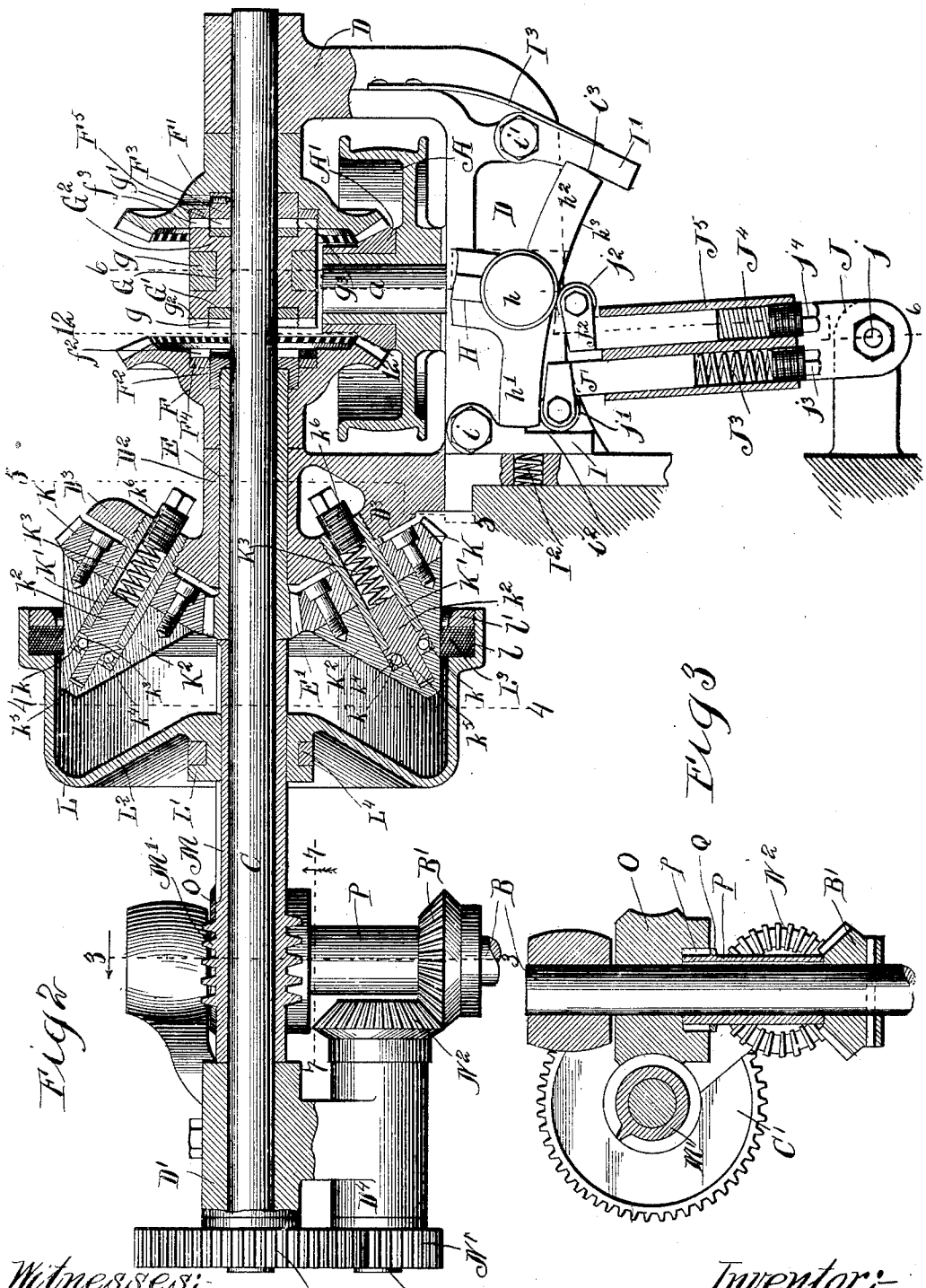


FIG 3

FIG 2

Witnesses:
Carl H. Crawford
William A. Hall

Inventor:
Oscar Norling
by Poole & Brown his Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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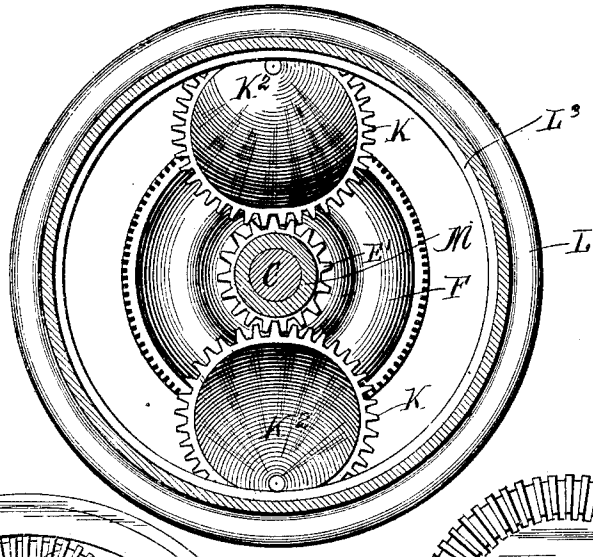
O. NORLING.

CHANGE SPEED GEAR.

(Application filed Mar. 8, 1900.)

(No Model.) 4 Sheets—Sheet 3.

Fig 4



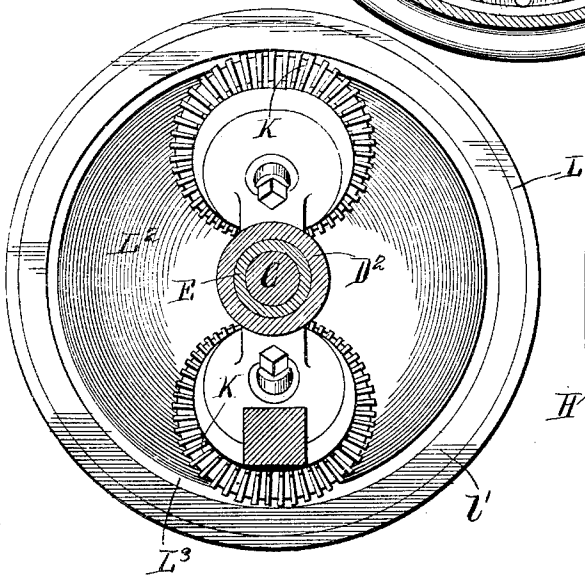


Fig 5

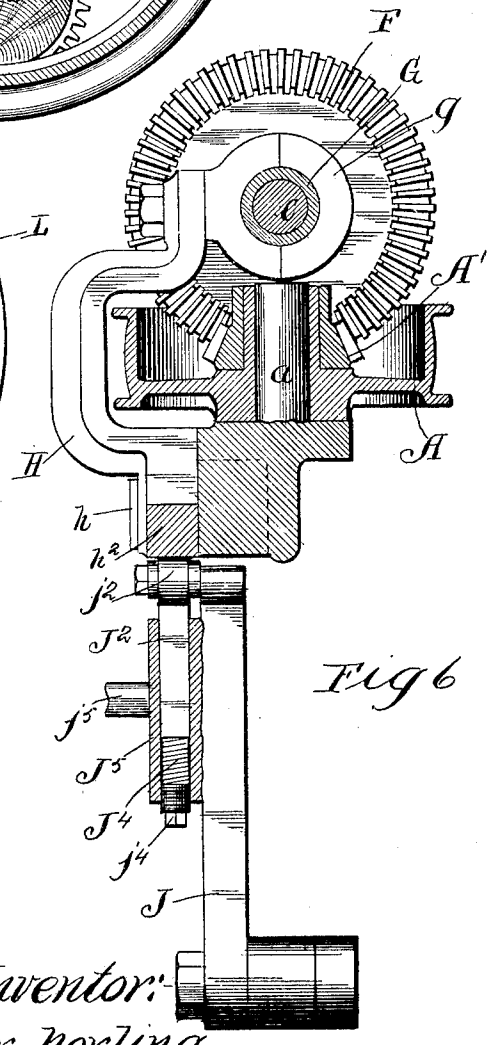


Fig 6

Witnesses:-
Carl H. Crawford
William L. Hall, by

Inventor:-
Oscar Norling
Poole & Brown
his Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 675,669. Patented June 4, 1901.

O. NORLING.

CHANGE SPEED GEAR.

(Application filed Mar. 8, 1900.)

(No Model.) 4 Sheets—Sheet 4.

Fig 12

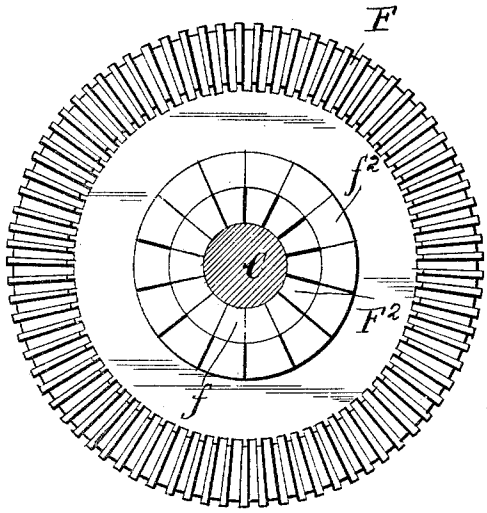


Fig 13

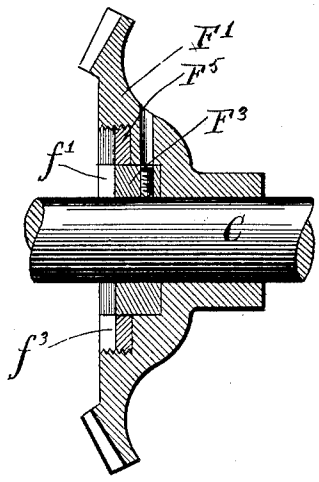
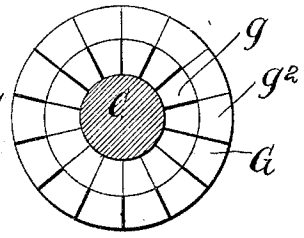


Fig 14



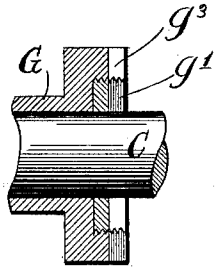


Fig 15

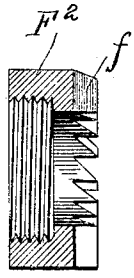


Fig 16

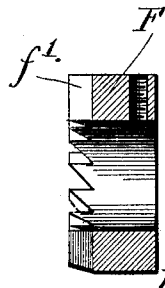


Fig 17

Witnesses:-
Carl H. Crawford
William H. Hall

Inventor:-
Oscar Norling
by Poole & Brown. Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

OSCAR NORLING, OF AURORA, ILLINOIS, ASSIGNOR TO AURORA AUTOMATIC MACHINERY COMPANY, OF SAME PLACE.

CHANGE-SPEED GEAR.

SPECIFICATION forming part of Letters Patent No. 675,669, dated June 4, 1901.

Application filed March 8, 1900. Serial No. 7,793. (No model.)

To all whom it may concern:

Be it known that I, OSCAR NORLING, of Aurora, in the county of Kane and State of Illinois, have invented certain new and useful Improvements in Change-Speed Gear; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to an improvement in change-speed gears, the same being intended more particularly for use in driving the feed mechanism of an automatic metal-working machine, but being adapted also for use in other cases where such devices are applicable.

The invention consists in the matters hereinafter described, and pointed out in the appended claims.

In the accompanying drawings, illustrating one practical embodiment of my invention, Figure 1 is a plan view of a mechanism embodying my invention. Fig. 2 is a longitudinal section taken on a plane passing horizontally through the central axis of the main shaft of the device. Fig. 3 is a detail vertical section taken on line 3 3 of Fig. 2. Fig. 4 is a detail section taken on line 4 4 of Fig. 2. Fig. 5 is a detail section taken on line 5 5 of Fig. 2. Fig. 6 is a detail section taken on line 6 6 of Fig. 2; Fig. 7, a detail cross-section taken on line 7 7 of Fig. 2. Fig. 8 is a detail section of the parts shown in Fig. 7, taken on line 8 8 of said Fig. 7. Fig. 9 is a detail plan view with parts broken away, illustrating more clearly the construction of the parts shown in Figs. 7 and 8. Fig. 10 is a detail plan view of the end of the sleeve shown in said Figs. 7, 8, and 9. Fig. 11 is a detail view of the spring-ring which is shown in said Figs. 7, 8, and 9. Fig. 12 is a face view of one of the bevel-gears shown in Figs. 1 and 2. Fig. 13 is a cross-sectional view of the other of said bevel-gears, showing the shaft on which said gear-wheel is mounted in side elevation. Fig. 14 is a face view of one end of the clutch-sleeve shown in Fig. 2. Fig. 15 is a detail sectional view of the opposite end of said clutch-sleeve. Fig. 16 is a detail sectional view of that one of the clutch members which is shown in Fig. 2 as attached to the sleeve which surrounds the main shaft. Fig. 17 is a similar view of the clutch member shown in Fig. 2 as attached to the main shaft.

As illustrated in said drawings, A indicates the belt-pulley, through the medium of which power is applied to the change-speed gear illustrated and which is driven by a driving-belt from any proper or available source of power.

B indicates a shaft to be driven alternately at uniform and variable speeds and which as illustrated in the present case is the shaft which drives the speed mechanism of an automatic metal-working machine, said machine being of that class in which several different cutting-tools are adapted to operate on a blank and in which it is desired that said tool should be fed or advanced at different speeds, according to the character of the work to be done by said tool, and in which also the feed device has a reverse or backward movement to retract the cutting-tool, the device illustrated being adapted to give alternate periods of fast movement and variable slower movement to said shaft B, which turns always in one direction.

C indicates the main supporting shaft or spindle upon which the principal operative parts of the device are mounted. This shaft is journaled at one end in a bracket D and at its opposite end in a bracket D′, said brackets being supported in any suitable manner, preferably by being attached to the frame of the machine on which the device is mounted. Said machine-frame as shown in the accompanying drawings is indicated by D^5.

E indicates a sleeve or hollow shaft which is mounted on the shaft C, as herein shown near the right-hand end of said shaft, and F F′ are two beveled gear-wheels, one of which is mounted on the sleeve E and the other of which is mounted on the shaft C at its end nearest the bearing D. The said bevel-gears F and F′ are arranged to face each other at a short distance apart, and said gears are adapted to intermesh with a gear-pinion A′, which is mounted on the driving-pulley A, which driving-pulley has bearing upon a horizontal bearing-stud *a*, secured to the bracket D and the axis of which is arranged radially with respect to the shaft C. Upon the shaft C, between the gears F F′, is

mounted a slidable clutch-sleeve G, which is free both to rotate and move endwise on said shaft. Said sleeve is connected with an oscillatory actuating-lever H through the medium of a ring g, which engages a groove in the central part of the sleeve and has pivotal connection by means of a pivot h with the end of the actuating-lever H. The sleeve G is for the purpose of establishing operative connection between the bevel-gear F′ and the shaft C or between the bevel-gear F and the sleeve E, on which the latter gear is mounted, said gears being constructed to turn freely on said shaft and sleeve when not connected therewith by means of the clutch device. Said clutch-sleeve and the opposing faces of the gears F and F′ are provided with clutch members or teeth arranged to face outwardly, so as to establish driving connection between said gears and clutch members F^2 F^3, which are secured to the end of the sleeve E and the shaft C within or adjacent to the hubs of the gear-wheels F F′. Said clutch members F^2 F^3 have the form of rings provided with a series of clutch-teeth $f f'$, which engage corresponding teeth $g g'$, formed on clutch-rings $G' G^2$, inserted in annular recesses formed in the ends of this clutch-sleeve, said rings being secured in the ends of said clutch-sleeve by screw-threaded connections, as clearly shown in Fig. 15. The gear-wheels F and F′ are provided outside of the ring F^2 F^3 with a series of clutch-teeth f^2 f^3, arranged to engage the clutch-teeth formed upon the outer parts of the clutching-ring, the said teeth g^2 g^3 being formed directly upon the sleeve, as clearly shown in the drawings. The clutch-teeth f^2 f^3 are, however, for convenience of construction formed on separate clutch-rings F^4 F^5, inserted in annular grooves or recesses formed in the inner faces of the bevel gear-wheels F F′, said rings F^4 F^5 having external screw-threads engaging screw-threads in the outer walls of said recesses in the said bevel-gears, as clearly seen in Fig. 13. The clutch-teeth on the clutch-sleeve, the gears, and the clutch members F^2 and F^3 are shown as made of triangular or ratchet shape to facilitate the interlocking or engagement thereof, and the inner and outer series of teeth in such instance face oppositely or in different directions in order to secure the proper interlocking thereof, as clearly shown in Figs. 12 and 13.

From the construction above described it will be understood that when the clutch-sleeve is moved into contact with the bevel-gear F′ driving connection will be established between the said bevel-gear and the shaft B, while the bevel-gear F will be left free to turn upon the adjacent end of the sleeve E, and it will also be understood that when the said clutch-sleeve G is moved in the opposite direction and toward the bevel-gear F driving connection will be established between said bevel-gear and the sleeve E, while the opposite bevel-gear F′ will be free to turn upon the shaft C.

The clutch device described affords a means of giving rotary motion at different rates of speed to the shaft B, the said shaft B being connected by suitable intermediate driving mechanism with said shaft C and with the sleeve E, as will be hereinafter described.

Now describing the devices illustrated for actuating the shifting-lever H for the purpose of shifting the clutch-sleeve G, these parts are made as follows: Said lever H is mounted on a vertical pivot-stud h and is provided adjacent to its pivot with two oppositely-extending transverse lever-arms $h' h^2$, the rear or outer edges of which together have a curved contact or bearing surface h^3. At the ends of said arms $h' h^2$ are located two detent-levers I I′, which are engaged to swing on vertical pivots $i i'$, which conveniently have the form of studs inserted in the frame and the arm D. The detent-levers I I′ are adapted to swing toward and from the ends of the arms $h' h^2$ and are provided with notches $i^2 i^3$, which are adapted for engagement with the ends of said arms $h' h^2$, the shoulders at the inner ends of said notches being so arranged that when the shoulder on one or the other of said detent-levers is engaged with one of the said arms $h' h^2$ of the shifting-lever the clutch-sleeve G will be held or locked at one limit or the other of its movement. The said detent-levers I I′ are held or thrown yieldingly toward the arms $h' h^2$ by suitably-applied springs I^2 I^3. As herein shown, the spring I^2 is of spirally-coiled form and is engaged at one end with a recess in the adjacent part of the machine-frame, so as to bear outwardly against the detent I, while the spring I^3 is of leaf form and is attached at one end to the bracket D and bears at its free end against the outer side of the detent-lever I′.

J indicates an actuating-lever which is pivotally mounted at one end on a stud j in such manner as to swing in a vertical plane, with its free end adjacent to the transverse arms h' h^2 of the lever H. Said lever J carries two longitudinally-slidable plungers J′ J^2, which are adapted to act against the arms $h' h^2$ and are provided with springs, which act on said plungers in a manner to throw them outward and keep them pressed constantly against the said arms $h' h^2$. The points at which the said plungers J′ J^2 bear against the arms $h' h^2$ are at such distance apart that when one of the said plungers is acting at the outer end of one of the arms the other plunger will bear against said arm adjacent to the pivot h. To avoid friction in the movement of said plunger along or over the bearing-surface h^3 said plungers are provided with antifriction-rollers $j' j^2$. As a convenient construction of the parts the plungers J′ J^2 are arranged to slide in a housing J^5, attached to the lever J, and actuating-springs J^3 J^4 are provided, which are made of coiled form and inserted within said housing between the inner ends of said plungers

and screw-studs j^3 j^4, which are inserted in the rear ends of the housing and are adapted for adjustment to vary the tension of the said springs. In the operation of this part of the device oscillatory movement is given to the lever J through the medium of any suitable actuating connection, which connection is not herein illustrated, it being understood that an actuating link or lever may be connected with the stud j^5, which projects upwardly from the top of the housing J^5, or that the said lever J may be moved by hand. The oscillatory movement of said lever J is such as to carry the rollers j' j^2 or other projecting parts of or upon the lever J or plungers J' J^2 against or in contact with the detent-levers I I' at the termination of the stroke of the lever J in either direction. The parts are so arranged, moreover, that the actuating-springs for the plungers J' J^2 will be normally under compression, said springs being strong enough to throw or move the clutch-sleeve G to one limit or the other of its movement when the pressure of one of said springs is exerted on the end of one of the arms h' h^2. It follows from the construction described that, assuming the clutch-sleeve to be at one limit of its movement and locked in such position by the engagement of one of the detent-levers, as I', with one of the lever-arms, as h^2, if the lever J be now swung so as to carry its free end toward the opposite detent-lever as soon as the end of the plunger at the side of the said lever adjacent to such opposite detent-lever comes in contact with the latter said detent-lever will be thrown outwardly free from the lever-arm engaged thereby, thus releasing said arm, and as soon as said lever is released the pressure of the plunger-spring throws the plunger outwardly, carrying with it the adjacent end of the lever-arm then engaged by it, with the result of swinging the lever H to the opposite limit of its throw. When said lever H reaches the opposite limit of its throw, the detent-lever, as I, which is engaged with the opposite lever-arm h', will come into holding engagement with said lever-arm, and thereby retain said lever H from backward movement until by the return of the actuating-lever J its adjacent plunger will release the engaged detent-lever and throw forward its associated lever-arm, thereby again shifting the clutch-sleeve backward to its original position. The same operation will obviously take place each time the operating-lever J is moved or thrown.

Now, referring to the change-speed gear constituting an important part of my invention, the same is made as follows: The sleeve E, which surrounds the shaft C, as before stated, has bearing in a stationary arm or bracket D^2, and at its end which projects beyond said bracket, at the left-hand side of the same, it is provided with a gear-pinion E'. Said gear-pinion intermeshes with a plurality of beveled gears K K, which are mounted on obliquely-arranged tubular bearing-studs K' K', which are rigidly attached to or mounted on radial arms D^3 D^3, forming a part of the bracket D^2, the said bearing-studs K' being inclined in a plane or planes which pass through the central axis of the shaft C. Attached to the outer faces of the beveled gears K K are conical friction-rollers K^2 K^2, having smooth contact-faces, the outer surfaces of which, or those at the greatest distance from the shaft C, are parallel to the said shaft.

L is a friction-wheel, the peripheral part of which is cylindric and surrounds the conical rollers K^2 K^2. Said wheel is mounted on a sleeve M, which sleeve surrounds the shaft C, between the sleeve E and the bearing D' of the said shaft. Said wheel is, moreover, provided with a central hub L', through which the sleeve M passes and to which it is connected by a spline and groove or the like, permitting the said wheel to slide endwise, but holding it from rotation on the sleeve. The hub is preferably connected with the outer or cylindric part of the wheel through the medium of an oblique or conical web L^2. Said wheel is provided adjacent to its open end with an inwardly-projecting friction surface or ring L^3, which is adapted for contact with the cones K^2 K^2. A friction-wheel and conical roller thus arranged together constitute a friction driving-gear adapted for varying the speed of a driven part by movement of the wheel or roller endwise with respect to the axis of rotation of the wheel in such manner that the friction ring or surface of the wheel will be engaged with the larger or smaller or any intermediate part of the conical roller.

So far as the general operation of the device is concerned the friction-ring L^3 may be formed or constructed in any manner to afford an inwardly-facing friction-surface on the wheel L for engagement with the conical friction-rollers K^2—as, for instance, said ring may consist merely of an inwardly-projecting rib on said wheel. As herein shown, however, and as a separate improvement, said friction-ring L^3 is made of a material different from that composing the wheel and is preferably made of paper, vulcanized fiber, leather, or like material. As herein shown said ring consists of a number of layers or thin rings of paper, vulcanized fiber, or leather, which are inserted in a groove or rabbet l, formed in the peripheral portion of the wheel L, and held in said groove or rabbet by a clamping-ring l', having screw-threaded engagement with the marginal part of the wheel.

As a further improvement I propose to make the conical friction-rollers K^2 movable endwise on their bearings or pivots and to apply springs between said cones and their bearings or supports in such manner as to force or press the rollers outwardly in a direction endwise of their axis of rotation, so that said rollers will be held by spring-pressure con-

stantly in contact with the friction-ring of the wheel L. As a still further improvement I propose to apply antifriction roller-bearings between said conical rollers and their bearings in such manner as to take the end thrust of the rollers. To now describe in detail the construction illustrated in the said conical rollers and their bearings, these parts are made as follows: The bearing-stud K′ of each roller is made hollow or tubular and has an exterior cylindric surface in bearing contact with a cylindric axial bearing aperture in the roller and in the bevel-gear K, which is attached to the base of said roller. The bearing aperture on the roller is made so deep as to extend considerably beyond the extremities of the bearing-stud, and within the inner end of said bearing-aperture is located a bearing-ring k, forming the external member of a ball-bearing. Within the end of the tubular stud K′ is inserted an endwise-slidable spindle k^2, which projects beyond the said stud and is provided on its projecting end with an annular bearing member or cone k^3, arranged in opposition to the outer annular bearing-ring k, which latter constitutes, in effect, a cup, antifriction-balls k^4 being interposed between the conical bearing-surface k^3 and the ring k. Said spindle k^2 is also preferably provided at its end with a reduced cylindric extension k^5, which enters a corresponding axial bearing-aperture forming a continuation of the larger bearing-aperture of the roller. In the inner end of the tubular bearing-stud K′, which latter is inserted through its supporting-arm D^3, is inserted a screw-plug k^6, and between said screw-plug and the inner end of the spindle k^2 is interposed a coiled spring K^3, which acts by its expansion to force or thrust the spindle k^2 outwardly, and thereby thrust or carry the conical roller outwardly upon its bearing-stud, with the result of pressing or holding it in contact with the friction-ring of the wheel L. The screw-plug k^6 being adjustable endwise in the bearing-stud K′ by reason of its screw-threaded connection with the same affords a means of adjusting the tension of the spring K^3 and of thereby varying the pressure of the conical roller against the said friction-ring. The antifriction-bearing, arranged as described between the conical roller and the endwise-movable spindle k^2, obviously takes the end thrust of said spindle against the roller and lessens the frictional resistance to the rotation of the roller, which is due to the endwise pressure of the roller against said spindle.

The friction-wheel L, mounted to slide endwise but not to rotate upon the shaft M, in connection with the conical friction-rollers K^2, connected by the beveled gears with the sleeve E, as described, obviously constitute a change-speed gear through which motion is communicated from said sleeve E to the sleeve M. Said wheel L will be moved or shifted endwise on the sleeve M so as to bring the friction-ring L^3 in engagement with the larger or smaller parts of the friction-rollers, and thereby vary the speed of rotation of the friction-wheel, by any suitable actuating connection adapted for operation by the hand or automatically by the machine in connection with which the device is used. In the particular construction illustrated the hub L′ of the said wheel is provided with a groove containing a ring L^4, which is connected by means of a link L^5 with an actuating-lever L^6, which lever may be operated by any suitable actuating device forming part of an automatic metal-working or other machine.

Now describing the driving connections between the main shaft C, the sleeve M, and the driven shaft B, these parts are constructed as follows: Said driven shaft B is arranged at right angles with and at some distance laterally from the shaft C, said shaft B being shown as journaled at its end in a bracket D^4, attached to the bearing D′, in which latter the end of the shaft C is mounted. A short counter-shaft N is arranged parallel with the end portion of the shaft C, the same being mounted in a bearing-sleeve D^4, which is rigidly attached to the bearing D′. The counter-shaft is driven from the shaft C by means of a gear-wheel C′, affixed to said shaft C, which intermeshes with a gear-pinion N′, affixed to the adjacent end of the counter-shaft N. Said counter-shaft N is arranged with its axis in the same plane with the driven shaft B, and said driven shaft has affixed to it a beveled gear B′, which intermeshes with a bevel-gear N^3 on the adjacent end of said counter-shaft N, whereby the shaft B receives motion from said counter-shaft. The shaft B also carries a worm-wheel O, which intermeshes with a worm M′ on the sleeve M. Said worm-wheel Q is not attached to said shaft, but is adapted to turn thereon and has driving connection therewith through the medium of a sleeve P, which is keyed to said shaft B and is provided at its end adjacent to the worm-wheel with ratchet-teeth p, adapted for engagement with the free end of a pawl O′, Figs. 7 and 10, which pawl is pivoted to the worm-wheel and engages said ratchet-teeth p. The pawl O′ is adapted to be moved or actuated by means of a spring-ring Q, which encircles the sleeve P in such manner as to have frictional engagement therewith and is provided with an outwardly-extending prong or arm q, which engages an aperture in a laterally-projecting lug o on the pawl O′. Said spring-ring Q by reason of its frictional engagement with the sleeve P tends to turn with said sleeve and the shaft B, and when said shaft is driven from the main shaft through the counter-shaft N the pressure of the arm q of said ring Q on the pawl O′ will throw said pawl outwardly and hold it free from the ratchet-teeth p, thereby enabling said shaft B to turn within the worm-wheel O without contact of the pawl with the ratchet-teeth so long as it is so driven or actuated by the shaft C. If, however, the shaft M be actuated

and the worm-wheel O be rotated therefrom through the medium of the worm M', the turning of said worm-wheel on the shaft B will bring pressure of the lug *o* against the spring-ring Q in a direction to carry the free end of the pawl into engagement with the ratchet-teeth *p*, thereby interlocking said worm-wheel with said shaft D, after which the said shaft D will be driven from the shaft M at a speed determined by the relative proportion of the worm and the worm-wheel and by the position of the friction-wheel L with respect to the friction-rollers K^2.

The operation of the device as a whole will be understood from the following: When it is desired to drive the shaft B at a relatively high and constant speed, as is required in an automatic machine for retracting the cutting-tools from their work, the clutch-sleeve G is thrown toward the bevel-gear F', so as to bring the clutch members or teeth thereon at once into engagement with the clutch member F^3 on the shaft C and the clutch-teeth on said bevel-wheel F'. This is the position illustrated in several figures of the drawings. At this time the bevel-gear F' will be engaged with the main shaft C, which will be then driven from the driving-pulley A at a speed determined by the gearing connecting these parts. The rotation of the shaft C will be transmitted to the counter-shaft N by the gear-wheels connecting them, and the driven shaft B will be actuated from said counter-shaft by the bevel-gears N^2 and B'. When said shaft B is so driven from the shaft C, it will be disconnected from the worm-wheel O, as the ratchet-teeth will be free to turn forwardly with respect to the pawl O'. Moreover, by reason of the action of the spring Q said pawl will at this time be held free from said ratchet-teeth. When it is desired to drive said shaft B in the same direction at a slower and variable speed, the clutch-sleeve G will be shifted toward the bevel-gear F, with the result of rigidly connecting the bevel-gear F with the sleeve E, it being understood that previous to such movement said bevel-gear was free to turn on the sleeve and that after the clutch-sleeve is thus moved or shifted the bevel-gear F' will be released from its connection with the shaft C and will be free to turn thereon. When the bevel-gear F is thus connected with the sleeve E, said sleeve will be rotated, thereby turning the pinion E' and giving rotary motion to the conical friction-rollers K^2. These rollers being pressed against the friction-ring of the wheel L, said wheel will be driven at a speed depending on the position of the friction-ring with respect to the ends of the rollers, the wheels L being driven more slowly when the ring is in contact with the smaller ends of the rollers and more rapidly when in contact with the larger ends of said rollers. The rotary motion so given to said wheel L will be transmitted to the sleeve M and from said sleeve, by the worm and worm-wheel connection described, to said shaft B. It will of course be understood that said shaft B will be driven from the worm-wheel through the action of the pawl O' and that the shaft C will be turned or rotated through the action of the gearing connecting it with said shaft B, although such rotation of the shaft C will have no effect whatever upon the operation of the other parts through which the shaft B is at this time being driven.

I claim as my invention—

1. A change-speed gear embracing two gear-wheels, an intermediate, endwise-movable clutch-sleeve and means for operating said sleeve comprising an oscillating lever provided with two lever-arms, spring-actuated detent-arms engaging said lever-arms, and an oscillating actuating-lever for actuating the lever-arms and detent-arms, said actuating-lever being provided with two spring-actuated plungers which act on said lever-arms to give oscillatory movement to the said lever.

2. A change-speed gear embracing a main shaft, a sleeve which turns on the shaft, two bevel-gears, one of which turns on the shaft and the other on the said sleeve, clutch members on the said gear-wheels, clutch members on the said shaft and sleeve, an endwise-movable clutch-sleeve provided at each end with two sets of clutch-teeth adapted for engaging the clutch members on the shaft, sleeve and gear-wheels, and means for actuating said clutch-sleeve.

3. A change-speed gear embracing a rotative friction-wheel provided with an inwardly-facing friction-ring, and a rotative, conical friction-roller having its outer surface in contact with the said friction-ring, and parallel with the axis of rotation of the wheel; said wheel and friction-roller having relative movement in the direction of the axis of rotation of said wheel.

4. A change-speed gear embracing a rotative friction-wheel provided with an inwardly-facing friction-ring, a conical friction-roller having its outer surface in contact with said ring, and power-transmitting connections for the roller, embracing a gear-wheel mounted concentrically with the axis of rotation of said wheel and having driving connection with the roller; said friction-wheel and the roller having relative movement in the direction of the axis of rotation of said friction-wheel.

5. A change-speed gear embracing a rotative friction-wheel provided with an inwardly-facing friction-ring, a conical friction-roller, a stationary part provided with bearing-studs for said roller, a spring applied between said stationary part and the roller tending to move the latter endwise in the direction to maintain its contact with said friction-ring, said part carrying said friction-roller and the said friction-wheel having relative movement in the direction of the axis of rotation of said wheel.

6. A change-speed gear embracing a friction-wheel provided with an inwardly-facing

friction-ring, a conical roller engaging said friction-ring, a bearing-stud for the roller, said roller being movable endwise on said bearing-stud, a roller-bearing for said roller embracing two annular parts or members one of which is movable endwise with respect to the said bearing-stud, and a spring applied to said part of the bearing which is movably connected with the stud to move said part outwardly with respect to the said bearing-stud.

7. A change-speed gear embracing a rotative friction-wheel provided with an inwardly-facing friction-ring, a rotative conical friction-roller, a bearing-stud of tubular form for said friction-roller, an antifriction roller-bearing comprising two annular parts one of which has the sliding engagement with the said bearing-stud, a screw-plug inserted in the inner end of said bearing-stud, and a coiled spring inserted in said tubular stud between said screw-plug and said sliding member of the ball-bearing.

8. A change-speed gear embracing a rotative friction-wheel provided with an inwardly-facing friction-ring, a plurality of conical friction-rollers engaging said friction-ring, bearing-studs for said rollers, a stationary part in which said studs are mounted, bevel-gears attached to said friction-rollers, a gear-pinion mounted in said stationary part concentrically with the axis of rotation of said wheel and intermeshing with said bevel-gears, and a rotative part on which said friction-wheel is mounted and with which it has endwise slidable but non-rotative connection.

9. A change-speed gear embracing a main shaft, a sleeve thereon, two bevel-gears, one mounted to turn on the sleeve and the other on the shaft, clutch members one of which is attached to the shaft and the other to the said sleeve, clutch members attached to said bevel-gears, a slidable clutch-sleeve provided at each end with two clutch members, said clutch members being adapted for engagement with the clutch members on the shaft, sleeve and bevel-gears, a friction-wheel mounted concentrically with said shaft and provided with an inwardly-facing friction-ring, a conical friction-roller engaging said friction-ring, a bevel-gear attached to said conical roller, and a gear-pinion on said sleeve intermeshing with said bevel-gear on the conical roller.

10. A change-speed gear embracing a main shaft, a sleeve thereon, two bevel-gears one turning on the shaft and the other on the sleeve, a driving-pinion intermeshing with said bevel-gears, clutch members secured to the shaft and to the said sleeve, clutch members on the said bevel-gears, a slidable clutch-sleeve provided at each end with two clutch members, said clutch members on the sleeve being adapted for engagement with the clutch members on the shaft, sleeve and bevel-gears, a rotative friction-wheel provided with an inwardly-facing friction-ring, a conical friction-roller engaging said friction-ring, a bearing-stud for said roller, a stationary support for said bearing-stud through which said sleeve passes and which affords a bearing for the same, a bevel-gear attached to said friction-roller, a gear-pinion on said sleeve intermeshing with said bevel-gear, a second sleeve on said shaft with which said wheel has sliding but non-rotative engagement, a shaft to be driven and driving connections between said main shaft and said shaft to be driven and also between said second sleeve and said shaft to be driven.

11. A change-speed gear embracing a main shaft, a shaft to be driven, two bevel-gears mounted on said shaft, a driving-pinion intermeshing with said bevel-gears, a sleeve surrounding said shaft, a clutch mechanism for connecting one of said bevel-gears with the shaft and the other with said sleeve, a second sleeve on said shaft, a speed-changing device affording driving connection between said first and second sleeves, gearing connecting said main shaft with the driven shaft, and gearing connecting said second sleeve with the driven shaft embracing a pawl-and-ratchet connection.

12. A change-speed gear embracing a main shaft, a shaft to be driven arranged at right angles with the main shaft, two bevel-gears mounted on said main shaft, a driving-pinion intermeshing with said bevel-gears, a sleeve surrounding said shaft, a clutch mechanism for connecting one of said bevel-gears with the shaft and the other with the sleeve, a second sleeve on said shaft, a speed-changing device affording driving connection between said first and second sleeves, gearing connecting said main shaft with the driven shaft embracing a counter-shaft and bevel-gears, and gearing connecting said second sleeve with the driven shaft embracing a worm on said sleeve, a worm-wheel on the shaft and a ratchet connection between said worm-wheel and said shaft.

13. The combination, with a main shaft, a sleeve thereon, a gear through which said main shaft and sleeve are given rotary motion, a counter-shaft, gearing connecting the main shaft with the counter-shaft, a driven shaft at right angles to the main shaft, bevel-gears connecting the counter-shaft with the driven shaft, a worm on said sleeve, a worm-wheel mounted to turn on said driven shaft, and a pawl-and-ratchet connection between said worm-wheel and said driven shaft.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 21st day of August, A. D. 1899.

OSCAR NORLING.

Witnesses:
W. A. HEMING,
J. H. ABERCROMBIE.