July 18, 1967 H. L. KITSELMAN 3,331,566

WIRE COILING APPARATUS

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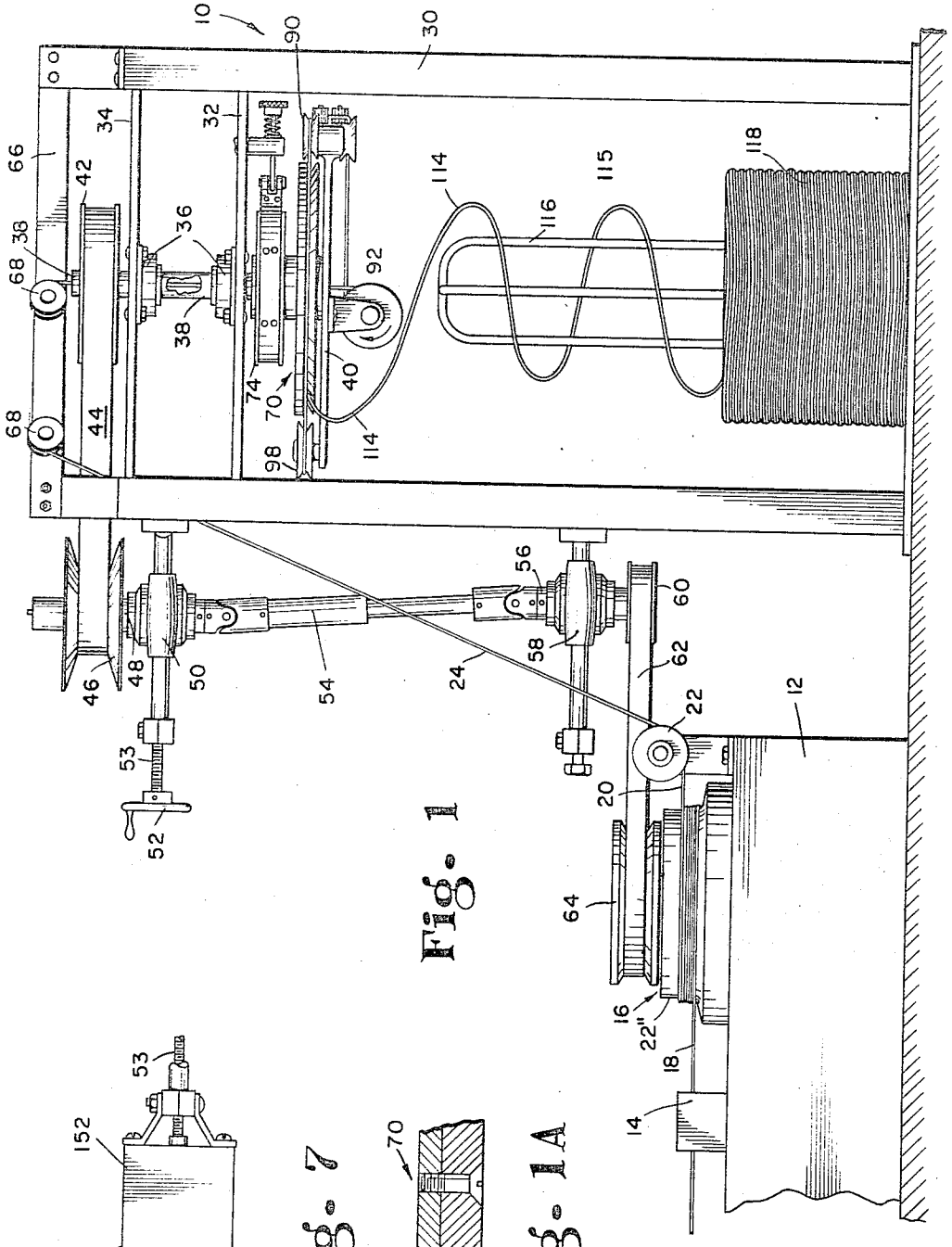


Fig. 1

Fig. 7

Fig. 1A

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WIRE COILING APPARATUS

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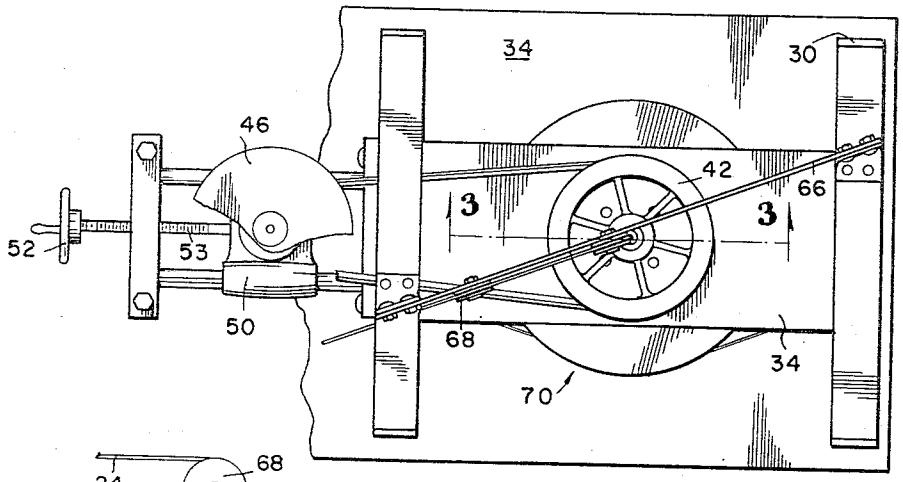


Fig. 2

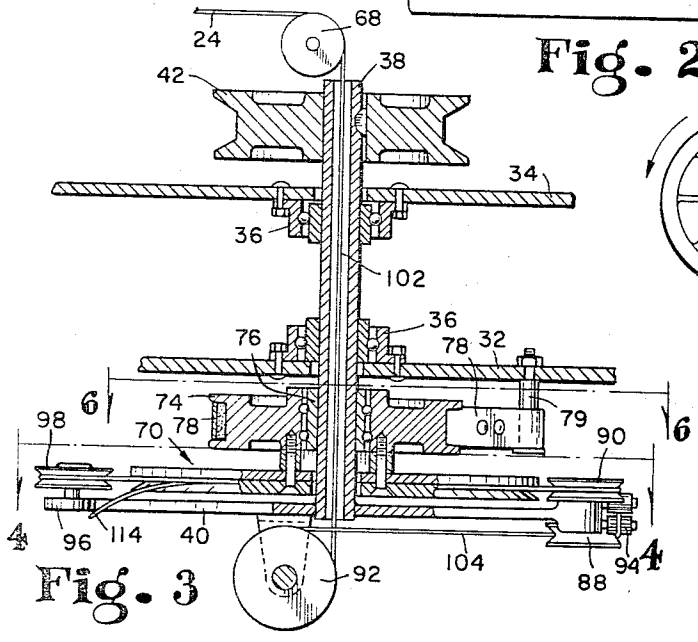


Fig. 3

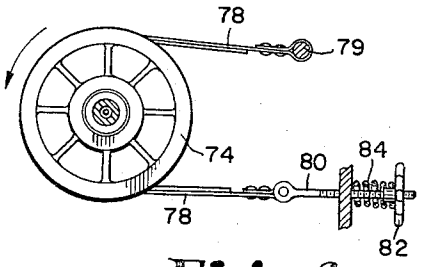


Fig. 6

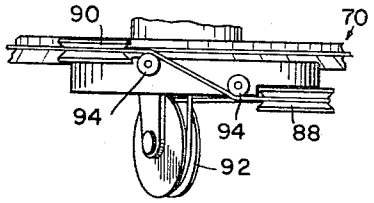


Fig. 5

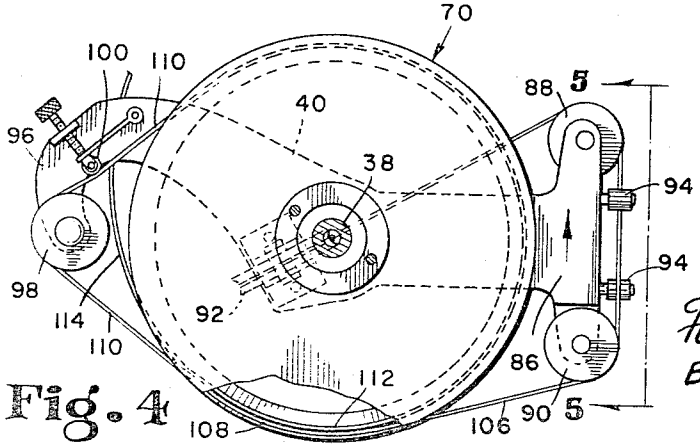


Fig. 4

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WIRE COILING APPARATUS

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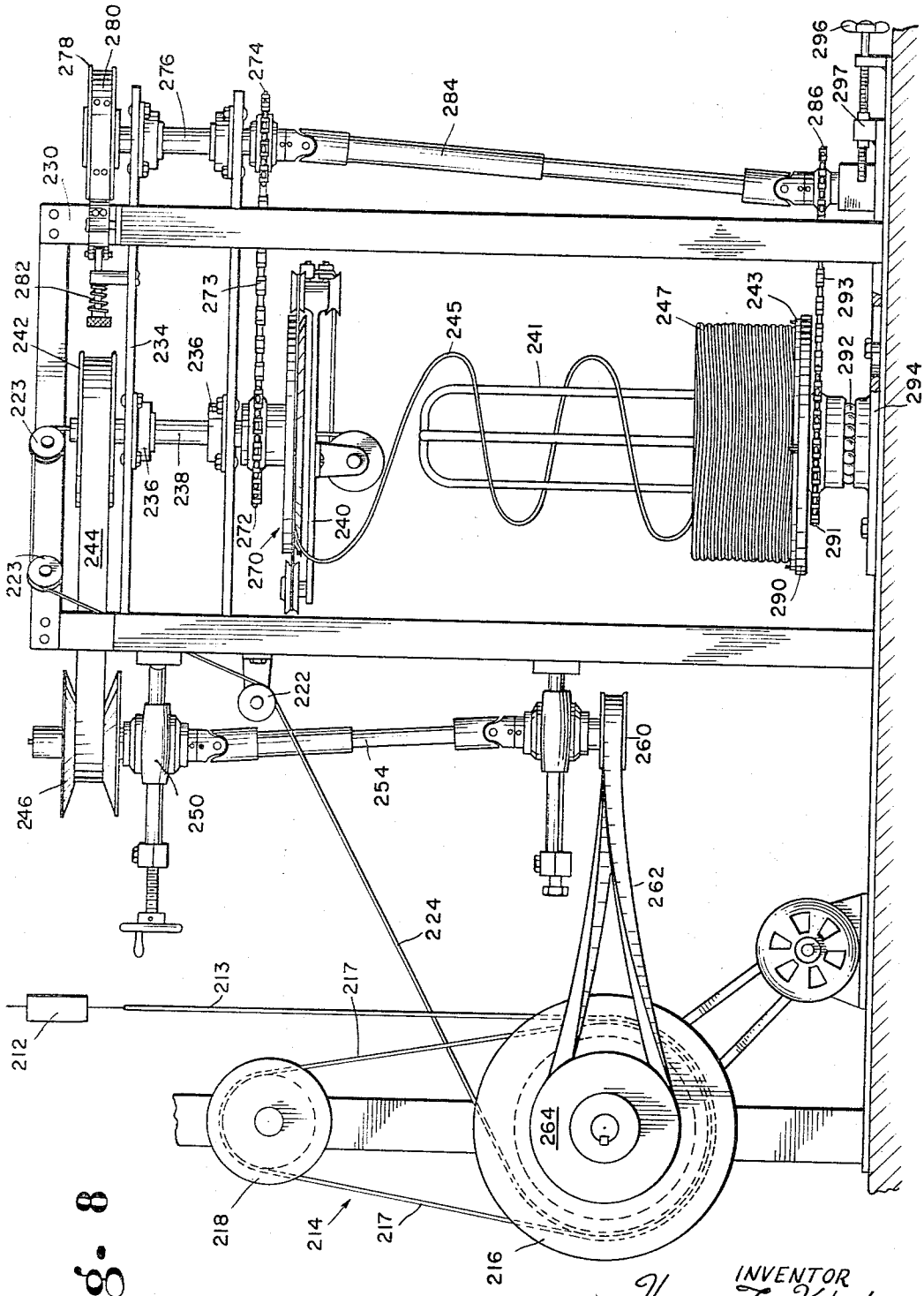


Fig. 8

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WIRE COILING APPARATUS

Filed Feb. 28, 1966 4 Sheets-Sheet 4

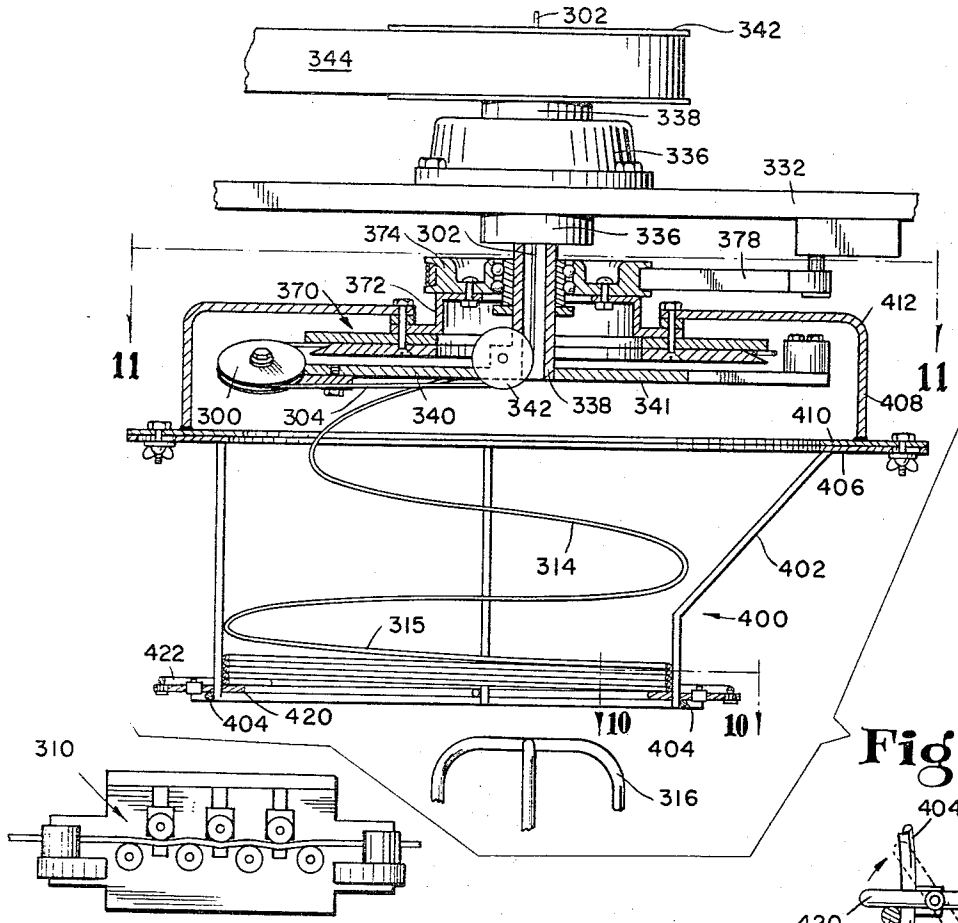


Fig. 9

Fig. 12

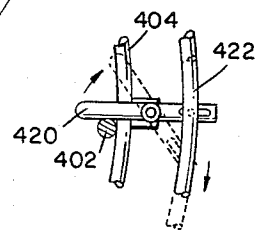


Fig. 10

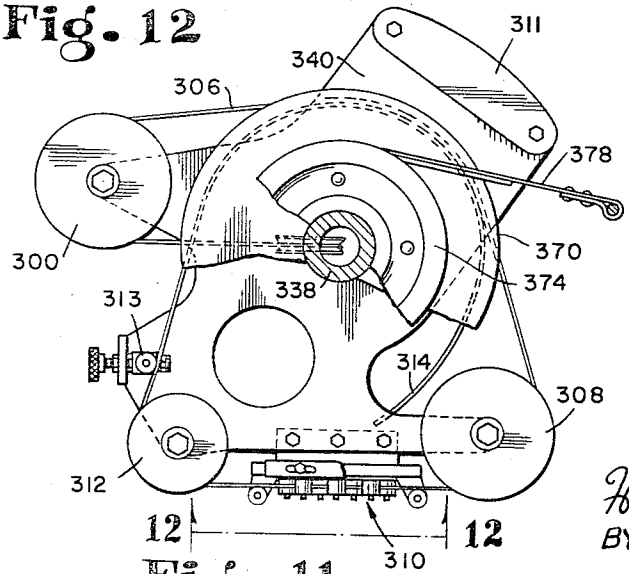


Fig. 11

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United States Patent Office 3,331,566
Patented July 18, 1967

3,331,566

WIRE COILING APPARATUS

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Filed Feb. 28, 1966, Ser. No. 530,707
10 Claims. (Cl. 242—83)

ABSTRACT OF THE DISCLOSURE

Wire from a wire-drawing machine or other supply source is delivered at a controlled supply rate to a coiler having a feeder, e.g., a flyer, and a reaction member, e.g., a capstan, relatively rotatable about the capstan axis. The feeder is deliberately over-driven at a wire-feed rate exceeding the supply rate, and the reaction member is mounted for rotation against a brake. The pull of the wire rotates the reaction member forward, and such rotation is used (a) to vary the size of the coils formed and/or (b) to progress angularly the positions at which the successive coils are delivered to the coil receiver. A casting device casts the coils to the delivered size. Adjustment of the brake varies the tension in the wire.

Background of the invention

This invention relates to wire coiling apparatus, for coiling into a hollow bundle wire drawn under tension from a supply source, such as a wire-drawing machine. It is especially applicable to "dead block" apparatus, but is not limited thereto.

In conventional dead block coiling apparatus, wire passes axially through a stationary capstan or "dead block," and thence to a feed roll on an orbiting flyer which wraps the wire onto the capstan. The wire engages the capstan over a sufficient peripheral distance or number of turns to be gripped by the capstan, and is then released from the capstan as a free-falling coil. The coils are gathered in an upward-building bundle on a receiver supported below the capstan.

A conventional capstan has a generally cylindrical peripheral surface on which several turns of wire are maintained, as by a spring-loaded retaining roll. While the present invention may be used with such conventional capstans, I preferably use a V-groove capstan of the type shown in my prior Patent No. 3,106,354, in which the capstan has a narrow peripheral V-groove shaped to receive and position two stretches of wire in radially superposed relation and to grip the inner wire in releasable wedging engagement. This preferred capstan apparatus gives a positive grip between the wire and the capstan which virtually prevents circumferential slippage.

Besides dead block coilers, my invention is also applicable to other coilers, including both those which discharge nonrotating coils, such as that shown in Patent No. 3,023,977, and those which discharge rotating coils.

In conventional coilers, the wire is wound onto the capstan by relative rotation of either the wire guiding means or the capstan, while the other of such elements is anchored against rotation, and such relative rotation pulls the wire from the wire source. The tension in the oncoming wire reacts on the anchored element to produce a turning moment on that element, but turning under this moment is prevented by the fixed anchorage. In my prior Patent No. 3,106,354, for example, the dead block capstan 25 shown in FIGS. 5 and 6 is fixedly anchored on a stationary support 27. Analogously, in the apparatus of Patent No. 3,023,977, the orbiting capstan 16 transmits the wire tension reaction through a cog belt 36 to a fixedly anchored sprocket 32.

In these devices, the coiler speed is closely matched to

the wire-supply rate. In true dead block apparatus, the size of the turns or rounds of the coil produced is fixed by the size of the capstan. Each revolution of the flyer and feed roll wraps onto, and releases from the capstan one full coil turn of fixed length equal to the circumference of the capstan, and all coil turns in the bundle are the same size. Semi-dead block apparatus has been proposed, as in Patents Nos. 2,929,575 and 2,929,576, in which both the flyer and the capstan are driven at variable rates to vary the coil turn size, but this involves separate and complex drive mechanism which my present invention avoids.

In order to produce a satisfactory bundle, good coiling practice requires that the wire be "cast" or shaped so that each round will lie dead flat and round in a single flat plane, otherwise a wild or springy bundle with locked-in stresses will result. Also, the bundle should have high density. For this, the successive coils of wire deposited in the bundle must be arranged in an orderly pattern, for example, with each coil turn positioned eccentrically, and with the successive turns progressively displaced angularly about the bundle axis. A number of methods are known for producing such patterned coils, all of which require very slow relative angular movement either of the coiling apparatus or of the wire receiver. Previous means of providing such slow angular movement require relatively expensive and complex drive mechanisms.

Summary of the invention

It is an object of the present invention to provide coiling apparatus which will permit coils of different or varying diameters to be produced from the same capstan, will provide for adjusting the tension in the oncoming wire from the wire source, and which will use the wire itself as a means to provide a differential rotation output which can be applied to produce the slow angular movement required for patterning coil turns in a bundle.

As noted above, in prior wire coilers which produce non-rotating coils, the capstan turning moment produced by the wire tension is positively opposed by a fixed anchorage. In accordance with the present invention, instead of positively opposing the capstan turning moment, such turning moment is applied to reaction means which is mounted for rotation against restraining means such as a brake, and the wire coiling apparatus is deliberately overdriven, at a wire-feed rate which is in excess of the wire-supply rate, so that the overdriving produces a turning movement against the rotation-restraining means. The amount of restraint imposed controls the tension in the wire, and can be adjusted to vary that tension.

If a small degree of overdriving is used, say of the order of 501:500, this produces a slow turning movement of the reaction means, and such turning movement can be applied to produce the desired patterning of the wire in the bundle.

If a large degree of overdriving is used, say of the order of 11:10 or more, the size of the coil turns formed by the coiler can be made substantially different from the size of the capstan, and can be varied over a wide range. The turn size can be held constant at a desired size or can be varied continuously as the bundle is formed.

The use of overdriving to change the size of the coil turns may be explained as follows. In a dead-block type coiler, if the flyer speed is made such as to feed wire onto the capstan at a rate which exactly matches the wire-supply rate, then the restrained-rotation capstan will remain stationary and each revolution of the flyer will produce one coil turn and each coil turn will have a length equal to the capstan circumference, as in prior fixed dead-block coilers. If, however, the flyer is overdriven, at a speed exceeding that which matches the wire-supply rate, then the overdriving will cause the restrainably-rotatable

capstan to be rotated forwardly against its restraint sufficiently to make up for the overdriving. The extent to which the capstan is rotated forwardly with the flyer will to that same extent reduce the *relative* rotation of the flyer with respect to the capstan.

The number of coil turns produced depends on the number of flyer revolutions in space, and each flyer revolution produces one coil turn. But the length or size of the turn depends on the *relative* rotation of the flyer with respect to the capstan. Accordingly, if for each one revolution of the flyer in space the capstan is pulled forward a quarter revolution, then the relative movement between the flyer and capstan, per flyer revolution, will be only three-quarters of a revolution, and the coil turn produced by the one flyer revolution in space will produce a coil turn which has a size or length of only three-quarters of the circumference of the capstan—instead of the full circumferential length which is produced when the capstan remains stationary.

The accompanying drawings illustrate the invention. In such drawings:

FIG. 1 is a side elevation of a coiler embodying my invention connected to be driven from a wire-drawing machine and to coil the wire delivered by such machine;

FIG. 1A is a fragmentary sectional view showing the V-groove of the capstan of FIG. 1;

FIG. 2 is a top plan view of the coiler shown in FIG. 1;

FIG. 3 is a vertical axial section taken on the line 3—3 of FIG. 2;

FIG. 4 is a plan view of the capstan and flyer assembly; taken on the line 4—4 of FIG. 3;

FIG. 5 is a fragmentary side elevation, taken on the line 5—5 of FIG. 4;

FIG. 6 is a plan view of the capstan restraining means or brake, taken on the line 6—6 of FIG. 3;

FIG. 7 is a fragmental side elevation of a modification, showing a motorized speed changing control for the coiler of FIG. 1;

FIG. 8 is a side elevation of a coiler similar to that of FIG. 1, connected to receive wire from and to be driven by a wire pay-out device of the type shown in my prior Patent No. 3,106,354 and in which the coiler is modified to use the restrained rotation of the capstan to drive the wire receiver;

FIG. 9 is a side elevational view showing another modification in which the restrained rotation of the capstan is utilized to drive a coil guide for producing patterned bundles;

FIG. 10 is a fragmentary view of a wire catcher associated with the coil guide for accumulating coils during changing of the wire receiver;

FIG. 11 is a horizontal sectional view taken on the line 11—11 of FIG. 9; and

FIG. 12 is a front elevation of the wire straightener shown in FIG. 11.

The coiler shown in FIG. 1 is driven from a wire-drawing machine 12 having a series of dies including a finishing die 14 through which the wire is drawn by a capstan 16 driven at a controlled rate by a suitable motor. The capstan 16 is of a conventional type having a generally cylindrical wire receiving face flanked by a shoulder 18, and the oncoming wire is fed to the space between the shoulder 18 and the previously wound turns of wire, which causes such turns to slide upward on the face. The wire 20 passes from the capstan 16 to an idler 22 and thence in a stretch 24 to the coiler.

The coiler 10 comprises a rectangular frame having corner uprights 30 interconnected at their upper ends by two spaced plates 32 and 34. Each plate 32 and 34 carries a bearing 36 for the hollow spindle shaft 38 of a flyer 40. At its upper end the spindle shaft 38 carries a V-groove pulley 42 which is driven by a belt 44 from a spring-loaded variable-pitch pulley 46 on a shaft 48 journaled in a bearing carrier 50 which is laterally adjustable by means of a hand screw 52 to vary the distance between the pulley

46 and the pulley 42, and hence to vary the effective pitch of the pulley 46.

The shaft 48 is connected by an articulated shaft 54 to a shaft 56 journaled in an adjustable carrier 58 and provided with a pulley 60 which is connected by a belt 62 to a pulley 64 mounted on the top of the capstan 16 of the wire-drawing machine 12. Adjustment of the carrier 58 tightens the belt 62.

Desirably, the pulley 60 is half the diameter of the capstan pulley 64 so that the variable speed pulley 46 is driven at twice the speed of the capstan 16. The diameter of the pulley 46 is desirably variable between an effective diameter half that of the driven pulley 42 and an effective diameter equal to that of the driven pulley 42, so that the speed of the spindle shaft 38 of the flyer can be varied over a range from a speed equal to that of the capstan 16 to a speed twice that of the capstan 16.

The upper end of the coiler frame carries a diagonal cross member 66 which supports two guide sheaves 68 which carry the wire to the axis of the hollow spindle shaft 38.

A coiler capstan 70 is rotatably mounted on the spindle shaft 38 immediately above the flyer 40. As shown in FIG. 3, the capstan 70 comprises an upper flat plate and a lower chamfered plate secured together to define a V-groove 72 at the periphery of the capstan, and attached by bolts to the hub of a brake drum 74 mounted for rotation on a bearing race 76 fixed on the spindle shaft 38. As shown in FIGS. 3 and 6, the brake drum 74 is engaged by a brake band 78 one end of which is fixed to a post 79 and the other end of which is joined to an adjustable tightening screw 80, the tension in which is controlled by adjustment of a hand wheel 82 against a spring 84. In operation, the brake drum 74 rotates counterclockwise, in the direction of the arrow in FIG. 6.

The flyer 40 comprises a T-shaped arm 86 which carries an idler sheave 88 below the capstan and a feed sheave 90 substantially co-planar with the V-groove of the capstan 70. The flyer 40 also carries a direction changing sheave 92 which receives the wire on the axis of the spindle 38 and discharges it radially to the sheave 88, from which it is transferred by rollers 94 to the sheave 90 which feeds it to the V-groove of the capstan 70. A hook-shaped arm 96 on the flyer mounts an idler sheave 98 at a point opposite the arm 86, and carries an adjustable casting roll 100.

The string-up of this capstan and wire assembly follows the teachings of my prior Patent No. 3,106,354. The wire supplied from the wire-drawing machine extends as the stretch 24 over the pulleys 68 to the axis of the spindle 38, thence through that hollow spindle as a stretch 102, thence around the sheave 92 and radially outward in a stretch 104 to the sheave 88, and thence over the rollers 94 to the feed sheave 90. The wire is wrapped onto the capstan 70 by the sheave 90 and extends as an entering stretch 106 into the groove 72 and part way along that groove as an outer stretch 108 (FIG. 1A) for an arc of the order of 90°. The wire then leaves the V-groove 72, passes as a stretch 110 over the idler 98 and under the casting roll 100, and then back to the groove 72 where it extends as an inner stretch 112 for an arc of the order of 270°, in the last 90° of which it underlies the outer stretch 108, so that the two stretches 108 and 112 lie in radially superposed relation and tension in the outer stretch 108 presses the inner stretch 112 into firm wedging engagement with the inwardly-converging side walls defining the V-groove 72. The wire then leaves the V-groove at a point opposite the idler 98, as a departing stretch 114 which forms a free-falling, non-rotating coil.

As shown in FIG. 1, a wire receiver 116 is positioned below the capstan and flyer to catch the free-falling coil of wire 115, and the coil is gathered in an upward-building bundle 118. Provision is desirably made for position-

ing the wire in a regular pattern in the bundle, but for purposes of simplicity this is not shown in FIG. 1.

The operation of the coiler shown in FIG. 1 is as follows: The wire to be coiled is delivered from the wire-drawing machine **12** at a controlled rate, normally a fixed rate, such as 500 feet per minute. The wire leaves the capstan **16** and is guided by the guide sheaves **22** and **68** to the axis of the flyer shaft **38**, passes axially through that hollow shaft, and extends about the flyer sheaves **92, 88, 90,** and **98** and about the capstan groove **72** in the string-up described above, and is discharged from the groove **72** as a free stretch **114** which drops downward beneath the curved arm **96** of the flyer and falls in coils **115** downward about the core **116** of the wire receiver to form a bundle **118**.

The coiler of FIG. 1 is driven from the pulley **64** on the main capstan **16** of the wire-drawing machine **12**, and the coiler speed is directly related to that capstan speed and hence to the supply-rate at which the wire is discharged by the machine **12**. The speed ratio between the driven flyer **40** and the capstan **16** depends on the adjustment of the variable-pitch pulley **46**, and is desirably variable between a 1:1 ratio and a 2:1 ratio. At the 1:1 ratio, the flyer **40** is driven at the same rate as the capstan **16**, and the wire is fed to the coiler capstan **70** at a feed-rate which is the same as the supply-rate at which it leaves the wire-drawing machine. At the 2:1 ratio, the flyer **40** is driven at twice the speed of the capstan **16** and feeds the wire to the coiling capstan at twice the supply-rate.

For purposes of explanation, assume that the effective diameter of the capstan **70** is the same as that of the capstan **16**. At a 1:1 drive ratio, the wire will be applied to the capstan **70** at a feed-rate which is the same as the supply-rate at which it is delivered from the wire-drawing machine **12**. Under these conditions, the capstan **70** will remain stationary, and the whole device will operate as a dead block coiler.

In accordance with the invention, however, the drive ratio will be higher than 1:1 and the flyer **40** will rotate at a higher speed than the supply capstan **16**, so that the wire-feed rate at the coiler capstan **70** will be greater than the wire-supply rate from the wire-drawing machine. Since the supply-rate is controlling, some compensating movement must occur; and what does occur is that the pull of the wire on the capstan **70** causes the capstan **70** to rotate forward, in the direction of rotation of the flyer **40**, against the restraining action of the brake band **78** on the brake drum **74**. Such forward rotation of the capstan **70** will proportionately reduce the relative rotation of the flyer **40** with respect to the capstan **70**. The length of wire which is fed to and released from the capstan for each revolution of the flyer **40** (in space) depends upon that *relative* rotation, and the reduction of that *relative* rotation will accordingly reduce the length of wire released for each revolution (in space) of the flyer. Since each revolution of the flyer (in space) produces one coil turn in the free-falling coil **115** of wire, the change of *relative* rotation will vary the size of the coil turns which are delivered to the bundle **118**.

To exemplify this operation, assume a wire-supply rate of 500 feet per minute, and a coiling capstan **70** having a circumference of 5 feet. A speed of 100 r.p.m. for the flyer **40** would then "match" the wire-supply rate and would feed the wire to the coiling capstan **70** at the same 500 feet per minute, to produce 100 coil turns per minute, each 5 feet in circumference. The wire would then exert no pull to overcome the restraining action of the captstan brake and the capstan would remain at rest.

If the flyer speed is increased above the matching speed of 100 r.p.m., however, the capstan will slip ahead against the restraining brake, in the direction of flyer rotation, and the slip will be such that exactly 500 feet of wire will be delivered every minute. If the flyer speed is increased to say 125 r.p.m., this means that only four feet of wire can be delivered for each revolution of the flyer and that the capstan must slip ahead one foot for every flyer revolution. Under these circumstances, each turn or round of the coil delivered from the coiling apparatus to the bundle will be only four feet in circumference.

The range of size variation of the coil turns or rounds which can be delivered by the coiling apparatus are indicated in the following table, in which it is assumed that the wire-supply rate is a constant 500 feet per minute and that the coiling capstan **70** has an effective circumference of five feet.

Flyer, r.p.m.	Round Circumference, ft.	Round Diameter, in.
100	5	19.2
125	4	15.3
166	3	11.48
200	2½	9.57
250	2	7.65

The speed of rotation of the flyer **40** is controlled and varied by adjusting the position of the carrier **50** for the variable-pitch pulley **46**. The speed can be set at a constant speed in order to produce a bundle containing coils of constant circumference and diameter. Also, the speed can be varied cyclically to produce a bundle containing cyclically varying coil-turn sizes. This can be done in a manner to produce in the bundle a repetitive pattern such that each successive coil-turn has a different diameter from that immediately preceding it, and in this way, a package comprising multiple layers of rounds of increasing and then decreasing diameter can be formed on a stationary receiver. This type of wire package is extremely dense and for some purposes is desirable.

To produce such a cyclic variation of the speed of the flyer **40**, an electromechanical control **152** shown in FIG. 7 can be substituted in place of the handle **52** shown in FIG. 1. This is operated continuously by its motor **151**, to progressively and continuously turn the shaft **53** which controls the position and pitch of the variable-pitch pulley **46**, and thus to vary correspondingly the rotational speed of the flyer **40**, in a cycle which first increases and then decreases the turn size of the wire coil deposited in the bundle. The bundle will then consist of a series of flat layers in each of which the turns are of progressively increasing or decreasing size. Such a bundle is known as a "pancake" bundle.

In the modification shown in FIG. 8, the wire is drawn from a supply source **212**, which may be of any type, and its supply-rate to the coiler is controlled by a pay-out apparatus **214** consisting of a positively driven V-groove capstan **216** and an idler sheave **218**, strung up in the manner disclosed in FIG. 1 of Patent No. 3,106,-354. The wire from the source **212** extends in a stretch **213** to V-groove of the V-groove capstan **216**, about that groove for approximately 180° as an outer stretch in the groove, thence in a stretch **217** away from the V-groove capstan **216** to the idler **218** and back again to the V-groove capstan beneath the incoming stretch **213**, thence as an inner stretch in the V-groove beneath the outer stretch previously mentioned for an arcuate distance in excess of 180°, and thence out in a stretch **224** leading to a guide roller **222** on the coiling machine.

The coiling machine comprises a frame **230** similar to that shown in FIGS. 1 and 2, having a pair of cross plates **232** and **234** near its upper end which support bearings **236** for the spindle shaft **238** for the flyer **240**. The shaft carries a drive pulley **242** which is driven by a belt **244** from a variable-pitch pulley **246** adjustably carried on a sliding block **250** and driven through a telescopic shaft **254** from a pulley **260** connected by a belt **262** to a sheave **264** fixed on and driven with the pay-out capstan **216**. The flyer **240** is identical with the flyer **40** of FIG. 1 and cooperates with a capstan **270**

similar to the capstan **70** of FIG. 1 and similarly rotatably mounted on the shaft **238**. Instead of being fixed to a brake drum as in FIG. 1, the capstan **270** is fixed to a sprocket **272** which is connected by a chain **273** to a sprocket **274** on a jackshaft **276** mounted in bearings on extensions of the plates **232** and **234**. The upper end of the jackshaft **276** carries a brake drum **278** engaged by a rotation-restraining brake band **280** controlled by an adjustable spring **282**. The lower end of the jackshaft **276** is connected by a telescopic shaft **284** to a sprocket **286** for driving the wire receiver support.

The wire receiver **241** having a base **243** is replaceably mounted on a turntable **290** on a bearing **292** carried by a slidable plate **294** which is adjustable to locate the turntable **290** concentric with, or at various amounts of eccentricity with respect to, the axis of the shaft **238**. Adjustment is by a hand wheel **296** which turns a threaded rod engaged in a nut **297** on the sliding plate **294**. The turntable carries a sprocket **291** which is connected by a chain **293** to the sprocket **286** driven from the jackshaft **276**.

In this modification, the rotation-restraining means for the capstan **270** is the brake band **280** acting on the drum **278**, which instead of being connected directly to the capstan, is mounted on the jackshaft **276** and connected by the chain **273** to the coiling capstan **270**.

The operation of the coiling mechanism of this modification shown in FIG. 8 is substantially like that of FIG. 1 described above. The wire is drawn from the source **212**, is payed out at a controlled and normally constant rate by the pay-out device **214**, is wrapped onto the coiling capstan **270** by the flyer **240**, and is discharged as a coil **245** in a free-falling state without rotation. The successive turns of the coil **245** fall about the core of the wire receiver **241** mounted on the turntable **290** to form a bundle **247**.

To produce a patterned bundle **247**, with the successive coil turns at eccentric positions in progressively angularly-displaced relation, the turntable supporting plate **294** is adjusted by the handle **296** to a position of eccentricity suitable to the size of the coil and the desired eccentricity of the coil turns; and the speed of the flyer **240** about the coiling capstan **270** is adjusted so that it is slightly in excess of a matching speed for the wire-supply rate provided by the pay-out device **214**. For example, if the wire-supply rate is controlled at 500 feet per minute, the flyer **240** may be driven at a speed which will produce at the capstan a wire-feed rate of say 501 feet per minute. The differential between these speed rates will cause the coiling capstan to be rotated forward at a speed of one revolution for each 500 revolutions of the flyer **240**. For each rotation of the flyer **240**, the capstan **270** will be advanced $\frac{1}{500}$ of a revolution, and this slow angular movement will be transmitted by the sprocket and chain connection to the turntable **290**, so that the turntable will rotate $\frac{1}{500}$ of a revolution for each revolution of the flyer **240**. As a result, the eccentrically deposited turns of the coil of wire **245** will be deposited in successive angularly displaced positions in the wire bundle **247** and a regularly patterned bundle will be produced.

This result is produced by overdriving the coiler flyer **240** with respect to the wire-supply rate, to produce a differential which the wire itself transmits to the coiling capstan **270** to cause that capstan **270** to rotate slowly forward, and such slow rotation is transmitted by the drive train to the turntable **290** and thence to the accumulating bundle.

The modification shown in FIGS. 9–11 is functionally similar to the modification of FIG. 1, except that it uses a modified form of flyer which includes a wire straightener, and except also that the wire coil is guided to the stationary receiver by a rotating eccentric coil guide driven by the capstan.

In the modification of FIG. 9, a flyer spindle shaft **338** is mounted for rotation in bearings **336** supported by a cross plate **332** at the top of the coiler frame. The upper end of the shaft carries a pulley **342** driven by a belt **344** from a variable speed drive such as that shown in earlier modifications. The lower end of the spindle shaft **338** carries a flyer **340** in the form of a plate having the configuration shown in FIG. 11. At the point of connection between the shaft **338** and the plate **341**, both are notched to clear a direction-changing sheave **342** mounted on the flyer, which directs the axially traveling wire **302** radially outward in a stretch **304** to a feed sheave **300** which wraps the wire on the capstan **370**. The flyer **340** also carries the sheaves **308** and **312**, a wire straightener **310**, and a casting roll **313**, and is balanced by the weight **311**.

The capstan **370** is bolted to the lower flange of a bell housing **372** which in turn is secured to the lower face of a brake drum **374** rotatably mounted on bearings **376** on the spindle **338**. As in other modifications, the brake drum is engaged by an adjustable brake band **378**. The coiling capstan **370** is formed of a pair of juxtaposed plates, the lower one of which is chamfered at its edge to form a V-groove of the configuration shown in FIG. 1*a*.

The incoming wire **302** passes axially through the hollow center of the spindle shaft **338**, is turned outward by the sheave **342** to the feed sheave **300**, which feeds it as a stretch **306** into the V-groove of the coiling capstan **370**. The wire extends as an outer stretch in such groove for an arc of the order of 120°, thence out to an idler sheave **308**, thence through the wire straightener **310** and to a second idler sheave **312**, then under the casting roll **313**, and from this back into the groove of the coiling capstan **370** where it lies as an inner stretch beneath the outer stretch referred to above, and is releasably wedged between the inward-converging walls of the groove by inward pressure from the outer stretch. At a point opposite the idler **308**, the wire is discharged as a free wire **314**, in the form of successive turns or rounds of a continuous coil **315**. The coil is allowed to fall toward a receiver **316** mounted coaxially with the shaft **338**, but is guided to an eccentric position and in a progressive angular displacement by a coil guide **400**.

The coil guide **400** is formed of a series of angularly spaced bars **402** connected at their lower ends by a ring **404** and carried at their upper ends by a slidably adjustable plate **406** bolted to a support plate **410**. Both ends of the coil guide may be circular in configuration, but the lower end is offset so that it is eccentric with respect to the upper end. The coil guide support plate **410** is part of a frame **408** connected by L-shaped brackets **412** to the bell housing **372** which carries the capstan **370**. Accordingly, the coil guide is supported with the coiling capstan **370**, and will be rotated therewith under the restraint of the brake **378**.

The coiling mechanism of FIGS. 9–11 operates in the same way as that of FIGS. 1–6. The wire is supplied at a controlled supply-rate and is wrapped onto the coiling capstan **370** by the feed sheave **300**. The wire makes non-slipping engagement with the capstan **370** and is discharged as a free wire **314** in the form of a continuous coil. In normal operation, the flyer **340** will be driven at a speed slightly in excess of the speed which matches the wire-supply rate, so that a speed differential is produced which causes the wire to pull the coiling capstan **370** forward against the restraint of the brake **378** in slow angular movement which is also transmitted to the coil guide.

The free-falling coil of wire **314** is deflected by the coil guide to an eccentric position, and the successive coil turns are dropped eccentrically onto that receiver **316**. Simultaneously, the slow angular movement of the coil guide, transmitted from the capstan, carries the lower end of the coil guide **400** in an orbital path about the axis of the receiver **316**, so that the successive turns of

the coil of wire are deposited at angularly spaced positions on the bundle of wire. This produces a patterned bundle.

Desirably, the lower end of the coil guide is provided with a circumferential series of coil catcher fingers **420** pivotally mounted for swinging movement into and out of the path of the coil of wire passing through the coil guide. A hand ring **422** interconnects the operating arms of the catcher fingers **420** and is operable to move them simultaneously between their wire catching position and a retracting position in which they allow the wire to fall through the coil guide. By moving the fingers **420** into catching position and cutting the wire, the coil can be collected temporarily in the wire guide while a full receiver **316** is replaced with an empty receiver. When the new receiver is in place, the catcher fingers **420** are retracted and the accumulated wire is allowed to drop onto the receiver. In this way, receivers can be changed without stopping the operation of the coiler.

I claim as my invention:

1. Wire coiling apparatus for coiling a continuous wire supplied thereto at a controlled supply-rate from a source, comprising

a capstan adapted to make gripping engagement with wire wound thereon,

guide means including a carrier and a feed roll mounted thereon, for guiding the wire from the source to the capstan and winding the same onto the capstan,

a drive for relatively rotating one of said capstan and carrier with respect to the other thereof, to draw the wire from the source under tension and wind the same onto the capstan at a feed-rate in excess of the controlled wire supply rate,

the other of said capstan and carrier being acted on by the wire tension to impose a turning moment thereon and being capable of turning into response thereto,

reaction means mounted for restrained rotation and connected to take the wire-imposed turning moment,

restraining means to restrain rotation of said reaction means and thereby control the tension in the wire.

2. Wire coiling apparatus according to claim **1** in which

the feed roll carrier is driven and revolves the feed roll in an orbital path about the capstan,

said capstan is connected to a brake rotor and mounted for restrained rotation therewith,

and said restraining means comprises a brake acting on said rotor.

3. Wire coiling apparatus according to claim **2** with the addition of means to adjust the braking action of the brake on said rotor.

4. Wire coiling apparatus according to claim **2** in which said drive comprises a variable-speed drive which is adjustable to change the differential by which said wire-feed rate exceeds said wire-supply rate.

5. Wire coiling apparatus according to claim **1** in which

said drive is connected to drive the feed roll carrier and the capstan is connected to said reaction means and mounted for restrained turning movement under restraint of said restraining means,

and said drive comprises a variable speed drive which is adjustable to produce a large differential of wire feed-rate over wire-supply rate and thereby to materially change the turn size of the coil formed by the coiling apparatus.

6. Wire coiling apparatus according to claim **5** with

the addition of means on the feed roll carrier for adjusting the "cast" imparted to the wire being coiled by said apparatus.

7. Wire coiling apparatus according to claim **1** in which

said drive is connected to drive the feed roll carrier and the capstan is connected to said reaction means and mounted for restrained turning movement under restraint of said restraining means,

said drive is operable to produce a small differential of wire-feed rate over wire-supply rate and thereby to cause said differential to turn said capstan at a slow rate of rotation,

a receiver for the coil of wire delivered by said apparatus,

positioning means for causing successive turns of said coil to be delivered eccentrically onto said receiver,

and rotational means to cause relative rotation between the positioning means and the receiver for causing the eccentric-coil position to progress about the axis of the receiver to produce a patterned bundle of wire thereon,

said last named means being connected to be driven by the slow capstan rotation produced by said small differential of feed-rate over supply-rate.

8. Wire coiling apparatus according to claim **7** in which said receiver is offset from the axis of the capstan to cause the coil to be delivered eccentrically thereon,

and said rotational means rotates the receiver to thereby cause the coil position to progress about the axis of the receiver.

9. Wire coiling apparatus according to claim **7** in which

said positioning means comprises a coil guide disposed between the capstan and the receiver and arranged to displace the coil to an eccentric position relative to the receiver,

and said rotational means rotates the coil guide to thereby cause the coil position to progress about the axis of the receiver.

10. Wire coiling apparatus according to claim **1** in which

said drive is operable to produce a small differential of wire-feed rate over wire-supply rate and thereby to cause said differential to turn said reaction means at a slow rate of rotation,

a receiver for the coil of wire delivered by said apparatus,

positioning means for causing successive turns of said coil to be delivered eccentrically to said receiver,

and rotational means to cause relative rotation between said positioning means and the receiver for causing the eccentric coil position to progress about the axis of the receiver to produce a patterned bundle of wire thereon,

said last named means being connected to be driven by said slow rotation of said reaction means, produced by said differential of feed-rate over supply-rate.

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