(No Model.)

3 Sheets—Sheet 1.

C. WHITAKER.

FLY FRAME.

No. 534,385.

Patented Feb. 19, 1895.

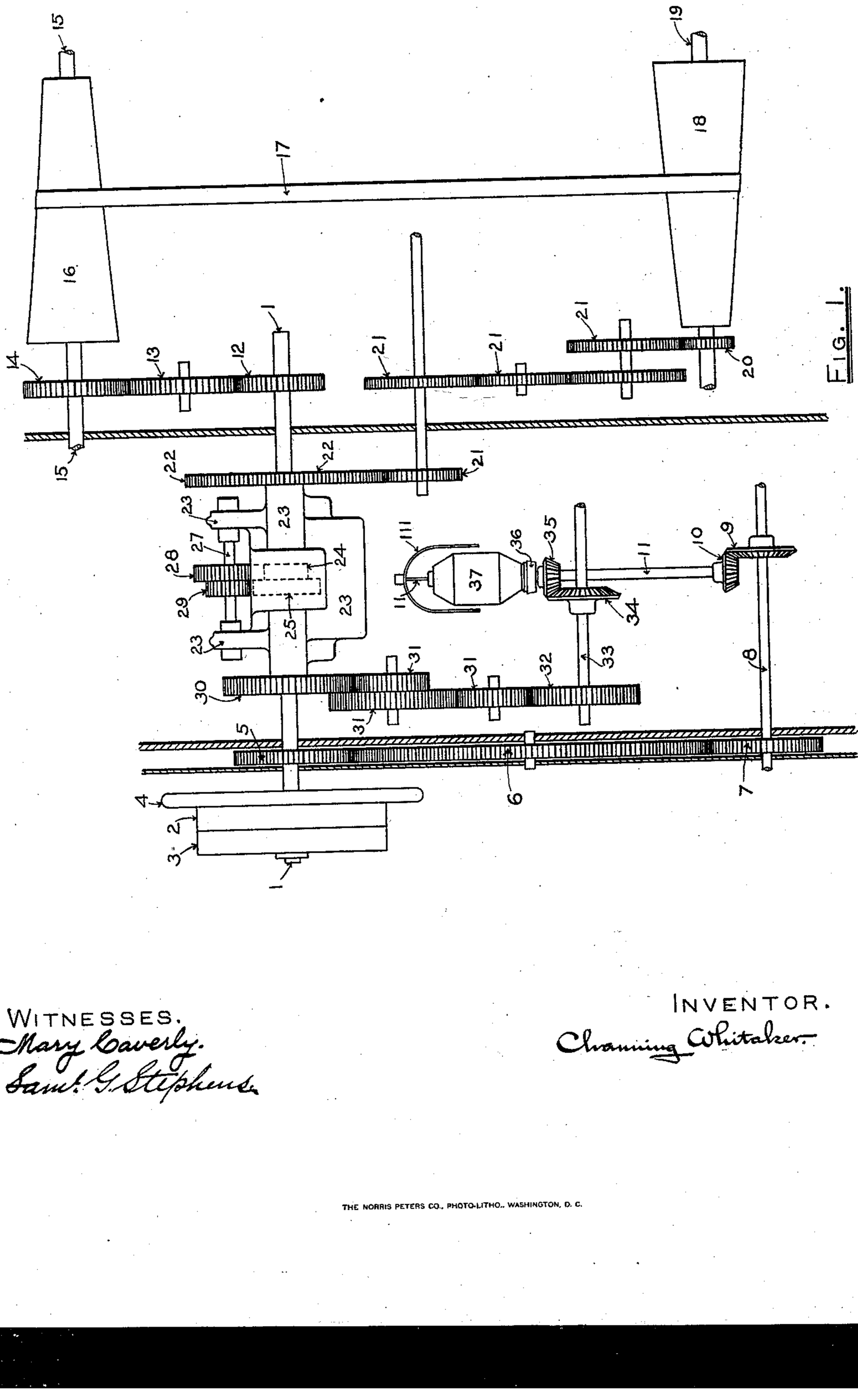

FIG. 1.

WITNESSES.
Mary Caverly.
Saml. G. Stephens.

INVENTOR.
Channing Whitaker.

(No Model.) 3 Sheets—Sheet 2.

C. WHITAKER.

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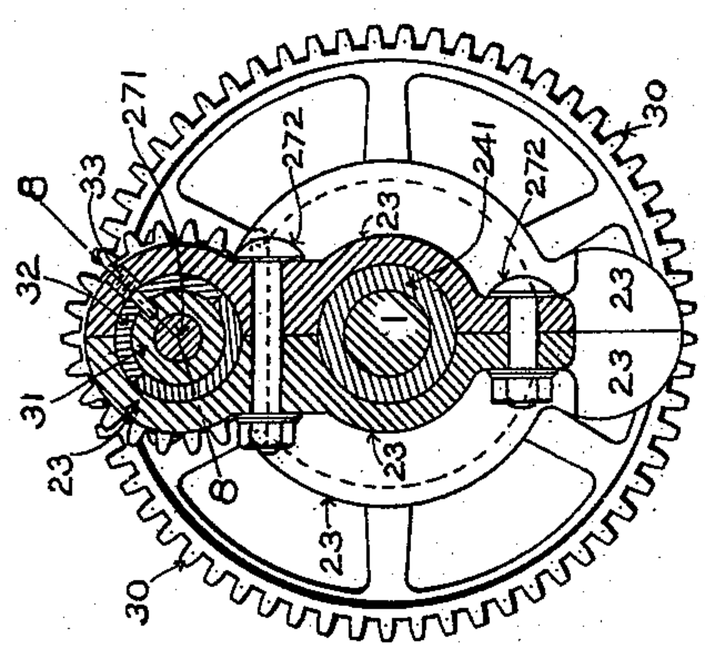

FIG. 3.

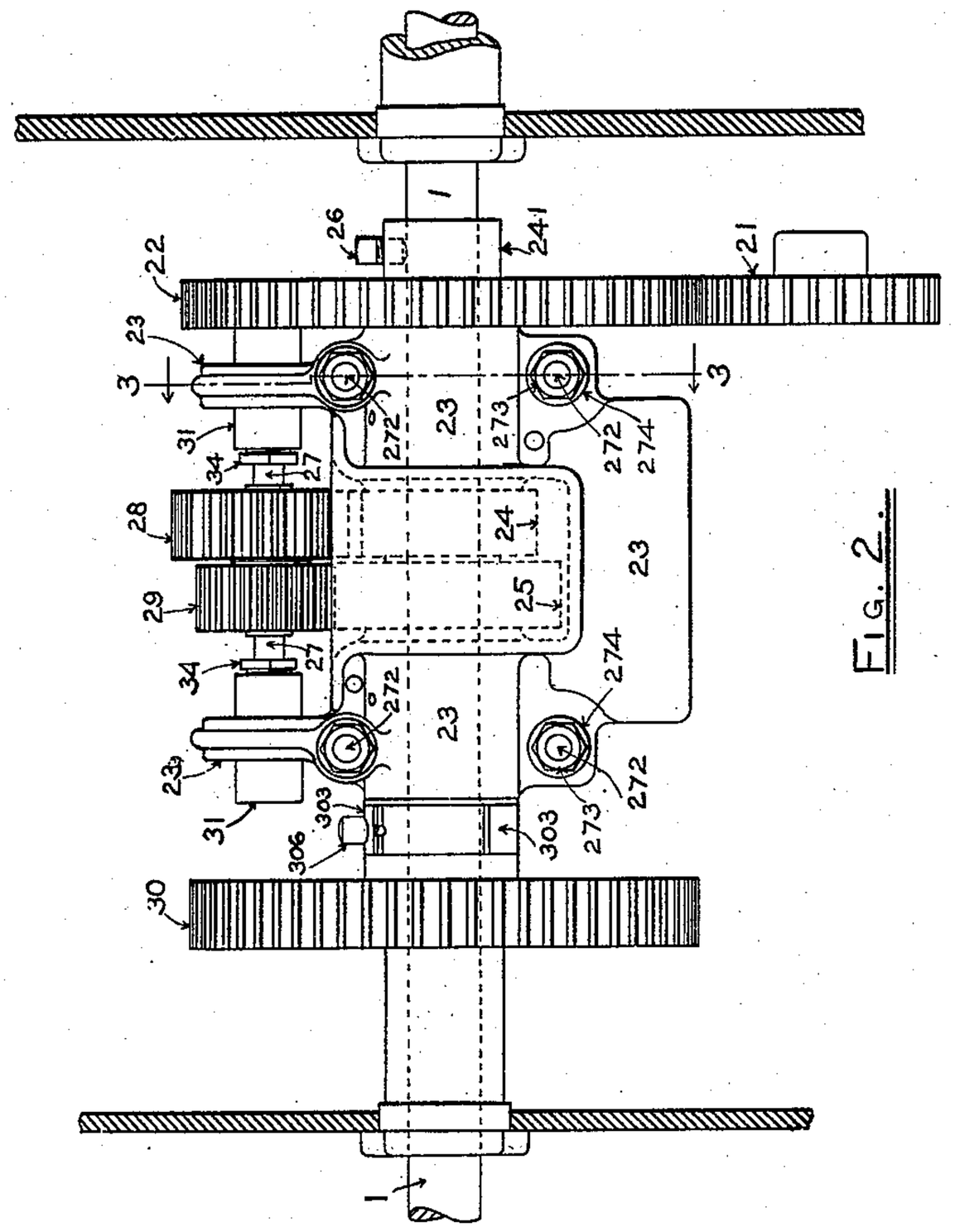

FIG. 2.

WITNESSES
Mary Caverly.
Saml. G. Stephens.

INVENTOR
Channing Whitaker.

(No Model.) 3 Sheets—Sheet 3.

C. WHITAKER.

FLY FRAME.

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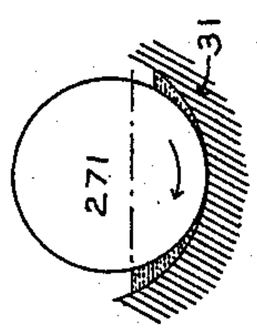

FIG. 9.

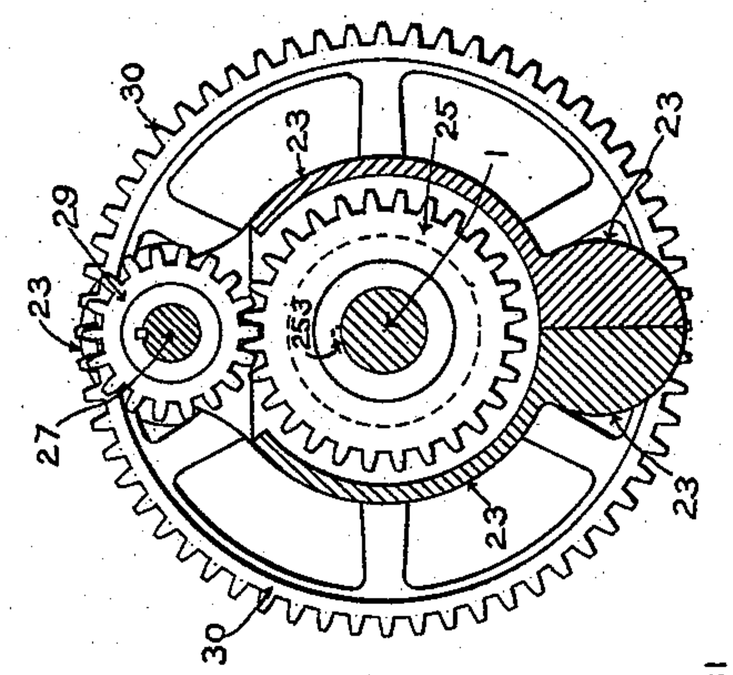

FIG. 5.

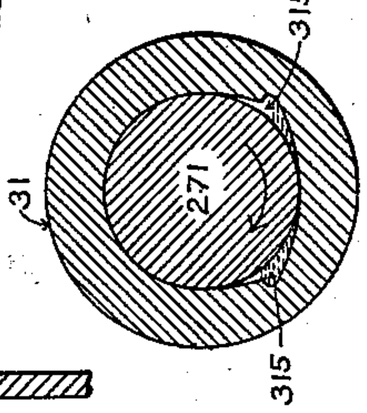

FIG. 14.

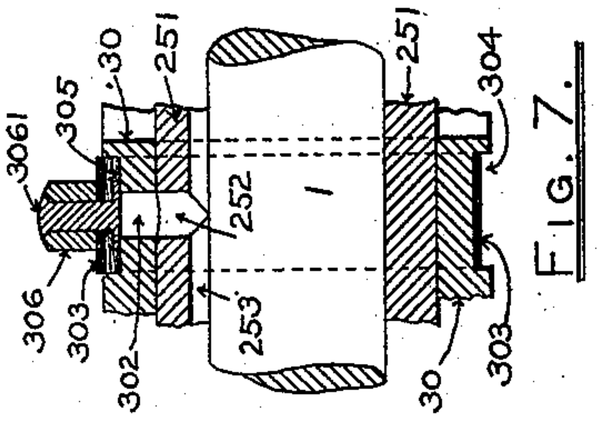

FIG. 7.

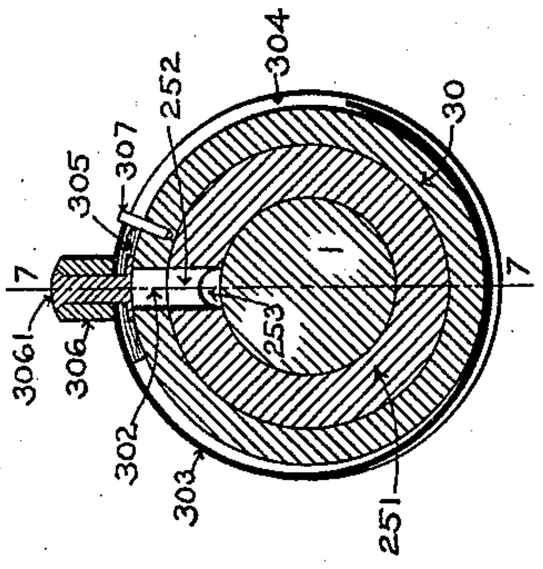

FIG. 6.

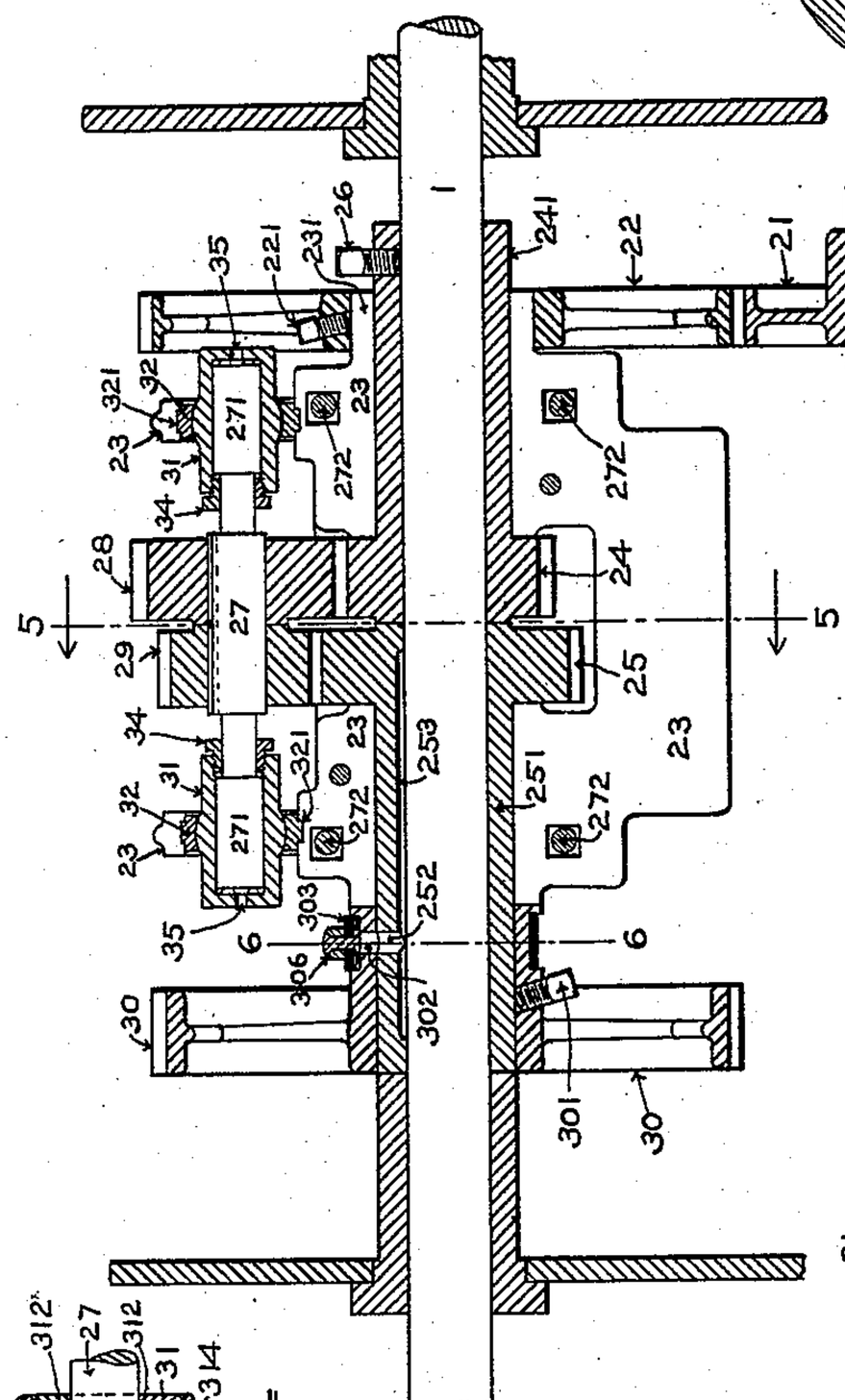

FIG. 4.

FIG. 8.

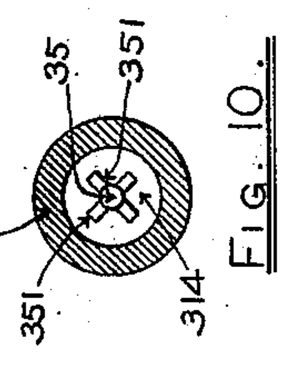

FIG. 10.

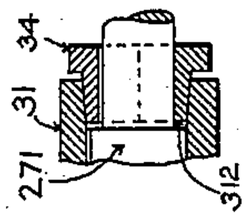

FIG. 11.

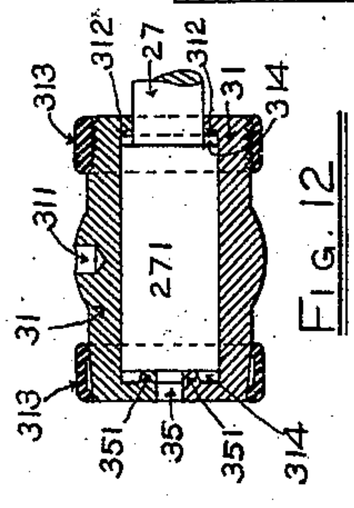

FIG. 12

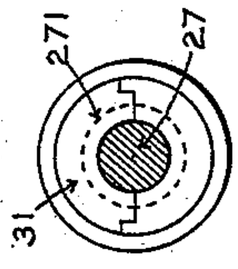

FIG. 13.

WITNESSES.

Mary Caverly.

Saml. G. Stephens.

INVENTOR.

Channing Whitaker.

UNITED STATES PATENT OFFICE.

CHANNING WHITAKER, OF TYNGSBOROUGH, ASSIGNOR TO THE LOWELL MACHINE SHOP, OF LOWELL, MASSACHUSETTS.

FLY-FRAME.

SPECIFICATION forming part of Letters Patent No. 534,385, dated February 19, 1895.

Application filed October 10, 1893. Serial No. 487,767. (No model.)

To all whom it may concern:

Be it known that I, CHANNING WHITAKER, a citizen of the United States, residing at Tyngsborough, in the county of Middlesex and Commonwealth of Massachusetts, have invented certain new and useful Improvements in Fly-Frames, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to fly-frames, and, more particularly, to the devices which are employed in fly-frames for the purpose of rotating the bobbins and automatically varying the speed of the bobbins relatively to that of the spindles and fliers in proportion as the bobbins fill with roving.

The invention consists in certain features of improved construction, and in certain novel and improved combinations of parts, all as first will be described fully with reference to the accompanying drawings, and then will be particularly pointed out and clearly defined in the claims at the close of this specification.

In the drawings, Figure 1 is a view in rear elevation of sufficient of a fly-frame to illustrate the connections and relations of my invention, the invention being represented as applied thereto. Fig. 2 is a view mainly in rear elevation, but partly in vertical section, illustrating certain parts to which the invention most directly relates. Fig. 3 is a view in vertical section on line 3—3 of Fig. 2. Fig. 4 is a view showing the parts of Fig. 2 in section at a plane passing through the axes of the driving and planetary shafts, and at right angles to the plane of the section which is represented in Fig. 3. Fig. 5 is a view in vertical section on line 5—5 of Fig. 4. Fig. 6 is a view in vertical section on line 6—6 of Fig. 4. Fig. 7 is a view in vertical section on line 7—7 of Fig. 6. Fig. 8 is a sectional view showing one of the enlarged journals of the planetary-shaft, its bearing, and the bearing support. Fig. 9 is a view on an enlarged scale of one of the enlarged end-journals of the planetary shaft and a portion of its bushing. Fig. 10 is a view in section on line 10—10 of Fig. 8. Figs. 11 to 14 are views showing modifications that are described hereinafter.

At 1 in the accompanying drawings, see particularly Fig. 1, is shown the driving-shaft of a fly-frame. At 2 and 3 are shown the fast and loose pulleys on the said shaft; at 4, the fly-wheel or hand-wheel thereon; at 5, a pinion on the said shaft transmitting motion through a gear 6 and pinion 7 to the spindle-driving shaft 8; at 9, one of the bevel pinions or gears on the spindle-driving shaft, the same being in mesh with the similar gear or pinion, 10, on the spindle, 11, the latter carrying the flier, 111.

At 12 is shown a pinion fast on the inner end of the driving-shaft, 1, which pinion serves to transmit motion through the intermediate gear, 13, to the gear, 14, and thus to the shaft, 15, on which are made fast the gear, 14, and the top-cone, 16. The cone-belt, 17, transmits motion from the top-cone, 16, to the bottom-cone, 18, it being shifted along the said cones in the usual manner to vary the speed of rotation of the bottom-cone. The shaft, 19, of the bottom-cone, 18, has fast thereon the pinion, 20, which transmits motion through the intermediate gears, 21, to the sun-wheel, 22. The sun-wheel, 22, rotates around the driving shaft, 1, and is made fast to the sun-frame, 23.

Upon the driving-shaft, 1, are mounted the two gears, 24, 25, the former of which is made fast upon the driving-shaft by means of the clamping-screw, 26, see Figs. 2 and 4, while the gear, 25, is free to turn upon the said shaft. See Fig. 4.

The sun-frame, 23, has mounted thereon, at a suitable distance from the center, the planetary shaft, 27, and fast with the said shaft, 27, are planetary gears, 28, 29, in mesh with the gears, 24 and 25, respectively. With the gear, 25, is connected the bobbin-gear, 30, see Fig. 4, and from the said gear, 30, motion is transmitted by the intermediate gearing, 31, to the gear, 32, fast on the bobbin driving-shaft, 33, on which are mounted bevel gears, 34, meshing with similar gears, 35, on the bobbin-carriers, 36.

Through the devices aforesaid, the bobbins, 37, and the spindles, 11, with the fliers, 111, are driven from the shaft, 1. The motion transmitted through the gearing, 5, 6, and 7, to the spindle-driving-shaft, 8, and thence to the spindles and fliers, remains the same throughout the filling of a set of bobbins,

whereas, as is well-known, the motion transmitted from the driving-shaft, 1, to the bobbin driving-shaft, 33, through the gearing, 24, 28, 29, 25, 30, 31, 32, is caused to vary progressively, in proportion as the bobbins fill with roving, the variation occurring in consequence of the cone-belt, 17, being shifted gradually along the cones, 16 and 18, and thereby causing an alteration of the speed of rotation of the sun-wheel, 22, and of the sun-frame, 23, carrying the planetary shaft, 27, on which the planetary gears, 28 and 29, are made fast.

The principles of the operation of the sun and planet type of differential gearing shown in the drawings are well-known, and, therefore, the same do not need to be explained herein. The said sun and planet gearing constitute essential features of what is known generally as the compound of a fly-frame.

The forms of differential gearing or compounds heretofore proposed for use in the bobbin-driving trains of mechanism contained in fly-frames have been objectionable or defective in various important respects. One leading objection or disadvantage has been the cost of construction. This applies particularly in cases where bevel gears are used, these requiring to be cut. This is an expensive mode of making gears. Other and exceedingly serious and troublesome objections or disadvantages are the amount of power consumed in the working of the compounds when constructed as heretofore, the difficulty of keeping bearing surfaces properly oiled, arising from the force with which they are pressed together, the great tendency to heat, and the excessive wear.

The improved form of differential gearing or compound which I am about to describe is simple and cheap in construction, and carefully made practical tests show that it is durable, consumes only a slight amount of power in its working, is easily kept well oiled, does not heat, and has slight tendency to wear.

In view of the expense incident to the use of bevel-gears, I use spur-gears, 24, 28, 29, and 25, as shown, in the construction of the compound. Spur-gears have been used in the like connection heretofore, but the constructions containing such gears have been open to the various objections which have just been set forth. In a well-known form of compound built with spur-gears, the planetary shaft has been equipped at its opposite ends with spur-gears which mesh with similar gears fast with the driving-shaft and bobbin gear, respectively, the intermediate portion of the planetary shaft being fitted to a long pipe bearing provided on the sun-gear or sun-frame. This form has the merit of cheapness and simplicity, but it is constructed upon faulty principles. The different stresses exerted upon the planetary shaft through the gears applied to the overhanging ends of the said shaft act with such great leverage upon the said over-hanging ends as to force the said ends laterally and to occasion an exceedingly great lateral pressure upon the sides of the bearing for the planetary shaft, the pressure being against one side of the said bearing at points adjacent to one end thereof, and against the opposite side at points adjacent to the other end of the bearing. This tends to twist the planetary shaft askew of the driving-shaft and causes the journal to contact with the bearings at two points, one near one outer extremity of the long bearing and the other near the other outer extremity of the long bearing, instead of causing the journal to contact with its bearing along a line extending the whole length thereof, as is the case in my improved construction. The pressure concentrated at the two points forces out the oil from between the contacting surfaces, and causes excessive friction with resulting heating and wearing. In accordance with the main features of my invention, I omit the said long pipe-bearing, and, instead of mounting the intermediate portion of the planetary shaft in a bearing, I provide it with end-journals, 271, 271, see Fig. 4, which are fitted to bearings provided therefor adjacent to the opposite ends of the sun-frame, 23, the spur-gears, 28 and 29, which are known as planetary gears, being located on the portion of said planetary shaft which is intermediate the said bearings, see also Fig. 2, while the spur-gears, 24 and 25, with which the planetary gears, 28 and 29, respectively mesh, are located adjacent to each other on the driving-shaft, 1. By enabling the planetary gears, 28 and 29, to be placed closely together at points intermediate the bearings for the planetary shaft, 27, and the gears, 24 and 25, to be placed closely together upon the driving-shaft, this arrangement causes the practical nullification of one, and almost the practical nullification of the other, of the opposite lateral stresses incident to the transmission of power through the said gears, the resultant stress acting in one direction only, pressing both ends of the planetary shaft in the same direction, and causing each journal of the planetary shaft to contact with its bearing throughout the whole length thereof. It also locates the bearings for the planetary shaft in positions in which they most advantageously operate to resist the said stresses. The spur-gears, 28, 29, may be applied to or fixed upon the planetary shaft, 27, in any preferred manner. I have shown them keyed in place thereon in Figs. 4 and 5. The sun-wheel, 22, and sun-frame, 23, are connected to turn in unison around the driving-shaft, 1. They may be formed integrally with each other, as will be obvious, but I prefer to form them separately, as shown, and to connect the sun-wheel to the sun-frame in suitable manner.

Fig. 4 of the drawings shows the eye of the sun-wheel slipped upon the hub, 231, formed on one end of the sun-frame, the said sun-wheel being clamped to the said hub, 231, by a

screw, 221, passing through a part of the sun-wheel and taking bearing at its inner end upon the surface of the hub, 231. The gears, 24 and 25, are formed with long sleeves, 241 and 251, respectively, fitting the exterior of the driving-shaft, 1, and the sun-frame, 23, takes bearing upon the exterior of these sleeves, at opposite sides of the gears, 24 and 25, as shown clearly in Fig. 4. The bobbin-gear, 30, is fitted upon the outer end of sleeve, 251, at one side of the sun-frame, 23, as shown in Fig. 4, and is caused to turn therewith by means of a clamping-screw, 301, which passes through a portion of the said gear and takes bearing by its inner end upon the surface of the said sleeve.

For the purpose of applying oil to the contacting surfaces of the sleeve, 251, and the driving-shaft, 1, I form holes, 302, 252, through the hub of gear, 30, and the sleeve, 251, respectively, see Figs. 4, 6, and 7, these holes being arranged to match with each other, and on the interior of the sleeve, 251, I provide an oil-containing groove, 253, leading lengthwise of the said sleeve. I provide an oil-hole cover consisting of a partial ring, 303, formed of a band of elastic material. The said ring is fitted to a groove, 304, formed in the exterior of the hub of the bobbin-gear, 30, its tendency to contract holding it therein, and it is provided on its under side with a pad, 305, of leather or other suitable material, and on its outer side with a button, 306, by means of which it may be moved to cover or uncover the oil-holes, the said pad and button being held to the partial ring by a rivet, 3061. The limits of the movements of the cover are determined by a pin, 307, with which the ends of the partial ring come in contact.

The bearings for the end-journals of the planetary shaft, 27, are in bushings, 31, 31, held in the opposite end-portions of the sun-frame, 23, as shown best in Figs. 3, 4, and 8. These bushings are of a self-aligning character, each of them being formed with an enlargement extending around the same, intermediate its ends, the said enlargement being formed preferably as a portion of a sphere, see Figs. 4 and 8, and fitting the concavity of a sectional ring, 32, within which ring the bushing is free to rock universally in a manner which enables it to adjust itself to the position of the planetary shaft, 27. Exteriorly, the sectional ring, 32, is formed with an enlarged portion, 321, extending around the same, and when the ring is fitted to its seat in the sun-frame, 23, this enlargement enters a groove formed in the sun-frame around the opening which is provided in the latter for the reception of the bushing. A screw, 33, is fitted to a threaded hole in the sun-frame, see Figs. 3 and 8, its reduced end, 331, passing into a hole, 332, formed in the ring, 32. The said screw serves to keep both parts of the sectional ring pressed together so as to inclose the bushing, and also to prevent the sectional ring from rotating. Preferably, the said reduced end extends also into a hole, 311, made in the exterior of the bushing, 31, in order to prevent the bushing from rotating with the planetary shaft, this hole, 311, being elongated lengthwise of the bushing so that the pin shall not interfere with the rocking movements of the bushing. Preferably, the end-journals, 271, 271, of the planetary shaft, 27, are enlarged, or of greater diameter than adjacent portions of the said shaft, as shown clearly in Figs. 4 and 8. Upon the reduced or smaller portion of the shaft, 27, adjacent to each enlarged end-journal, 271, is applied a tapering collar, 34, which, either is threaded exteriorly and is screwed into the interiorly threaded inner end of the bushing, 31, as shown in Fig. 8, or, is smooth exteriorly and is simply forced into the smooth inner end of the said bushing, as indicated in Fig. 11, and held therein by frictional contact. The inner end of the said collar forms a dam, 312, for the retention of the lubricant which is poured into the interior of the said bushing. The said collar is in halves or sections as indicated in Figs. 2, 8, and 11, in order to facilitate its application to the planetary shaft, 27.

In some cases, I substitute for the one-piece bushing, 31, of Figs. 2, 8, and 11, and its tapering collar, 34, made in halves or sections, the bushing, 31, of Figs. 12 and 13. This bushing is made in halves, the halves contacting with each other on longitudinal joints which, preferably, are rabbeted, as shown in Fig. 13. The separate tapering collar, 34, is dispensed with, and one-half of the dam, 312, is cast upon each half of the bushing. I secure the halves of this bushing together, preferably, by the aid of hoops or collars, 313, 313, with tapering interiors, which are forced or screwed upon the correspondingly tapered exterior of the bushing.

In the outer end of the bushing, 31, whether made in one piece or more, is formed a central oil-hole, 35, through which the lubricant may be fed to the interior of the bushing. The outer end of each journal, 271, of the planetary shaft is separated slightly from the adjacent end of the chamber within the corresponding bushing, 31, by means of short radial projections, 351, 351, which are formed on the said end of the chamber, as indicated in Figs. 8, 10, and 12. These projections hold the end of the journal far enough from the end wall of the bushing to facilitate the introduction of the lubricant through the oil-hole, 35, and to leave a space, 314, large enough to hold a considerable supply of the lubricant, as well as permit free flow thereof. In consequence of having these projections, 351, 351, provided in each of the bushings, 31, 31, the planetary shaft is prevented thereby from having any considerable endwise movement in either direction within the said bushings. The length of the chamber within each bushing is greater than that of the enlarged journal which is fitted therein, so that there exists at the inner end of each bushing, between

the inner end of the enlarged journal and the dam, 312, a space, 314, corresponding with that above described which is secured at the other end of each bushing, this space between the said dam and the inner end of the journal being maintained in consequence of the fact that any considerable endwise movement of the planetery shaft is prevented, as aforesaid. When the lubricant is fed to the interior of a bushing, 31, it may be supplied until the space, 314, at each end of the journal is filled with the lubricant nearly or quite to the height of the dam, 312. The construction described provides a reservoir for the lubricant having a circular dam at each end enabling it to hold a supply of the lubricant sufficient to keep the parts in proper running condition for a considerable period of time without replenishing. The enlarged end-journal, 271, may have a somewhat loose fit in the bushing, 31, so that the exterior of the said journal contacts with the interior of the bushing on a single line only, as indicated in Fig. 9, or, in cases where a somewhat loosely fitting bushing is objectionable, I may cut one or more channels, 315, 315, in the bushing, see Fig. 14, extending the entire length of the bearing, and uniting the spaces, 314, 314, at the ends of the bushing. These grooves vary in depth in the direction of their width, as indicated by the cross-section which is represented in Fig. 14. For convenince in designation I term them, in view of their form in the cross-section of the bushing, "tapering channels." The sharp edges of the tapering cross-sections of the channels preferably are located not far from the so-called line of contact of the journal and its bearing. In both of the constructions which are represented in Figs. 9 and 14 there exist, adjacent to the line of contact, spaces or channels tapering in their cross-section as seen in Figs. 9 and 14 filled with the lubricant and extending from end to end of the bushing, as shown. These facilitate the circulation of the lubricant and the feeding of the lubricant at the line of centact.

Under satisfactory conditions of lubrication there is found, in all bearings receiving journals, a coating of the lubricant between the bearing surfaces of the so-called line of contact. The pressure of the journal against its bearing tends to force the lubricant out from between these surfaces. When the pressure is sufficiently severe, it brings the journal into actual contact with its bearing, metal against metal, and, in consequence, heating, excessive wear, and perhaps destruction of the parts may ensue. Sometimes the supply of lubricant is too meager, or is too long intermitted. In such cases, also, there may ensue heating, wear and destructive effects. The bearings which are shown and described herein fit their journals somewhat loosely or are provided with channels with tapering cross-sections which extend preferably throughout the length of the bearings. They have spaces, 314, 314, at both ends of the journals communicating with the longitudinal spaces or channels of tapering cross-section adjacent to the lines of contact between the journals and the bearings, and they have dams at their opposite ends to retain the lubricant and to enable the journals to revolve constantly in pools of the latter. Such bearings tend to insure an efficient lubrication of the bearing surfaces. Not only do they do this under ordinary conditions, but they secure ample lubrication of the said surfaces in cases when the pressure between the journal and its bearing is so great that the lubricant would be forced out from between them, if an ordinary bearing were used, and would escape at the ends of the said bearing. The friction of the journal with the lubricant tends to cause a flow of the lubricant continually through between the journal and its bearing at the so-called line of contact, to elevate the upper surface of the lubricant on the side toward which the journal is running, and to depress the upper surface on the opposite side, as is shown in Figs. 9 and 14. The lubricant returns to its original position by gravity, flowing along the ends of the journals through the spaces, 314, 314, existing at the said ends. With such bearings and journals as are shown and described, the lubricant will be found between the journal and its bearing even when the journal is running with some pressures which are severe enough to force the lubricant from between the bearing surfaces when the journal is not in motion.

For convenience in assembling the parts, or removing the same for repairs or inspection, the sun-frame is made in two parts which separate on a line passing diametrically through the driving-shaft, 1, and planetary shaft, 27, these parts being held together by bolts, 272, 272, provided with nuts, 273, 273, and washers, 274, 274. The side of the sun-frame opposite to that in which the planetary shaft is mounted is enlarged, as shown, and thereby made heavy enough to counterbalance the weight of the said planetary shaft and its appurtenances.

I do not lay broad claim herein to the combination with the planetary shaft having journals at its ends, of the sun-frame, and self-aligning bushings applied to the sun-frame and receiving the said journals; nor to such a combination embodying self-aligning bushings fitting openings in the sun-frame on narrow intermediate portions, for this is not of my invention.

I claim as my invention—

1. The combination with a shaft, and the gear 30, of sleeved gears of which one is fast with the said shaft and the other has the gear 30 fast on the sleeve thereof, the sun-wheel, a sun-frame fitted on the sleeves of the said gears and rotating thereon in unison with the sun-wheel and also provided at opposite sides of such gears with bearings for the end-jour-

nals of the planetary shaft, a planetary shaft having at its ends journals which are received in the said bearings, and planetary gears fast on the planetary shaft intermediate the said bearings and meshing with the sleeved gears, substantially as described.

2. The combination with a shaft, and the gear 30, of sleeved gears one of which is fast with the said shaft and the other has the gear 30 fast on the sleeve thereof, the sun-wheel, a sun-frame fitted on the sleeves of the said gears and rotating thereon in unison with the sun-wheel and provided at opposite sides of such gears with bearings for the end-journals of the planetary shaft and also weighted to counterbalance the said planetary shaft and the gears thereon, a planetary shaft having at its ends journals which are received in the said bearings, and planetary gears fast on the planetary shaft intermediate the said bearings, and meshing with the gears aforesaid, substantially as described.

3. The combination with the driving-shaft, and the gear 30, of gears fast with the driving-shaft and gear 30, respectively, the sun-wheel, variable speed devices whereby the sun-wheel is driven with varying velocity, a sun-frame rotating in unison with the sun-wheel and provided at opposite sides of the gears aforesaid with bearings for the end-journals of the planetary shaft, a planetary shaft having at its ends journals which are received in the said bearings, and planetary gears fast on the planetary shaft intermediate the said bearings and meshing with the gears aforesaid, substantially as described.

4. The combination with the driving-shaft, and the gear 30, of gears fast with the driving-shaft and gear 30, respectively, the sun-wheel, variable speed devices whereby the sun-wheel is driven with varying velocity, a sun-frame rotating in unison with the sun-wheel and provided at opposite sides of the gears aforesaid with bearings for the end-journals of the planetary shaft and also weighted to counterbalance the said planetary shaft and the gears thereon, a planetary shaft having at its ends journals which are received in the said bearings, and planetary gears fast on the planetary shaft intermediate the said bearings and meshing with the gears aforesaid, substantially as described.

5. The combination with the driving-shaft, the top-cone, means for rotating the top-cone from the driving-shaft, the cone-belt, the bottom-cone, the sun-wheel, means for rotating the sun-wheel from the bottom-cone, the sun-frame rotating in unison with the sun-wheel, a planetary shaft having at its ends journals mounted in bearings in the said sun-frame, planetary gears fast on the planetary shaft intermediate the said bearings, the bobbin-gear, gears fast with the driving-shaft and bobbin-gear respectively and in mesh with the said planetary gears, and bobbin operating devices driven from the said bobbin-gear, substantially as described.

6. The combination with the driving-shaft, the top-cone, means for rotating the top-cone from the driving-shaft, the cone-belt, the bottom-cone, the sun-wheel, means for rotating the sun-wheel from the bottom-cone, the sun-frame rotating in unison with the sun-wheel, a planetary shaft having at its ends journals mounted in bearings in the said sun-frame, planetary gears fast on the planetary shaft intermediate the said bearings, the bobbin-gear, sleeved gears in mesh with the planetary gears and of which one is fast with the driving-shaft and the other has the bobbin-gear fast on the sleeve thereof the said sun-frame rotating on the sleeves of the said gears, and bobbin operating devices driven from the said bobbin-gear, substantially as described.

7. The combination with a sun-frame, of a planetary-shaft having journals at opposite sides of the planetary-gears, planetary gears fast on the planetary-shaft, self-aligning bearings carried by the sun-frame and receiving the said journals, and gears in train with said planetary-gears, substantially as described.

8. The combination with a sun-frame, of the planetary-shaft having enlarged journals at opposite sides of the planetary-gears, planetary-gears fast on the planetary-shaft, bushings carried by the sun-frame and each provided at opposite ends of the journal received therein with dams for the retention of a lubricant, and gears in train with said planetary-gears, substantially as described.

9. The combination with a sun-frame, of the planetary-shaft having enlarged journals at opposite sides of the planetary-gears, planetary-gears fast on the planetary-shaft, self-aligning bushings carried by the sun-frame and each provided at opposite ends of the journal received therein with dams for the retention of a lubricant, and gears in train with said planetary-gears, substantially as described.

10. The combination with a sun-frame, of the planetary-shaft having enlarged journals at opposite sides of the planetary-gears, planetary-gears fast on the planetary-shaft, bushings provided exteriorly with spherical enlargements extending around the same fitted to concaved supports on the sun-frame and provided interiorly with dams at the opposite ends of the journals received therein, and gears in train with said planetary-gears, substantially as described.

11. The combination with a sun-frame, of the planetary-shaft having enlarged journals at opposite sides of the planetary-gears, planetary-gears fast on the planetary-shaft, bushings provided exteriorly with spherical enlargements extending around the same and provided interiorly with dams at the opposite ends of the journals received therein, sectional rings having concaved interiors fitting the said spherical enlargements and supporting the bushings on the sun-frame, and gears in train with said planetary-gears, substantially as described.

12. The combination with a sun-frame, of the planetary-shaft having enlarged journals at opposite sides of the planetary-gears, planetary-gears fast on the planetary-shaft, bushings carried by the sun-frame and each provided at opposite ends of the journal received therein with dams for the retention of a lubricant, the dam at the inner end of each bushing consisting of a collar fitted into such end and the dam at the outer end thereof consisting of the closed end of the bushing, the said end having a central oil-hole and projections for holding the end of the journal away from the dam, and gears in train with said planetary-gears, substantially as described.

13. The combination with a sun-frame, of the planetary-shaft having enlarged journals at opposite sides of the planetary-gears, planetary-gears fast on the planetary-shaft, bushings carried by the sun-frame each provided at opposite ends of the journal received therein with dams for the retention of a lubricant and also presenting spaces or channels of tapering cross-section extending from end to end of the bushing adjacent to the line of contact with the journal whereby to secure circulation of the lubricant and efficient lubrication, and gears in train with said planetary-gears, substantially as described.

14. The combination with a sun-frame, of the planetary-shaft having enlarged journals at opposite sides of the planetary-gears, planetary-gears fast on the planetary-shaft, bushings provided exteriorly with spherical enlargements extending around the same and fitted to concaved supports on the sun-frame and provided interiorly with dams at the opposite ends of the journals received therein and also presenting spaces or channels of tapering cross-section extending from end to end of the bushing adjacent to the line of contact with the journal whereby to secure circulation of the lubricant and efficient lubrication, and gears in train with said planetary-gears, substantially as described.

15. The combination with a sun-frame, of the planetary-shaft having enlarged journals at opposite sides of the planetary-gears, planetary-gears fast on the planetary-shaft, bushings provided exteriorly with spherical enlargements extending around the same and provided interiorly with dams at the opposite ends of the journals received therein and also presenting spaces or channels of tapering cross-section extending from end to end of the bushing adjacent to the line of contact with the journal whereby to secure circulation of the lubricant and efficient lubrication, sectional rings having concaved interiors fitting the said spherical enlargements and supporting the bushings on the sun-frame, and gears in train with said planetary-gears, substantially as described.

16. The combination with a sun-frame, of the planetary-shaft having enlarged journals at opposite sides of the planetary-gears, planetary-gears fast on the planetary-shaft, bushings carried by the sun-frame and each provided at opposite ends of the journal received therein with dams for the retention of a lubricant, the dam at the inner end of each bushing consisting of a collar fitted into such end and the dam at the outer end thereof consisting of the closed end of the bushing, the said end having a central oil-hole and projections for holding the end of the journal away from the dam, each bushing also presenting spaces or channels of tapering cross-section extending from end to end of the bushing adjacent to the line of contact with the journal whereby to secure circulation of the lubricant and efficient lubrication, and gears in train with said planetary-gears, substantially as described.

In testimony whereof I affix my signature in the presence of two witnesses.

CHANNING WHITAKER.

Witnesses:
MARY CAVERLY,
SAML. G. STEPHENS.