

June 24, 1930.

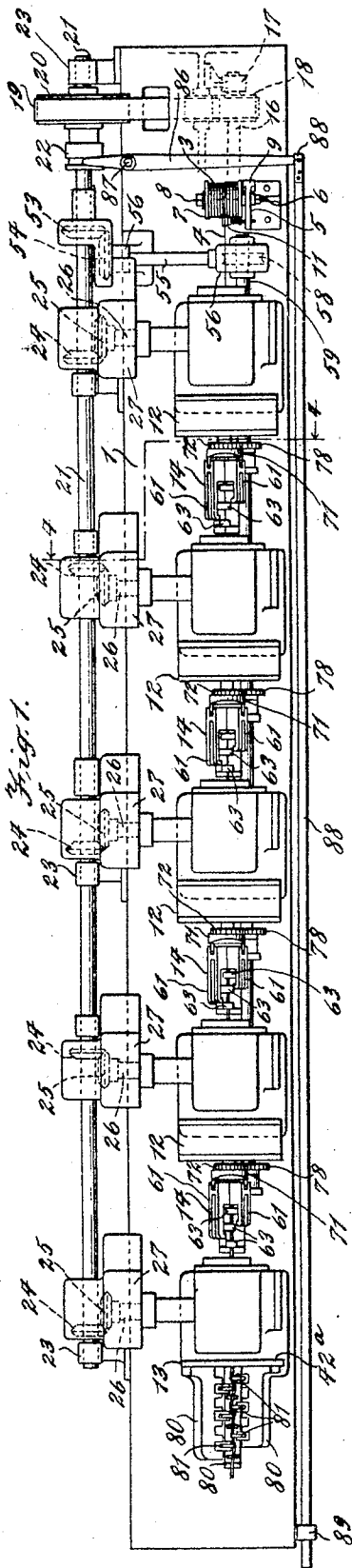
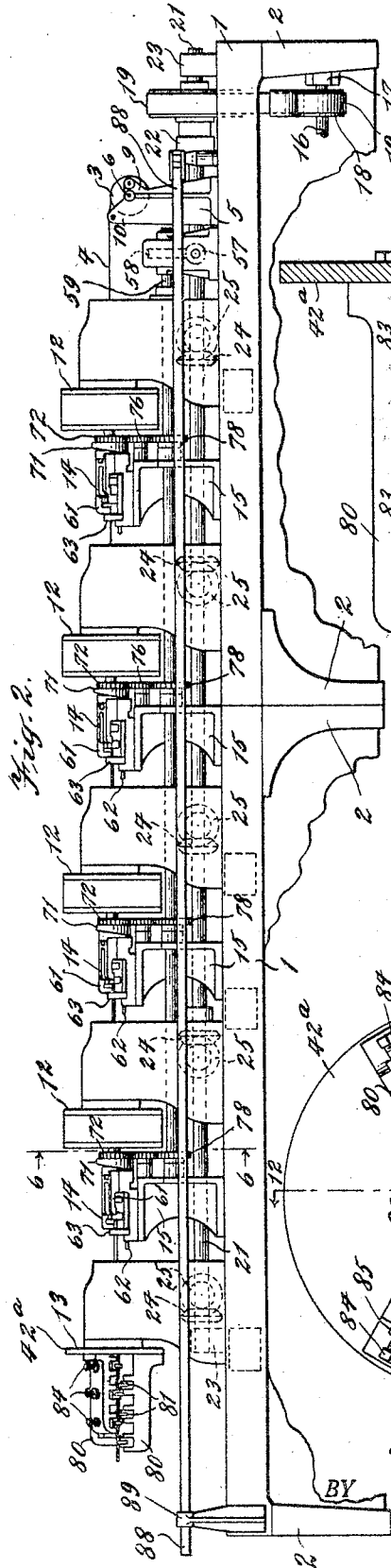
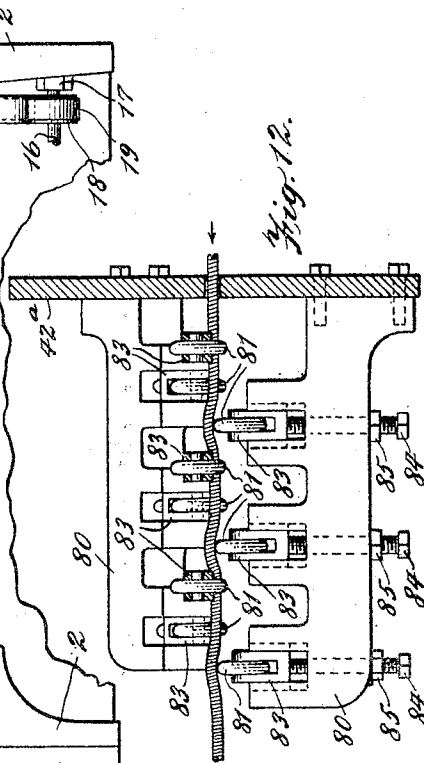
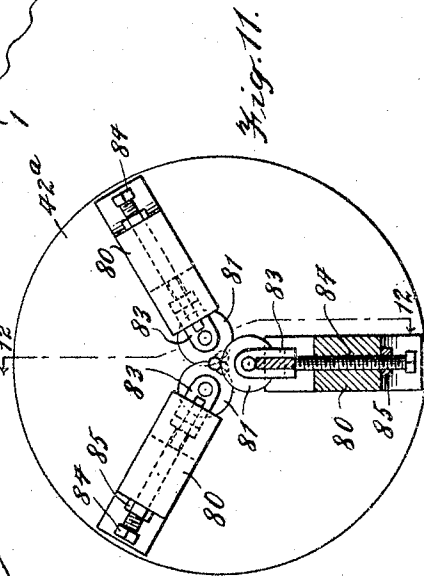
L. H. MORIN

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FLEXIBLE SHAFT MAKING MACHINE

Filed July 29, 1927

5 Sheets-Sheet 1



INVENTOR.
Louis H. Morin
BY Victor D. Bonst
ATTORNEY

June 24, 1930.

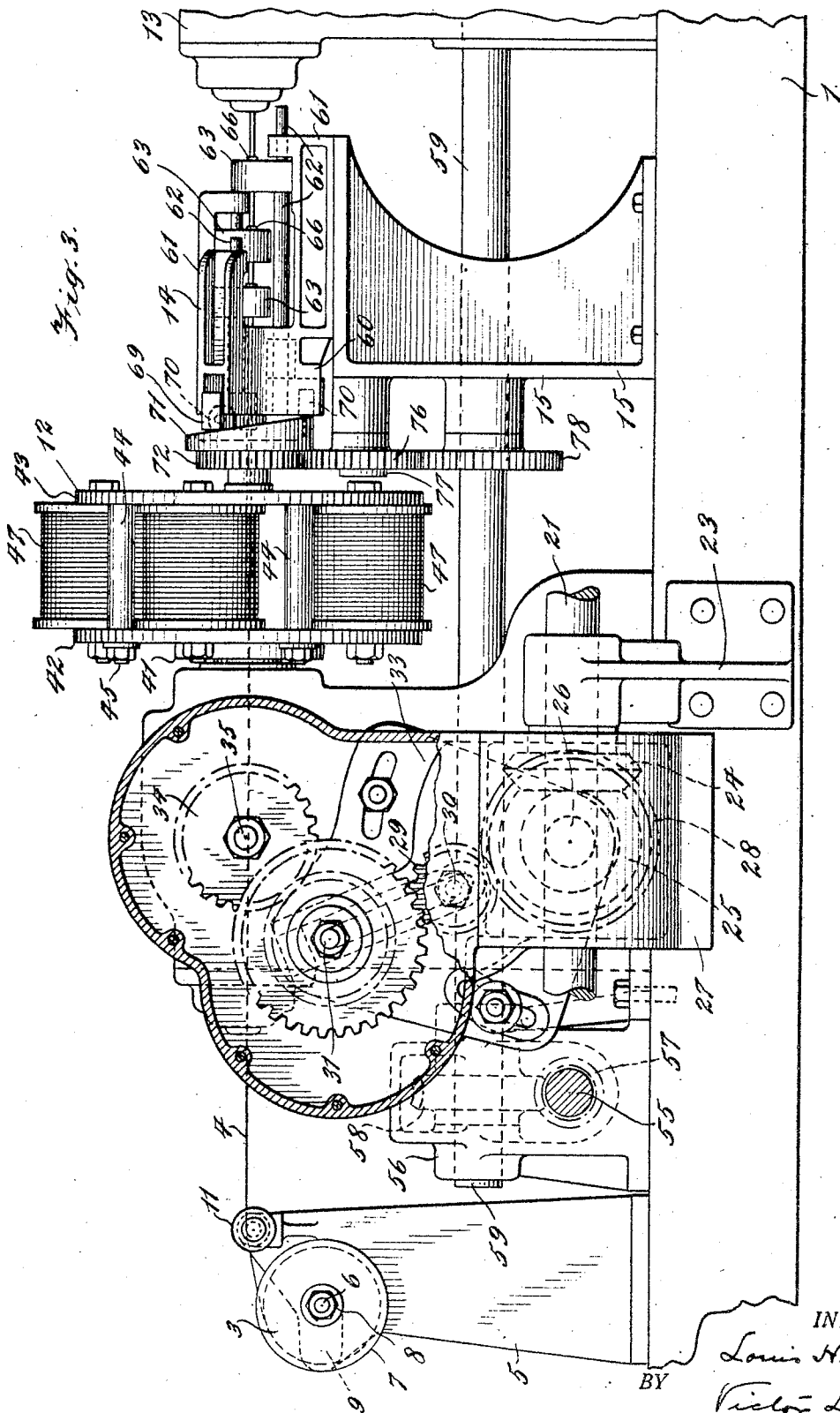
L. H. MORIN

1,767,692

FLEXIBLE SHAFT MAKING MACHINE

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5 Sheets-Sheet 2



INVENTOR.

Louis H. Morin

Victor D. Borat

ATTORNEY

June 24, 1930.

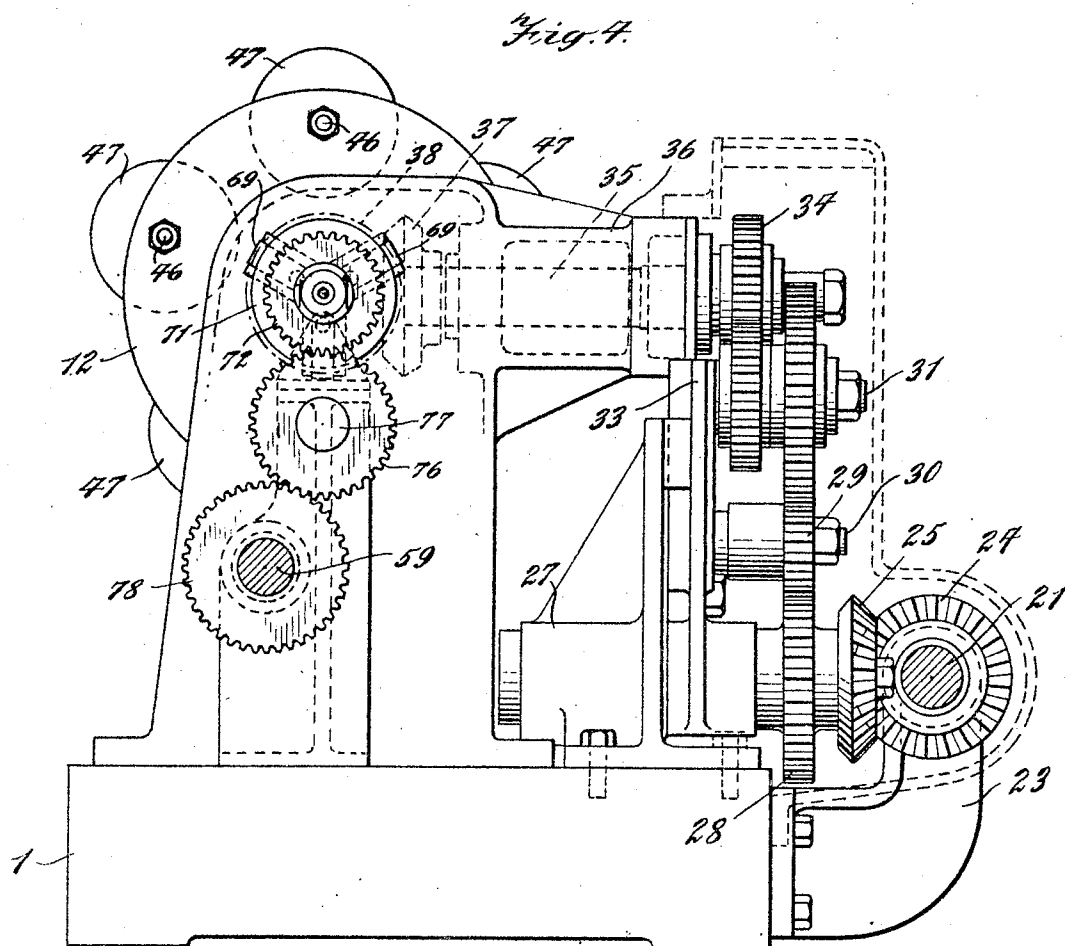
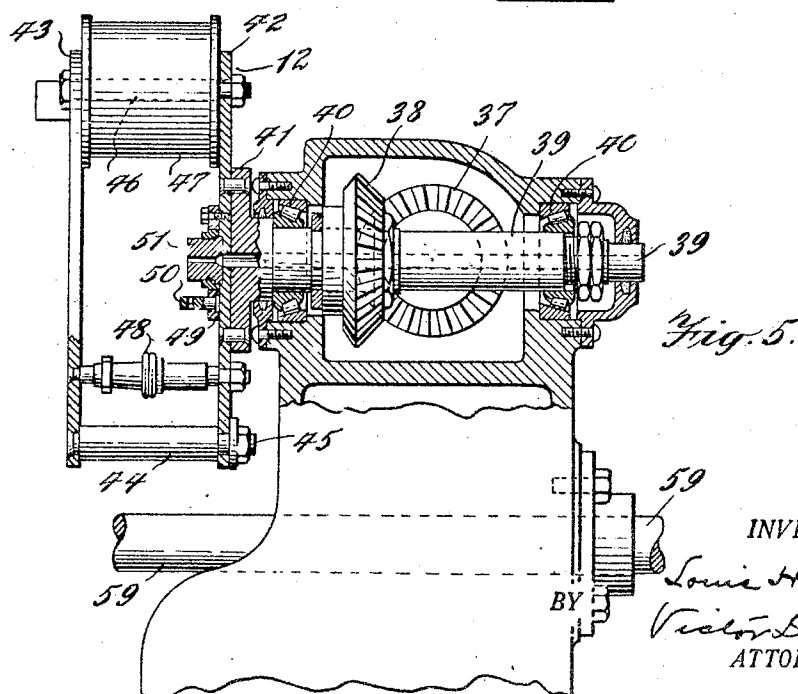
L. H. MORIN

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FLEXIBLE SHAFT MAKING MACHINE

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5 Sheets-Sheet 3



INVENTOR.

Louis H. Morin

BY Victor D. Bost
ATTORNEY

June 24, 1930.

L. H. MORIN

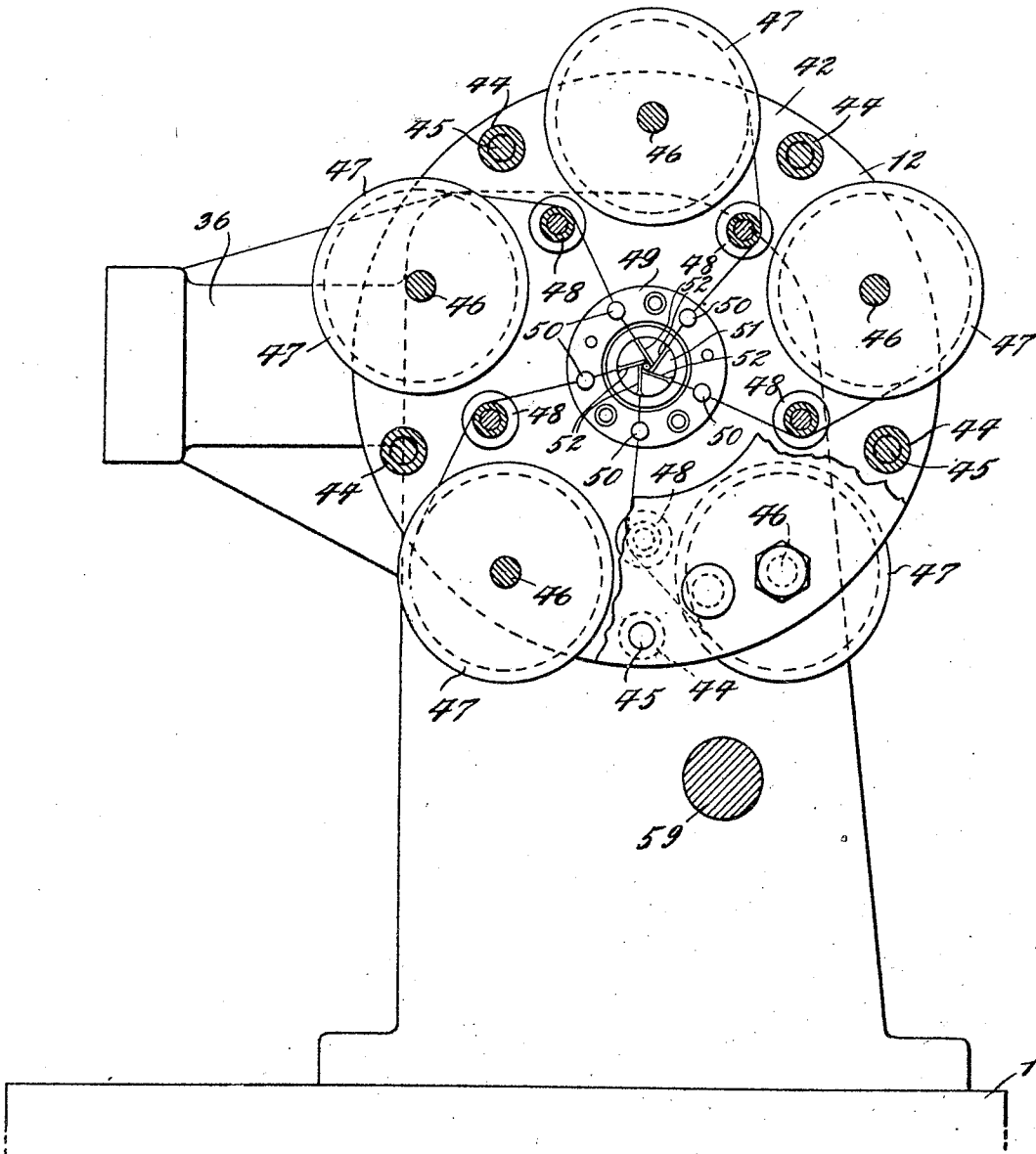
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FLEXIBLE SHAFT MAKING MACHINE

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Fig. 6.



INVENTOR.

Louis H. Morin

BY

Victor D. Bond
ATTORNEY

June 24, 1930.

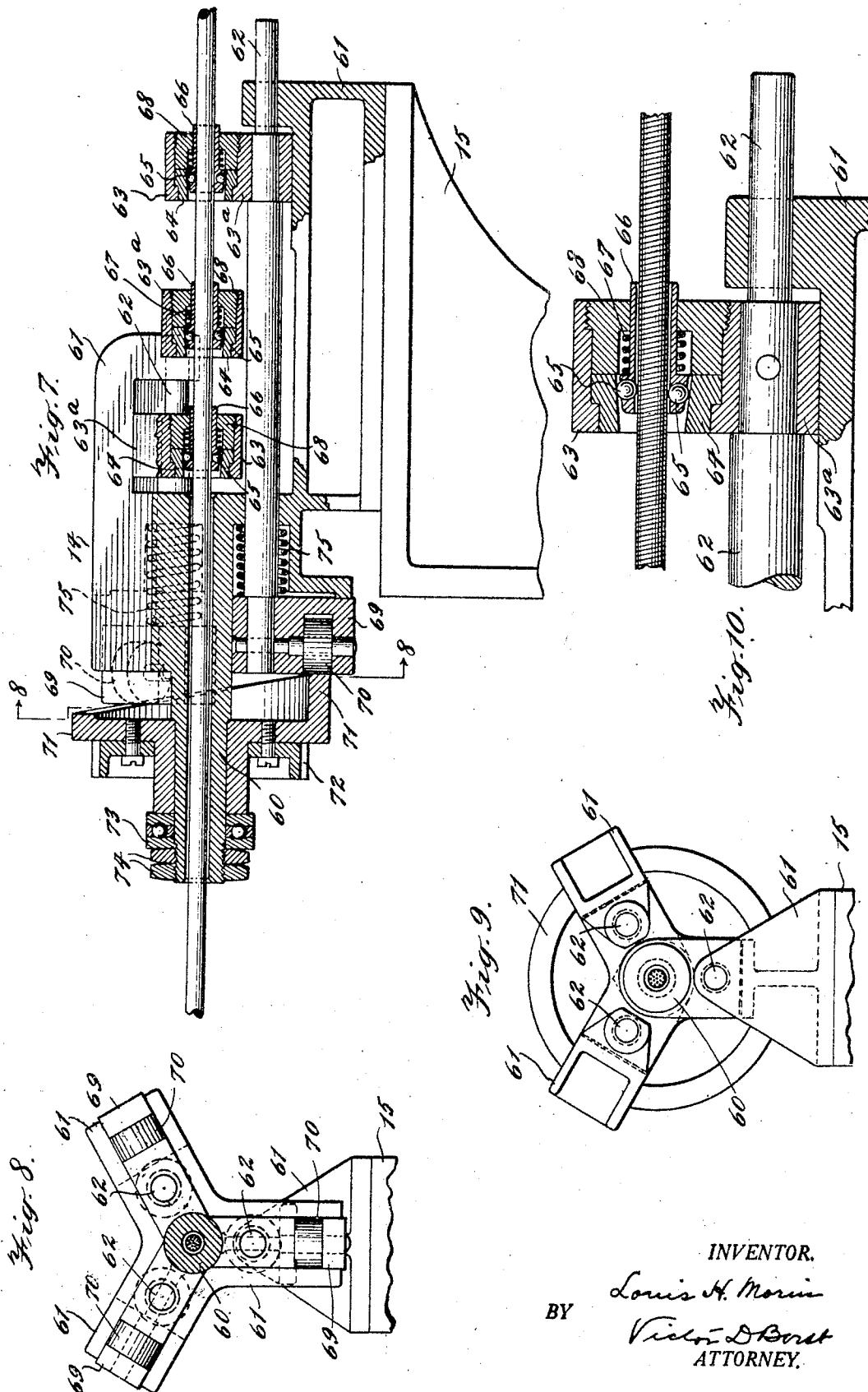
L. H. MORIN

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FLEXIBLE SHAFT MAKING MACHINE

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UNITED STATES PATENT OFFICE

LOUIS H. MORIN, OF NEW YORK, N. Y.

FLEXIBLE-SHAFT-MAKING MACHINE

Application filed July 29, 1927. Serial No. 209,205.

This invention relates to machines for making flexible shafting such as is commonly used for transmitting torque to translating devices not in alignment or not rigidly secured together and is an improvement upon such a machine as is disclosed in my co-pending application Serial No. 183,972 filed April 15, 1927.

Flexible shafting must necessarily be tightly wrapped in order to be resistive to torsion and yet must be supple and limber. It has been, therefore, a difficult problem to make such a shaft. Heretofore it has been the general practice to manufacture such shafting by hand whereby a plurality of strands of wires are wound around a single strand or core wire, the convolutions of the winding and strands being close together and the alternate layers thereof wound in relatively reversed directions.

I propose to provide a machine which will automatically simultaneously wrap several layers of wire around a central core wire, the successive layers being wound in relatively reversed positions and the winding being accomplished while the core wire is constantly fed forward by a plurality of feeding units each of which grips the core wire and feeds it continuously and evenly, and which will flex the completely wound shaft as it leaves the last winding operation to make the shaft readily flexible and limber for immediate use. It is the particular purpose of this invention to provide a simple yet effective feeding means for continuously feeding a core wire relatively to the means for wrapping the layers of wires therearound and also to provide means for automatically flexing the completed flexible shaft as it leaves the last winding operation of the machine whereby it is made supple and ready for use.

To carry out these purposes I provide a machine composed generally of a plurality of rotary winding heads which apply the wrappings around the core wire and also a head which is positioned at the output end of the machine and which flexes the completely wound shaft as it is fed out of the machine. As a means for continuously feeding the core wire I provide adjacent each

head a feeding unit each of which is composed of a plurality of ball chucks which alternately grip the core wire and the wound layers thereon with overlapping grips to continuously pull the core wire through the successive heads.

The machine will now be described in more particularity in connection with the drawings which illustrate an embodiment thereof.

Fig. 1 is a plan view of a machine constructed in accordance with this invention;

Fig. 2 is a front elevation of the same;

Fig. 3 is an enlarged front elevation partly in section of the head end of the machine showing the core wire supporting spool, one rotary head, and its associated grippers;

Fig. 4 is an enlarged section taken on line 4—4 of Fig. 1;

Fig. 5 is an enlarged longitudinal vertical section of one of the rotary winding heads;

Fig. 6 is a section on line 6—6 of Fig. 2;

Fig. 7 is an enlarged longitudinal vertical section through one of the feeding or gripper units;

Fig. 8 is a section on line 8—8 of Fig. 7;

Fig. 9 is an end elevation of one of the gripper units;

Fig. 10 is an enlarged detail of one of the ball chucks and its actuating shaft;

Fig. 11 is an end elevation of the flexing unit or head;

Fig. 12 is a section on line 12—12 of Fig. 11.

The particular machine shown by way of illustration comprises a bed or frame 1 supported upon end and center legs 2, the bed 1 constituting a support for the core wire feeding mechanism, the wrapping or winding mechanism and the flexing mechanism. A spool 3 of the core wire 4 is supported upon an angle bracket 5 (Figs. 1, 2 and 3) rigidly secured to the bed 1 adjacent the right or head end thereof. Bracket 5 is threaded to receive a spindle 6 extending at right angles therefrom which spindle is threaded upon its outer end to receive a spool retaining flange 7 and a locking nut 8. Bracket 5 is formed with an extending ear

portion 9 which carries a friction device adapted to contact against one flange of the spool 3 to resist rotation thereof, and is also formed with a second projecting ear 10 which carries a spring pressed guide and friction drag for guiding the core wire 4 as it is reeled off the spool 3 into and through the winding heads for winding a plurality of layers of wire around the core wire.

After leaving the guide 11 core wire 4 is passed through the center of the first of a series of successive turrets or winding heads 12, and then through a flexing head 13 rotatively carried by the bed 1 in spaced relationship and adapted to wind successive layers of convolutions of wire around the core wire, each of the four winding heads being constructed to carry and feed five strands of wire from five spools mounted thereon. The four winding heads utilized in the illustrated machine are substantially the same in structure, and each successive head is driven in a direction relatively reversed to the direction of rotation of the preceding head from a common drive shaft. The fifth or flexing head 13 is substantially different from the preceding heads all of which will later be described in detail.

As the core wire 4 leaves the first head 12 having had a layer of wire wound thereon it passes between and is engaged by the first of a series of gripping and feeding units 14, each supported upon a bracket 15 bolted or otherwise secured to the bed 1. A feeding unit is placed adjacent the output end of each of the winding heads and also adjacent the flexing head whereby the core wire is gripped and fed as it leaves each head. The gripper members are all substantially similar in structure later to be described and are actuated from a common shaft in such a manner and sequence that the core wire is fed continuously and evenly under a constant tension during the time that the rotary heads are winding layers of wire therearound.

Any convenient source of energy may be used to drive the machine and may be operatively connected to a shaft 16 (Figs. 1 and 2) supported by a bearing 17 bolted or otherwise secured to the end legs. Shaft 16 carries a pulley 18 over which a belt 19 passes. Also passing over a pulley 20 freely mounted on drive shaft 21 and adapted to be connected thereto by any standard clutch mechanism 22. Drive shaft 21 is rotatively supported by outboard bearings 23 attached to the rear face of bed 1 at frequent intervals and extends longitudinally of the machine substantially the entire length thereof. A bevel gear 24 is keyed or otherwise secured to the drive shaft opposite each of the winding heads (Figs. 1, 2, 3 and 4). Each gear 24 engages a coacting bevel gear 25 mounted upon the end of a stub shaft 26

carried by a bracket 27 fastened to the machine bed adjacent each of the rotary heads. Gears 24 are mounted upon alternate sides of gears 25 in order to have the successive heads rotate in opposite directions. Bevel gears 25 each have secured thereto so as to rotate therewith a spur gear 28 which meshes with spur gear 29 (Figs. 3 and 4) constituting one end of a train of removable gears carried by studs 30 and 31 adjustable by means of an arm 33, the train terminating in a spur gear 34 fast upon the outer end of a transverse shaft 35 rotatively supported in an extending housing 36 projecting from each of the rotary heads. By means of the adjustable studs various sizes of spur gears may be inserted in a train of gearing to produce any desired driving ratio between spur gear 28 and spur gear 34. The inner end of transverse shaft 35 carries a bevel gear 37 which meshes with another bevel gear 38 (Fig. 5) fast upon a turret or head shaft 39 intermediate the ends thereof. The turret shaft being supported at its ends by taper bearings 40 mounted in the two ends of each of the rotary head supports. It is readily seen that whenever energy is supplied the shaft 21 is driven if clutch 22 is engaged and shaft 21 will drive each of the stub shafts 26 and through the associated train of removable gears will drive the shaft 35 and through it will rotate the turret shaft 30.

One end of the turret shaft 39 terminates in a flange 41 (Figs. 3 and 5) to which is rigidly secured one of a pair of spool supporting disks 42 and 43. The second disk 43 of substantially the same diameter is secured to disk 42 in parallel spaced relationship thereto by means of spacing ferules 44 and bolts 45. Between the two disks are mounted five spindles 46 upon which spools 47 of wire may be rotatively mounted. Adjacent each spool 47 and also extending between the two disks 42 and 43 there is a friction spring guide and drag 48 over which the wire passes as it leaves the spools to be wound around the core wire.

In order to guide the strands of wire as they come off the friction guides preparatory to winding them around the core wire, there is bolted to disk 42 a ring 49 (Figs. 5 and 6) having studs 50 projecting therefrom which studs are bored to form guiding apertures leading toward the axis of the disk and through which the wires are passed. At the center of disk 42 there is also secured a cylindrical sleeve 51 bored longitudinally to the exact size of the core wire in accordance with the particular head to which the sleeve is attached. Sleeve 51 is also bored radially at five points spaced axially along the sleeve to provide guiding apertures 52 through which strands of wire are passed to guide them accurately

to the core wire thus causing the five wires to lie closely adjacent each other in one single layer upon the core wire as the head is rotated around the core wire. Then as the five heads are rotated about the core wire the five strands of wire will be reeled off the five spools on each head and wound around the non-rotating core wire which is kept under the constant tension by the feeding means to form a plurality of reversely wound layers of wire thereon while the core wire is being constantly fed axially through the heads.

Drive shaft 21 also has a bevel gear 53 (Figs. 1, 2 and 3) secured thereto near the right end thereof which engages with a co-acting bevel gear 54 fast on the end of a cross shaft 55 rotatively supported in pedestal bearings 56 and having a worm 57 keyed to its other extremity. Worm 57 drives the worm wheel 58 keyed to grip the actuating shaft 59. It follows therefore that shaft 55 will be driven from shaft 21 and will in turn drive gripper shaft 59.

A gripper or feeding unit one of which is positioned adjacent each head is shown in detail in Figs. 7, 8, 9 and 10. The units are carried by a housing 60 mounted upon bracket 15 which housing is bored centrally to permit passage of the flexible shaft there-through. The housing is formed with three horizontally extending arms 61 of unequal length disposed radially about the housing which arms form bearing supports for the outer ends of three reciprocating shafts 62, the lower arm also serving as a support for the entire unit by resting upon bracket 15. Each of shafts 62 carries a ball clutch or gripper 63 secured adjacent its outer end and so disposed as to surround the flexible shaft being made one behind the other. Each clutch is carried by an arm 63^a secured to one of the reciprocating shafts 62 adjacent the outer end thereof which arm constitutes a support for a sleeve 64 bored conically with the smaller diameter toward the head. Three steel balls 65 are mounted within the bore of the sleeve and are held therein by a retaining element 66. The balls are constantly urged toward the smaller end of the sleeve by a compression spring 67 held under compression between the retainer 66 and a cap element 68 threaded into the arm 63. The opposite end of each reciprocating shaft carries an arm 69 in which a cam roller 70 is mounted adapted to contact with a cam disk 71 rotatably mounted upon the housing 60 and to which is secured a driving gear 72. The cam and attached gear may be restricted from axial movement by a thrust bearing 73 and lock nut 74 secured to the extremity of the housing 60. The reciprocating shafts 62 and rollers 70 are constantly urged toward the cam 71 by coil spring 75 placed

around the reciprocating shafts 62 and forced under compression in a recess formed in the housing between the housing and the arms 69. Gear 72 meshes with an idle pinion 76 rotatably carried by a stub shaft 77 mounted in the rear end of bracket 15. Pinion 77 in turn is driven by a pinion 78 rigidly mounted upon shaft 59 one of such pinions being secured to shaft 59 adjacent each bracket 15.

It readily follows that as cam 71 is driven shafts 62 will be reciprocated in sequence and consequently each ball clutch will likewise be reciprocated. As each ball clutch moves toward the head adjacent thereto the balls 65 will recede into the larger end of the bore in sleeve 64 but as the chucks are moved away from the head adjacent thereto the balls will move into the smaller end of the sleeve and grip the flexible shaft and pull the same toward the exit end of the machine. Having the three grippers disposed radially around the flexible shaft and having a long slope to the cam surface will result in an even pulling effort since there will be an overlap in the grippers i. e. there will always be two grippers pulling while the third is making a return movement to regrip the flexible shafting.

In order to limber up the shafting as it comes out of the machine a final flexing head 13 is secured to the bed 1 after the final winding head 12 as shown particularly in Figs. 1, 2, 11 and 12. The driving mechanism of this last head is similar to that of the winding heads. The head has only one disk 42^a thereon, however, to which is secured three arms 80 radially disposed about the center of the disk and extending rearwardly therefrom. Each arm carries three rollers 81 adjustably mounted in clevises 83 therein and positioned unequally distant from the center of the disk and the flexible shaft. The rollers may be adjusted toward and from the flexible shaft by means of a stud 84 which is threaded into arms 80 and contacts with the clevises 83. The studs may be locked in any position by means of lock nuts 85.

In order that the main driving clutch 22 may be controlled at any point along the length of the machine a lever 86 (Figs. 1 and 2) secured at one end to the clutch mechanism is pivoted intermediate its ends at 87 to the frame and extends from the back to the front thereof terminating at the front of the machine where it is pivotally connected to a control rod 88 which extends the full length of the machine being supported at the ends by brackets 89 secured to the bed of the machine. Then operator therefore may start and stop the machine from any point along the side thereof by merely moving rod 88 to the right or left.

In making flexible shaft with the machine illustrated the machine is first prepared by placing a spool 3 of core wire 4 of suitable size upon the spindle 6 supported by the bracket 5 and by placing other spools of suitable size upon each of the spindles 46 upon the rotary heads 12. The core wire is then passed between the guide and drag 11 and then through each head 12 successively and associated feeding grippers 14. The five strands of wrapping wire from the first head are then brought down to their respective guides 48 and attached to the core wire 4. The machine is then run until the point of attachment has traversed the machine to the next head 12 where the next five winding wires are attached and so on till the point of attachment has traversed all the winding heads when it is passed through the flexing head.

With the machine running normally a core wire is fed continuously and under constant tension by the grippers and simultaneously with this feeding action the heads are rotated about the core wire to wind the respective layers of strands of wire thereupon, the alternate heads being rotated in the same direction. Thus the flexible shaft is made by continuously feeding a core wire and simultaneously winding thereon successive layers and the completed shafting is thoroughly flexed and limbered so that it is ready for immediate use.

It is obvious that any number of spool spindles may be provided upon each head and that any number of heads may be used according to the size of flexible shaft desired and that many other changes may be made in details of construction without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. In a flexible shaft making machine, means for continuously feeding a core wire, said feeding means comprising a plurality of ball chucks operable to grip the core wire when moved in one direction only and means for actuating said chucks in sequence to cause them to alternately grip the core wire and feed it continuously through the machine.

2. In a flexible shaft making machine, means for feeding a core wire, said feeding means comprising a plurality of ball chucks operable to grip the core wire when moved in one direction only and means for actuating said chucks in sequence to alternately feed the core wire through the machine with overlapping pulling efforts.

3. In a flexible shaft making machine, means for continuously feeding a core wire comprising a plurality of ball chucks adapted to grip the core wire when moved in one direction and to slide freely thereover when moved in the opposite direction and a cam

for alternately reciprocating said chucks to alternately grip said core wire.

4. In a flexible shaft making machine, means for continuously feeding a core wire comprising a plurality of ball chucks disposed longitudinally about said core wire and adapted to grip the core wire when moved in one direction and to slide freely thereover when moved in the opposite direction and a cam for alternately reciprocating said chucks to alternately grip said core wire.

5. In a flexible shaft making machine, means for continuously feeding a core wire comprising a support, a plurality of arms disposed radially thereon and extending therefrom, a plurality of ball chucks carried thereby and disposed longitudinally along said core wire and adapted to grip the core wire when moved in one direction and to slide freely thereover when moved in the opposite direction and a cam for alternately reciprocating said chucks to alternately grip said core wire.

6. In a flexible shaft making machine, means for continuously feeding a core wire comprising a housing, a plurality of arms radially disposed on said housing, a ball chuck carried by each of said arms and means for independently reciprocating said chucks.

7. In a flexible shaft making machine, means for continuously feeding a core wire comprising a housing, a plurality of arms radially disposed on said housing, a ball chuck carried by each of said arms, and a common actuating means for independently reciprocating said chucks.

8. In a flexible shaft making machine, means for continuously feeding a core wire comprising a housing, a plurality of arms radially disposed on said housing, a ball chuck carried by each of said arms, a cam rotatably carried by said housing operative to reciprocate said chucks, and means for rotating said cam.

In witness whereof, I hereunto subscribe my signature.

LOUIS H. MORIN.