

No. 708,679.

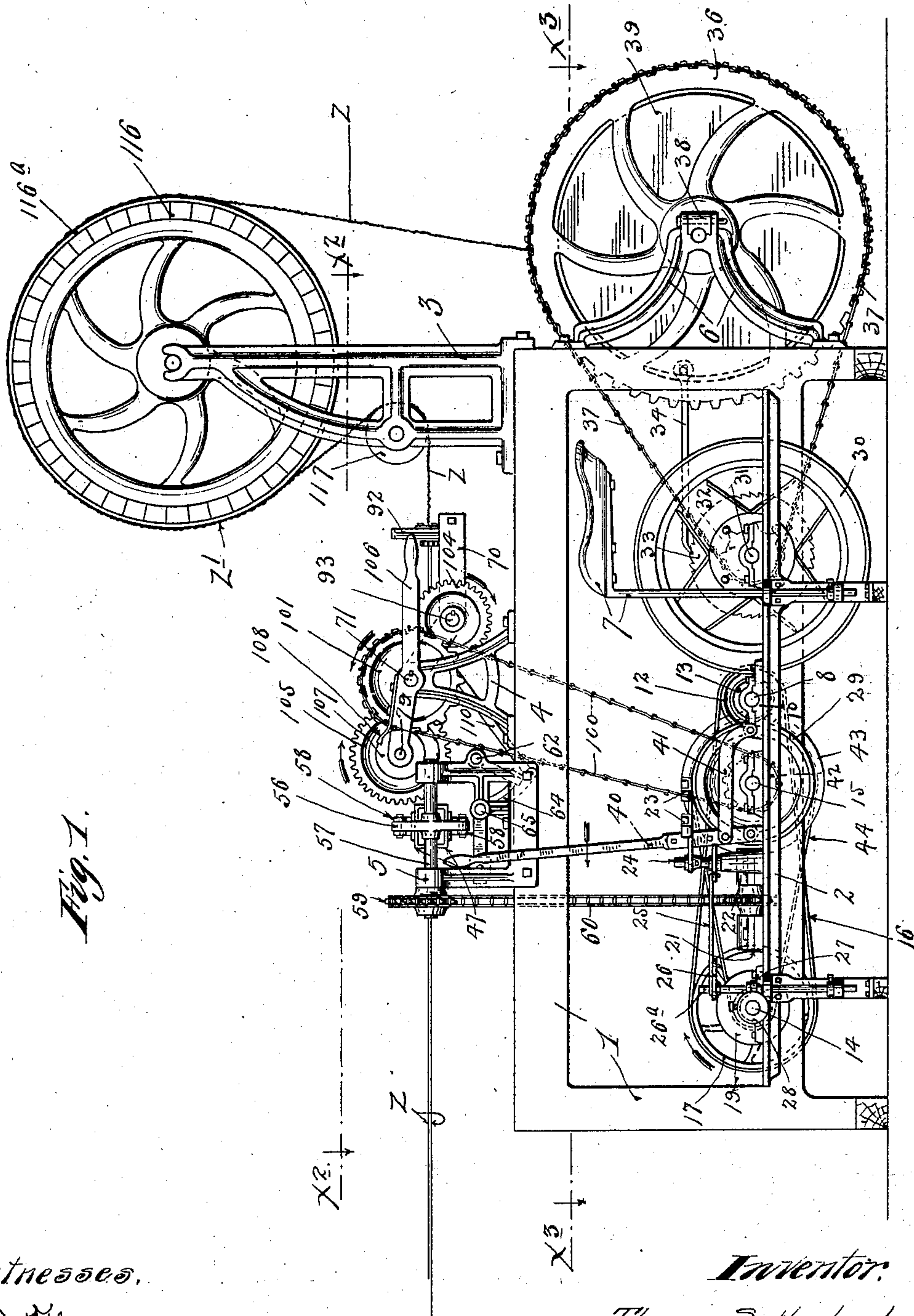
Patented Sept. 9, 1902.

T. SUTHERLAND.
WIRE FABRIC MACHINE.

(Application filed Mar. 22, 1902.)

(No Model.)

10 Sheets—Sheet 1.



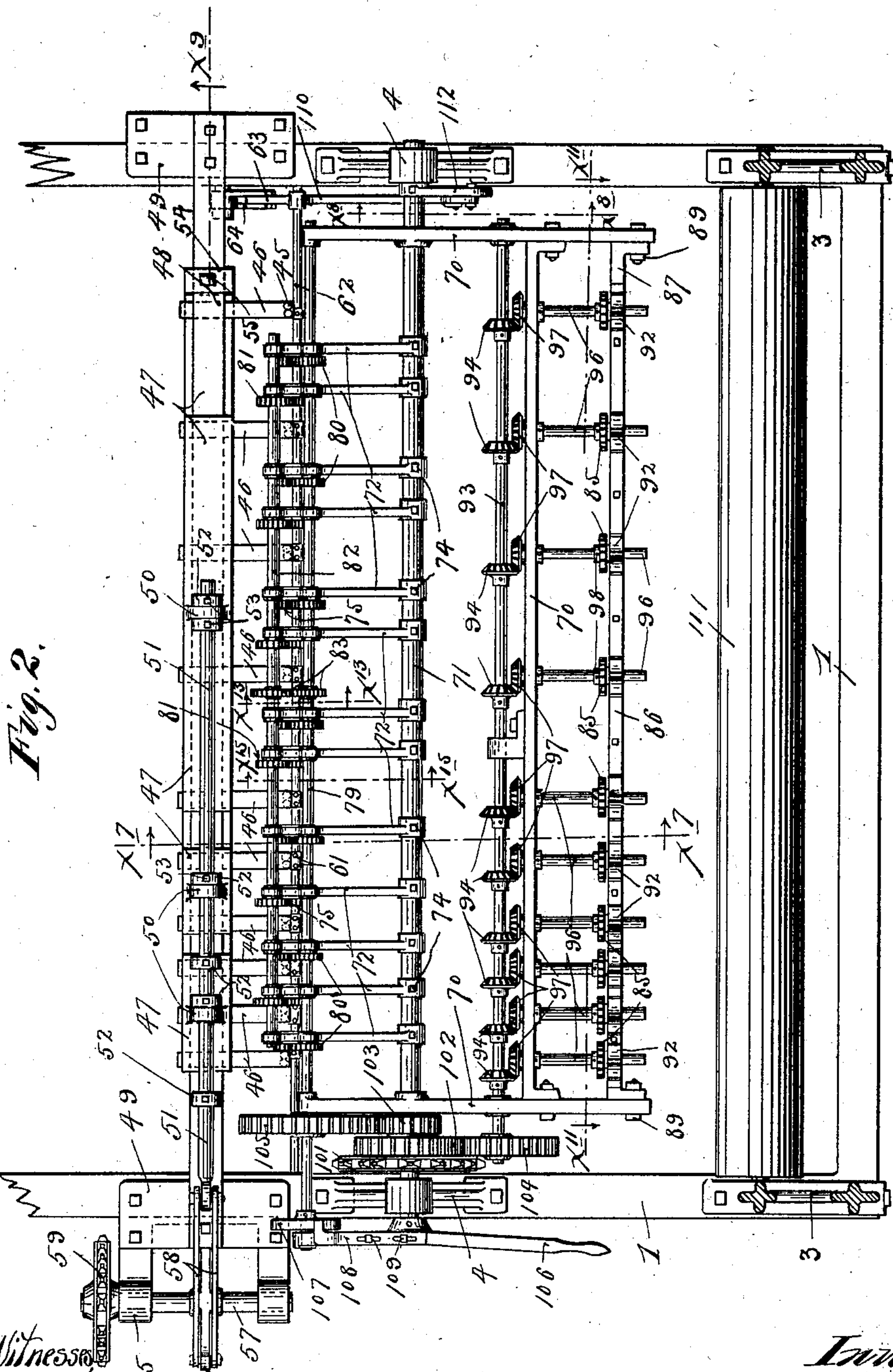
Witnesses.
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A. H. O'Connell.

Inventor.
Thomas Sutherland,
By his Attorneys,
Williamson & Merchant

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10 Sheets—Sheet 2.



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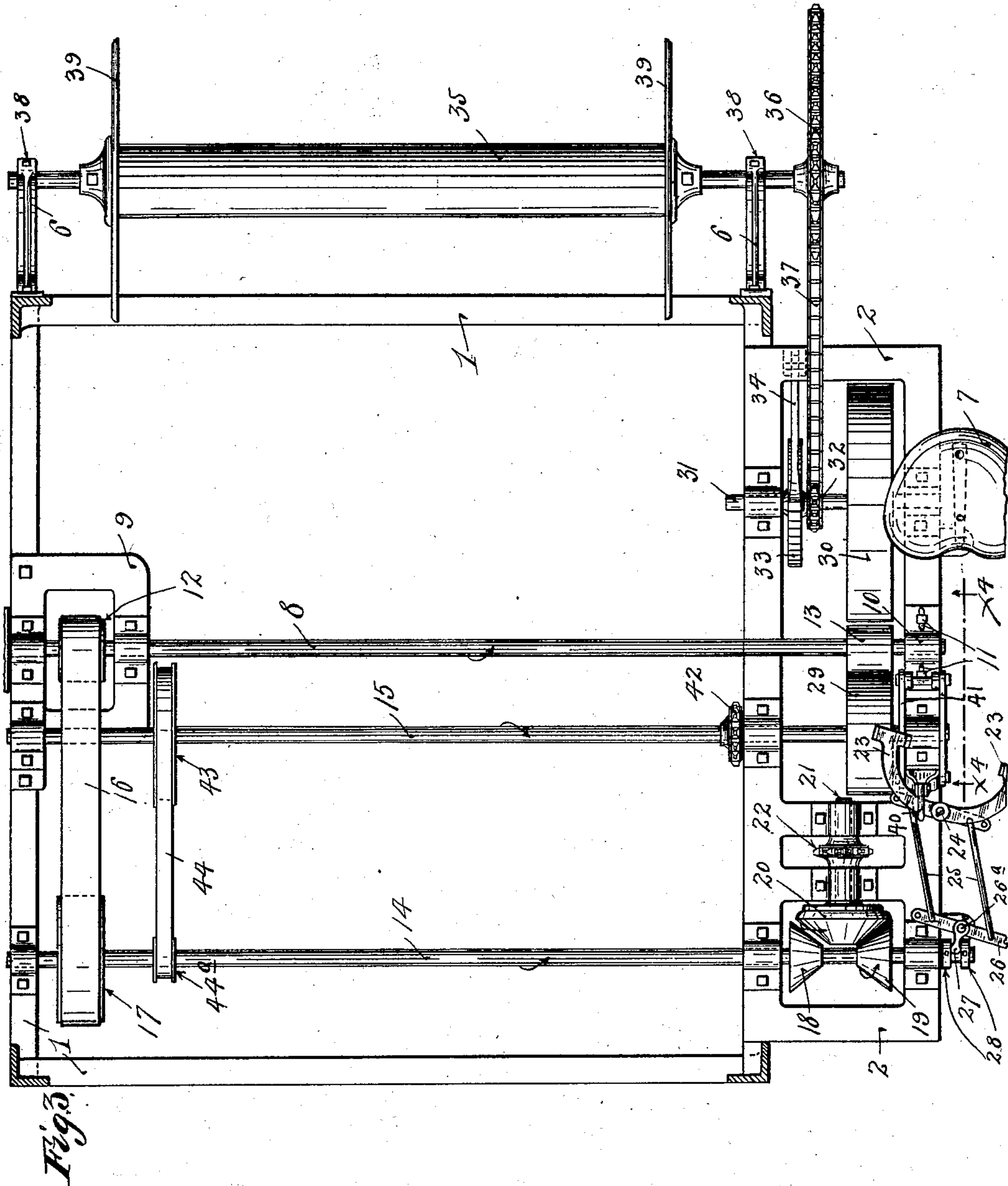
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Fig. 5.

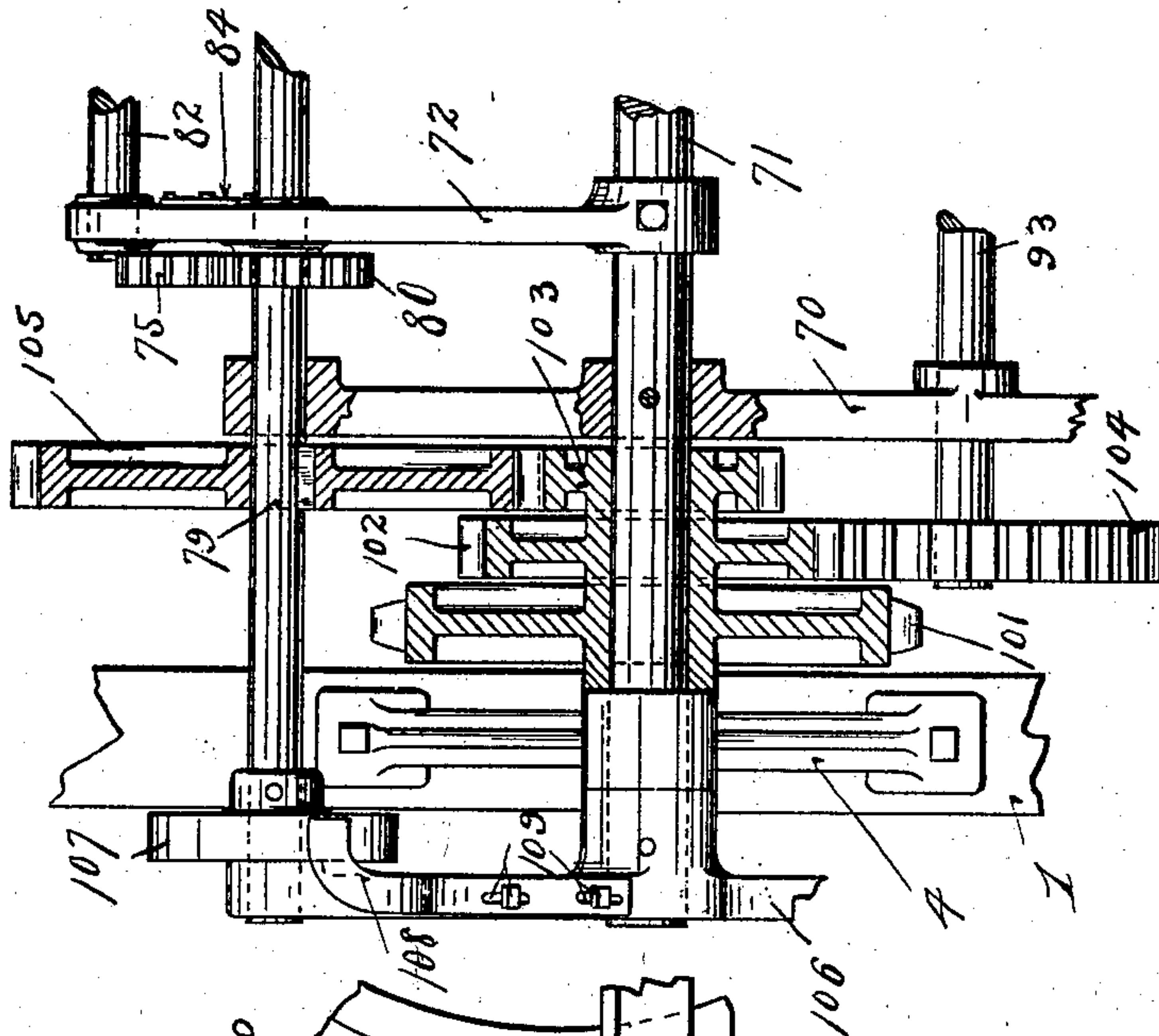


Fig. 4.

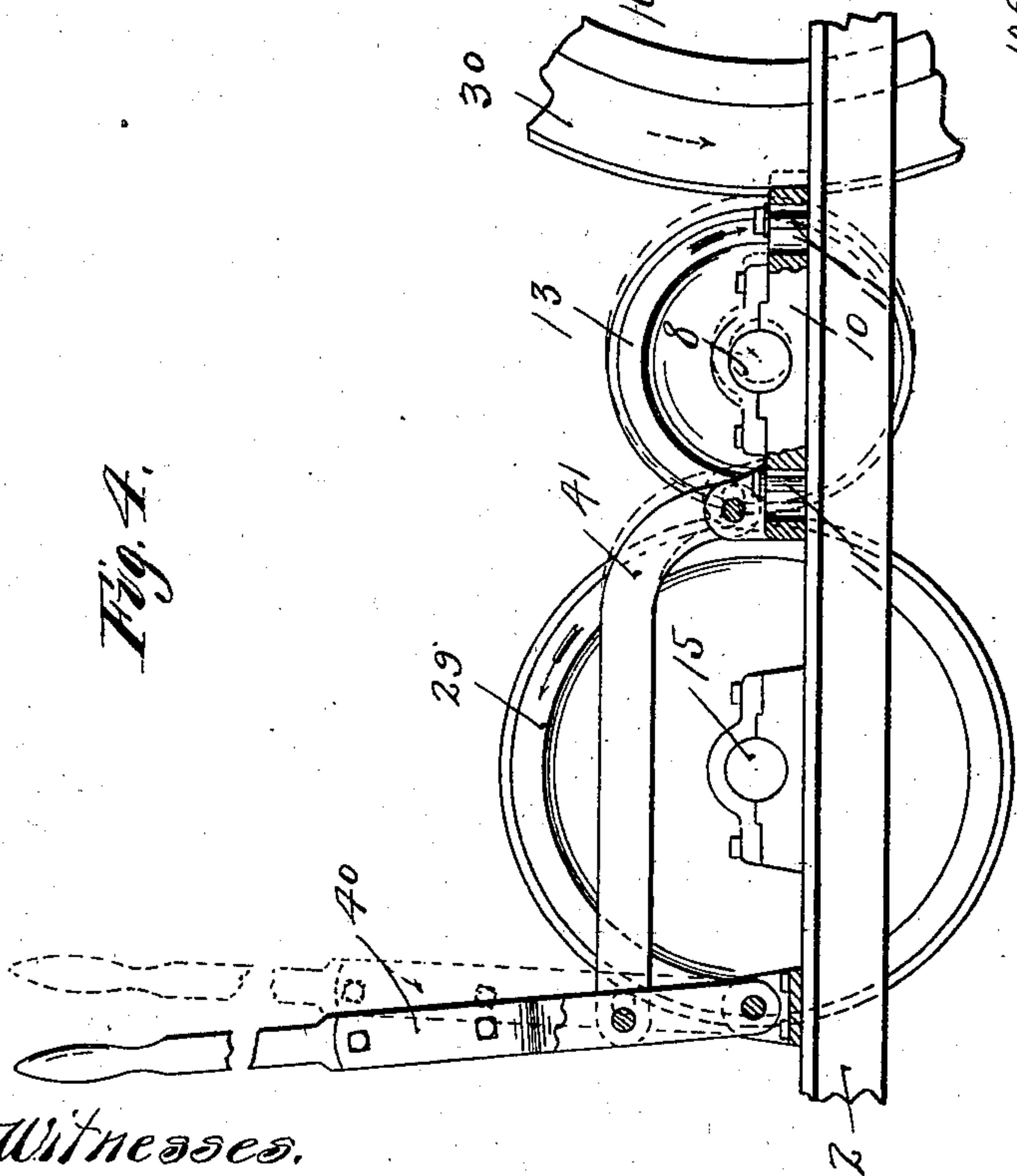
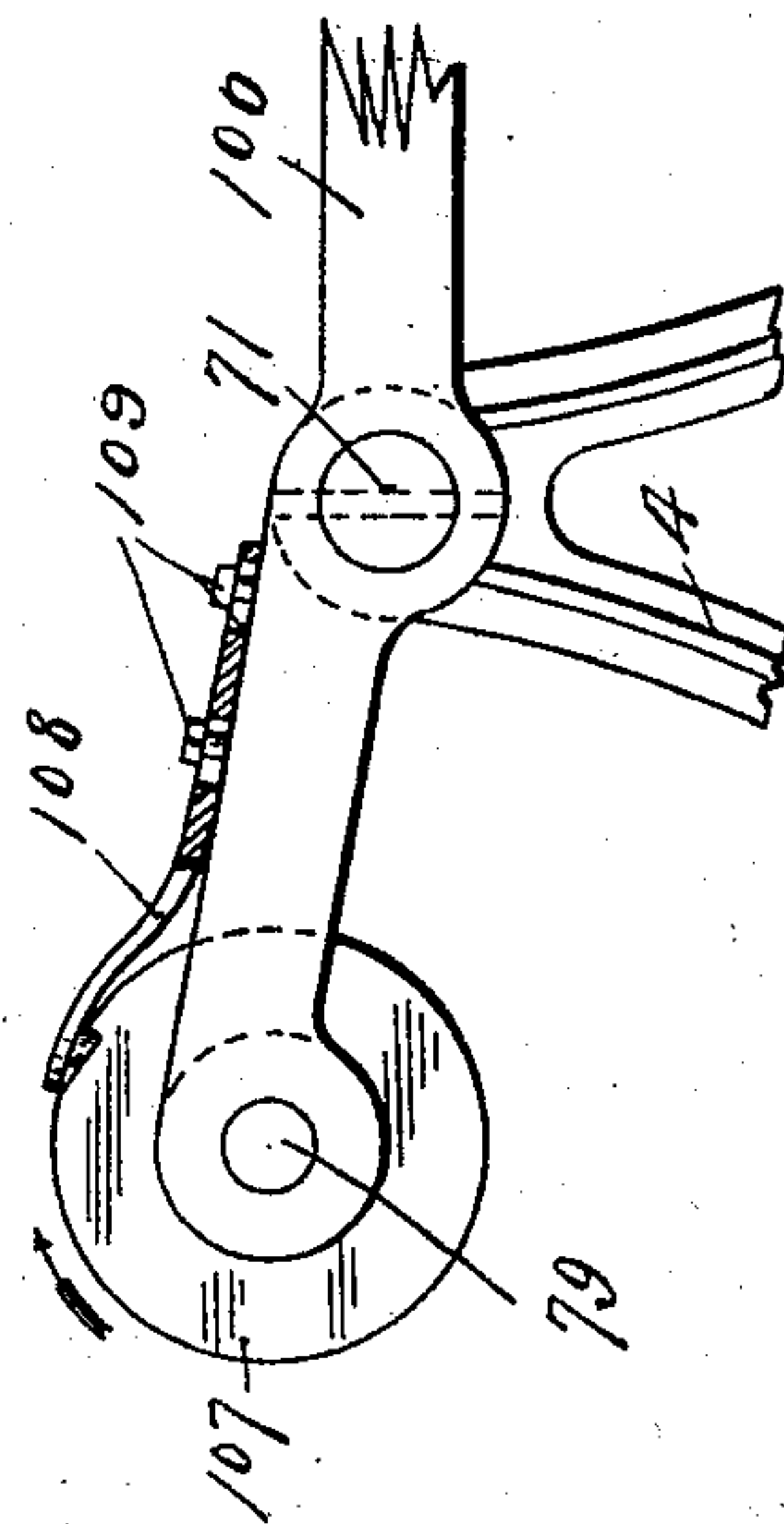


Fig. 6.



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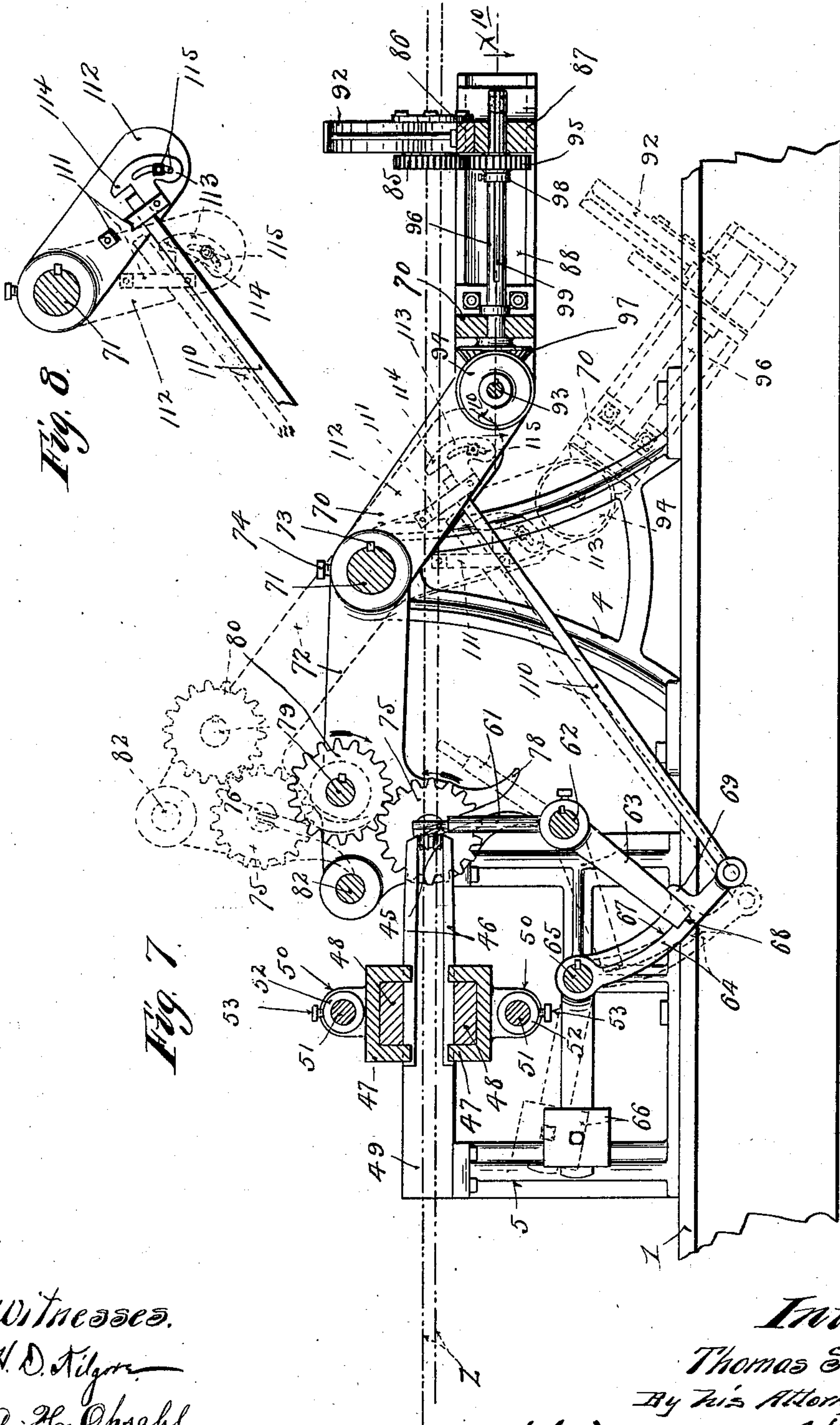
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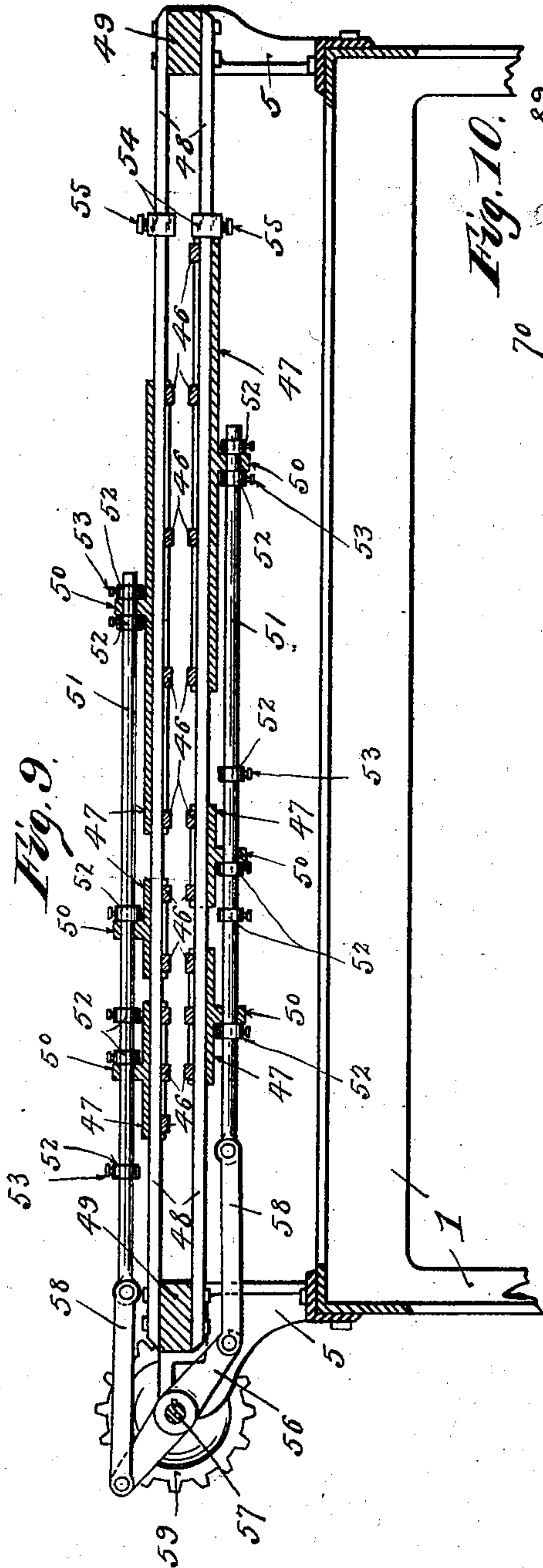


Fig. 9.

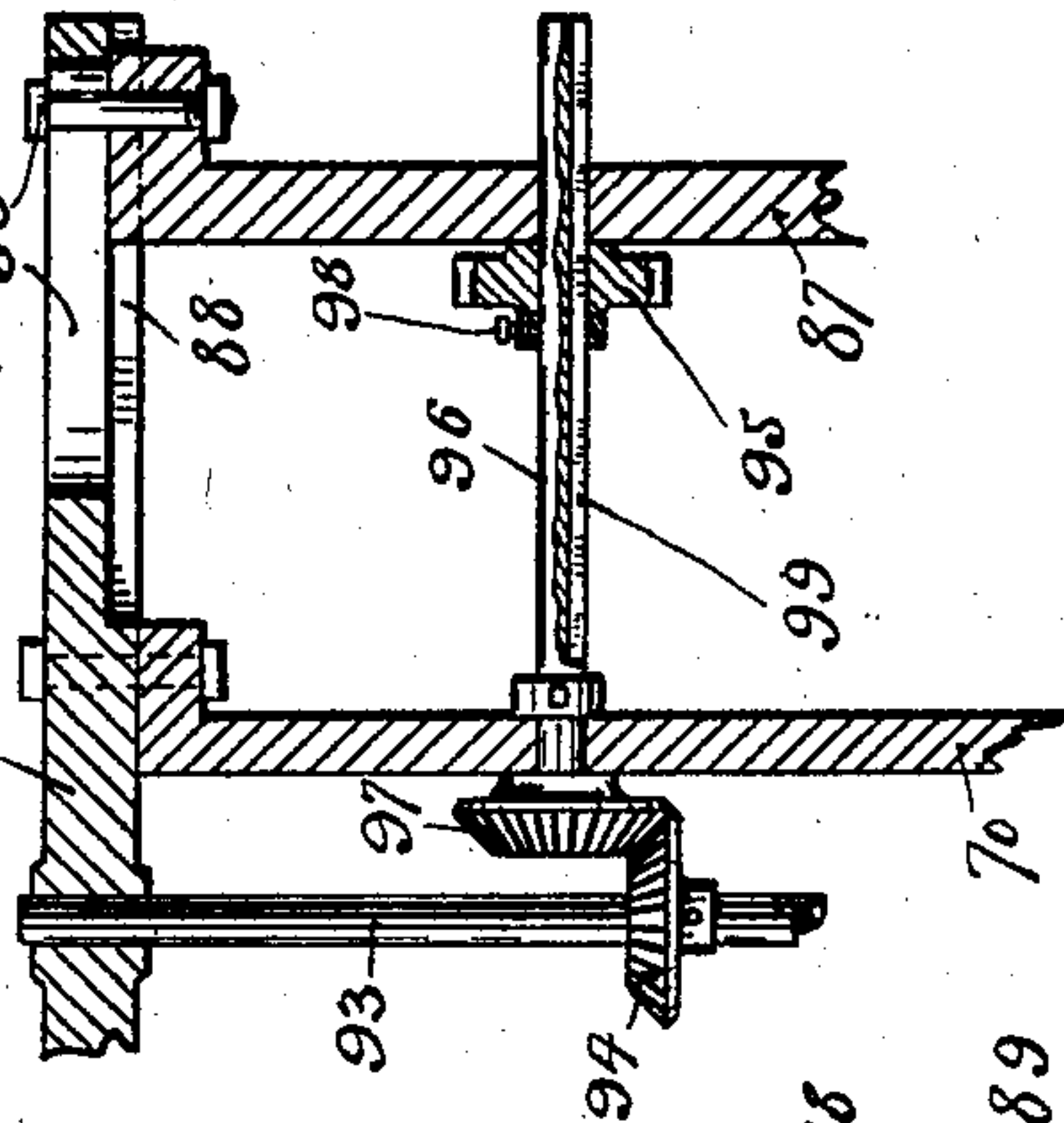
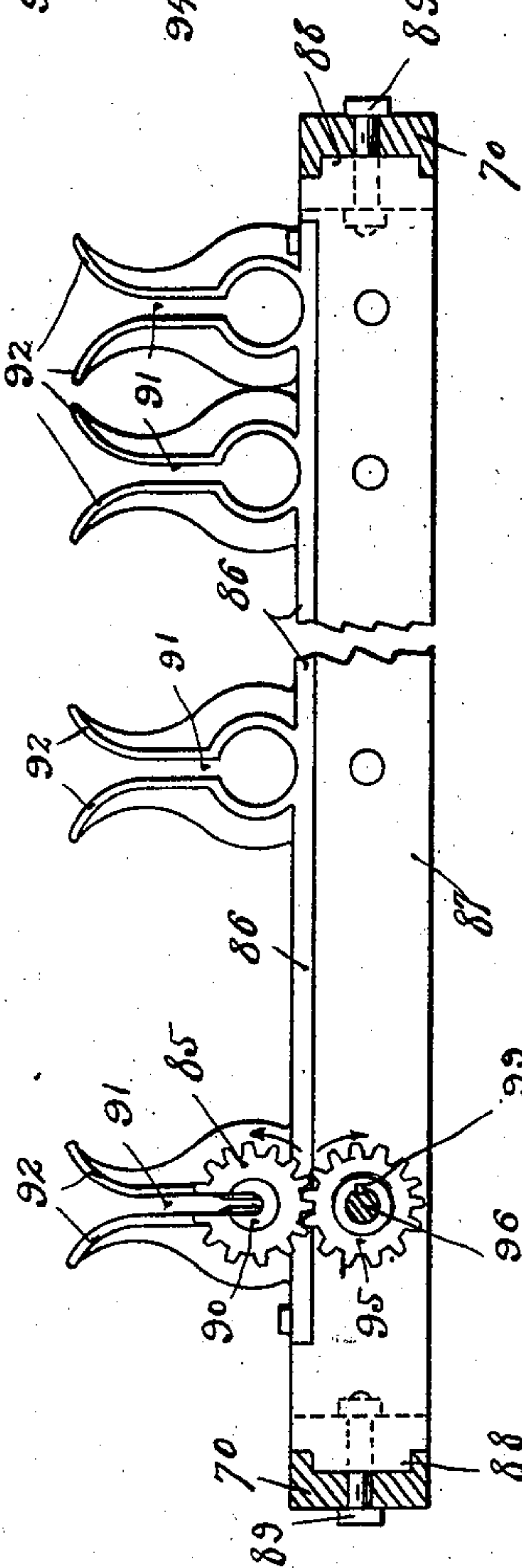


Fig. 10.

Fig. 11.



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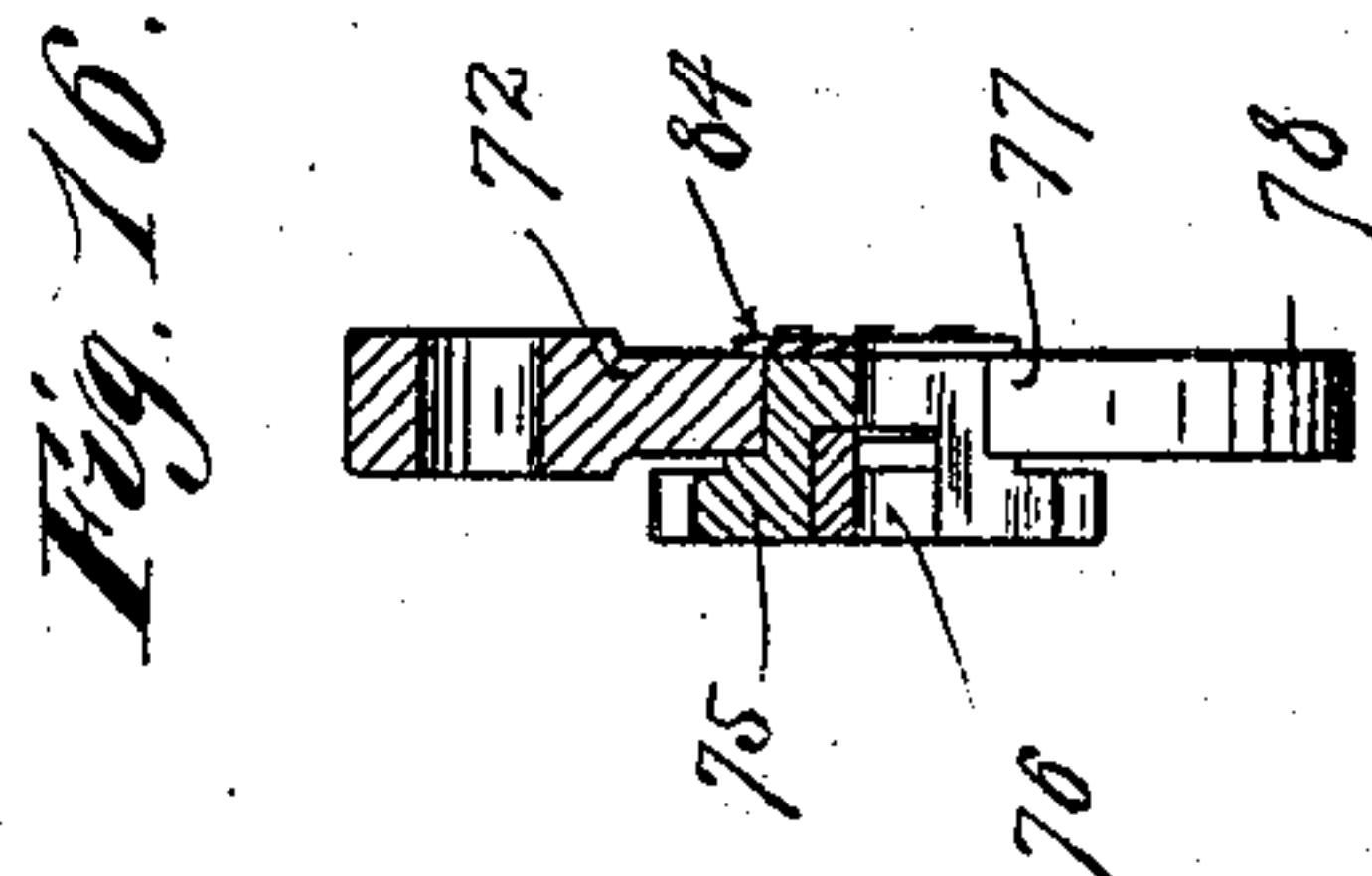
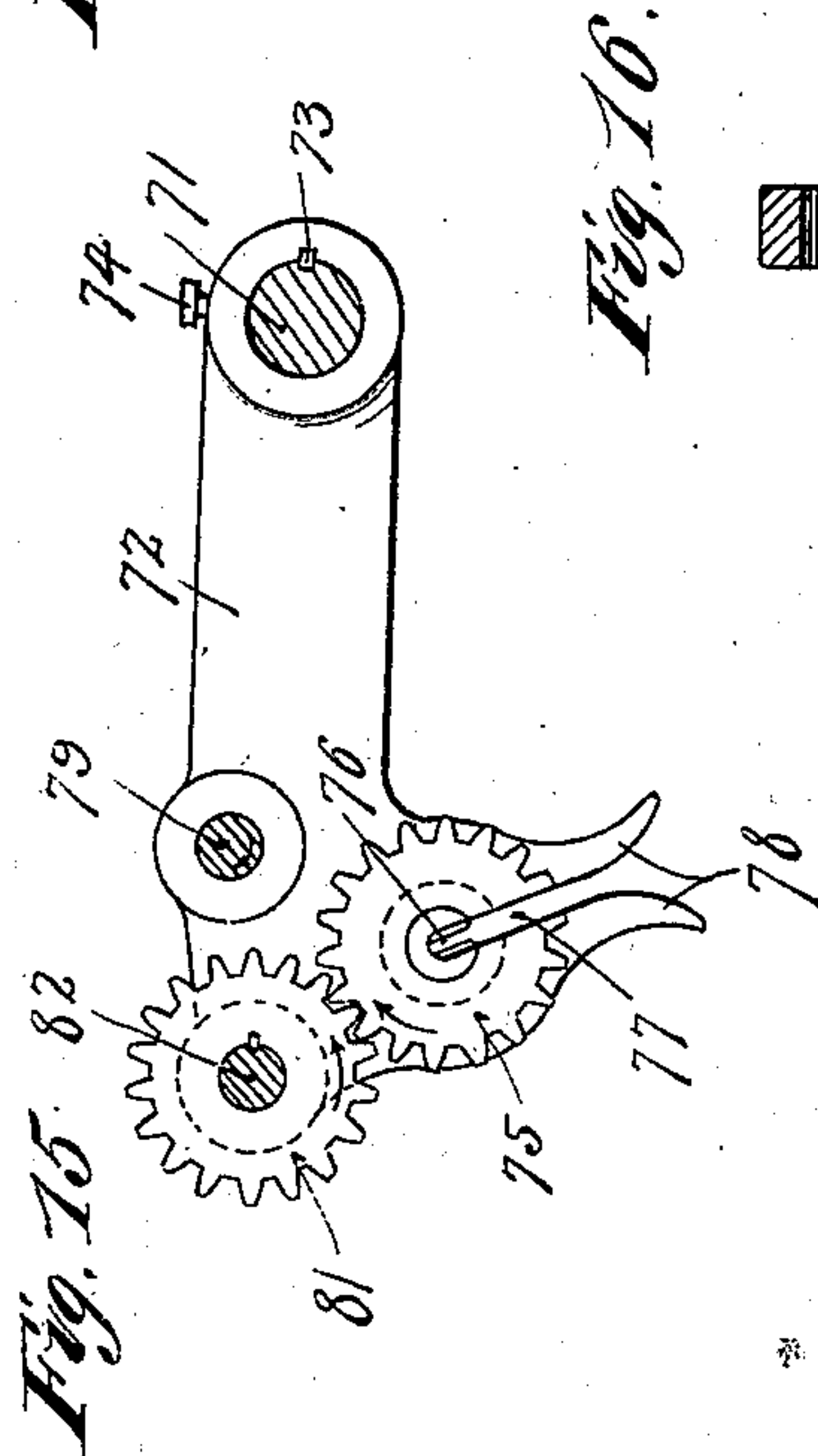
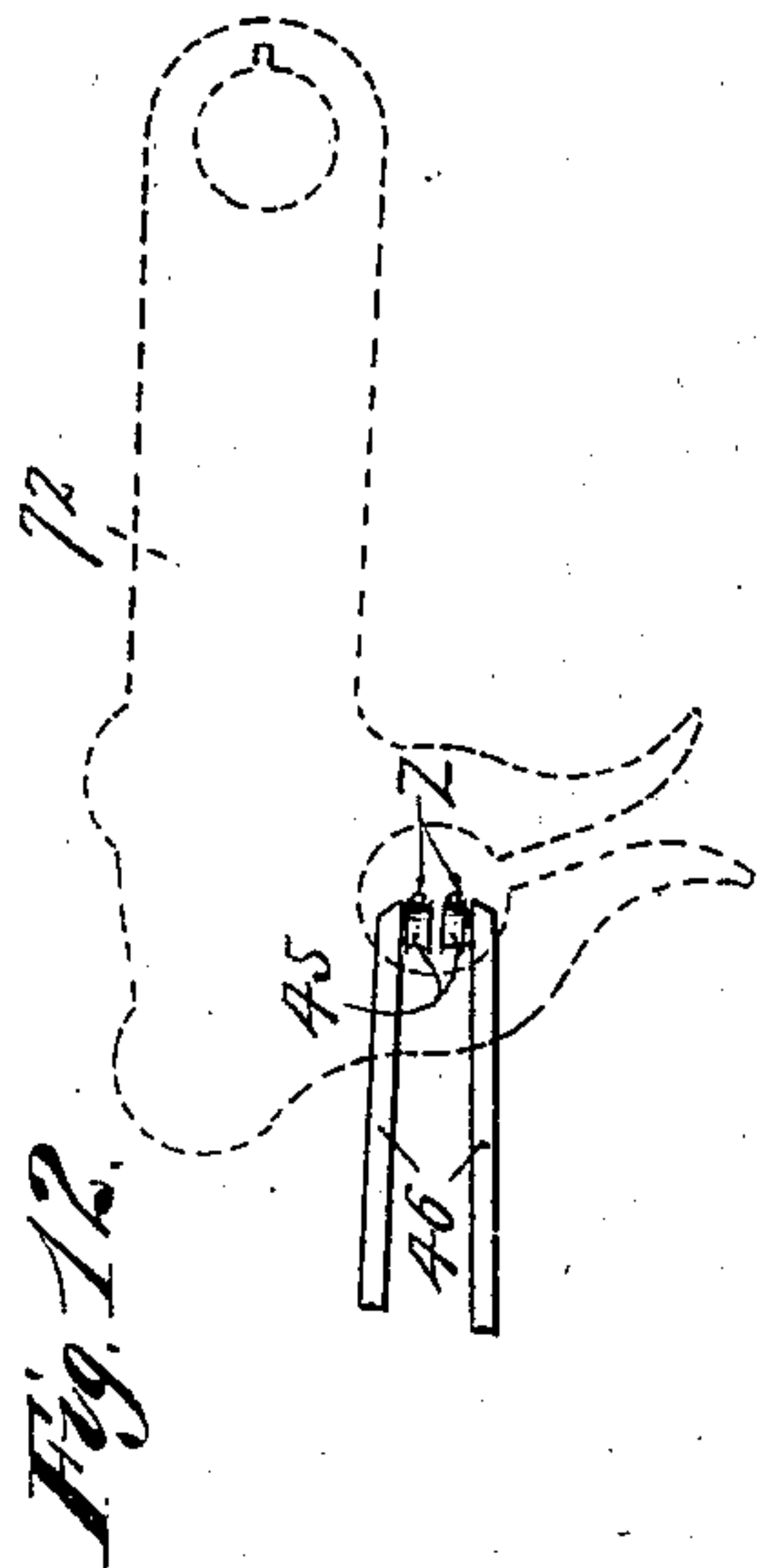
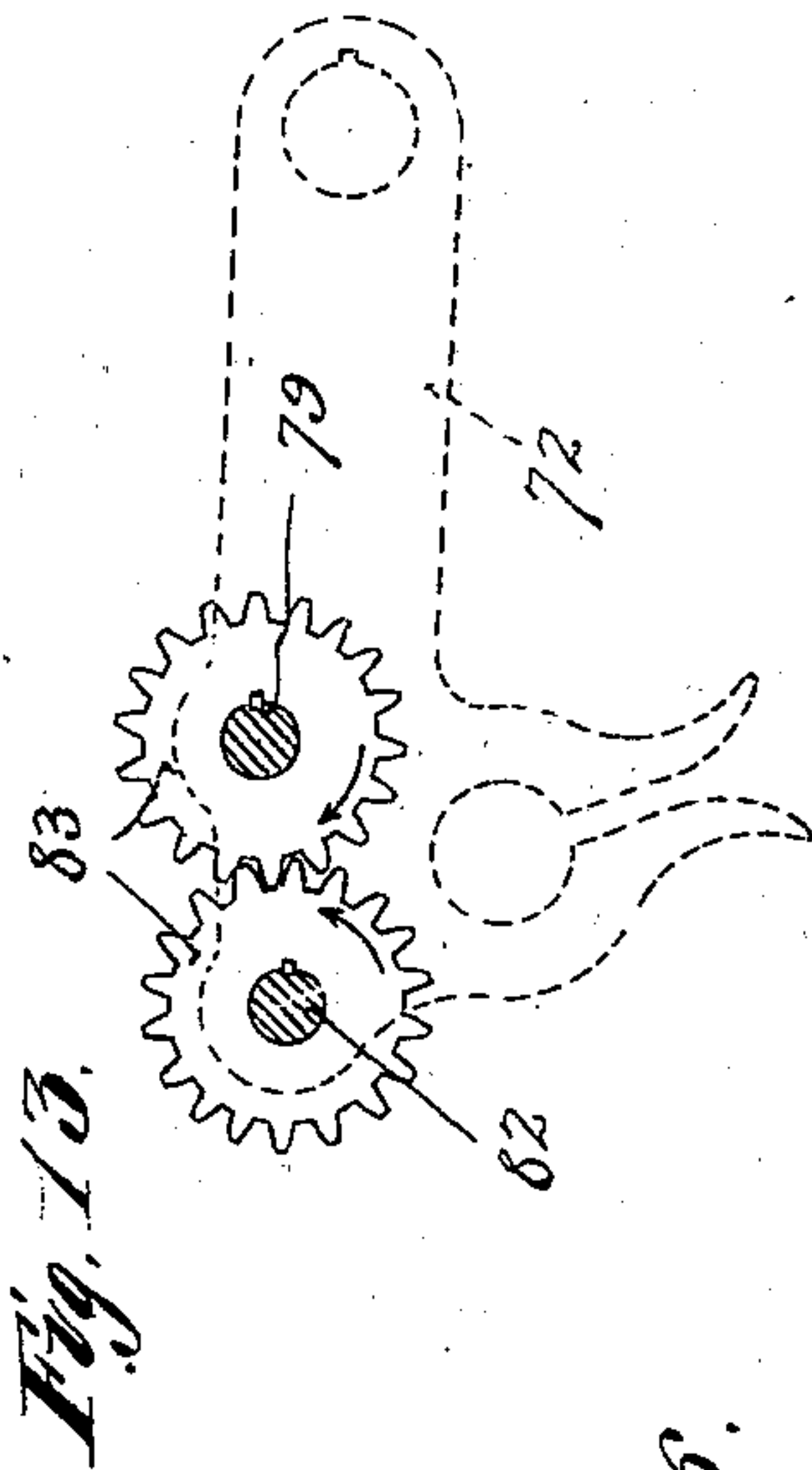
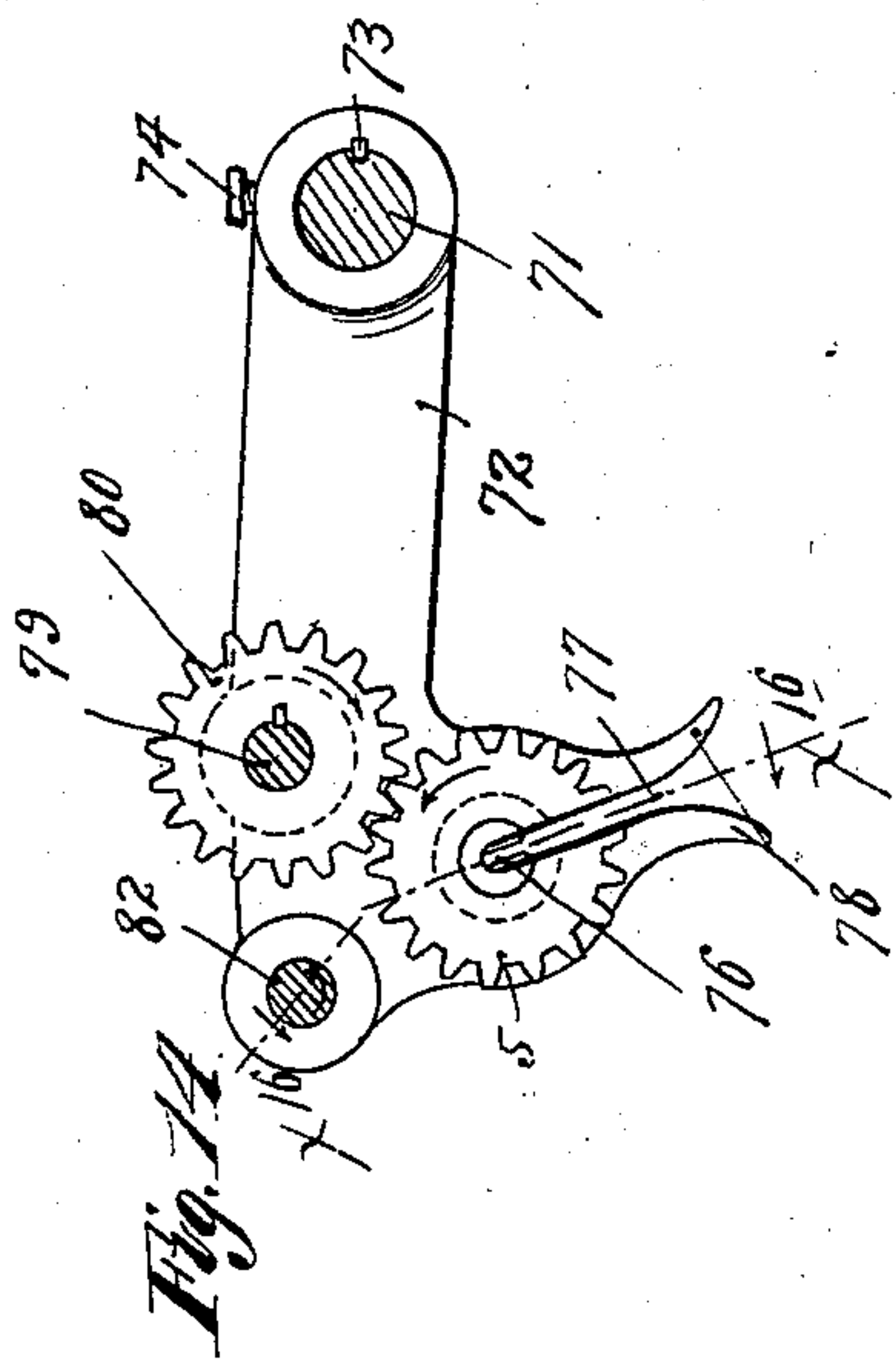
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10 Sheets—Sheet 8.

Fig. 17.

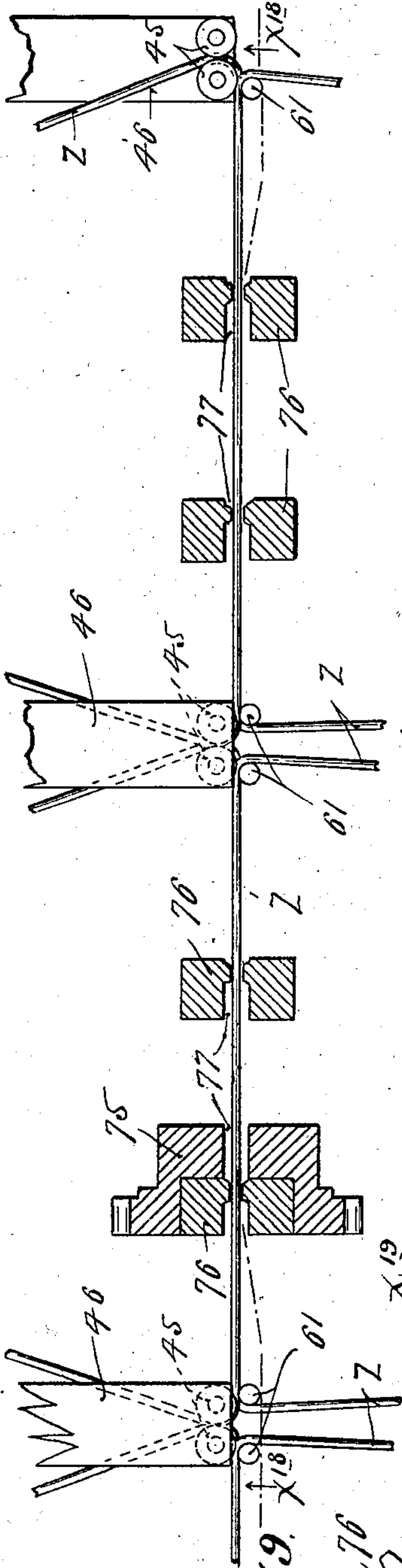


Fig. 18.

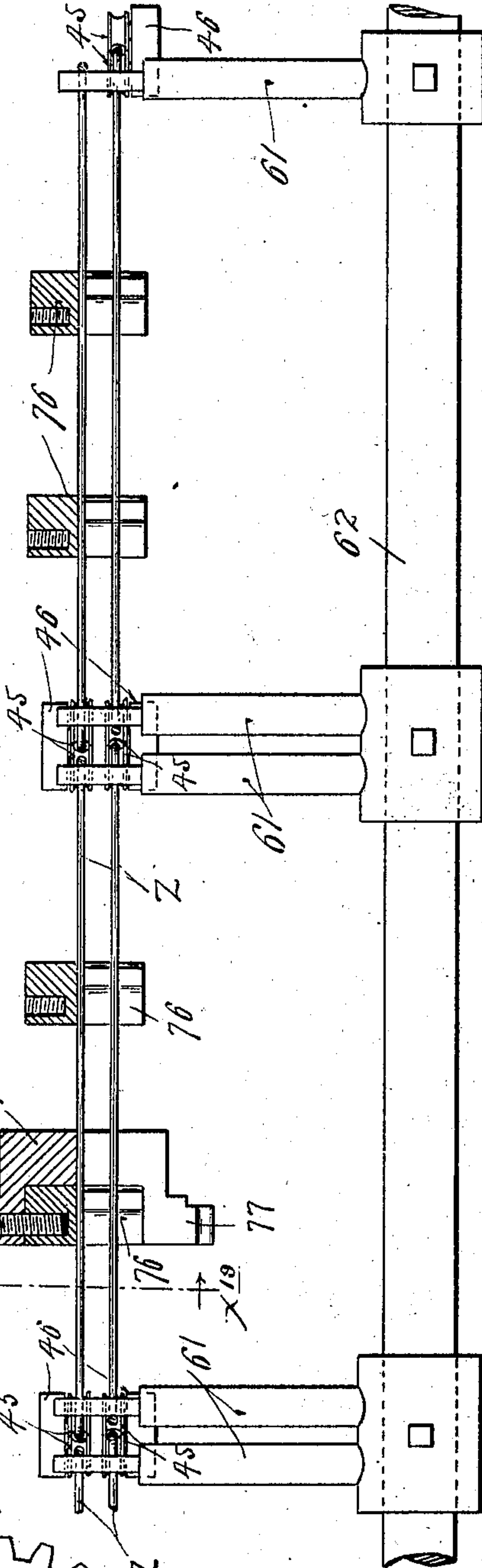
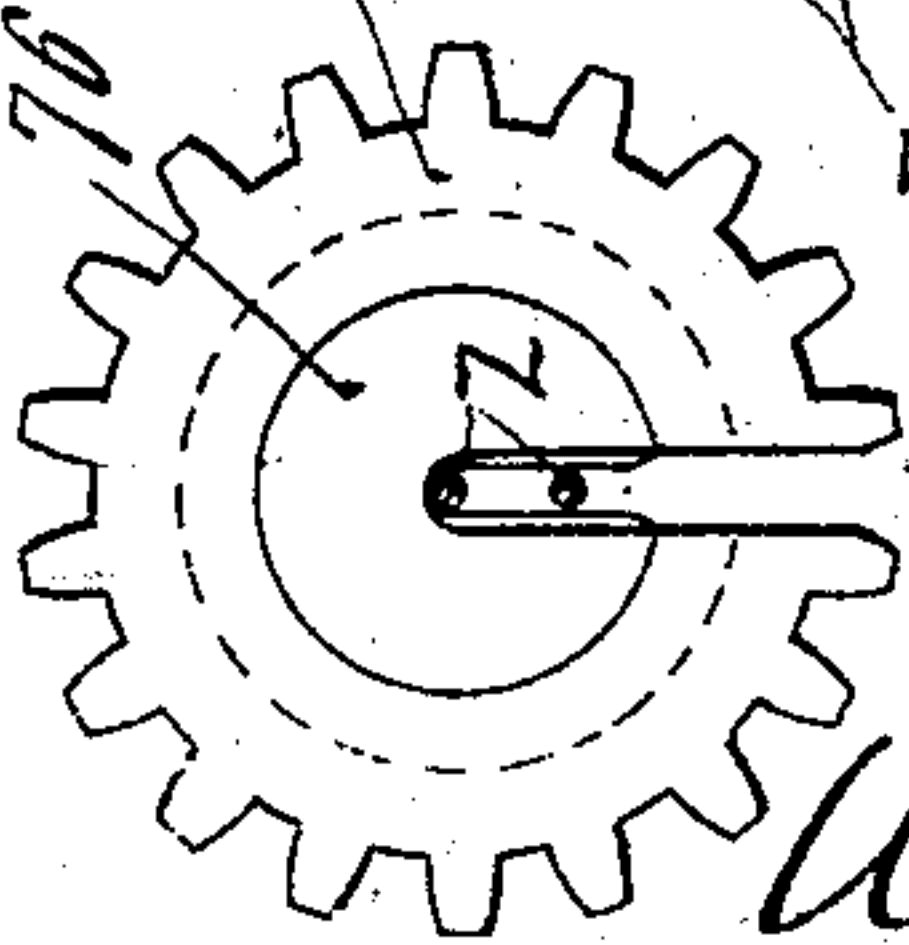


Fig. 19.



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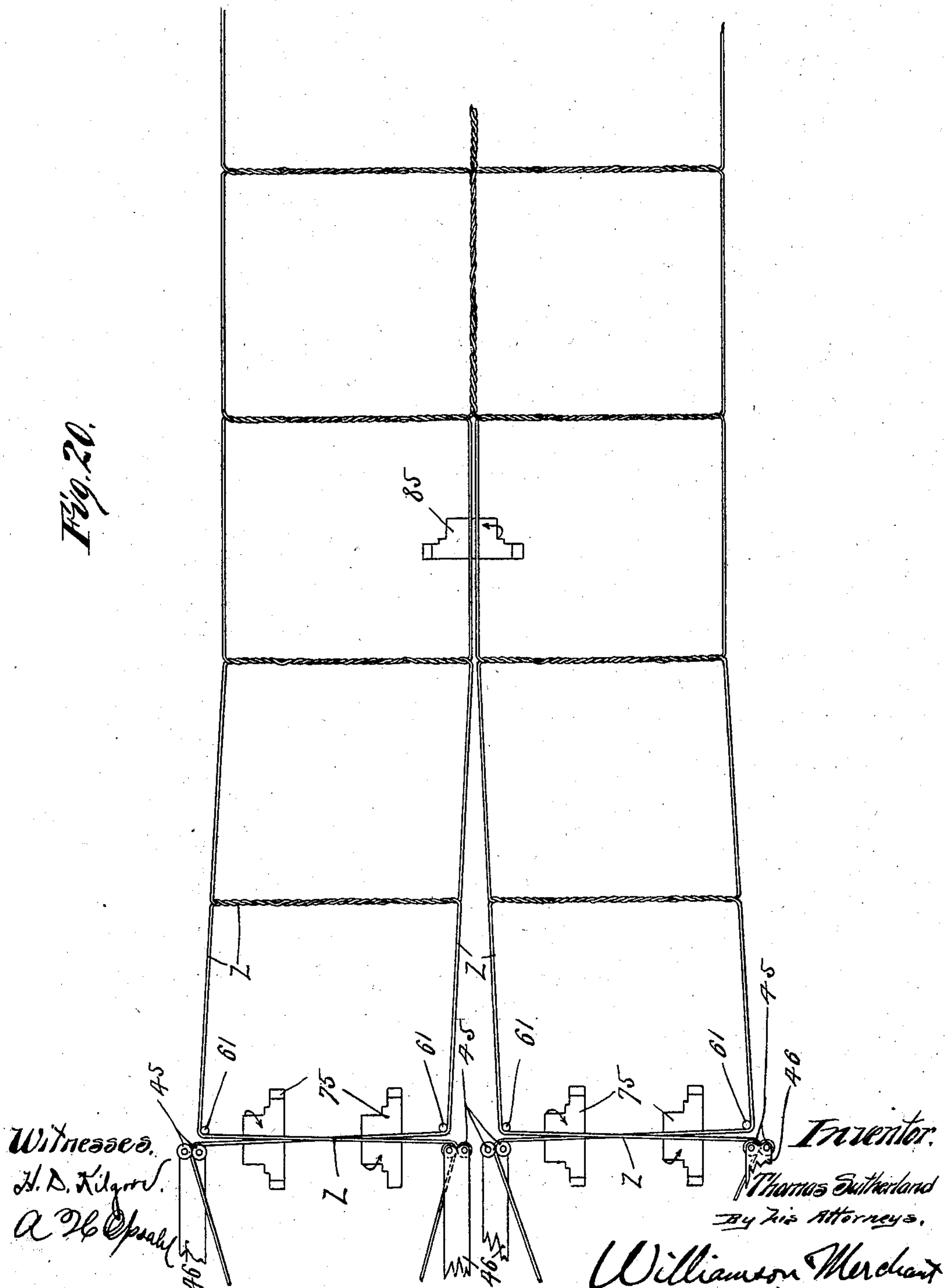
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Fig. 20.



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Fig. 22.

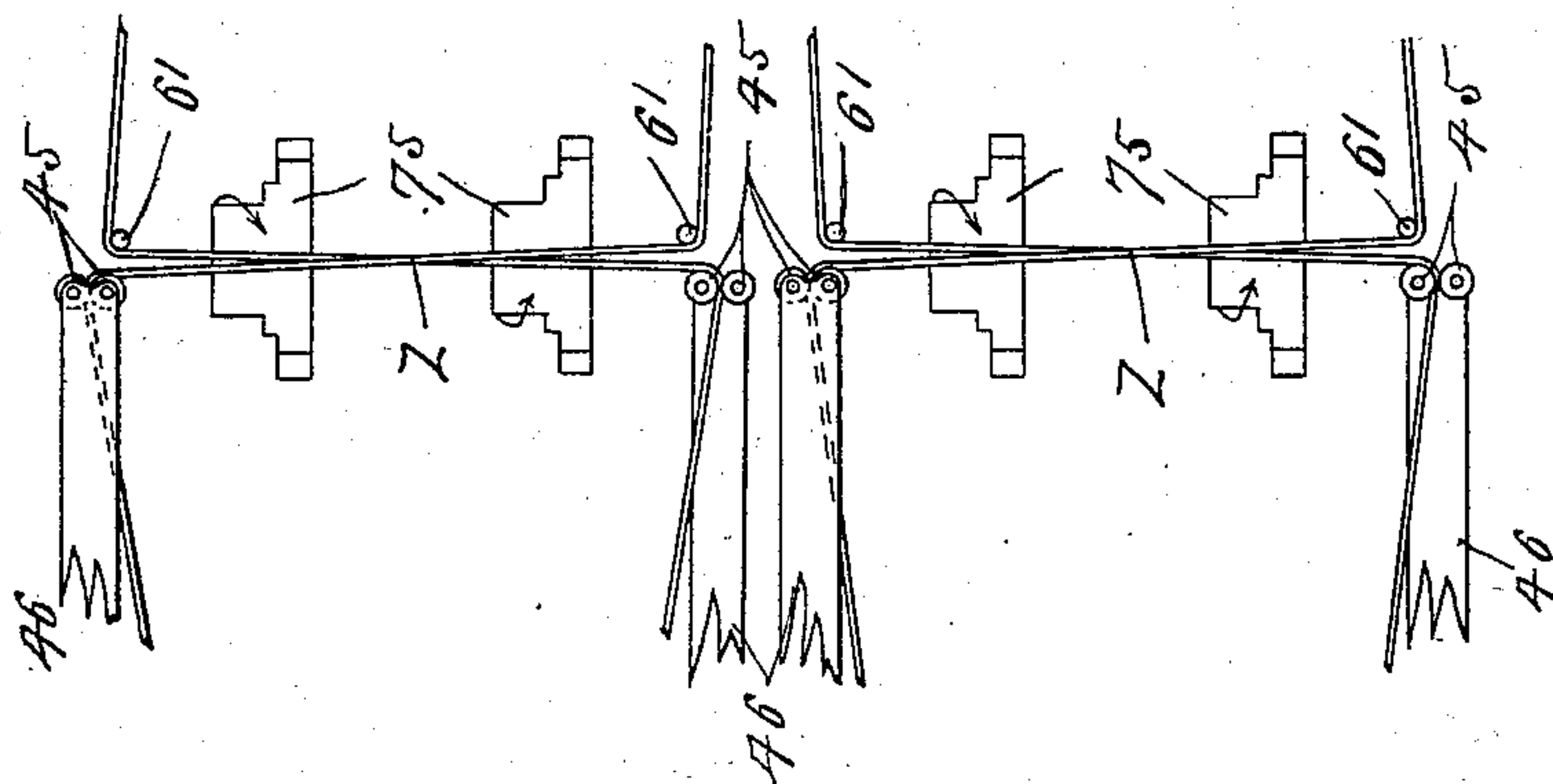
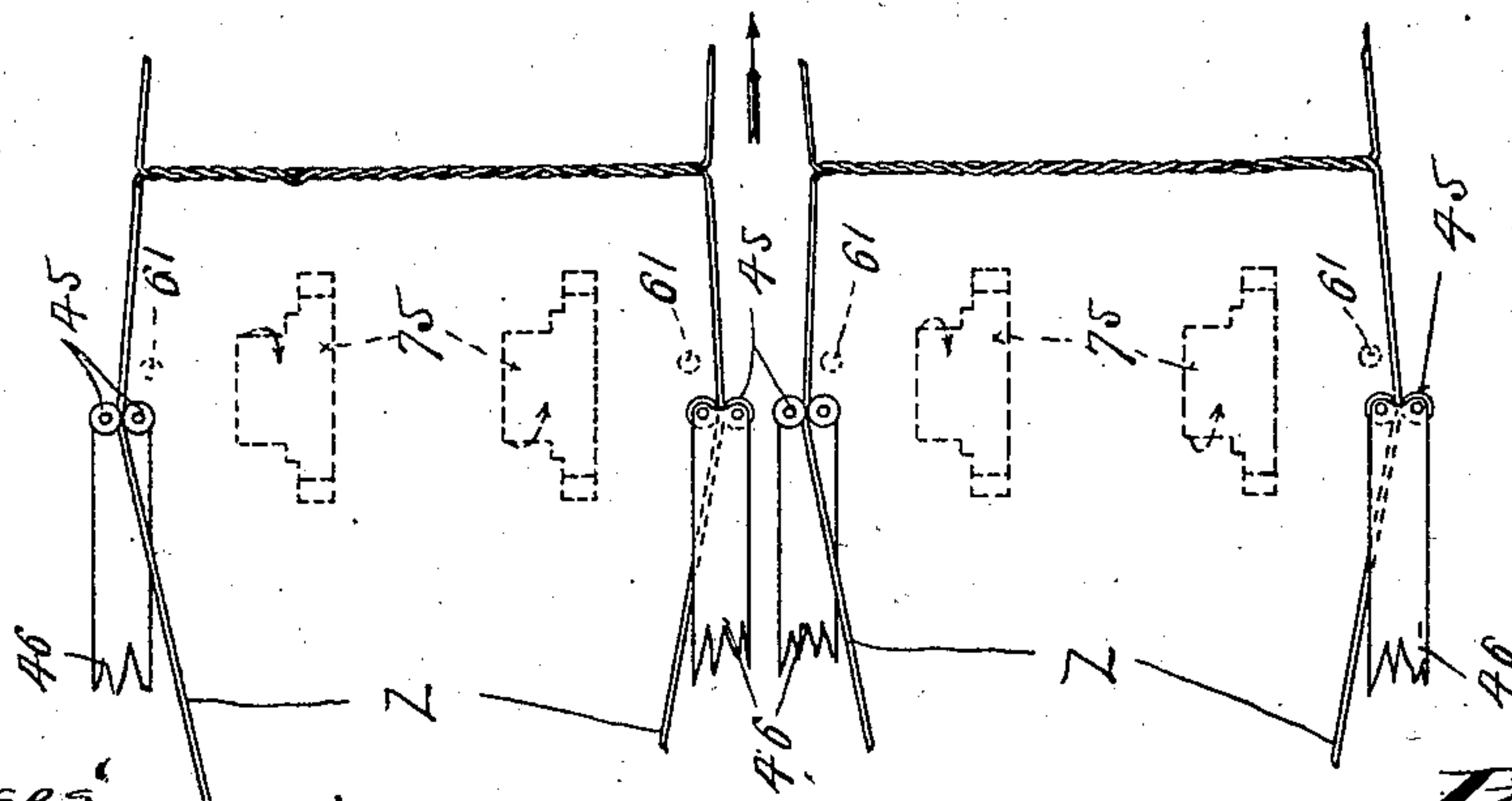


Fig. 21.



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UNITED STATES PATENT OFFICE.

THOMAS SUTHERLAND, OF HUTCHINSON, MINNESOTA.

WIRE-FABRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 708,679, dated September 9, 1902.

Application filed March 22, 1902. Serial No. 99,409. (No model.)

To all whom it may concern:

Be it known that I, THOMAS SUTHERLAND, a citizen of Canada, residing at Hutchinson, in the county of McLeod and State of Minnesota, have invented certain new and useful Improvements in Machines for Making Wire Fabric; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My present invention relates to machines for making wire fence and similar wire fabrics, and has for its especial object to provide an efficient machine for making the wire fabric or fence set forth and claimed in my prior application, Serial No. 93,324, filed February 10, 1902, entitled "Wire fabric." The machine is, however, capable of use in making wire fabric in which the wires are differently disposed than in my said prior application. The machine is, in fact, capable of use in making wire fabrics of various constructions in which longitudinal wires are to be twisted together to form the line wires or cables, while transverse wires or sections are to be twisted together to form the stays of the fabric. Certain features of the machine, however, are especially directed to means for disposing the wires so as to form the fabric disclosed in my said prior application.

To the ends above indicated, the invention consists of the novel devices and combinations of devices hereinafter described, and defined in the claims.

In the accompanying drawings I have illustrated a machine embodying the several features of my invention and in which various parts of the machine are controlled by hand-operated and foot-operated devices. These various devices are, however, capable of being operated automatically.

In the drawings like characters indicate like parts throughout the several views.

Figure 1 is a view in left side elevation, showing a complete machine embodying the several features of my invention as above indicated. Fig. 2 is a view, partly in plan and partly in horizontal section, on the line $x^2 x^2$ of Fig. 1, showing the main portions of the machine, but with some parts broken away. Fig. 3 is a horizontal section taken approxi-

mately on the line $x^3 x^3$ of Fig. 1. Fig. 4 is a detail in side elevation, but with some parts broken away and others sectioned, showing that portion of the machine which lies in the vicinity of the line $x^4 x^4$, marked on Fig. 3. Fig. 5 is a detail view, partly in plan and partly in horizontal section, showing a portion of the driving mechanism for the so-called "stay-twisters" and "line-twisters." Fig. 6 is a detail in side elevation showing a portion of the mechanism illustrated in Fig. 5. Fig. 7 is a section on the line $x^7 x^7$ of Fig. 2, showing the parts on a larger scale than in said Fig. 2. Fig. 8 is a detail in vertical section on the line $x^8 x^8$ of Fig. 2. Fig. 9 is a transverse vertical section taken approximately on the line $x^9 x^9$ of Fig. 2. Fig. 10 is a horizontal section approximately on the line $x^{10} x^{10}$ of Fig. 7. Fig. 11 is a transverse vertical section on the line $x^{11} x^{11}$ of Fig. 2, some parts being broken away and others being removed. Figs. 12, 13, 14, and 15 are detail views, principally in diagram, showing the stay-twisters, said views 13 and 15 being taken, respectively, on the lines $x^{13} x^{13}$ and $x^{15} x^{15}$ of Fig. 2. Fig. 16 is a section on the line $x^{16} x^{16}$ of Fig. 14. Fig. 17 is a diagrammatic view in plan, illustrating the action of the stay-twisters and reversely-vibrating shuttles or wire-guides. Fig. 18 is a vertical section on the line $x^{18} x^{18}$ of Fig. 17, illustrating also the so-called "corner pins" and devices for supporting the same, which latter parts are not fully shown in Fig. 17. Fig. 19 is a detail in vertical section on the line $x^{19} x^{19}$ of Fig. 18. Fig. 20 is a diagrammatic view illustrating the actions of the stay-twisters, line-twisters, and shuttles or wire-guides on the wires of the fabric in the process of manufacture; and Figs. 21 and 22 are similar views to Fig. 20, but showing the parts in different positions.

By reference to my said prior application above identified it will be seen that the wire fabric or fence therein disclosed is made by first bending any desired number of independent wires into similar reverse rectangular loops the transverse portions of which are overlapped and twisted together to form the stays of the fabric, while the longitudinal sections or strands of the several sections of the fabric thus formed are brought into parallel adjacent positions and are twisted together

to form the line-cables of the fabric and to thereby bind together the several sections of the wire fabric. This statement may prepare the reader for a more ready understanding of the action of the machine illustrated in the drawings.

The numeral 1 indicates as an entirety the rectangular skeleton frame of the machine, which, as shown, is provided with a laterally-projecting bearing-bracket 2, vertically-projecting brackets 3, 4, and 5, end brackets 6, and various other parts hereinafter noted.

The numeral 7 indicates a seat suitably supported from the bracket 2 at the left-hand side of the machine.

Power is transmitted to the machine through a power-driven shaft 8, extended transversely of the machine and mounted at one end in a fixed bearing-bracket 9 on the frame 1 and at its other end—to wit, its left-hand end—in a sliding bearing 10, shown as mounted on the bracket 2 by means of slot-and-screw engagements 11. (Best shown in Fig. 2, but also in Fig. 1.) Near its right-hand end the driving-shaft 8 is provided with a pulley 12 and near its left-hand end it is provided with a friction-pulley 13.

Mounted in fixed bearings on the frame 1 and bracket 2 and extending parallel with the shaft 8 are two other shafts 14 and 15. The shaft 14 receives motion from the shaft 8 through a belt 16, which runs over the pulley 12 and over a pulley 17 on said shaft 14. The shaft 14 is capable of a slight endwise movement in its bearings, and near its left-hand end it is provided with a pair of reversely-beveled friction-cones 18 and 19, which are adapted to be thrown into frictional contact in reverse order with a driven friction-cone 20, carried by a short shaft 21, mounted in suitable bearings on the bracket 2 and provided with a sprocket-wheel 22. The sliding movement is imparted to the shaft 14 through a double-ended foot-controlled lever 23, shown as pivoted to the bracket 2 at 24 and connected by parallel links 25 to a shipper-lever 26, pivoted at 26^a to the bracket 2 and provided with a finger 27, which works between collars 28 on said shaft. The lever 23 is adapted to be engaged by both feet of the operator while seated on the seat 7, and hence may be given a rocking motion in either direction at will by the operator. At this point it may be simply stated that through the foot-operated connections just described the sprocket 22 may be driven at will in either direction to impart reverse reciprocating movements to the wire-delivery shuttles or guides hereinafter described.

The driving friction-pulley 13 is adapted to be thrown into frictional engagement in alternate order with a pair of friction-wheels 29 and 30, the former of which is carried by the shaft 15 and the latter of which is carried by a short counter-shaft 31, suitably mounted in the bracket 2 and provided with a sprocket-

wheel 32 and a ratchet-wheel 33. A retaining-pawl 34 coöperates with the ratchet-wheel 33 to prevent backward rotations thereof when the wheel 30 is released, and thereby prevent unwinding movements of a windlass-drum 35, suitably mounted in the end brackets 6 and provided with a relatively large sprocket-wheel 30, over which and the sprocket-wheel 32 a sprocket-chain 37 runs to impart winding movements to the said windlass-drum. The windlass-drum 35 is shown as detachably held in place by detachable half-bearings 38, secured to the brackets 6. Said drum is also preferably provided with detachable heads 39, which enable the wound fabric or product of the machine to be removed in rolls therefrom, all as will hereinafter more fully appear. The driving friction-pulley 13 is adapted to be thrown into engagement with the one or the other of the friction-wheels 29 and 30 by a hand-lever 40, (best shown in Figs. 1, 2, and 4,) which lever is pivoted at its lower end to the bracket 2 and connected to the sliding bearing 10 by means of links 41. The shaft 15 is further provided with a sprocket-wheel 42 and with a flanged sheave 43. A small and loose belt 44 runs over the flanged sheave 43 and over another flanged sheave 44^a on the shaft 14.

The driving-shaft 8, being driven in the direction indicated by the arrow marked thereon, will positively drive the shaft 14 in the direction indicated by the arrow marked on said shaft in Fig. 3, and through the belt 44 the shaft 15 will at a certain time and for an important purpose hereinafter noted be driven in a direction reverse from that indicated by the arrow marked thereon in said Fig. 3. However, this driving action of the belt 44 is capable of being readily overcome and will be so overcome whenever the friction-pulley 13 is brought into engagement with the friction-wheel 29, at which time the said shaft 15 will be driven in the direction indicated by the arrow marked thereon in said Fig. 3. It is here only desirable to further state that both the line-twisters and the stay-twisters are given their twisting movements through driving connections directly driven from the sprocket-wheel 42 on the said shaft 15 under the driving action of the friction-pulley 13 when engaged with the friction-wheel 29, as above described.

The so-called wire-delivery shuttles or guides are best afforded by coöperating pairs of closely-positioned grooved guide rolls or sheaves 45, carried in pairs by arms 46, as best shown in Figs. 7, 17, 18, 20, 21, and 22, but also indicated in Fig. 2. The arms 46 are directly secured to slides 47, which are movable transversely of the machine on transversely-extended guide-bars 48, supported at their ends, one above the other, by means of bars 49, which in turn are supported by the brackets 5, as best shown in Figs. 7 and 9. There are several of these slides 47 on the upper bar 48 and a corresponding number on

the lower bar 48. As illustrated in the drawings and best shown in Fig. 9, the left-hand slides are provided each with three arms 46, the right-hand slides are provided each with four arms 46, and the intermediate slides are provided each with two of said arms. Each arm is, as already stated, provided with a cooperating pair of guide-sheaves 45, herein designated broadly as shuttles. These shuttles are, as best shown in Figs. 7 and 18, arranged to work or pass one below the other in as close contact as practicable, and each upper shuttle cooperates with a lower shuttle, the members of a given pair of shuttles being of course carried by corresponding upper and lower guides 47.

If a fabric or fence were to be made having its line-wires all equally spaced, then all of the upper shuttles might be carried by a single slide and all of the lower shuttles be carried by another single slide. However, in making a wire fence and many other classes of wire fabric it is desirable to have the line-wires thereof, or some of them, unequally spaced, and hence I make the following provision for accomplishing this latter result:

Each slide 47 is provided with a perforated lug 50. A plunger or driving-rod 51 is passed through the lugs 50 of all of the upper slides, and another plunger 51 is passed through the lugs of all of the lower slides. On the plungers are driving-collars 52, adjustably secured thereon by set-screws 53 or other suitable devices. Extreme movements of the right-hand slides 47 are limited by adjustable stops 54, secured one on each guide-bar 48 by set-screws 55 or other suitable devices. By the proper disposition of the collars 53 any desired movements may be given to the several slides 47. In the drawings (see Fig. 9) the said collars are so disposed that the right-hand slides 47 will be given as great movements as are the driving-plungers 51, while the left-hand and intermediate slides will be given materially less movements. Equal movements in opposite directions are simultaneously imparted to the upper and lower driving-plungers 51 through an oscillating lever 56, carried by a rock-shaft 57, mounted in the left-hand brackets 5. The ends of the lever 56 are connected one to the upper and the other to the lower plunger 51 by links 58. On the rock-shaft 57 is rigidly secured a sprocket 59, over which and the sprocket 22 of the shaft 21 runs a sprocket-chain 60, as shown in Fig. 1.

For cooperation with each pair of shuttles is a pair of so-called "corner-pins" 61. (Best shown in Figs. 7, 17, 18, 20, 21, and 22.) The wires (indicated by the character z) are adapted to be bent over the so-called "corner-pins" 61 to form the corners of the wire loops of the fabric. These corner-pins 61 are all carried by a common rock-shaft 62, mounted in the inner portions of the brackets 5 and normally locked in position to hold the corner-pins in upright or operative positions

close to the cooperating shuttles by means of a lock or latch involving in its best form an arm 63 on said shaft 62 and a pivoted latch-lever 64, which latch-lever is shown as pivoted at 65 to the right-hand bracket 5 and provided on its outwardly-extended end with an adjustable counterweight 66. The depending or operative end of said latch-lever 64 is provided with a segmental cam-surface 67, a lock-notch 68, and a stop-lug 69, which cooperate with the free end of the arm 63 in a manner set forth in the description of the operation.

All of the line-twisters and all of the stay-twisters are carried by an oscillating frame, indicated as an entirety by the numeral 70 and made up chiefly of a pair of laterally-spaced levers and a transverse tie-bar and provided with a heavy transversely-extended shaft 71, mounted in the bearing-brackets 4 and to which the side levers of the said oscillating frame are rigidly secured. The shaft 71, as is obvious, affords an intermediate pivot for the said oscillating frame 70.

Each stay-twister is carried by an arm 72, which is held for pivotal movements with the shaft 71 by means of a key 73 or other suitable device, (see Figs. 2, 7, 14, and 15,) but is adapted to be adjusted laterally on the said shaft and to be held where set by set-screws 74 or a similar device. In the free end of each arm 72 is a stay-twister 75, shown as formed with gear-teeth and with an internal twisting-die 76. The twisters 75 and their dies 76 are provided with radial slits 77 for receiving and discharging the wires. Each arm 72 is formed at its free end with a depending wire-receiving crotch 78, with which the slit 77 of the cooperating twister normally registers, as best shown in Figs. 7, 14, and 15, but see also Figs. 12, 13, 16, and 19. All of the stay-twisters 75 receive motion from a transverse shaft 79, journaled in the arms 72 and the forward ends of the sides of the oscillating frame 70. In the arrangement described alternate members of the twisters 75 are directly driven from gears 80, carried by said shaft 79 and engaging the teeth of the said twisters. (See Fig. 14.) The other alternate members of the said twisters 75 are driven in a reverse direction directly from gears 81, carried by a counter-shaft 82, mounted in the free ends of the arms 72 and driven from the shaft 79 by a pair of cooperating gears 83, carried one by each of the said shafts. (See Figs. 13 and 15.) As shown in Fig. 16, the twisters 75 are held against lateral movements in the arms 72 by retaining-washers 84, secured to the hubs thereof, overlapping said arms and provided with radial slits in line with the slits 77 of said twisters. Where the spaces between the line-wires of the fabric are not great, a single twister will serve to properly twist the stay. When, however, such distance is great or when the stay is too long to be properly twisted by a single twister, two twisters are

applied to the section or stay, and it then becomes very important to run these two twist-
ers in opposite directions. As is obvious,
two twist-ers making four rotations in oppo-
5 site directions will give a twist equal to that
given by a single twister making eight rota-
tions, and, furthermore, a better twist is pro-
duced in the former instance. In the draw-
ings two reversely-acting stay-twisters are
10 applied to twist the stays disposed by the
shuttles which are carried by the right-hand
slides 47. (See Figs. 17, 18, 20, 21, and 22,
and also Fig. 2.)

The line-twisters 85, which in construction
15 are very much like the stay-twisters, instead
of being located with their axes in line with
each other transversely of the machine are
located with their axes extending parallel to
each other longitudinally of the machine and
20 are spaced apart transversely of the machine.
These line-twisters 85 are, as shown, mount-
ed directly in a detachable strip or section 86
of a transverse supporting-bar 87, secured
at its ends to the rear ends of the side levers
25 of the frame 70, with freedom for adjust-
ments longitudinally of the machine by means
of tongue-and-groove engagements 88 and
slot-and-bolt connections 89 or other suitable
devices. (See especially Figs. 10 and 11.)
30 These line-twisters 85, like the stay-twisters,
are provided with dies 90 and wire-receiving
slits 91. While the wire-receiving slits of
the stay-twisters are normally turned down-
ward, these wire-receiving slits 91 of the line-
35 twisters are normally turned upward and reg-
ister with the wire-receiving crotches or di-
verging guides 92, carried by the bar 87 and,
as shown, formed as part of the detachable
strip 86 thereof. All of the line-twisters re-
40 ceive motion from a counter-shaft 93, suit-
ably journaled in the oscillating frame 70 and
provided with miter-gears 94, one for each
twister. Each line-twister 85 is directly
driven by a spur-gear 95, shown as adjust-
45 ably secured on a short counter-shaft 96, suit-
ably journaled in the bar 87 and in the trans-
verse bar of the oscillating frame 70 and pro-
vided at its forward end with the miter-gear
97, which meshes with the coöperating miter-
50 gear 94 of the shaft 93. The gears 95 are ad-
justably secured on the respective shafts 96
by adjustable collars 98, but are held for ro-
tation therewith by long keys 99.

Both the stay-twisters and the line-twisters
55 are driven from the heretofore-noted sprocket
42 in the shaft 15 through a sprocket-chain
100, which runs over said sprocket and over a
sprocket 101, loosely mounted on the left-
hand portion of the oscillating pivot-shaft 71
60 and cast integral with or rigidly secured for
rotation with two spur-gears 102 and 103, the
former of which meshes with the spur-gear
104 on the left-hand end of the shaft 93, and
the latter of which meshes with a spur-gear
65 105 on the left-hand portion of the shaft 79.
(See especially Figs. 2 and 5.) The oscillat-
ing frame 70 is adapted to be given its rock-

ing motions by means of a hand-lever 106,
shown as secured to the left-hand end of the
rock-shaft 71.

To limit the untwisting or return move-
ments of the stay-twisters and line-twisters,
one of the driven members—to wit, as shown,
the shaft 79—is provided with a disk 107, hav-
ing a single notch, with which the tooth of a
75 spring-pawl 108 coöperates to form a stop.
The spring-pawl 108 is shown as adjustably
secured to a projecting end of the hand-lever
106 by means of slot-and-screw engagements
109. (Best shown in Figs. 5 and 6.) By adjust-
80 ments of the said pawl 108 the wire-receiving
slits of the stay-twisters and line-twisters
may normally be brought into exact alinement
or registration with their respective or coöp-
erating wire-receiving crotches. That posi-
85 tion of the oscillating frame 70 which holds
the stay-twisters and line-twisters in opera-
tive positions is indicated in the drawings
(see Figs. 1 and 7) by full lines, while its in-
operative position is indicated in Fig. 7 by
90 dotted lines. The initial movement of the
said frame from its operative into its inoper-
ative position acts through a trip device to re-
lease the latch-lever 64, which holds the cor-
ner-pins 61 normally in operative positions.
95 This latch device is best illustrated in Figs. 7
and 8. As therein shown, this trip comprises
a trip-rod 110, pivoted at one end to the free
end of said latch-lever 64 and working at its
other end through a slotted keeper 111, car-
ried by a short arm 112, shown as secured to
100 the rock-shaft 71 near its right-hand end.
The free end of the trip-rod 110 is adapted to
rest upon a pivotally-adjustable tripping-
block 113, carried by the arm 112 and pro-
105 vided with a tripping-lug 114. As shown,
the block 113 is adjustably secured to the
arm 112 by a slot-and-bolt connection 115.
When the frame 70 is moved from its full-
line position into its dotted-line position, the
110 tripping-lug 114 will engage the free end of
the trip-rod 110 and force the latch-lever 64
into its releasing position, (indicated by dot-
ted lines in Fig. 7,) and thereby release the
arm 63 and permit the same under the strain
115 of the twisted sections of the wire fabric to
move rearward on the pivot 62, and thereby
carry said arm 63 out of alinement with the
notch 68. Under continued movement the
free end of the trip-rod 110 will be carried
120 above the lug 114, as indicated in Fig. 8. In
this way the corner-pins 61 are released, so
that they may be moved into the dotted-line
position indicated in Fig. 7 under the subse-
quent movement of the fabric or fence, as will
125 be hereinafter more fully described. It may
be here further stated, however, that the
weight of the arm 63 is such that it will when-
ever the strain from the fabric is removed
from the corner-pins 61 act on the cam-sur-
130 face 67 of the latch 64 and force its way back
into the notch 68, and thereby automatically
lock the said corner-pins again in their opera-
tive positions. The finished fabric or fence

is at the proper intervals intermittently moved rearward from the stay-twisters and line-twisters and wound upon the windlass-drum 35, as already indicated. On its way to the said drum it is passed over and preferably more than half-way around a so-called "tension-equalizing friction-drum" 116, which, as shown, is detachably mounted in the vertical brackets 3. Said fabric is, as shown, also passed over a small idle roller 117, also mounted in the said brackets 3. The equalizing friction-drum 116 is provided with a facing 116^a, of soft rubber or other suitable material.

Operation: We will assume, for a starting-point, that the condition of the fabric or fence being made by the machine is that indicated in Fig. 20, that the fabric is stretched taut, that the corner-pins 61 are locked in their operative or upright positions, and that the shuttles 45 have just disposed or overlapped the stay-forming sections of the wires and are for the time being held stationary. As hitherto indicated, the stay-twisters 75 and line-twisters 85 are reversely moved to and from operative positions—that is, the one is moved upward while the other is moved downward—such movements being imparted to said twisters by rocking the frame 70 from its dotted-line position into its full-line position, or vice versa. Such rocking movement may of course be readily given to said frame 70 by taking hold of the handpiece 106. As is evident in Fig. 7, the operative positions of the twisters are indicated by full lines, while the inoperative or normal positions are indicated by dotted lines. When the said twisters are thus thrown into operative positions, they are given their twisting movements by forcing forward the lever 40, and thereby throwing the driving friction-pulley 13 into engagement with the friction-wheel 29, all as heretofore more fully described. When the proper number of rotations have been given to the twisters, the operator by the manipulation of the lever 40 releases the friction-wheel 13 from the wheel 29, whereupon the reverse driving strain transmitted through the loose belt 44 in a manner already described will impart reverse or unwinding movements to the twisters sufficient to relieve the twisted sections of the fabric from unwinding tension. This unwinding movement will of course be intercepted by the engagement of the tooth of the pawl 108 with the notch of the disk 107, which engagement, as already stated, insures the alinement of the slits of the twisters with the cooperating guide-crotches. The twists being accomplished, the frame 70 is thrown back into its dotted-line position, (indicated in Fig. 7,) under which movement, as already described, the corner-pins 61 are released and moved slightly rearward or from their operative positions by the strain put upon the same from the tension of the fabric. The load on the oscillating frame 70 is so nearly

counterbalanced that the twisters may be very easily moved from their operative into their inoperative positions. The said frame 70 is held in its dotted-line position and the shuttles 45 retain the same positions as indicated in Fig. 20 while the fabric is moved forward a distance equal to the space desired between the stays of the fabric. It is not necessary that this movement be made with great accuracy, and an operator by exercising a little care and with a little experience soon becomes able to manipulate the machine in this respect as well as in all others.

In Fig. 21 the fabric is shown as being moved forward, and hence the corner-pins 61 and stay-twisters 45 not being in operative positions are indicated by dotted lines. In Fig. 22 the same position of the parts is indicated as in Fig. 20, except that the shuttles 45 and their supporting-arms 46 have been given their extreme movements, so as to overlap the stay-forming sections of the wires in reverse directions from that indicated in Fig. 20.

As already clearly stated, the winding-drum 35 is moved by drawing the lever 40 rearward, thereby throwing the friction-wheel 13 into engagement with the friction-wheel 30. As also clearly indicated, the reverse movements are at the proper time—to wit, just after the said windlass-drum 35 has been given its winding movement and the fabric drawn rearward—imparted to the upper and lower shuttles 45 by oscillating the foot-lever 23 in the one direction at one time and in the other direction the next time, so as to alternately engage the friction-cones 18 and 19 with the friction-cone 20.

When the finished fabric is wound onto the windlass-drum 35, uneven tensions will be put upon the wires of the fabric, due to the irregularities in the wound material. This would tend to pull certain of the wires of the fabric faster than others and would thus throw the stay-wires of the fabric out of parallel with each other and out of proper positions with respect to the line-wires of the fabric. It is to prevent this action that the so-called "equalizing-drum" 116, with its frictional face, is provided. As the fabric is drawn over the rubber facing 116^a the wires thereof will be frictionally held against slipping movements thereon and will, in fact, where the rubber or pliable facing is provided be slightly embedded therein, so that there is no possibility of any one of the longitudinal or line wires of the fabric being drawn ahead faster than the other.

As heretofore stated, the machine may be very easily made completely automatic in its action. However, I have found in practice by continued use of a machine designed substantially as illustrated in the accompanying drawings that in some respects more satisfactory results are attained by making the several devices described operative at will. A single operator can with ease control all of

those parts of the machine herein described as being thrown into and out of action by the combined use of the hands and feet.

The machine is of course capable of many modifications within the scope of my invention as herein set forth and claimed.

What I claim, and desire to secure by Letters Patent of the United States, is as follows:

1. The combination with means for alternately and reversely lapping the line-wires and twisting the same together to form stays, of means for moving the fabric to draw out the line-wires, and means for twisting together the adjacent line-wires of the several sections of the fabric, to form cables thereof and connect the said fabric-sections.

2. The combination with a plurality of wire-delivery shuttles or guides working in reversely-movable pairs to lap the line-wires, of stay-twisters operating to twist together the lapped section, to form stays thereof, means for intermittently moving the fabric to draw out the line-wires, and line-twisters arranged to twist together the line-wires between the stays, to form a cable thereof and bind together the sections of the fabric.

3. The combination with wire-delivery shuttles or guides, of a plurality of stay-twisters operative on the transverse sections of the incomplete fabric, to form the stays thereof, and a plurality of line-twisters operating to twist together adjacent line-wires between the stays, to form cables thereof and bind together the sections of the fabric.

4. The combination with wire-delivery shuttles or guides, of an oscillating frame, a series of stay-twisters and a series of line-twisters mounted on said frame and carried in reverse directions, to and from operative positions, under the movements of said frame, and means for driving the said twisters, to twist the stay and line sections of the fabric, substantially as described.

5. The combination with reciprocating wire-delivery shuttles or guides working in reversely-movable pairs to lap the line-wires, of corner-pins over which the wires are bent, stay-twisters operating to twist together the lapped sections of the wires, to form stays thereof, means for intermittently moving the fabric to draw out the line-wires, and line-twisters arranged to twist together the adjacent line-wires between the stays, to bind together the sections of the fabric, substantially as described.

6. The combination with a pair of reversely-reciprocating wire-delivery shuttles or guides, of a pair of cooperating corner-pins over which the wires are bent, under the movements of said shuttles, to overlap the line-wires, stay-twisters for twisting together the overlapped sections of the wires, means for moving the fabric to draw out the line-wires, and means for causing said stays and corner-pins to clear each other, under the movement of the fabric.

7. The combination with a pair of reversely-

reciprocating wire-delivery shuttles or guides, of a pair of corner-pins over which the line-wires are bent, under the movements of said shuttles, to overlap the line-wires, and twist-ers operating to twist together the overlapped sections of the wires while the same are held stretched by the said corner-pins.

8. The combination with a pair of reversely-reciprocating wire-delivery shuttles or guides, of a pair of corner-pins over which the line-wires are bent, under movements of said shuttles to overlap said wires, twisters for twisting together the overlapped sections of the wires to form stays thereof, means for throwing said corner-pins into inoperative positions, to permit the twisted stays to pass over the same, and means for intermittently moving the fabric to draw out the line-wires, substantially as described.

9. The combination with a plurality of reversely-reciprocating wire-delivery shuttles or guides, cooperating corner-pins over which the line-wires are bent to overlap the same, a latch normally holding said corner-pins in operative positions, an oscillating frame or support, stay-twisters and line-twisters carried by said support and movable thereby into and out of operative positions, and a trip for said latch arranged to be thrown into action under that movement of said frame which carries the said twisters from their operative into their inoperative positions.

10. The combination with a plurality of wire-delivery shuttles or guides working in reversely-reciprocating pairs, of a rock-shaft provided with a plurality of corner-pins, a latch normally holding said corner-pins in operative positions, an oscillating frame, stay-twisters and line-twisters mounted on said frame and receiving reverse movements thereby, to and from operative positions, means for drawing the fabric forward to draw out the line-wires, and a trip for the said latch arranged to be thrown into action and then to be again released or rendered inoperative by that movement of said frame which carries the said twisters from their operative into their inoperative positions.

11. The combination with a reciprocating driver, of a plurality of slides receiving different movements therefrom, wire-delivery shuttles or guides carried by said slides, means for moving the fabric to draw out the line-wires, and means for twisting together the stay and line forming sections of the wires, substantially as described.

12. The combination with a pair of reversely-movable drivers, of slides driven by said drivers, wire-delivery shuttles or guides carried by said slides and operating in reversely-movable pairs, means for feeding the fabric to draw out the line-wires, and stay-twisters for twisting together the overlapped sections of the wires, to form stays thereof, substantially as described.

13. The combination with reversely-reciprocating drivers, of slides receiving different

movements from each driver, wire-delivery shuttles or guides carried by said slides, the upper and lower members thereof coöperating in reversely-movable pairs, means for moving the fabric to draw out the line-wires, and means for twisting together the overlapped stay-forming sections and the parallel line-sections of the wires, substantially as described.

14. The combination with parallel upper and lower guides of a plurality of slides on each guide, wire-delivery shuttles or guides carried by said slides, reversely-reciprocating driving-plungers operating one on the upper and one on the lower series of slides, and adjustable driving collars or elements on said plungers for varying the driving actions thereof, on the respective slides, substantially as described.

15. The combination with a pair of parallel guides, of slides movable thereon, wire-delivery shuttles or guides carried by said slides and operating in reversely-movable pairs, and means for reversely reciprocating the upper and the lower members of said slides, and an oscillating lever with connections extending thereto, substantially as described.

16. The combination with a pair of parallel guides, of slides movable thereon, wire-delivery shuttles or guides carried by said slides and operating in reversely-movable pairs, and means for reversely reciprocating the upper and lower members of said slides, involving a reversible frictional clutch, an oscillating lever driven from said clutch and connections from said lever to said slides, substantially as described.

17. The combination with means for disposing the wires to form stay and line sections, of stay-twisters for twisting together the stay-forming sections of the wires, line-twisters spaced transversely of the fabric with their axes at right angles to the common axes of the stay-twisters, and means for adjusting the said line-twisters toward and from the stay-twisters, substantially as described.

18. The combination with a wire-twister and a stop for limiting to normal the return or unwinding movement thereof, of a drive for imparting twisting movements to said twister, and a reverse drive normally tending to impart return or untwisting movement to the said twister, but adapted to be overcome by the said former drive, substantially as described.

19. The combination with a wire-twister and a stop for limiting the return or unwinding movement thereof, of a frictional return drive tending to impart return or unwinding movements to said twister, and a primary drive for imparting twisting movements to said twister, against the action of said frictional return drive, substantially as described.

20. The combination with a plurality of twisters and a stop for limiting to normal positions the return movements thereof, of a primary drive for imparting twisting move-

ments to said twisters and a secondary or return drive for said twisters adapted to be overcome by said primary drive and involving in itself a pair of coöperating pulleys and a belt running loosely thereover, substantially as described.

21. The combination with corner-pins over which the wires are adapted to be bent, of means for bending the wires and overlapping the same from one corner-pin to the other, and a pair of reversely-rotatable twisters for twisting together the overlapped wire-sections between said corner-pins, substantially as described.

22. The combination with corner-pins over which the wires are adapted to be bent, of reversely-movable wire-delivery shuttles or guides operating in pairs to cause the wires to overlap from one pin to the other, and a pair of reversely-rotatable twisters, for twisting together the overlapped wire-sections, between said corner-pins, substantially as described.

23. The combination with corner-pins arranged in pairs, of reversely-movable upper and lower wire-delivery shuttles or guides for lapping the wires over said corner-pins, means for twisting together the lapped wire-sections to form stays thereof, means for releasing said corner-pins after the stays have been twisted, means for moving the fabric to draw out the line-wires, and means for restoring the said corner-pins to their normal positions and there locking the same, substantially as described.

24. The combination with means for disposing the wires to form line and stay sections, of an oscillating frame pivoted at its intermediate portion and provided with a handpiece by means of which it will be moved at will, a plurality of stay-twisters mounted at one end of said frame and provided with normally downturned wire-receiving slits, another series of line-twisters mounted at the other end of said frame and provided with normally upturned wire-receiving slits, corner-pins over which the line-wires may be bent to form the stays, an automatic lock for holding said corner-pins in operative positions, a trip for said lock operated by said oscillating frame, and means for automatically restoring said corner-pins to normal positions and rendering the same again subject to said lock, substantially as described.

25. The combination with means for delivering the wires and twisting the same together to form a fabric, of a drum for receiving the finished fabric and drawing the same forward, and a tension-equalizing drum provided with a facing of soft rubber over which the fabric is adapted to be rolled, but by which it is held against slipping, substantially as described.

26. The combination with an oscillating frame provided with a plurality of twisters and with a handpiece for moving the same to carry the twisters to and from operative

positions, of reversely-reciprocating wire-delivery shuttles or guides, and means for moving said guides involving a foot-operated lever adapted to be engaged by the feet and operated, substantially as described.

27. The combination with means for disposing the wires to form the line and stay sections, of an oscillating frame, a plurality of twisters for twisting together the line and stay sections of the fabric, a drum onto which the finished fabric is wound, and means for intermittently driving said drum and said twisters in alter-

nate order involving a pair of driven friction-wheels, and a shiftable frictional driving-wheel movable alternately into engagement with said friction-wheels, substantially as described.

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

THOMAS SUTHERLAND.

Witnesses:

MAURICE D. PENDERGAST,
WINNING S. PENDERGAST.