Jan. 6, 1953 J. DUNOD 2,624,367

LOOM FOR CIRCULAR WEAVING

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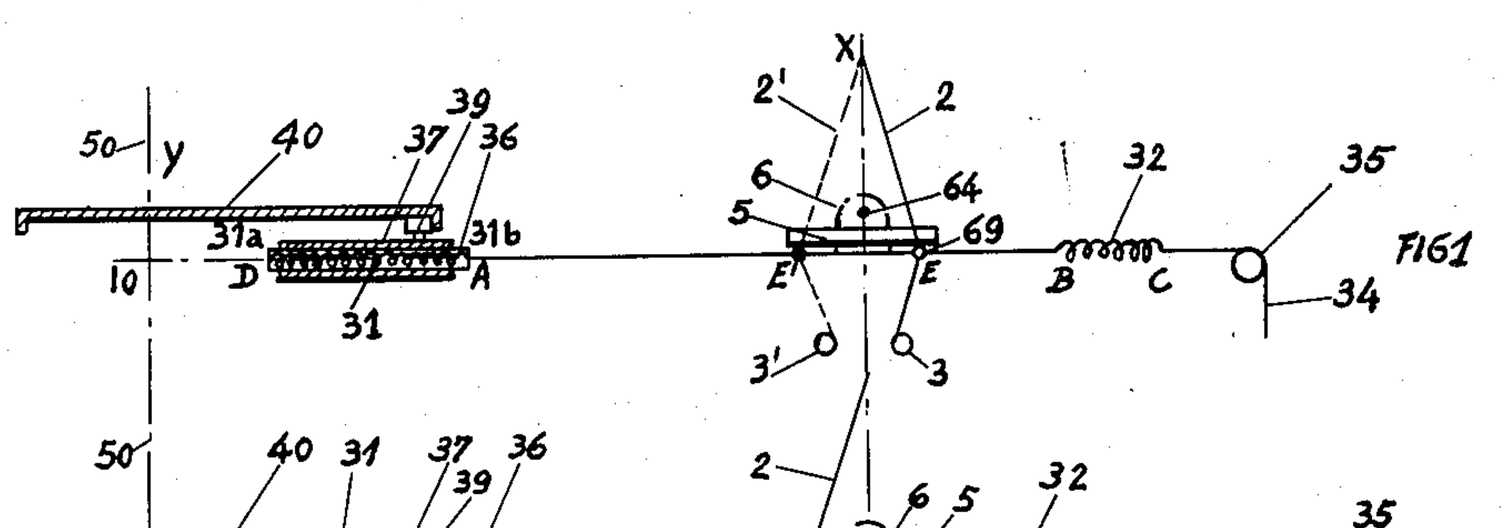

FIG1

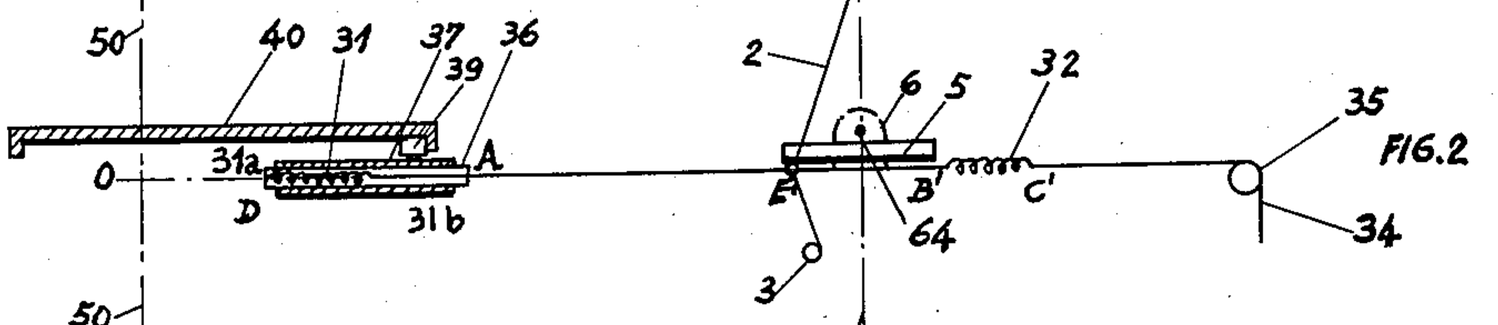

FIG.2

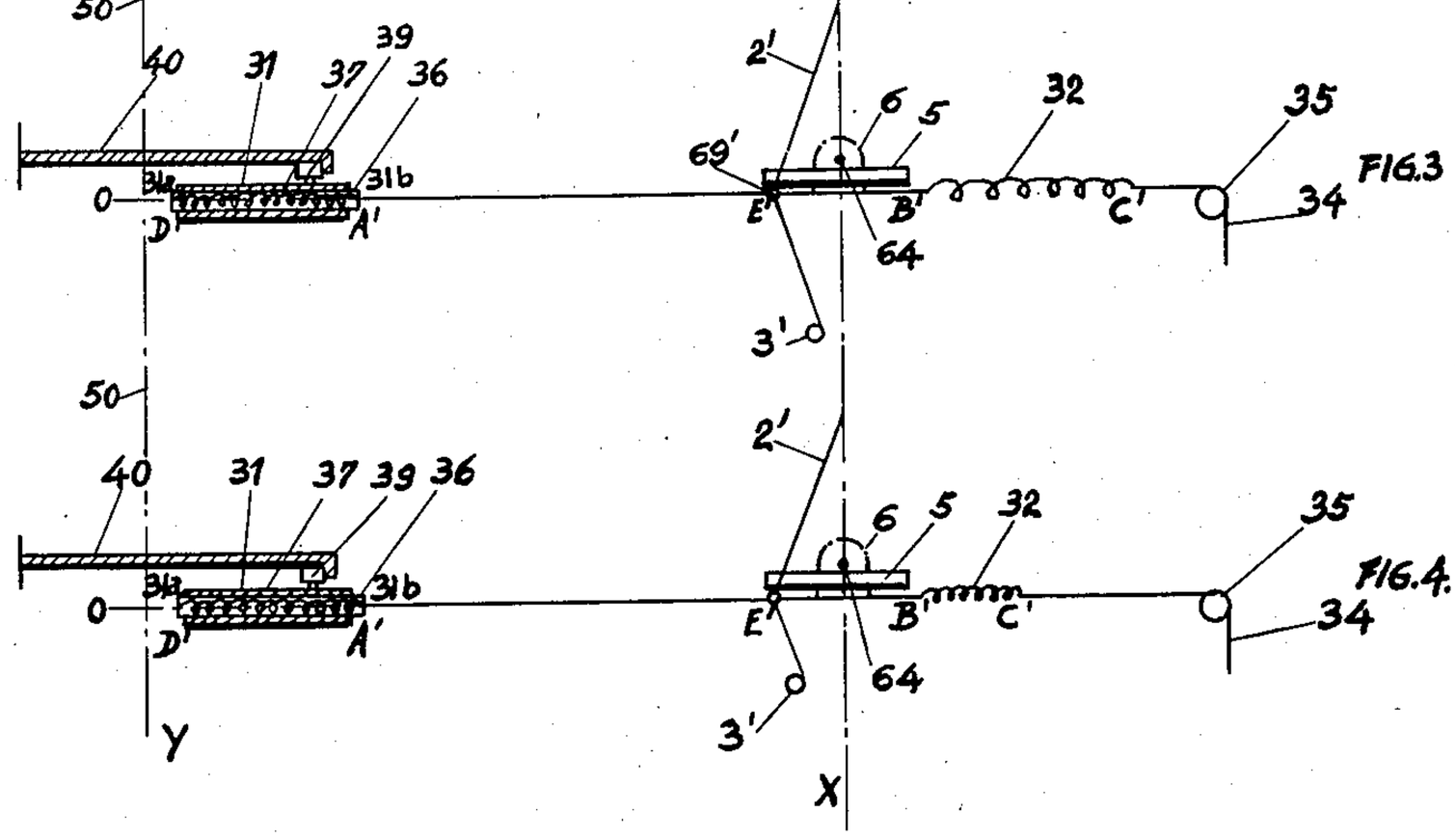

FIG.3

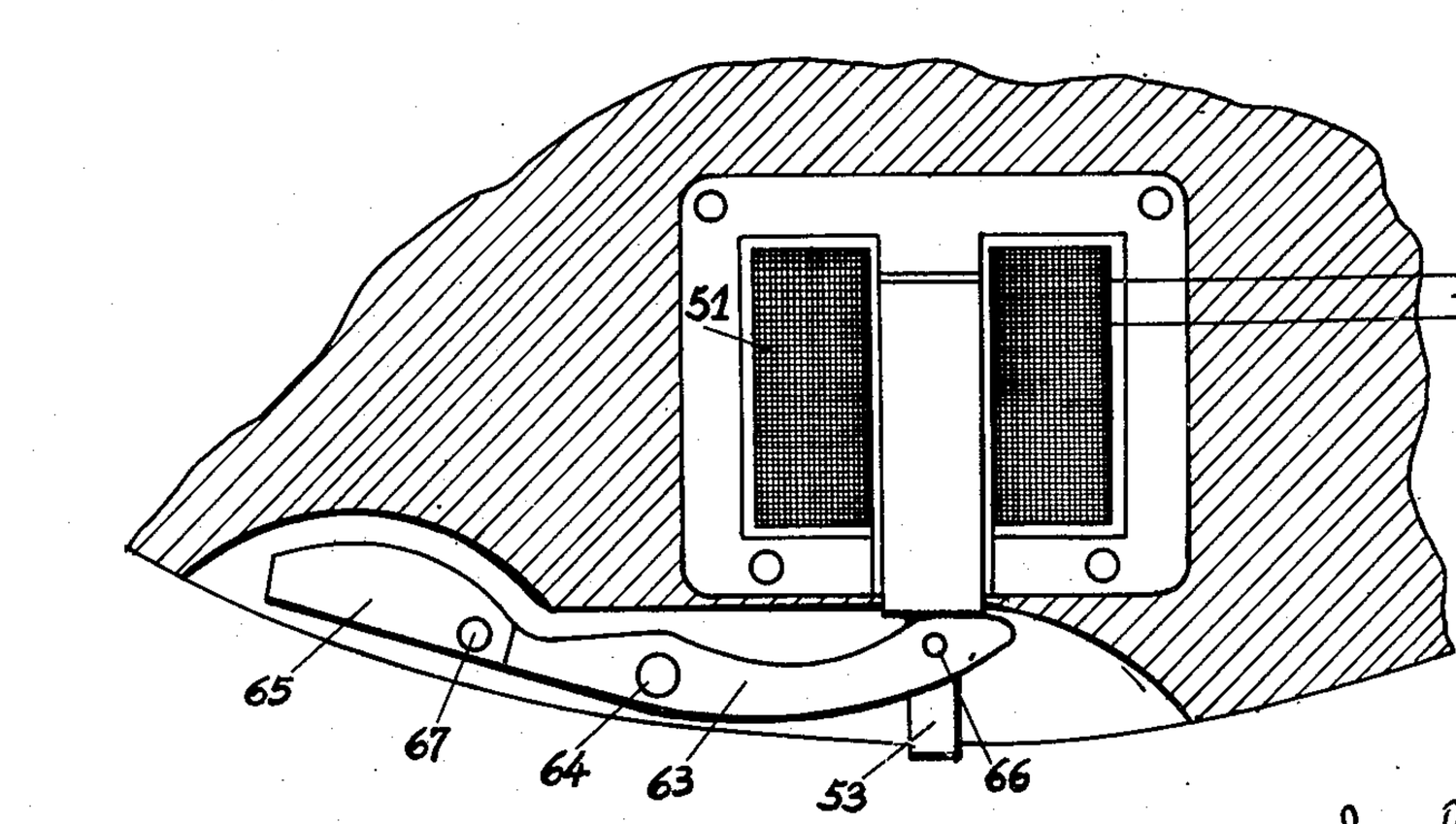

FIG.4.

Fig. 8a.

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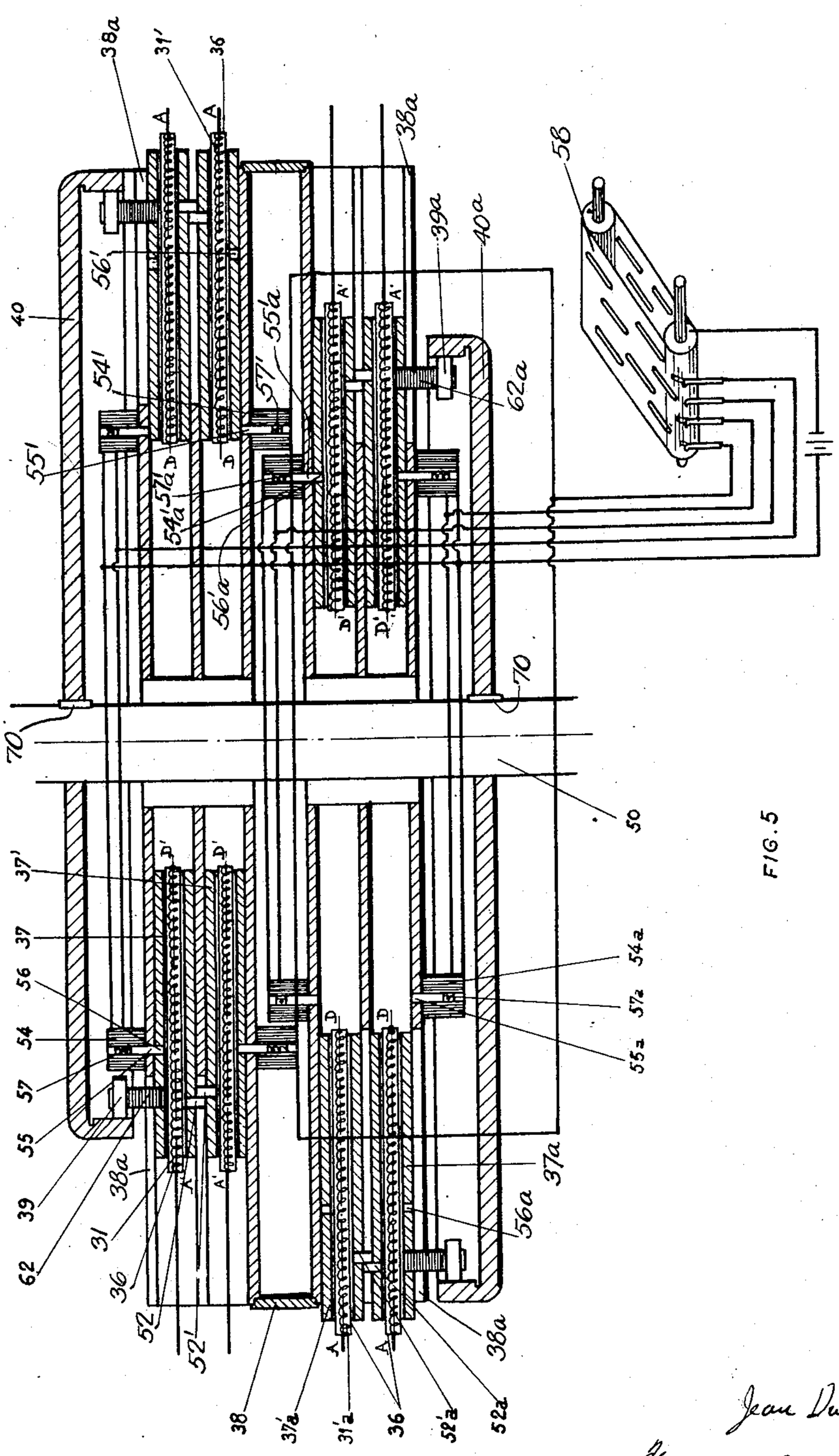

FIG. 5

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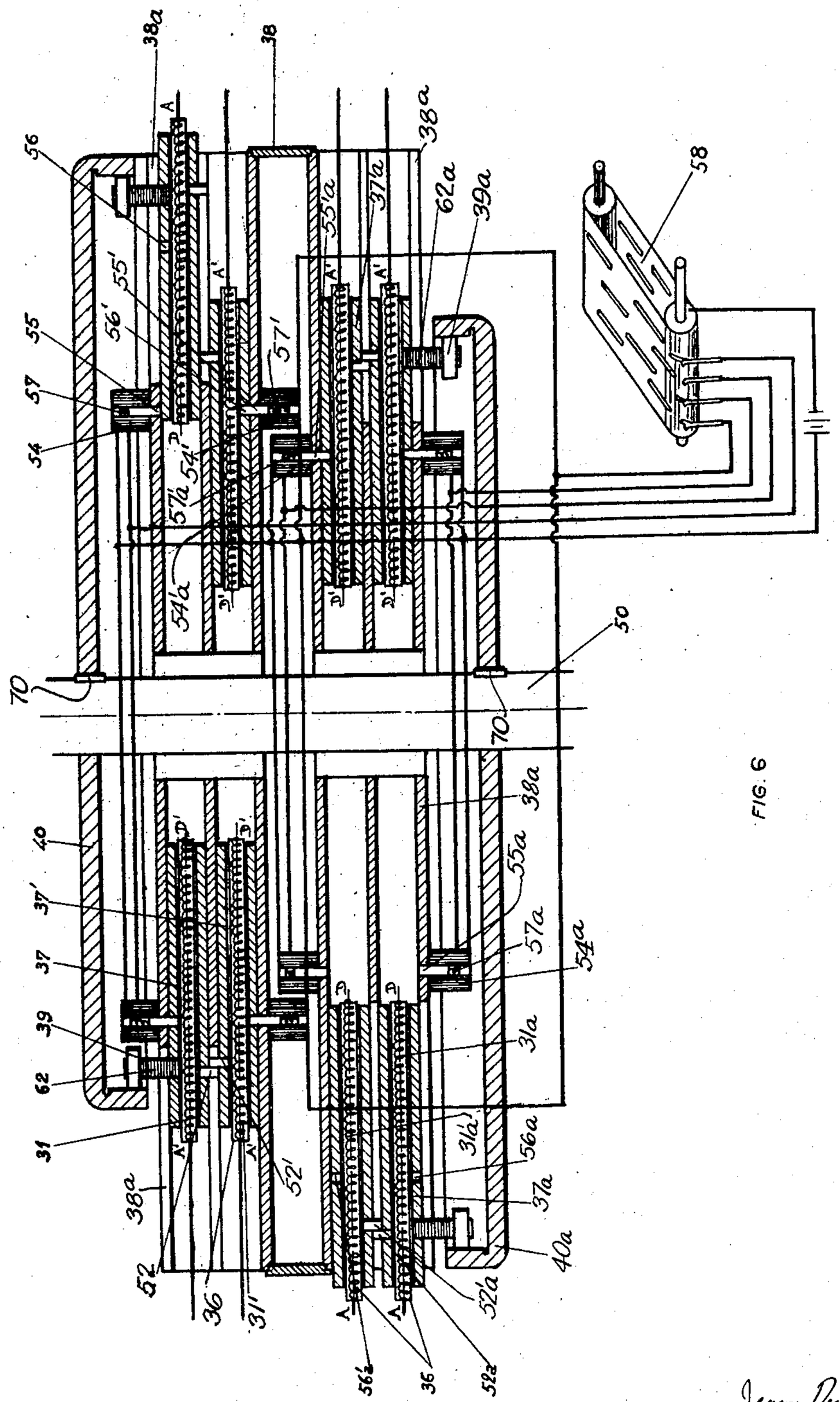

FIG. 6

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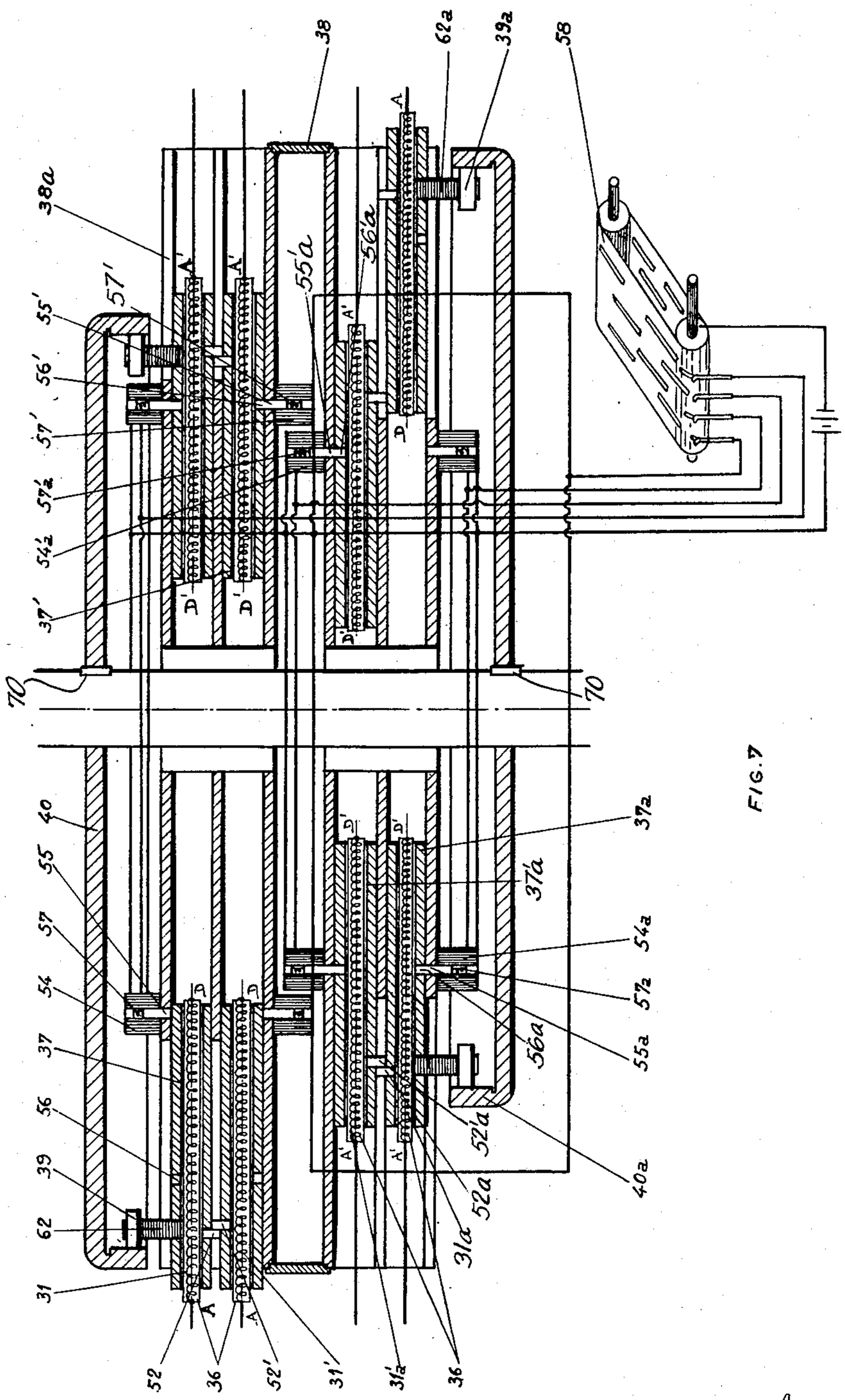

FIG. 7

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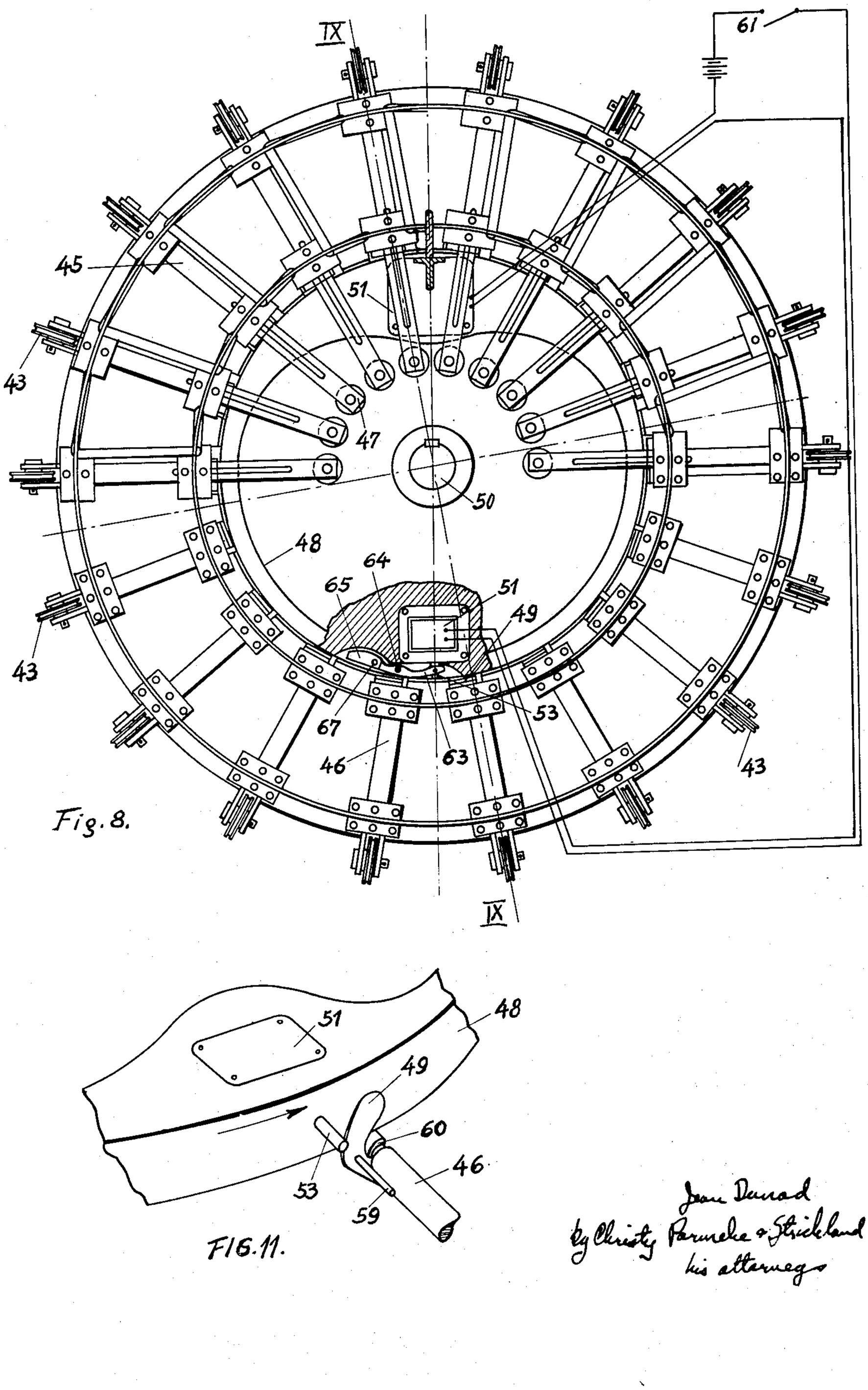

Fig. 8.

FIG. 11.

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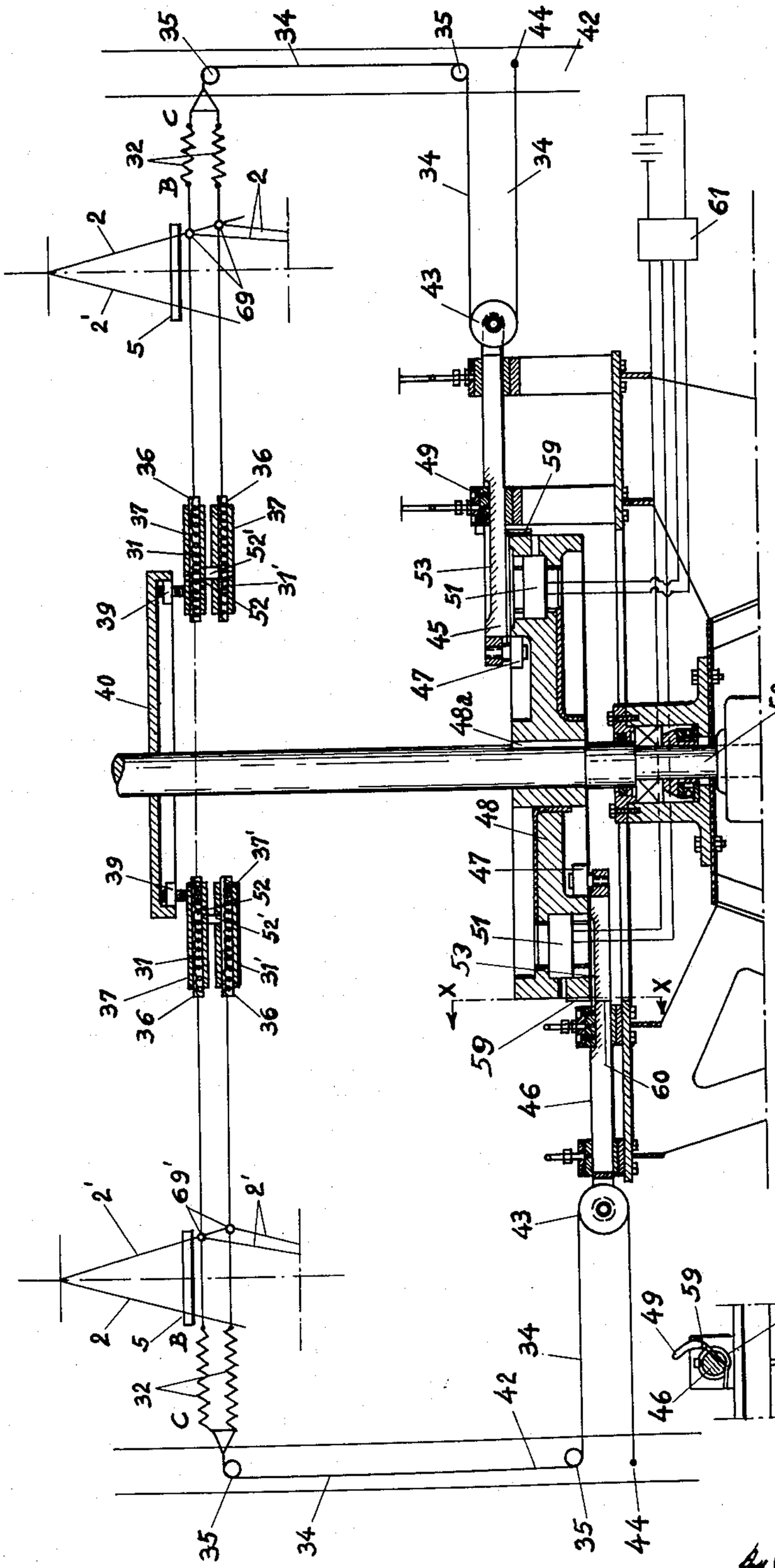

FIG. 9.

FIG. 10.

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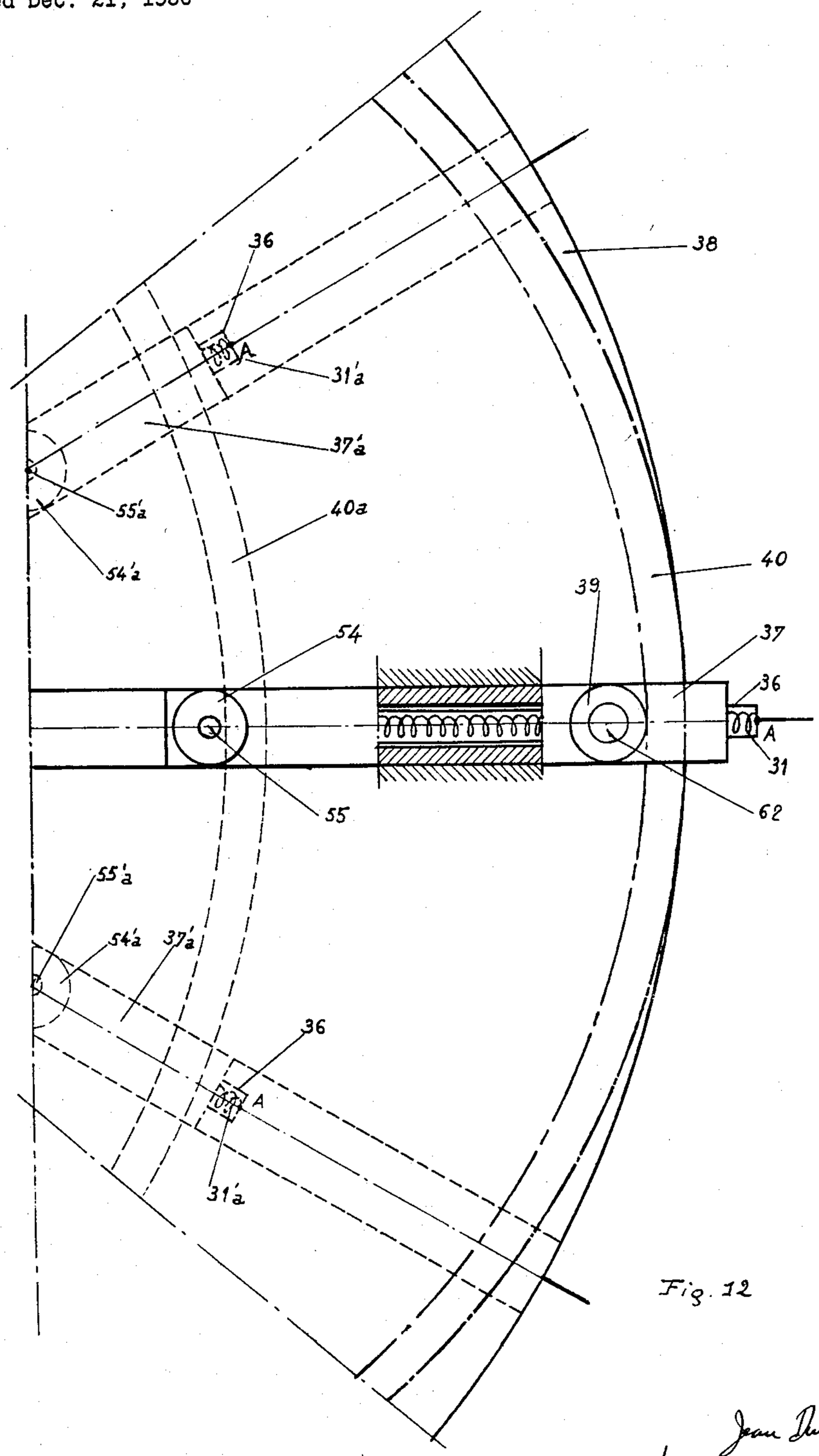

Fig. 12

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UNITED STATES PATENT OFFICE

2,624,367

LOOM FOR CIRCULAR WEAVING

Jean Dunod, Paris, France

Application December 21, 1950, Serial No. 201,964
In France May 3, 1947

6 Claims. (Cl. 139—16)

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My invention relates to a loom for circular weaving, permitting of the weaving of natural or synthetic textile threads as well as metallic threads, wherein:

(*a*) The warp threads are arranged along the generatrices of a vertical cylinder and are supplied by bobbins placed at one end (for example at the bottom) of the loom, there being a number of bobbins equal to that of the threads:

(*b*) The opening of the shed is controlled by harness.

This application constitutes a continuation-in-part of an earlier filed application, now abandoned, Serial No. 23,606, filed April 27, 1948.

My invention has for its object to provide a circular weaving loom with means for opening the shed to permit the passage of the shuttle during the normal operation of the loom, and means for retracting all the warp threads towards one and same side of the reed in order to uncover the shuttle, for example to permit the re-loading of said shuttle.

One practical manner of carrying my invention into practice has been illustrated diagrammatically and by way of example in the annexed drawings:

Fig. 1 shows, in the system of harness according to my invention, one heddle in the normal position, the point connected to the member producing the to-and-fro motion being most distant from the centre of the loom and the warp thread being on the outside of the shuttle.

Fig. 2 is similar, but the warp thread has been drawn towards the centre of the loom in order to uncover the shuttle.

Fig. 3 shows one heddle in the normal position, the point connected to the member producing the to-and-fro motion being nearest to the centre and the warp thread being on the inside of the shuttle.

Fig. 4 is a view similar to Fig. 3 but corresponds to the position of the warp thread during the reloading of the shuttle.

Figs. 5 to 7 are sections showing in three different positions how the internal springs are secured to slides, and how some of said slides can be arrested in the inner position.

Fig. 8 is a plan view of the mechanism for retracting the warp threads clear from the shuttle.

Fig. 8*a* is a fragmental plan view at a larger scale.

Fig. 9 is a section on IX—IX in Fig. 8 with parts thereof shown diagrammatically.

Fig. 10 is a section on X—X in Fig. 9.

Fig. 11 is a perspective view of details of the mechanism shown in Figs. 9 and 10.

Fig. 12 is a fragmental plan showing the positioning of three different slides shown in Figs. 5 to 7.

According to my invention, the harness producing the to-and-fro motion of the warp threads in order to normally open the shed during the normal operation of the loom is controlled by cams, and each warp thread is passed through an eye of a heddle, the harness comprising a number of heddles equal to the number of the warp threads. Each heddle is connected through springs, on the one hand (towards the inside of the loom), to the element producing the to-and-fro motion and, on the other hand (towards the outside), to a point which is normally fixed but which may be displaced at will, the external spring being more powerful than the internal spring. A special arrangement of the heddles permits all the warp threads to be drawn to one and the same side of the shuttle so as to be clear of the latter, and, in particular, to permit to replace the spool carried by the shuttle.

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Referring at first to Figs. 1 to 4, it will be noted that said figures are merely diagrammatic and illustrate only the principle of the invention. On said figures, **2** designates the warp thread, **3** the bobbin which supplies this thread, **5** the reed, **6** the shuttle, and **64** the weft thread. X—X is the axis of symmetry of the reed, and Y—Y is the axis of the loom driving shaft **50**. Each heddle AB extends substantially in a horizontal plane, which encounters the axis Y—Y at the point O, as seen in dotted line. This heddle is attached at A to an internal spring **31** and at B to an external spring **32**. For sake of clearness, it will be assumed that the cam **40** producing the to-and-fro motion of each of the heddles is secured at O on the loom driving shaft **50** and acts upon a member **37** attached at D to the inner end of the spring **31**. In Figs. 1 to 4, I have shown only the cam **40** and the slide **37** with its roller **39**. Similarly, for sake of clearness, only one stage of slides and heddles has been shown, although practically the heddles are divided between several stages. The actual structures of said devices are shown in detail in Figs. 5 to 7.

The operation of the heddle is following: during the normal operation of the loom, it is necessary to open the shed of the warp threads **2**, in order to allow for the free passage of the shuttle. Consequently, the eye **69** of any one of the heddles is drawn from E to E′ i. e. from one side of the reed **5** to the other side of said reed, and at the same time the adjacent heddle is drawn from E′ to E, and conversely. When a warp thread **2** is in the position E shown in full line in Fig. 1, the next warp thread **2′** coming from the bobbin **3′** is in the position E′ shown in dotted line in the same figure, i. e. symmetrical as to the axis X—X. Assuming that the heddle AB is directly attached to the driving member **37**, it would be positively reciprocated from E to E′ at each action of said driving member. But it would be impossible to keep all the warp threads retracted towards one

and the same side of the reed, since at every moment each two warp threads would be on one side of the line X—X whereas the other warp threads would be on the other side.

According to my invention, it is possible to stop certain of the heddles without stopping the driving member, and consequently to retract towards one side of the reed (for example towards the centre of the loom) all the warp threads which, at a given moment, are positioned on the other side of the reed, without at the same time displacing towards the outside of the loom the warp threads that already are on the inner side of the reed. This result is achieved, according to my invention, by means of the mechanism that will be now described.

While the heddle AB is attached at A to an internal spring **31**, this latter being itself attached at D to the sliding member **37**, as disclosed above, this heddle is attached to B to an external spring **32**, the outer end C of this spring being attached at C to a "semi-fixed" point, that is a point which may normally be considered as fixed, but which can, when necessary, be displaced at will by means of a suitable control mechanism represented diagrammatically in Figs. 1 to 4 by a cable **34** passing over an idle pulley **35**.

The spring **32** is stronger than the spring **31**. Said spring **32** can not expand as long as the spring **31** is allowed to expand. But the expansion of the spring **31** is limited by a suitable tension limiting device **36**. Said device **36** may be constituted by a tube forming a sheath, against the inner ends of which the ends **31***a*, **31***b* of the spring **31** bear (Figs. 1, 3 and 4). The device **36** may also be constituted by a flexible cable the ends of which are attached to the ends of the spring **31**. Such tension limiting devices are well known in the art. The device **36** is designed for allowing a displacement $AA'=EE'$, equal to the opening of the shed.

It will thus be seen that, in normal operation, owing to the said tension limiting device **36**, the spring **31** behaves as a rigid connection, whilst the spring **32** absorbs the total motion of the heddles, since the point C is deemed to remain stationary.

Fig. 1 shows the position of the heddle and spring mechanism, in normal operation, for the threads **2**. Fig. 3 shows in the same conditions the position of the threads **2'**. In this last figure, both springs **31** and **32** are as much expanded as possible; it is assumed that the point C is fixed.

Now supposing that it is desired for any reason, and particularly at the time of re-loading of the shuttle, to draw all of the warp threads towards the centre of the loom, which has the effect of causing the shuttle to emerge from its cage of threads and to become located outside of all the threads, it is necessary to bring to E' the threads **2** which would normally be at E at this time, that is to say, to bring B to B' and C to C' for these threads (Fig. 2), without modifying the position of the member **37**. This is effected by releasing (as described thereafter) the cable **34**, and results in bringing to C' the point C without modifying the tension of the spring **32**.

The displacement of B (Fig. 1) to B' (Fig. 2) is equal to the displacement of C to C' and to that of E to E', since the tension of the spring **32** remains constant, the magnitude of the movement of the eccentric device from D to D' being equal to the width EE' of the reed **5** and the tension of the spring **31** being maximum. But

it is evident that the displacement AA' of the end of the heddle is equal to the distance EE', magnitude of the opening of the shed, and to the distance CC', magnitude of the displacement of the point C; consequently

$$AA'=BB'=CC'=DD'=EE'$$

There are two cases:

(1) The point of attachment D of the spring **31** is in its position furthest removed from the point O.

When the cable **34** is relieved, the spring **31**, which is no longer subject to the action of the spring **32**, collapses, drawing A to A' and consequently E to E' (Fig. 2).

(2) The point D of attachment of the spring **31** is in its position D' nearest to the centre O (case of the threads **2'** in Fig. 3).

The spring **31** is extended as much as allowed by the device **36**. The eye **69'** which was already at E' does not shift (Fig. 3). The spring **32** is also extended.

When the cable **34** is relieved, the point C is brought at C' (Fig. 4) and the spring **32** collapses, the spring **31** remaining under the maximum tension.

It will be noted that, when the tension on the cable **34** is relieved, the spring **32** remains collapsed; the point B remains stationary as well as the heddle AB, and the end D of the spring **31** alone follows, between the points D and D', the motion of the device controlling the to-and-fro movement, the spring **31** being alternatively collapsed or expanded.

If now it is desired to re-establish the normal process of opening of the shed, it will suffice to pull the cable **34** for moving the point C' to C. Assuming that the mechanism had stopped in the position of Fig. 4, the threads **2'** assume again the position of Fig. 3, and assuming that the mechanism had stopped in the position of Fig. 2, the threads **2** assume again the position of Fig. 1.

From what has been said, it follows that the to-and-fro motion of the member **37** may be rendered inoperative on the threads as these threads have been moved towards the internal edge of the reed. If necessary, it would also be possible to effect this movement towards the external edge by a similar system, symmetrically disposed with respect to the axis X—X; the principle of operation would be the same, but the actual structure of the reciprocating device **37**, **39**, **40** would be modified.

The displacement of the point C to C', that is to say the return of the warp threads towards the internal edge of the reed, is effected in practice by means of the mechanism illustrated in Figs. 8 to 11 which will be described thereafter.

I shall now refer to Figs. 5 to 7, in order to indicate how the heddles are attached in practice to the driving device, and how it is furthermore possible, according to my invention, to produce different kinds of weaves.

In view of the considerable number of the heddles, a certain number of these heddles may be connected to one pair of springs **31** and **32**, and these springs are themselves divided between several levels or stages, as is shown in Figs. 5 to 7.

In practice, the springs **31** are generally housed in the bores of slides **37**, **37'**, **37***a*, **37'***a* (Figs. 5 to 7) and are secured at D at the inner ends of these bores.

The slides may consist of tubes sliding in housings **38***a* arranged radially in a circular body **38** (Figs. 5 to 7 and 12).

It will be seen that the slides may be arranged in the body **38** at several levels. Four stages of slides **37**, **37'** and **37*a***, **37'*a*** are to be seen in Figs. 5 to 7. The slides **37**, **37'** and their springs **31**, **31'** correspond to a first group of threads and the slides **37*a***, **37'*a*** and their springs **31*a***, **31'*a*** to a second group of threads. The slides **37**, **37'** on the one hand and **37*a***, **37'*a*** on the other hand are connected together, respectively, by driving pins **52** and **52*a***, **52'** and **52'*a***, respectively secured to the slides **37**, **37*a*** and **37'**, **37'*a*** and projecting from each of said slides.

In the practice, the slides **37** and **37'** as well as the corresponding heddles and springs **31**, **31'** and **32** are connected to a single cable **34**; the slides **37*a***, **37'*a***, although being apparently in a same vertical plane in Figs. 5 to 7 are, in fact, positioned under the slides **37**, **37'** but in a different angular setting, as viewed in Fig. 12. There are also only two stages of slides in a given radial plane of the loom, and a single cable **34** for each pair of slides. In Fig. 12, the cam **40** has been omitted, and only its outer edge or track has been indicated in chain line.

Each slide **37** receives its to-and-fro motion from a roller **39** which rolls upon the internal track of a cam **40**. A second cam **40*a*** offset by 180° in relation to the first is arranged under the body **38** (Figs. 5 to 7). It acts upon a roller **39*a*** which is symmetrical in relation to the roller **39** and moves the slide **37*a***. The rollers **39**, **39*a*** are journalled on pivots **62**, **62*a*** secured to the slides **37**, **37*a*** and are maintained against the cams **40**, **40*a*** by the tension of the springs **31**.

It is to be noted that the circular body **38** is firmly secured to the frame of the loom (not shown) by any suitable means, the loom driving shaft **50** rotating freely in a circular bore of said body, whilst the cams **40**, **40*a*** are keyed at **70** to the loom driving shaft.

In Figs. 5 to 7 and 12 the tension limiting devices **36** are diagrammatically shown and reciprocate with the slides, to which they are secured at D. The arrangement of the springs **31** in the interior of the slides is necessary in the case of a loom of small diameter. In the case of a loom of larger diameter, the springs **31** may be external to the slides.

According to my invention, it is possible to temporarily stop any one of the several stages of slides and consequently to produce different kinds of weaves.

Thus, I have provided a mechanism which would arrest, for example, one of two stages alternatively or which would automatically arrest several stages successively in a predetermined order depending upon the nature of the weave desired.

For example, in the case of Fig. 5, the slides **37** or **37*a*** may continue to operate, whilst the slides **37'** and **37'*a*** are arrested in the inner position (that of the slide **37'*a***). A suitable system of bolts **55**, **55'** and **55*a***, **55'*a*** may be employed for arresting at will the slides **37**, **37'**, **37*a*** and **37'*a***.

In Figs. 5 to 7, it will be seen that each slide **37** is associated with an electromagnet **54** whose core **55** is biased by a spring **57** to protrude outwardly as a bolt for engagement with a notch **56** provided in the slide **37**, when the electromagnet **54** is not energized. Similar arrangements are provided for the slides **37'**, **37*a*** and **37'*a***. The device operates as follows: during the normal operation of the loom, all the slides **37**, **37'** and **37*a***, **37'*a*** are reciprocated. The electromagnets **54**, **54*a*** and **54'**, **54'*a***, are energized, so that the cores or bolts **55**, **55'** and **55*a***, **55'*a*** remain retracted against the springs **57**, **57'** and **57*a***, **57'*a***. Consequently, the slides **37**, **37'** on the one hand and **37*a***, **37'*a*** on the other hand are connected by the engagement of the driving pins **52**, **52'** and **52*a***, **52'*a***, and are reciprocated under the action of the roller and cam devices **39**, **40** and **39*a***, **40*a*** (Fig. 5). But if it is desired to arrest for example the slides **37'** and **37'*a***, the supply to the electromagnets **54'** and **54'*a*** is interrupted by the rotating commutator **58**. Under the action of the springs **57'**, **57'*a***, the bolts **55'**, **55'*a*** will come into engagement with the corresponding notches **56'**, **56'*a*** as soon as the slides **37'**, **37'*a*** in their alternating motion are in their inner position (Fig. 6). Thus the slides **37'**, **37'*a*** are held in said inner position during the further motion of the slides **37**, **37*a***, the engagement between the driving pins **52**, **52'** and **52*a***, **52'*a*** respectively being no more effective. In Fig. 6 there are shown the pins **52** and **52'** separate from each other, the slide **37** being at this moment in its outer position while the slide **37*a*** is at this moment in its inner position. From Fig. 7 it can be viewed how it is also possible to stop the motion of three stages of slides: **37**, **37'** and **37'*a***, by energizing only the electromagnet **54*a*** so as to hold the bolt **55*a*** retracted in the body **38**. The electromagnet **54'** does not need to be energized, because the slide **37'** is reciprocated only by the engagement of the driving pins **52**, **52'**. The rotating commutator **58** may be designed, as shown in the drawings, so as to energize temporarily the electromagnets **54'** and **54'*a***, so that the slides **37'**, **37'*a*** may be temporarily arrested in the inner position according to the kind of weave desired. It is of course impossible to arrest only the slides **37** and **37*a***, since the slides **37'** and **37'*a*** are reciprocated only by the slides **37** and **37*a***, by means of the pins **52**, **52'** and **52*a***, **52'*a***.

The mechanism for displacing the point C of attachment of the outer end of the external spring **32** will be now described, with reference to Figs. 8 to 11.

Each heddle-tensioning spring **32** (or each pair of springs **32** corresponding to two superposed stages **37**, **37'** or **37*a***, **37'*a*** of slides) is attached at its outer end to a cable **34** (Figs. 1 to 4 and 9) passing over two idle pulleys **35**, and then over a pulley **43** and attached finally at a fixed point **44** to the frame **42** of the loom (Fig. 9).

The pulleys **43** are mounted at the ends of slides **45** and **46** (in number equal to that of the pairs of slides **37**, **37'** and **37*a***, **37'*a***, for example eighteen) arranged half and half, at two different levels on each side of a diameter Z—Z (Figs. 8 and 9).

The slides carry rollers **47** which may bear against the internal tracks of a cam **48** keyed at **48*a*** on the main driving shaft **50** of the loom and having two symmetrical crests.

It is to be noted that the stages of slides **45** and **46** as well as the cam **48** are disposed concentrically with the stages of slides **37**, **37*a*** and cams **40**, **40*a***, but at a different level: in Fig. 9, it will be seen that the slides **37**, **37*a*** are positioned above the slides **45**, **46**. But my invention provides also for the slides **45**, **46** being above the slides **37**, **37*a***.

In normal operation, the slides **45** and **46** are maintained clear from the cam **48** (in the position shown in Fig. 8) by means of latches **49** (Figs. 9 to 11) which engage a groove **60** provided in the proximity of the inner end of each slide **45** or **46**, and will be described thereafter.

A rotating commutator **61** supplied from a suit-

able source of current energizes two electromagnets 51 acting upon pins 53 slidably housed in the rim of the cam 48 for rendering inoperative the latches 49 (Figs. 8 to 11).

Each pin 53 is pivotably connected to a push-member 63 by a pin 66 (Fig. 8*a*). Said push-member is pivotably mounted at 64 upon the upper face of the cam 48, and it is submitted to the action of a mass 65, to which it is pivotably connected at 67. The mass 65 is biassed outwardly by the centrifugal force, during the rotation of the cam 48, and consequently causes the push-member 63 to be retracted inwardly, thus biassing the pin 53 inwardly (Figs. 8 and 8*a*) during the normal operation of the loom.

Under these conditions, the cam 48, turning with the vertical shaft 50, is normally inoperative as to the rollers 47.

But if it is desired to move all the warp threads towards the centre, for example to free the shuttle for the purpose of permitting its re-loading, the rotating commutator 61 (Figs. 8 and 9) is actuated and establishes an exciting current in the electromagnets 51 at the instant when the symmetrical crests of the cam 48 are passing the axis Z—Z (Fig. 8). These electromagnets cause the pins 53 to emerge from the rim of the cam 48 against the action of the mass 65 and push-member 63.

The mechanism for releasing the latches 49 is shown in part in Fig. 11.

In this figure, the bearing for mounting the slide 46 which at the same time carries the pivot 59 of latch 49 has been omitted. It will be seen from Figs. 9 to 11 that each latch 49 engages normally a groove 60 provided at the end of the slide 46. As already stated, the electromagnet 51, when energized, causes the pin 53 to protrude outwardly from the rim of the cam 48, and the rotation of this cam in the direction of the arrow brings the pin 53 into engagement with the latch 49. This latch tilts about its pivot 59 and disengages the groove 60 of the slide 46, thereby freeing the slide. The operation of the slide 45 is similar. As the release is effected just at the instant when the crest of the cam 48 is passing under the corresponding roller, this operation takes place without shock, since the slide continues in this case to be held by its roller and by the crest of the cam in the position in which it had previously been maintained by the latch 49. The slides being free, the rollers 47 descend symmetrically along each of the two crests in proportion to the rotation of the cam 48.

It will thus be seen that, at the end of a half turn of the cam 48, all of the slides 45 and 46 will be in their external positions and consequently also that the pulleys 43 will allow relaxation of the cables 34 tensioning the springs 32 and displacement towards the centre, to C', of the ends C of these springs.

The movement shown diagrammatically in Figs. 1 to 4 has thus been realised.

From this instant, the exciting current for the electromagnets 51 is interrupted, whereby the pins 53 are retracted into the rim of the cam 48 due to the action of the masses 65. As the cam 48 continues its rotation, the rollers 47 are acted upon by the second parts of its track-profiles. They therefore return towards the centre, entraining the slides and their pulleys 43 and, by pulling upon the cable 34, putting the springs 32 again under tension. The latch 49 engage in their lodgments 60 and the whole reassumes its original position.

The arrangement which has just been described thus permits of the drawing towards the centre of all the warp threads in such a fashion as to free the shuttle.

It is to be noted that, as the control of the heddle by cam and rollers permits (as has been seen above) of the arresting at the centre of any one group of slides 37, 37*a* or 37', 37'*a*, it is possible to arrest all of the groups and as a result to bring all the threads to rest towards the inside part of the reed without having recourse to the auxiliary mechanism described above with reference to the Figs. 8 to 11, at the same time suppressing all of the external return springs 32 (Figs. 1 to 4). In this case, the outer end B of each heddle A—B would be directly attached as at 44 to the frame 42 of the loom. The locking and release of the slides 37, 37*a* would then be effected by means of the mechanism illustrated in Figs. 5 to 7.

The rotating commutator 58 (Figs. 5 to 7) is actuated by suitable means which do not form a part of my invention. When the mechanism illustrated in Figs. 8 to 11 is associated with the mechanism illustrated in Figs. 5 to 7, the commutator 58 is designed for allowing the operation of the loom according to the desired kind of weave, that is to say may be constituted in the manner of the known perforated sheets for weaving looms. But when only the mechanism shown in Figs. 5 to 7 is used for retracting all the warp threads towards the centre of the loom in order to uncover the shuttle, the rotating commutator 58 is designed furthermore to keep all the warp threads retracted during the re-loading of the shuttle, and in this case it is actuated by any known safety device, for example of the kind disclosed and claimed in my copending U. S. Application Serial No. 23,607 filed April 25, 1943 which is now Patent No. 2,587,982.

The rotating commutator 61 is actuated, when the shuttle is to be re-loaded, by any suitable means, for example by the device disclosed and claimed in my aforesaid U. S. Patent No. 2,587,982.

What I claim is:

1. In a circular weaving loom for weaving textile or metal threads means for normally controlling the opening of the shed formed by the warp threads and for drawing all of the warp threads towards the centre of the loom in order to uncover the shuttle, which include a number of heddles equal to that of the warp threads, means located inside the loom and adapted to produce at will a reciprocating movement of said heddles, springs operatively connecting said means to the inner ends of the corresponding heddles, further springs secured to the outer ends of the heddles, and means for adjustably securing the outer ends of last mentioned springs in accordance with the desired opening and closing of the shed, the last mentioned springs being stronger than the first mentioned springs.

2. In a circular weaving loom of the aforesaid type, heddles in number equal to that of the warp threads, an axial loom driving shaft, a cam member actuated by said shaft and arranged in a plane perpendicular thereto, at least one internal track on said cam member, slides arranged in at least two different planes perpendicular to the loom driving shaft and adapted to assume a reciprocating movement, rollers journalled in said slides and adapted to roll upon said internal tracks on the cam member, means for temporarily arresting at least some of said slides in their innermost position, a plurality of encased

springs radially positioned, each connecting operatively at least one heddle with the corresponding slide, means for limiting the expansion of said springs, and means for connecting the outer end of the heddle to the frame of the loom.

3. In a circular weaving loom according to claim 2, external radial springs each attached to the outer end of at least one heddle, a plurality of cables, attached on the one hand to the outer end of the corresponding external spring and on the other hand to the frame of the loom, a plurality of idler and movable pulleys for said cables, each cable passing over at least one idler and over a movable of said pulleys, slides carrying said movable pulleys at their outer end and distributed by halves in two planes perpendicular to the loom driving shaft, bearings for mounting said slides, a roller carried by each slide at its inner end, a cam actuated by said driving shaft, arranged in a plane perpendicular thereto and including an internal track of symmetrical outline, means for normally maintaining the rollers clear from off the track on the cam, and means for causing said rollers to cooperate with said track.

4. In a circular weaving loom according to claim 3, a groove on each pulley carrying slide, a rocking latch cooperating with said groove and carried by the bearing in which is mounted the corresponding slide, an electromagnet system, means for energizing same, pins in number equal to that of the electromagnets and slidably housed in the rim of the cam, for engaging said latches and tilting up same clear from the corresponding groove in the slide when protruding outwardly under the action of the energized electromagnets, push-members pivotably mounted upon the upper face of the cam and pivotably connected at one end to said pins for biassing normally inwardly said pins, and rocking masses adapted to be outwardly biassed by centrifugal forces and pivotably connected at the outer end of said push-members.

5. In a circular weaving loom of the aforesaid type, heddles in number equal to that of the warp threads, means for connecting the outer ends of said heddles to the frame of the loom, an upper

cam and a lower cam with internal tracks, offset by 180°, actuated by the axial loom driving shaft and arranged in two parallel planes perpendicular thereto, four stages of superposed slides arranged in parallel planes perpendicular to the loom driving shaft but disposed by pairs in different radial planes of the loom, a roller journalled on the upper face of each slide of the uppermost stage and cooperating with the upper cam track, a roller journalled on the lower face of each slide of the lowermost stage and cooperating with the lower cam track, means on each uppermost and on each lowermost slide for positively driving the corresponding slide of each middle stage, bolts cooperating with notches in the slides for locking each slide in its innermost position, springs for biassing said bolts in engagement with the slides, electromagnets for retracting said bolts when energized, means including a rotating commutator for energizing at will said electromagnets, springs operatively connecting said slides to the inner ends of the corresponding heddles, and means for limiting the expansion of said springs.

6. In a circular weaving loom of the aforesaid type, heddles in number equal to that of the warp threads, internal springs secured to the inner ends of the heddles, tension limiting devices for said springs, external springs stronger than the internal ones and secured to the outer ends of the heddles, a first cam member actuated by the loom driving shaft for reciprocating the heddles through slides and rollers, and a second cam member situated below the first one for displacing at will the outer ends of the external spring through a mechanism including slides, rollers, cables and pulleys.

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The following references are of record in the file of this patent:

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