(No Model.) 3 Sheets—Sheet 1.

S. TWEEDALE.

DIFFERENTIAL MOTION FOR SLUBBING AND ROVING FRAMES.

No. 386,906. Patented July 31, 1888.

Fig. 1.

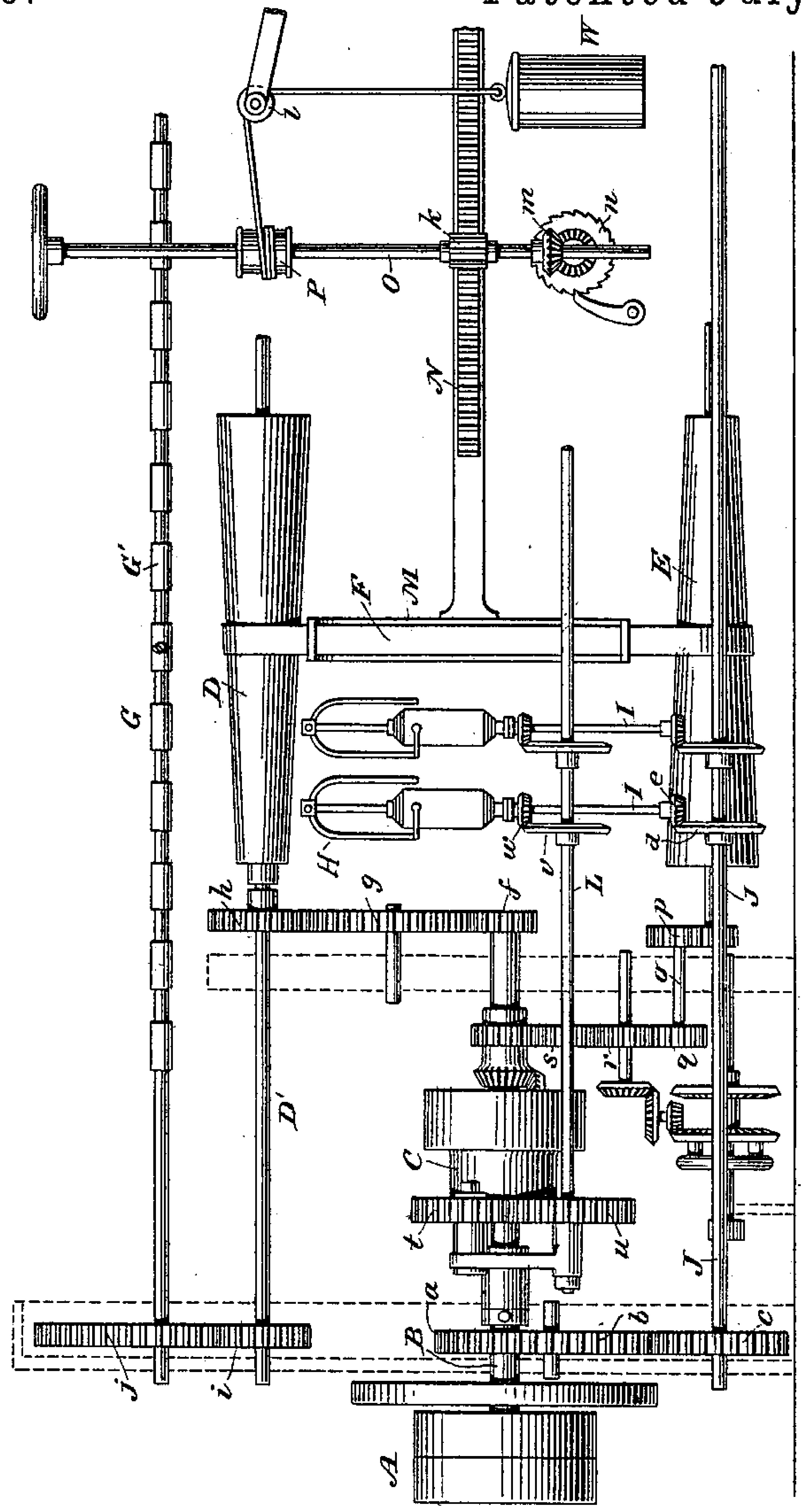
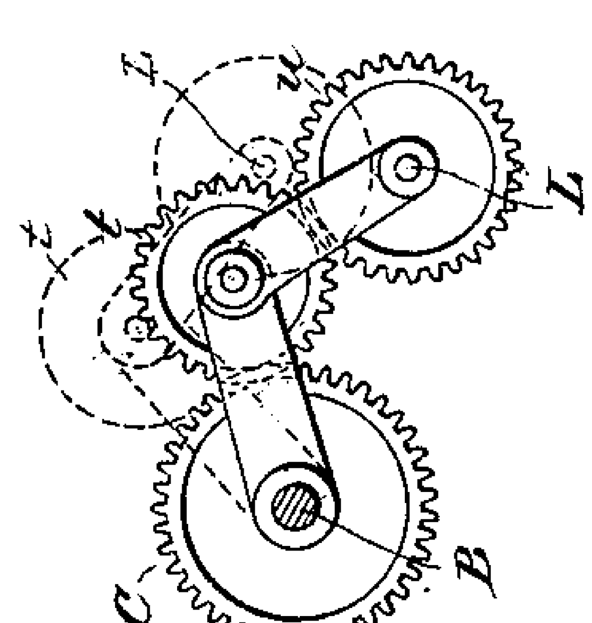


Fig. 1a.



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(No Model.) 3 Sheets—Sheet 2.

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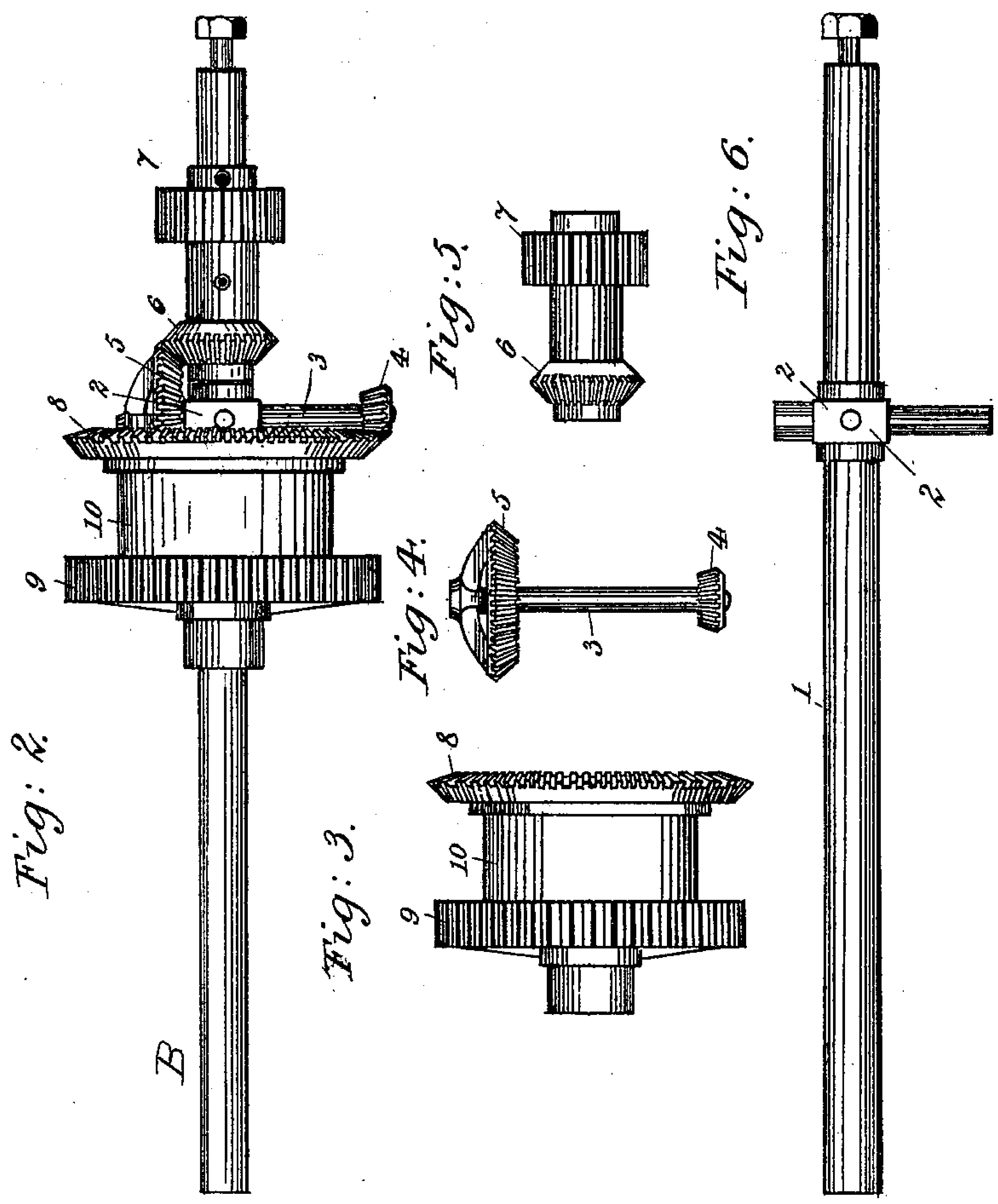

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(No Model.) 3 Sheets—Sheet 3.

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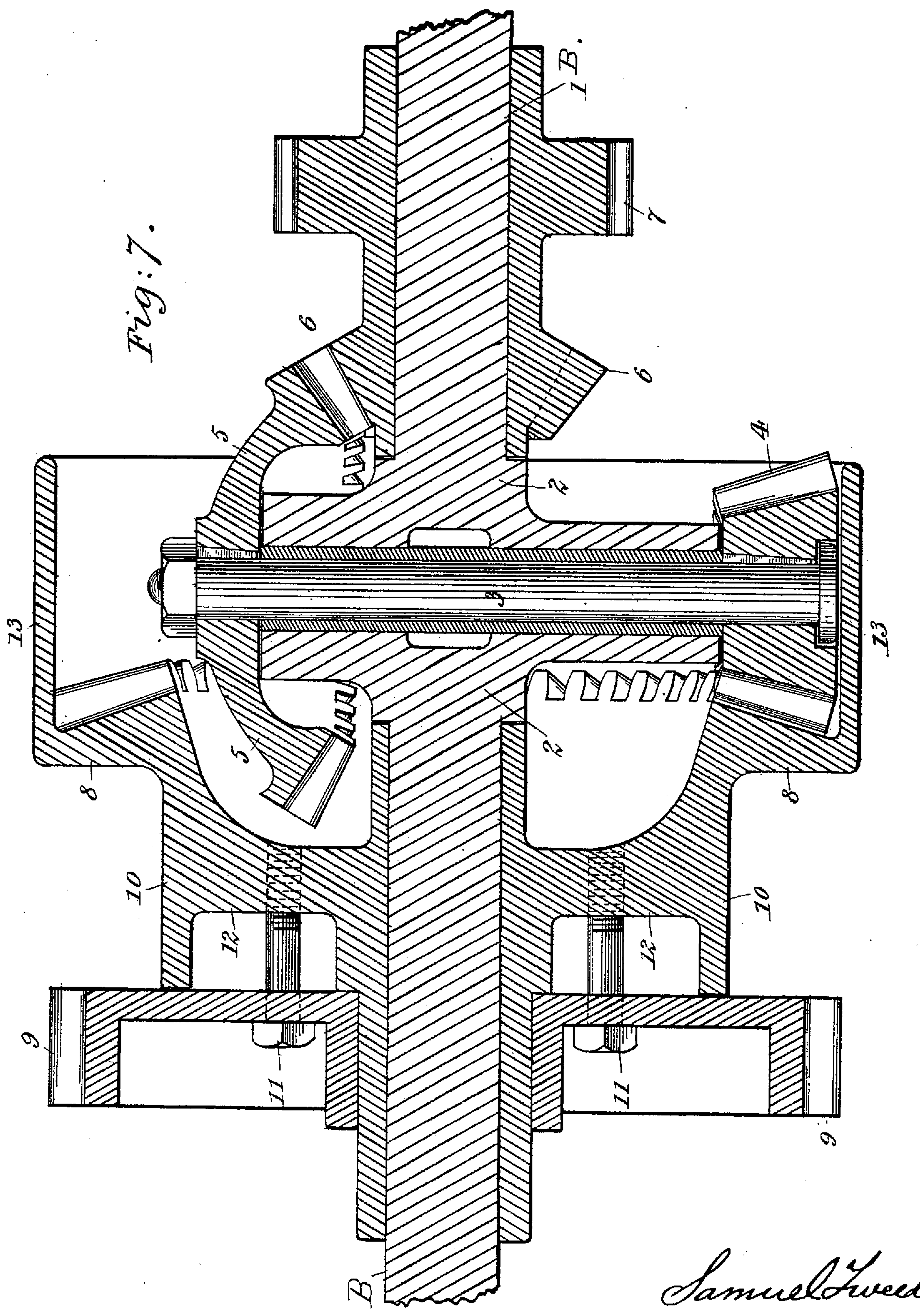

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UNITED STATES PATENT OFFICE.

SAMUEL TWEEDALE, OF ACCRINGTON, COUNTY OF LANCASTER, ENGLAND.

DIFFERENTIAL MOTION FOR SLUBBING AND ROVING FRAMES.

SPECIFICATION forming part of Letters Patent No. 386,906, dated July 31, 1888.

Application filed January 22, 1887. Serial No. 225,227. (No model.) Patented in England November 29, 1884, No. 15,720; in France March 27, 1886, No. 175,081, and in Austria-Hungary May 28, 1886, No. 5,717.

To all whom it may concern:

Be it known that I, SAMUEL TWEEDALE, a subject of the Queen of Great Britain, residing at Accrington, in the county of Lancaster, England, have invented certain new and useful Improvements in Differential Motions for Slubbing and Roving Frames, of which the following is a specification.

This invention has been patented in Great Britain, No. 15,720, dated November 29, 1884; in France, No. 175,081, dated March 27, 1886, and in Austria-Hungary, No. 5,717, dated May 28, 1886.

This invention relates to the "jacks" or differential gears employed in slubbing-frames, intermediate frames, roving-frames, and other machinery in the nature of bobbin and fly frames for giving the requisite differential motions to the bobbin and fly, respectively, in order to insure the uniform winding on of the slubbing, roving, or yarn upon the bobbins.

In the preparation of cotton or other fibers for spinning, the sliver from the carding-engine is first attenuated by passing through drawing-rollers in a drawing-frame, several slivers being doubled together during this operation, and the drawing being repeated as many times as may be necessary and until the sliver becomes so attenuated that its fibers will not sufficiently cohere if simply laid parallel, and at this stage of the process a slight twist is imparted to the sliver or slubbing in order to give it the necessary strength for the subsequent operations. This twist is imparted in the slubbing-machine, wherein the slubbing on emerging from the drawing-rolls passes to a flier which revolves around the bobbin on which the slubbing is wound, and by its revolution gives the requisite twist. The slubbing is then ordinarily passed through an intermediate frame, which further attenuates it and gives it an additional twist, and from this it passes to the rolling-frame, wherein it is still further drawn out and is given still more twist. The roving then passes to the spinning machinery. The slubbing, intermediate, and roving frames are all, essentially, bobbin and fly frames, as is also the throstle type of spinning-machine. It is to machines of this nature, having bobbins and fliers for twisting and winding, that my invention pertains.

In bobbin and fly machines the winding of the roving, &c., on the bobbin is effected by the difference of speed between the bobbin and the flier, both of which revolve in the same direction. In some machines the speed of the bobbin exceeds that of the flier, while in some other machines the bobbin is driven slower than the flier. In either case it is essential that the difference in their speeds shall be greatest at the beginning of the winding on, when the diameter of the spool or bobbin is the least, and that the difference in speed shall become less as the diameter of the bobbin increases. When the bobbin runs in advance of the flier, the speed of the bobbin has to be gradually diminished, as its diameter increases by each successive layer of roving which is wound on. Otherwise the delicate roving would be irregularly stretched or broken by the relatively-increasing surface speed of the bobbin, since the speed of the drawing-rollers and the flier must be kept constant in order that an equal amount of twist may be put into the roving throughout its entire length. On the other hand, when the bobbin follows the flier, its speed of revolution has to be gradually increased as its diameter increases by the winding. In either case the vertical reciprocating movement of the bobbin-lifter, by which the roving is caused to be laid on in regular successive layers, has to be gradually retarded to allow a longer time for winding each successive layer of roving upon the increasing circumference of the bobbin.

The mechanism by which the requisite variation of speed is imparted to the bobbins in machines of this character is known as a "differential motion" or "jack," which consists of an arrangement of differential gearing, the speed of which is varied by means of the shifting of the belt from one end to the other of one or more coned pulleys, an example of which is the well-known "Houldsworth differential gear," patented in England in 1826, No. 5,316. The kind of differential motion on which my invention is most directly an improvement is that known as "White's differential motion," wherein the revolving idler bevel-wheels are carried on transverse arms fixed on the shaft and gearing with bevel-gears which turn loosely on the shaft, and one of which bevel-gears is driven at a variable speed through the medium of the cone-drums and shifting-belt.

In the construction of jacks or differential gears used prior to my invention the idler-wheels tend by their rapid revolution around the shaft to fly outward centrifugally, and thereby considerable friction is generated, which results in the journals or carrying-studs becoming greatly heated, and also involves considerable strain of the working parts.

The object of my invention is to provide an improved construction of jack which shall avoid the centrifugal action inherent in the old constructions, and which consequently shall run with less friction and without heating or strain due thereto.

In the accompanying drawings I have illustrated my invention as applied to a slubbing-frame, wherein the bobbins are driven at a higher speed than the fliers.

Figure 1 is a front elevation of the general driving-gear of the machine in so far as is essential to illustrate the application to the ordinary slubbing-frame or other analogous machines of the improved construction of differential gear provided by my invention. Fig 1^a is a detail view of the swing-wheel. Fig. 2 is an elevation of my improved jack on a larger scale. Figs. 3, 4, 5, and 6 are elevations of the several parts or elements of my jack separated. Fig. 7 is a longitudinal mid-section of the jack on a still larger scale.

Referring first to Fig. 1, let A designate the driving-pulleys; B, the driving-shaft; C, the jack or differential gear as a whole; D, the upper or positive-motion coned pulley; E, the lower- or variable-speed cone-pulley; F, the belt by which the lower pulley is driven from the upper one; G G', the drawing-rolls; H H, the fliers; I I, the flier-spindles; J, the spindle-driving shaft; K K the bobbins, and L the bobbin-driving shaft. Only two fliers and bobbins are shown.

The drawing rolls, the fliers, and the upper coned pulley are driven from the main shaft B at a uniform speed, as usual. The fliers are driven by a gear, *a*, on the main shaft, which imparts motion through the arm-wheel *b* to the gear *c* on the spindle-shaft J, on which are fixed bevel-gears *d d*, meshing with bevel-pinions *e e* on the respective spindles I I, on which spindles the fliers are fixed.

The upper cone-pulley, D, is driven by a gear, *f*, on the main shaft, (called the "twist-wheel,") which transmits motion through an idler, *g*, (called the "twist-wheel carrier,") to the gear *h*, fixed on the shaft D', which carries the cone-pulley D. The drawing-rollers are driven by a gear, *i*, on the shaft D', meshing with a gear, *j*, on the shaft of the front drawing-roller.

The belt F is shifted along the coned pulleys during the filling of the bobbins by means of the belt-shipper M, which is fixed on the shipper-rod N, which rod carries a rack meshing with a pinion, *k*, on a vertical shaft, O, which carries a winding-drum, P, on which winds a chain carried over a sheave, *l*, and to the end of which is hung a weight, W. The shaft O is geared by miter-gears *m* to a ratchet-wheel, *n*, which ratchet-wheel is acted upon by a pawl operated from the bobbin-lifting mechanism at each vertical reciprocatory movement of the bobbins. The bobbin-lifting gear is so well known as applied to machines of this class that I do not consider it necessary to illustrate it, since it has no direct connection with the improved construction introduced by my invention.

I will now describe the construction of my improved jack.

The driving shaft B is constructed with a transverse tubular boss, 2, as shown in Figs. 6 and 7, which forms a carrier or bearing for a cross shaft, 3, on the opposite ends of which are secured, respectively, two bevel-gears, 4 and 5. These gears are keyed fast to the shaft 3, so that both must rotate together. The larger bevel-gear, 5, meshes with a bevel-gear, 6, on a sleeve which turns loosely on the shaft B. This sleeve (shown detached in Fig. 5) is formed also with a gear, 7, which is driven from the variable-speed coned pulley E, through the medium of gears *o*, *p*, *q*, *r*, and *s*, as shown in Fig. 1. The smaller bevel-gear, 4, on the shaft 3 gears with a plate-bevel, 8, which turns loosely on the shaft B. This gear 8 is preferably constructed with a boss, 10, to which a gear, 9, is fastened by means of screws 11 11, engaging the solid web 12, Fig. 7. A cylindrical cover or guard, 13, may be cast on the wheel 8, as shown in Figs. 1 and 7, or otherwise fastened thereto, and serves to inclose and protect the gears 4 and 5. This guard is omitted in the other figures.

The gear 9, which turns with the plate-bevel 8, drives the bobbin-shaft L through the medium of the usual "swing-wheel," *t*, Fig. 1^a, which communicates the movement to the gear *u* of the shaft L, which shaft drives the bobbins through the medium of bevel-gears *v v*, meshing with bevel-pinions *w w* on the bobbin-spools. Thus it will be understood that while the fliers are driven at a uniform speed directly from the main shaft, the bobbins are driven at a varying speed through the medium of the cone-pulleys D E, the shifting-belt F, and the jack or differential motion C.

The operation of the jack will now be described.

As the shaft B revolves its tubular boss 2 carries the cross-shaft 3 around with it, and if this cross-shaft did not revolve the plate-bevel 8 would be carried around also with the shaft B. To insure this result it would be necessary that the gears 6 and 7 should be revolved (through the medium of the bevel-coned pulleys) at the same speed with the shaft B and in the same direction. This extreme, however, does not occur in practice, since the gears 6 7 are driven forward at a varying speed considerably less than that of the shaft B. If the wheel 6 were stationary, the revolution of the shaft 3 around the axis of the main shaft would cause the gear 5 to roll around the gear 6 and execute a partial revolution inversely proportional to their respective diameters; and the wheel 4, turning likewise a partial revolution, would turn the plate-bevel 8 a small fraction of a revolution (inversely proportional to their respective diameters) backward relatively to the direction of motion of the shaft B, and this relative backward rotation, being deducted from the forward rotation of the shaft B, gives the net forward rotation of the plate-bevel 8. For example, supposing that the proportions of the respective gears 6, 5, 4, and 8 are such that if the shaft B were held stationary and the gear 6 rotated backward, a backward rotation would be imparted to the gear 8 at one-fifth the speed of the gear 6. Then if the shaft B were revolved forward and the gear 6 held stationary the gear 8 would be revolved forward four-fifths of a revolution, being the entire forward revolution of the shaft B less the one-fifth backward revolution imparted through the differential gears. In practice neither of these extremes occurs, since the gear 6 is revolved forward at varying speeds, which may be, for example, from one-half to one-twefth the speed of the shaft B, and consequently the forward rotation of the plate-gear 8 and wheel 9 varies from nine-tenths of a revolution down nearly to four-fifths of a revolution.

At starting, or when commencing to wind onto the bare spools, the belt F is at the extreme right hand in Fig. 1 and the bobbins are driven at the maximum speed. As the diameter of the bobbins increases with each layer laid on, the belt is shipped successively toward the left, and when winding on the last layer on the full bobbins the belt is at the left-hand ends of the pulleys and the speed of the bobbins is consequently reduced to the minimum. In the former case the gear 6 is driven at its maximum speed, which we may assume, for example, to be one-half that of the shaft B, and consequently the gears 8 and 9 (and the bobbins driven by them) are rotated at their maximum speed. In the latter case the gear 6 is driven at its minimum speed, which we may assume, for example, to be one-twelfth that of the shaft B, and the gears 8 and 9 are driven at their minimum speed.

It will be understood that the relative proportions of the several gears constituting my improved jack are immaterial to my invention, these proportions being variable according to the pleasure or judgment of the constructor of the machines in which it is to be used. The relative proportions of the gears 6, 5, 4, and 8 will be governed largely by the proportions of the remainder of the driving-gearing of the machine.

In the particular construction shown in the drawings the gear 6 has eighteen teeth, the gear 5 has thirty teeth, the gear 4 has sixteen teeth, and the gear 8 has forty-eight teeth. Thus the ratio between gears 6 and 8 is as 5 to 1. The gear 9 having fifty teeth, the ordinary wheel, *u*, for driving the spindles should have one-fifth less teeth—that is, forty teeth.

It will be observed that in my improved jack the centrifugal action tending to throw the gears 4 and 5 outward is resisted by the cross-shaft 3 and does not come against the bearings. Consequently all undue strains, friction, and heating are avoided. This result is further due to the perfect balancing of the parts, which is accomplished by arranging the larger gear, 5, closer to the center than the smaller and lighter gear, 4, so that the centrifugal force acting upon them (which is the product of their weight multiplied by the square of their distance from the center and by the speed) is equalized, or very nearly so. In like manner the cross arm or boss 2 on the shaft B is balanced by making its shorter arm thicker than its longer arm, as clearly shown. By virtue of these proportions the centrifugal action is effectually neutralized and all tendency of the gears to fly out of mesh is obviated.

I claim as my invention the improvements in jacks or differential motions applicable to slubbing and roving machinery or other analogous machines, defined as follows, substantially as hereinbefore specified, namely:

1. A differential gearing consisting of the combination of a shaft formed with a transverse bearing-boss, a cross-shaft mounted to turn in said bearing, bevel-gears fixed to the opposite ends of said cross-shaft, and bevel-gears mounted to turn on an axis concentric with the axis of said shaft and gearing, respectively, with the gears on opposite ends of said cross-shaft.

2. A differential gearing consisting of the combination of a shaft formed with a transverse bearing-boss, a cross-shaft mounted to turn in said bearing, bevel-gears of different size fixed on the opposite ends of said cross-shaft, and bevel-gears mounted to turn on an axis concentric with the axis of said shaft and gearing, respectively, with the bevel-gears on opposite ends of said cross-shaft.

3. A differential gearing consisting of the combination of a shaft formed with a transverse bearing-boss, a cross-shaft mounted to turn in said bearing, bevel-gears of different size fixed on the opposite ends of said cross-shaft, the larger one of said gears arranged nearer the main axis of rotation than the other in order to compensate for the difference in their weight and thereby equalize, or partially so, their centrifugal tendency, and bevel-gears mounted to turn on an axis concentric with the axis of said main shaft and gearing, respectively, with the bevel-gears on opposite ends of said cross-shaft.

4. A differential gearing consisting of the combination of a shaft formed with a transverse bearing-boss, a cross-shaft mounted to turn in said bearing, bevel-gears fixed on the opposite ends of said cross-shaft, and two bevel-gears arranged on opposite sides of said transverse boss turning loosely on the main

shaft and gearing, respectively, with the bevel-gears on opposite ends of said cross-shaft.

5. A differential gearing consisting of the combination of a shaft formed with a transverse bearing-boss, one arm of which is longer than the other, and the shorter arm of which is formed of greater thickness in order to counterbalance its weight against the weight of the longer arm, and thereby to equalize, or approximately so, the centrifugal force, a cross-shaft mounted to turn in said bearings, bevel-gears of different size fixed on the opposite ends of said cross-shaft, and bevel-gears mounted to turn on an axis concentric with the axis of said shaft and gearing, respectively, with the bevel-gears on opposite ends of said cross-shaft.

6. A differential gearing consisting of a shaft formed with a transverse bearing-boss, a cross-shaft mounted to turn in said bearing, bevel-gears fixed to the opposite ends of said cross-shaft, a variable-speed bevel-gear gearing with one of the gears on said cross shaft, and a driven bevel-gear gearing with the other gear on said cross shaft, in combination with speed-varying coned pulleys, their driving-belt and belt-shipper, and gearing driven by the variable-speed pulley and driving said variable-speed bevel-gear.

7. The combination of a main shaft formed with a transverse bearing-boss, a cross-shaft mounted to turn in said bearing, bevel-gears fixed to the opposite ends of said cross-shaft, a coned pulley geared to said main shaft, a reversed coned pulley, a belt connecting said coned pulleys, a belt-shipper for moving said belt along said pulleys to impart a variable speed to the driven pulley, a bevel-gear turning loosely on said main shaft driven by said driven pulley and gearing with one of the gears on said cross-shaft, and a bevel-gear turning loosely on said main shaft and gearing with the other gear on said cross-shaft.

8. The combination of a main shaft formed with a transverse bearing-boss, a cross-shaft mounted to turn in said bearing, bevel-gears fixed on the opposite ends of said cross-shaft, fliers geared to and driven from said main shaft, a coned pulley geared to said main shaft, a reversed coned pulley, a belt connecting said coned pulleys, a belt-shipper for moving said belt along said pulleys to impart a variable speed to the driven pulley, a bevel-gear turning loosely on said main shaft driven by said driven pulley and gearing with one of the gears on said cross-shaft, a bevel-gear turning loosely on said main shaft and gearing with the other gear on said cross shaft, and bobbins geared to and driven from said last-named bevel-gear.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

SAMUEL TWEEDALE.

Witnesses:
JOSEPH SMALLEY,
JOSEPH GRIMSHAW.