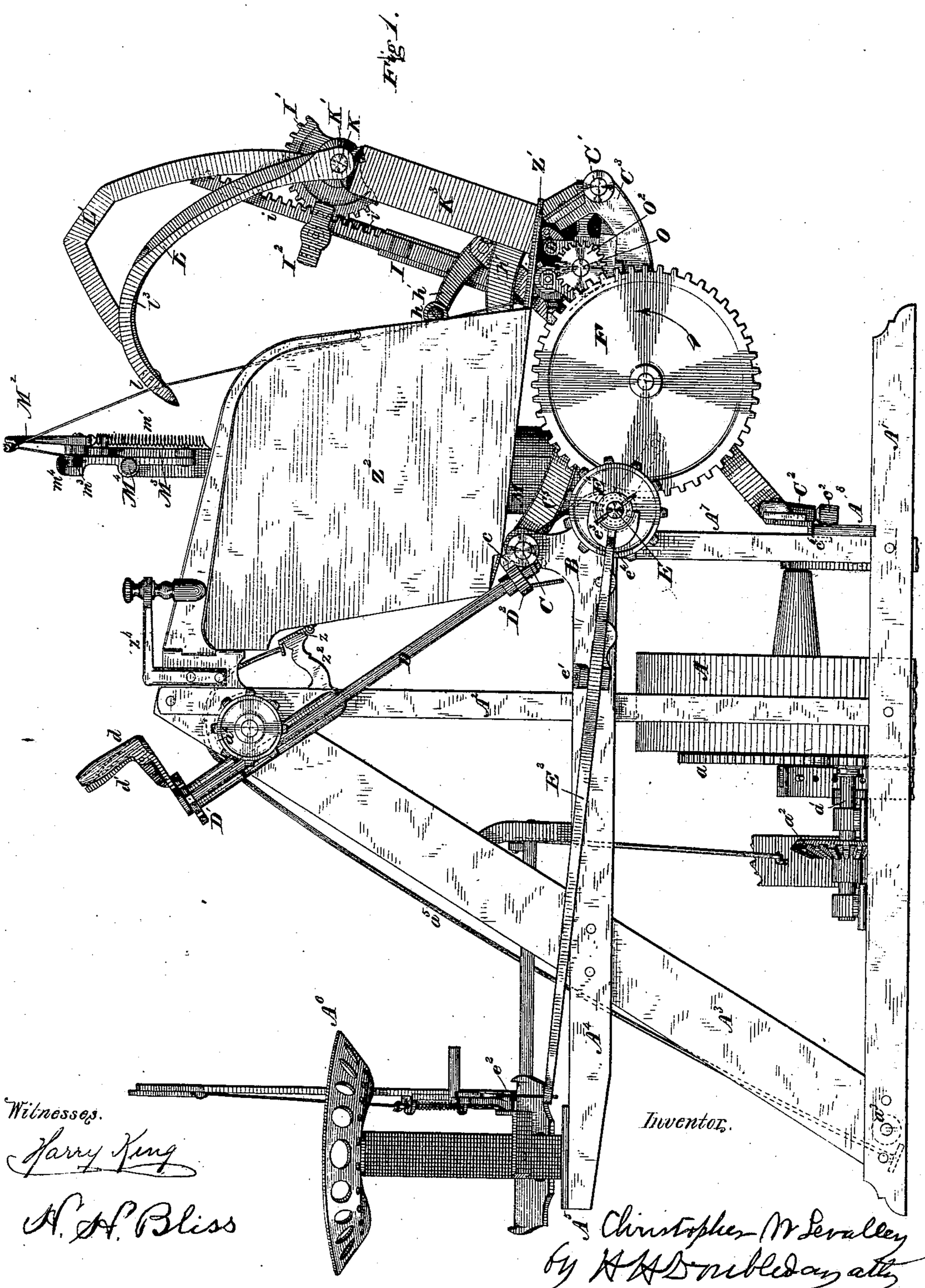
12 Sheets—Sheet 1.

# C. W. LEVALLEY.

## Grain-Binder.

No. 226,865. Patented April 27, 1880.



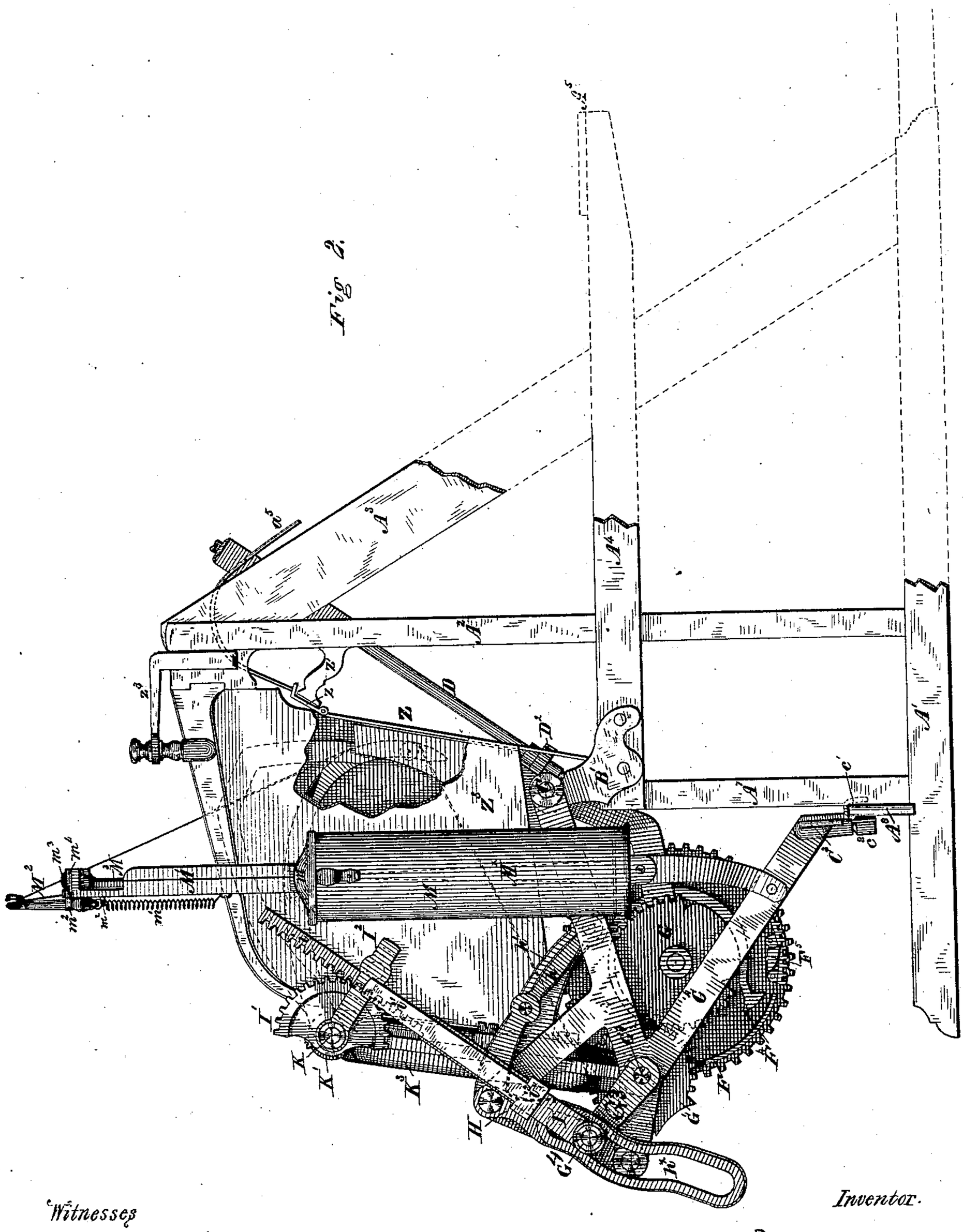
12 Sheets—Sheet 2.

# C. W. LEVALLEY.

## Grain-Binder.

No. 226,865. **Patented April 27, 1880.**

Fig 2.



Witnesses

Harry King

N. H. Bliss

Inventor.

Christopher W Levalley

by H H Doubleday atty

12 Sheets—Sheet 3.

# C. W. LEVALLEY.

## Grain-Binder.

No. 226,865. Patented April 27, 1880.

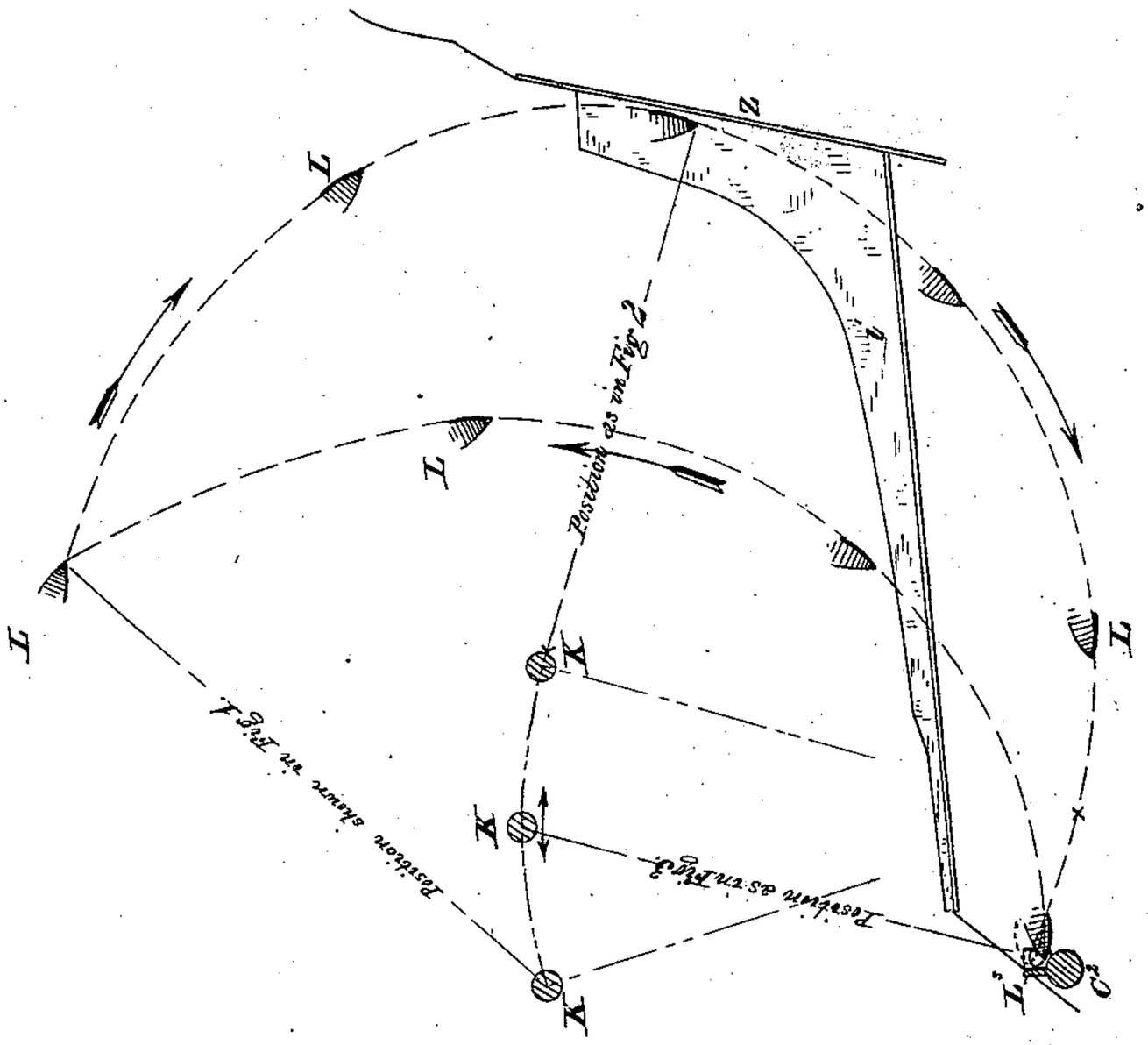



Fig 2 3.

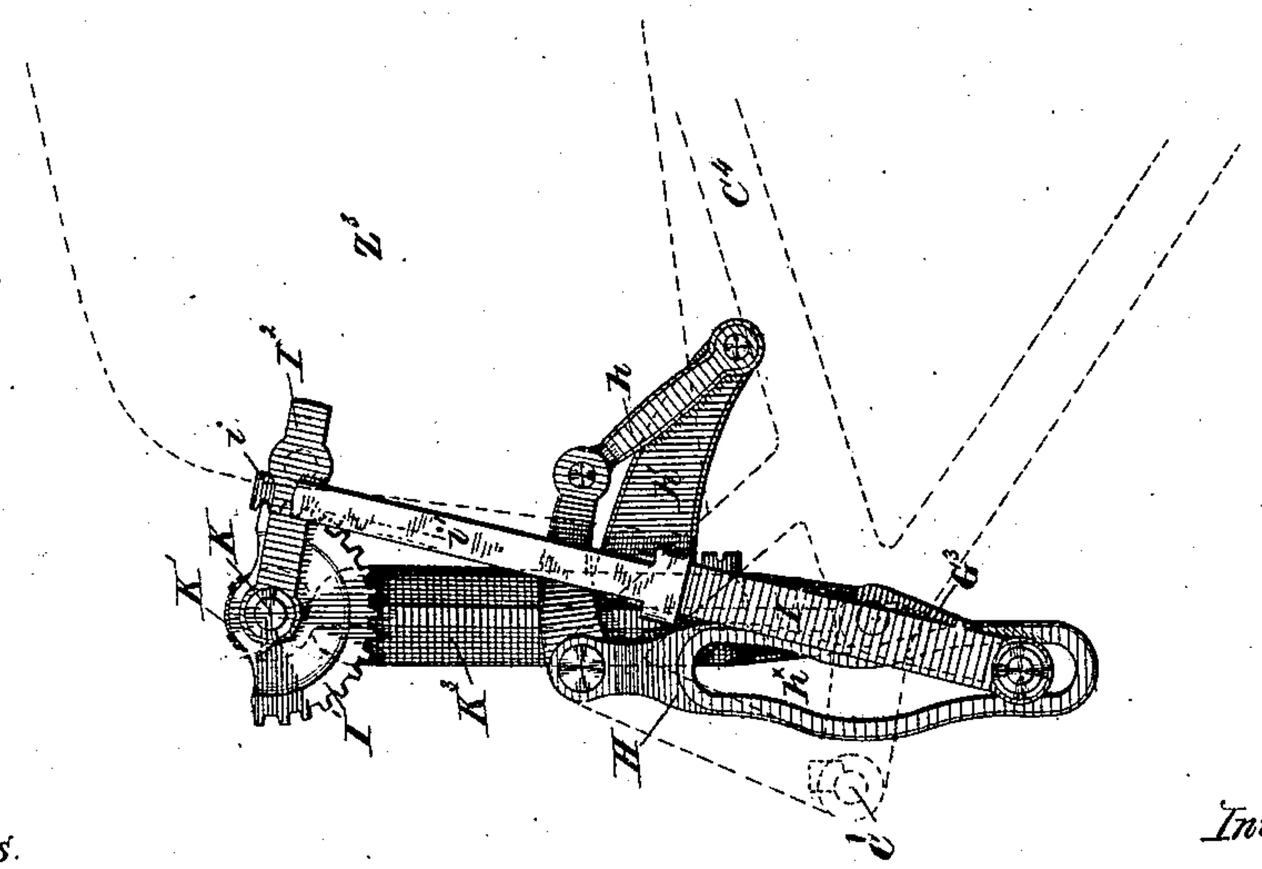



Fig. 3.

Witnesses.

Harry King

A. A. Bliss

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(No model.)

16 Sheets—Sheet 4.

# C. W. LEVALLEY.

## Grain-Binder.

No. 226,865. **Patented April 27, 1880.**

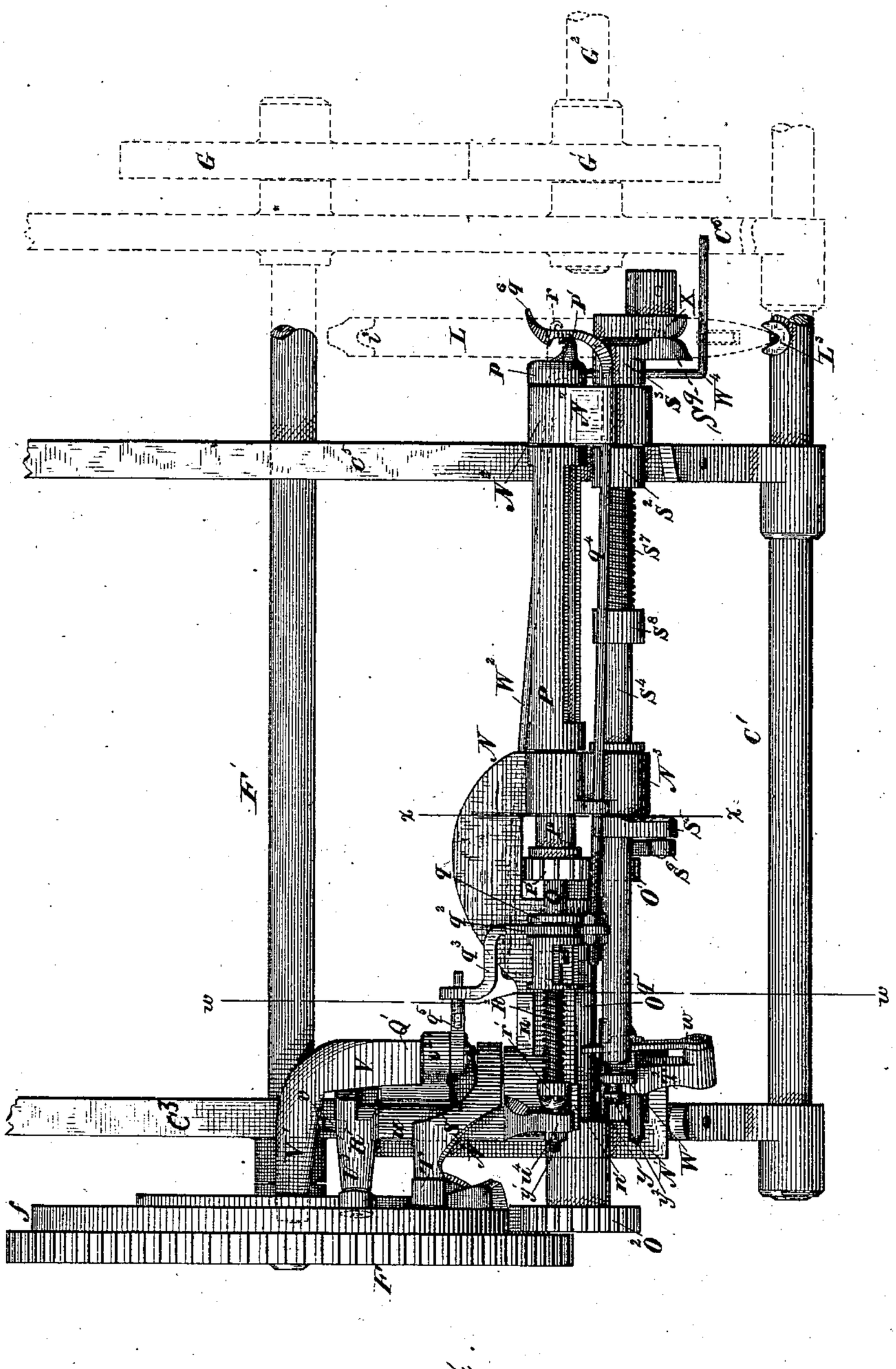

Fig. 4.

Witnesses.

Harry King

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Inventor.

Christopher W Levalley

by W. H. Doubleday atty.

12 Sheets—Sheet 5.

# C. W. LEVALLEY.

## Grain-Binder.

No. 226,865. Patented April 27, 1880.

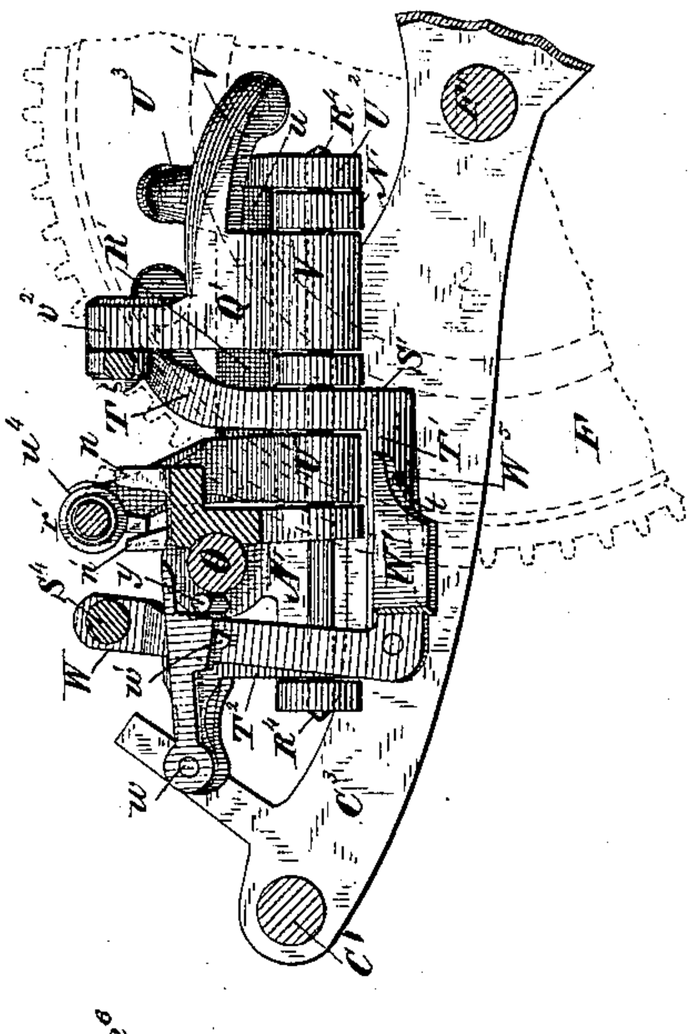

Fig 6.

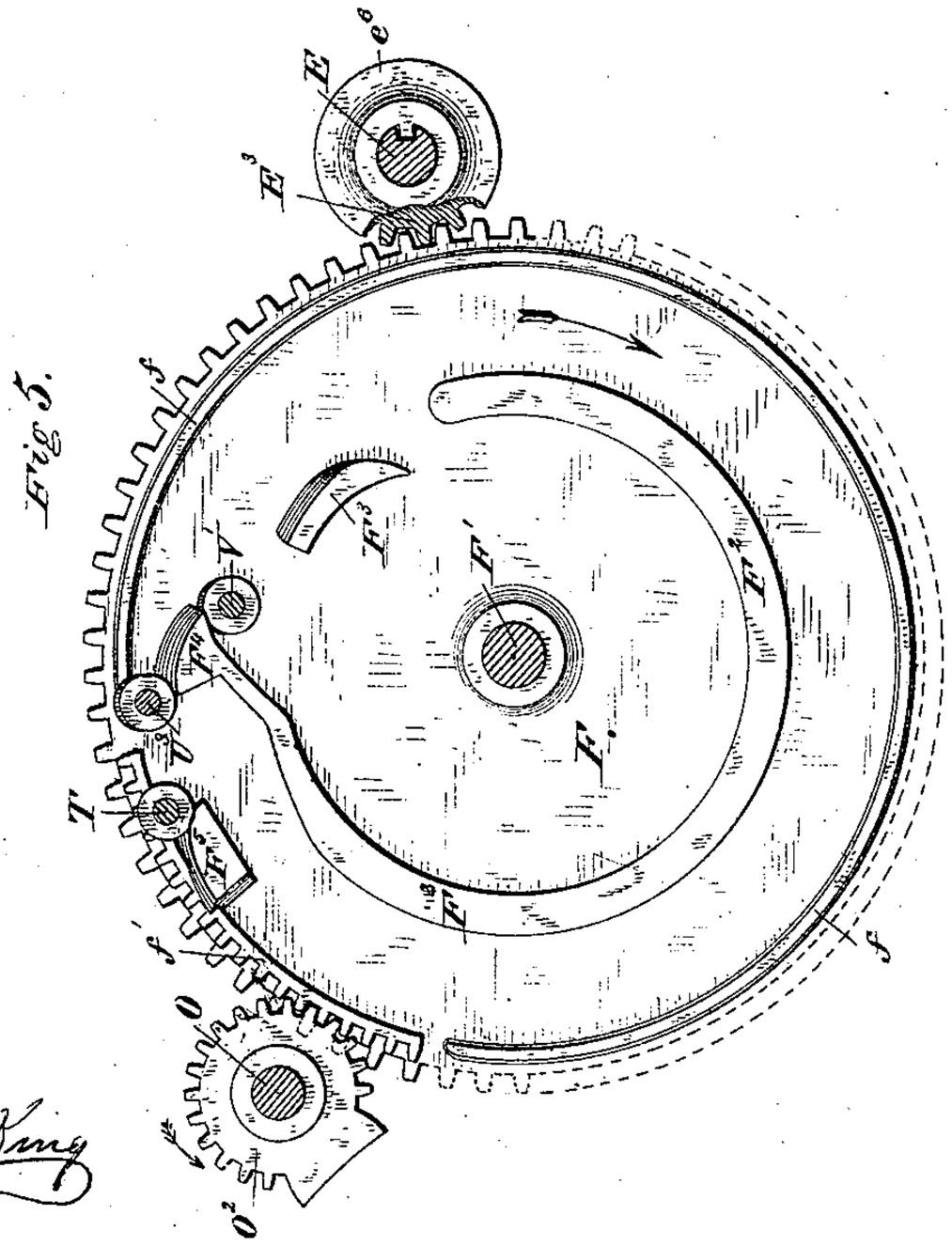

Fig 5.

Witnesses.

Harry King

H. H. Bliss

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Christopher W. Levalley
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12 Sheets—Sheet 6.

# C. W. LEVALLEY.

## Grain-Binder.

No. 226,865. Patented April 27, 1880.

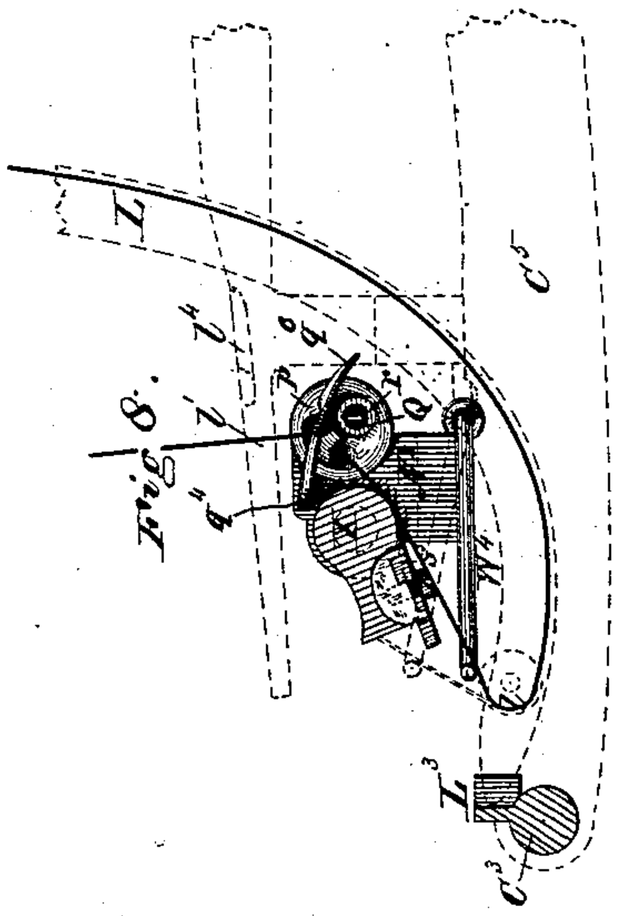

Fig. 8.

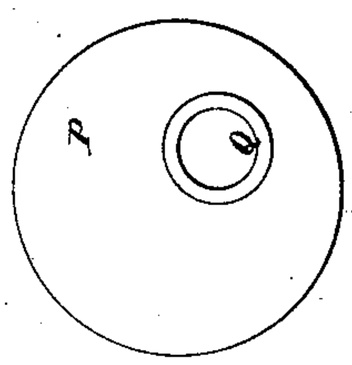

Fig. 10.

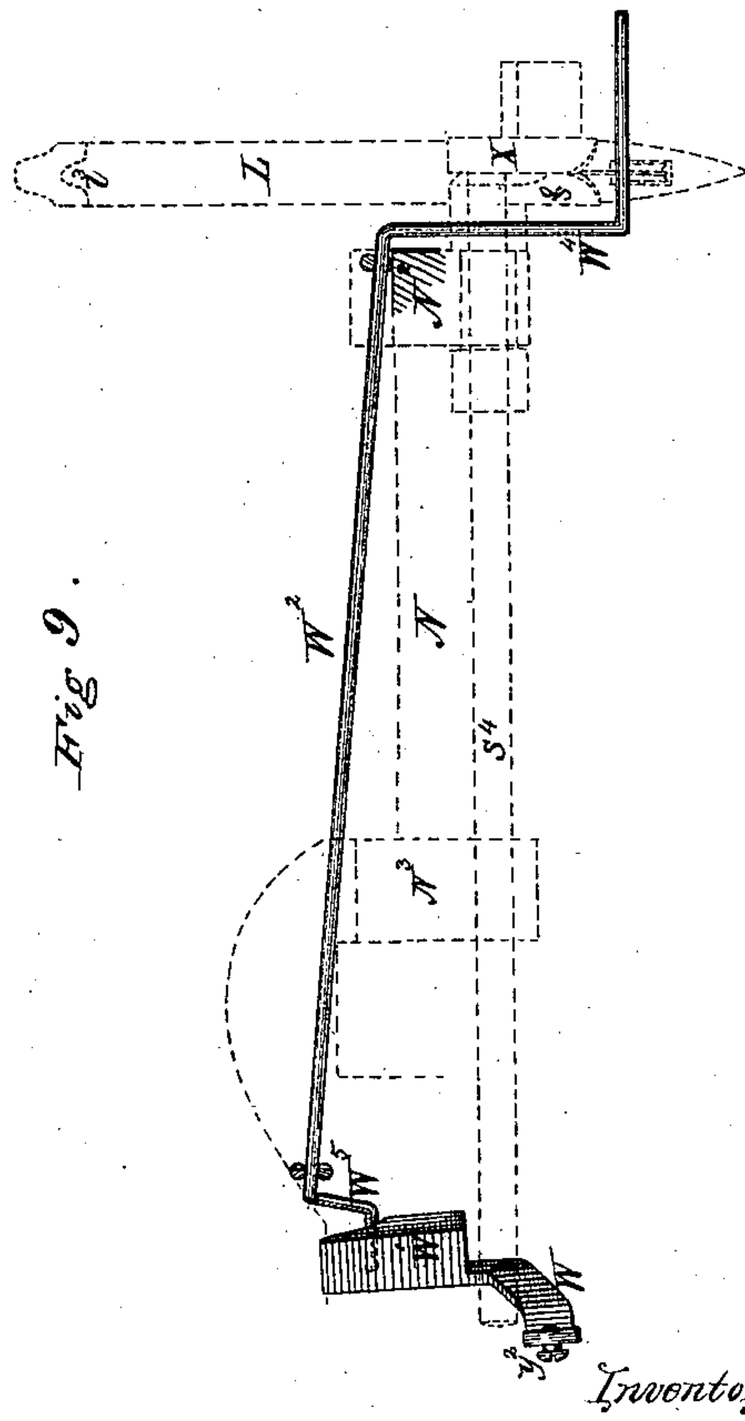

Fig. 9.

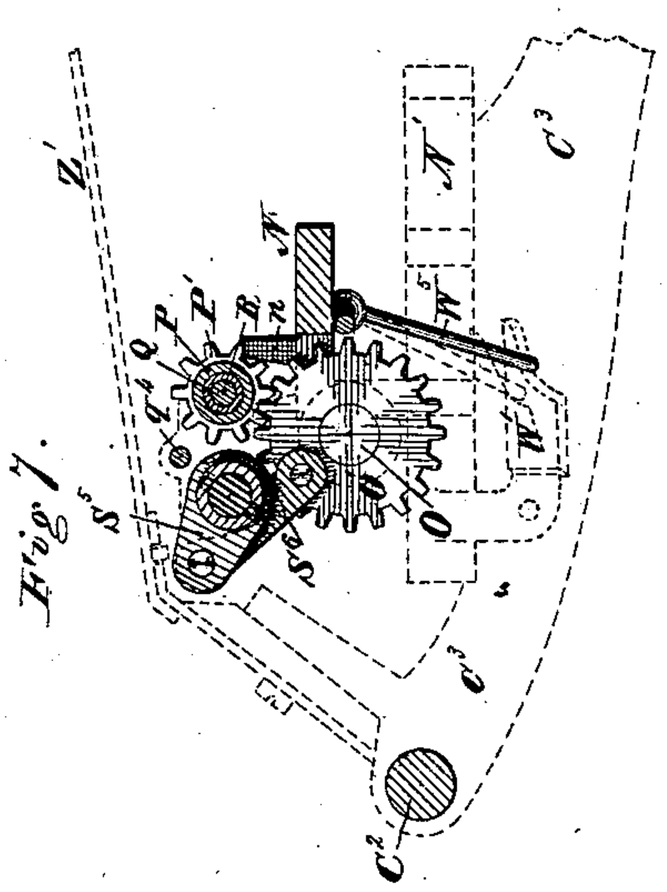

Fig. 7.

Witnesses

Harry King

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Inventor.

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12 Sheets—Sheet 7.

# C. W. LEVALLEY.

## Grain-Binder.

No. 226,865. Patented April 27, 1880.

Fig. 11.

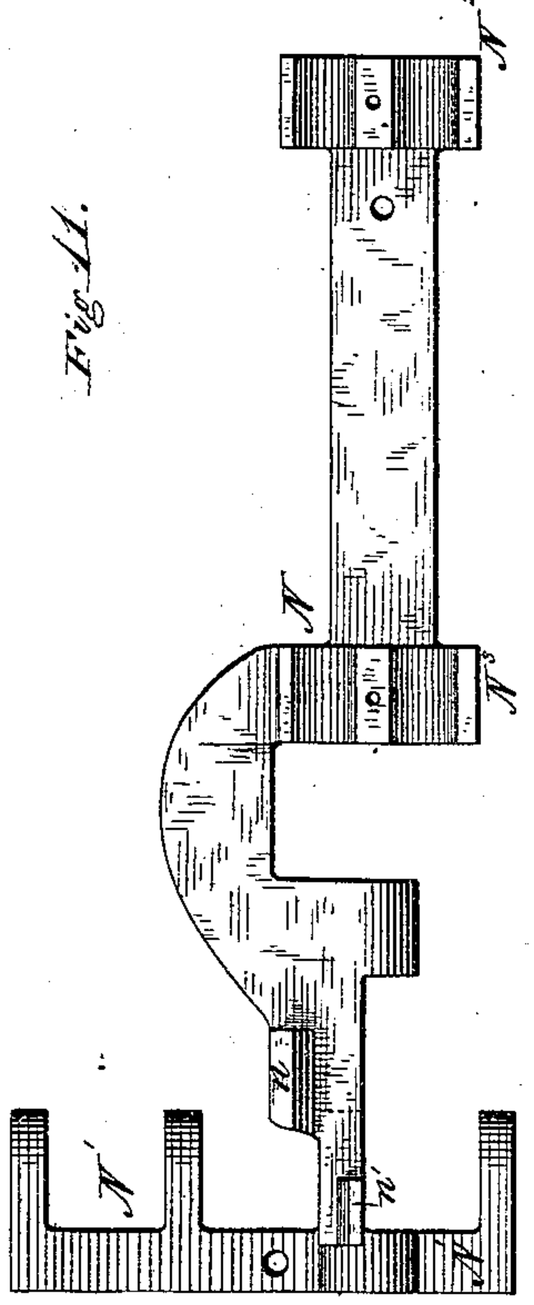
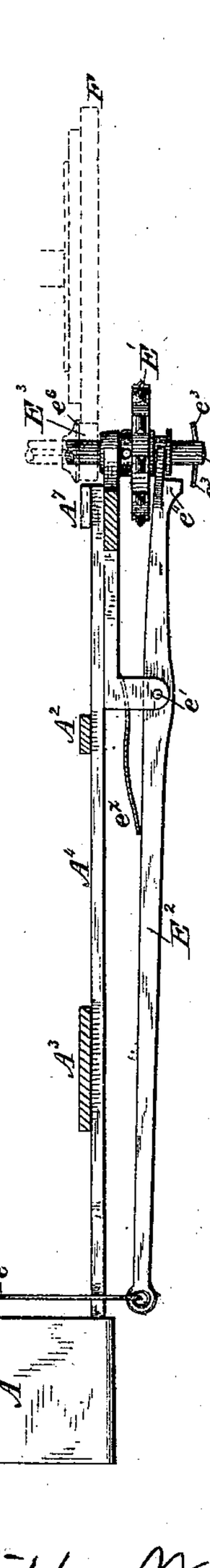



Fig. 12.




Witnesses.

Harry King

H. H. Bliss

Inventor.

Christopher W. Levalley

by H. A. Donbleday atty

12 Sheets—Sheet 8.

# C. W. LEVALLEY.

## Grain-Binder.

No. 226,865. Patented April 27, 1880.

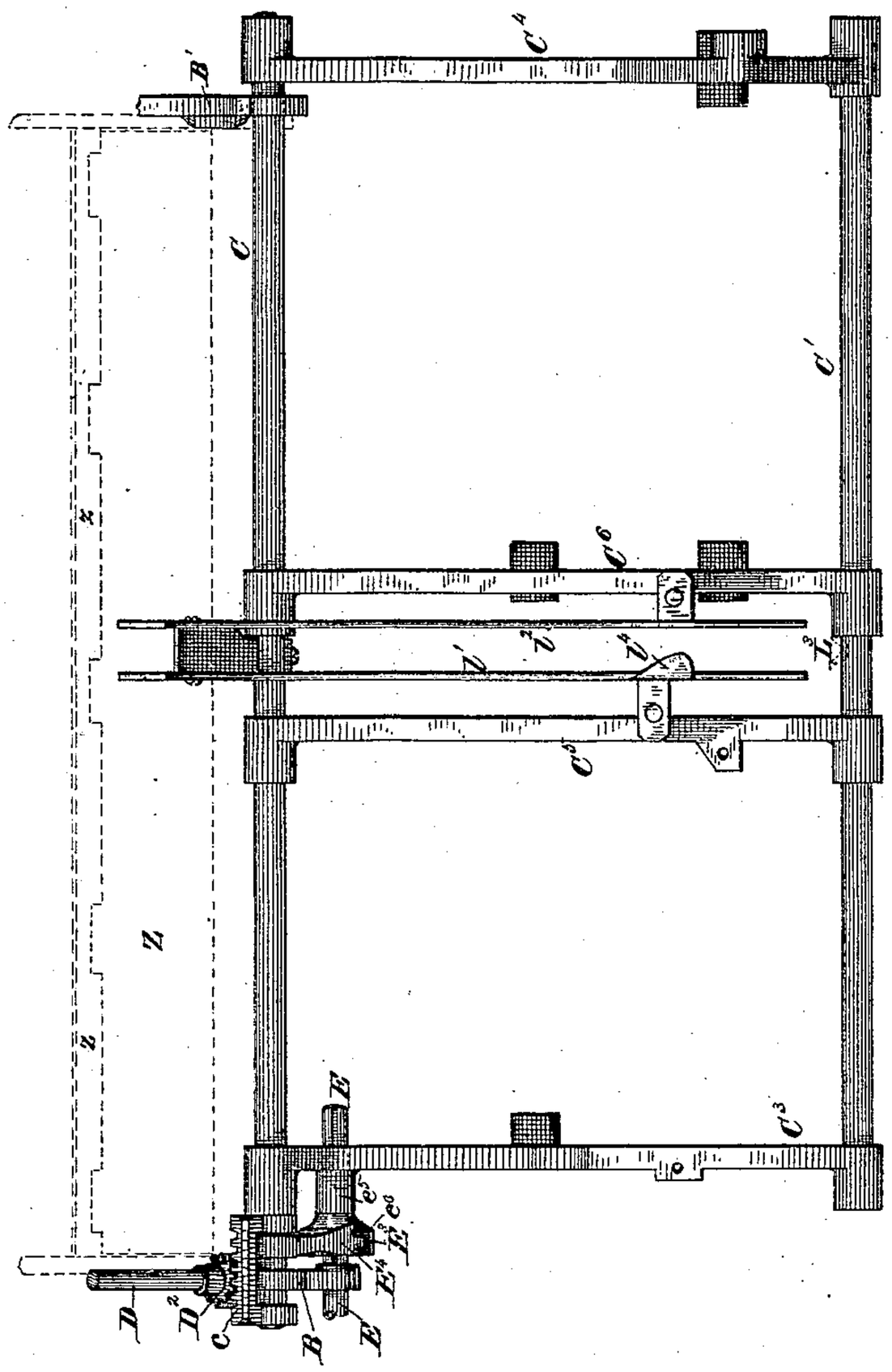



Fig. 13.

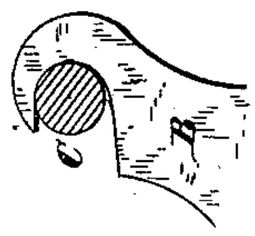



Fig. 14.


Fig. 15.

Witnesses.

Harry King.

H. H. Bliss

Inventor

Christopher W Levalley
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12 Sheets—Sheet 9.

# C. W. LEVALLEY.

## Grain-Binder.

**No. 226,865.** **Patented April 27, 1880.**

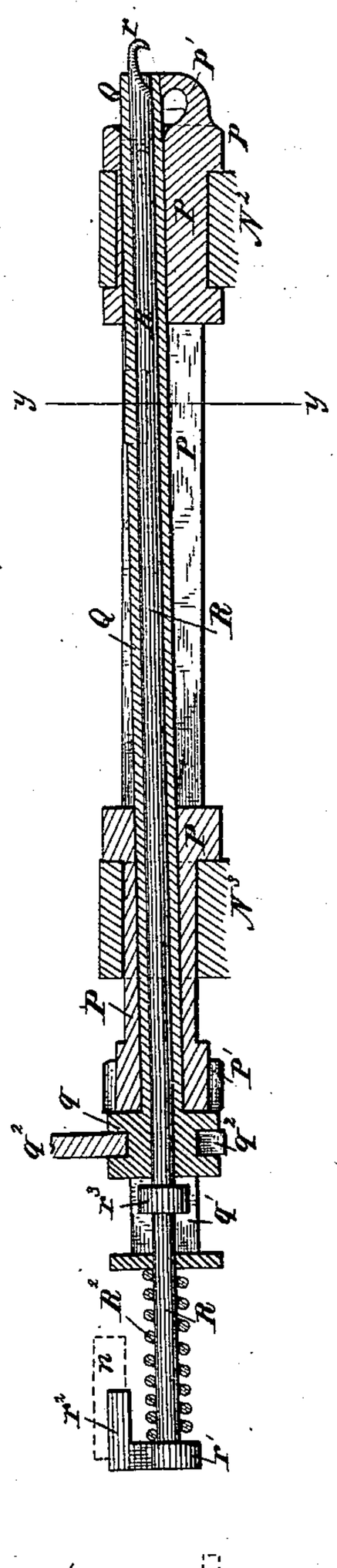

Fig. 16.

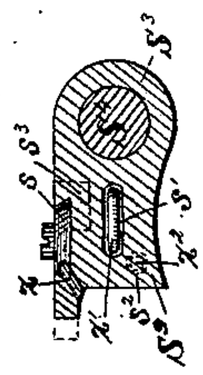

Fig. 19.

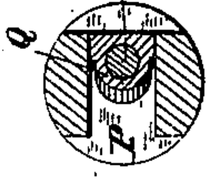

Fig. 17.

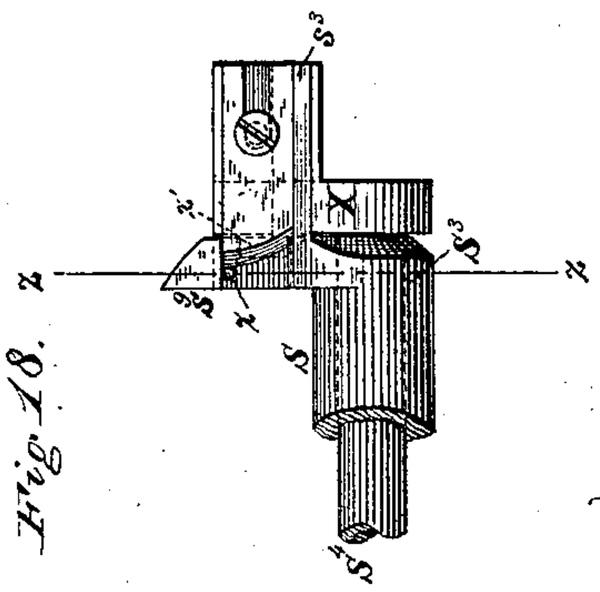

Fig. 18.

Witnesses.

Harry King

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Inventor.

Christopher W Levalley

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12 Sheets—Sheet 10.

# C. W. LEVALLEY.

## Grain-Binder.

No. 226,865. Patented April 27, 1880.

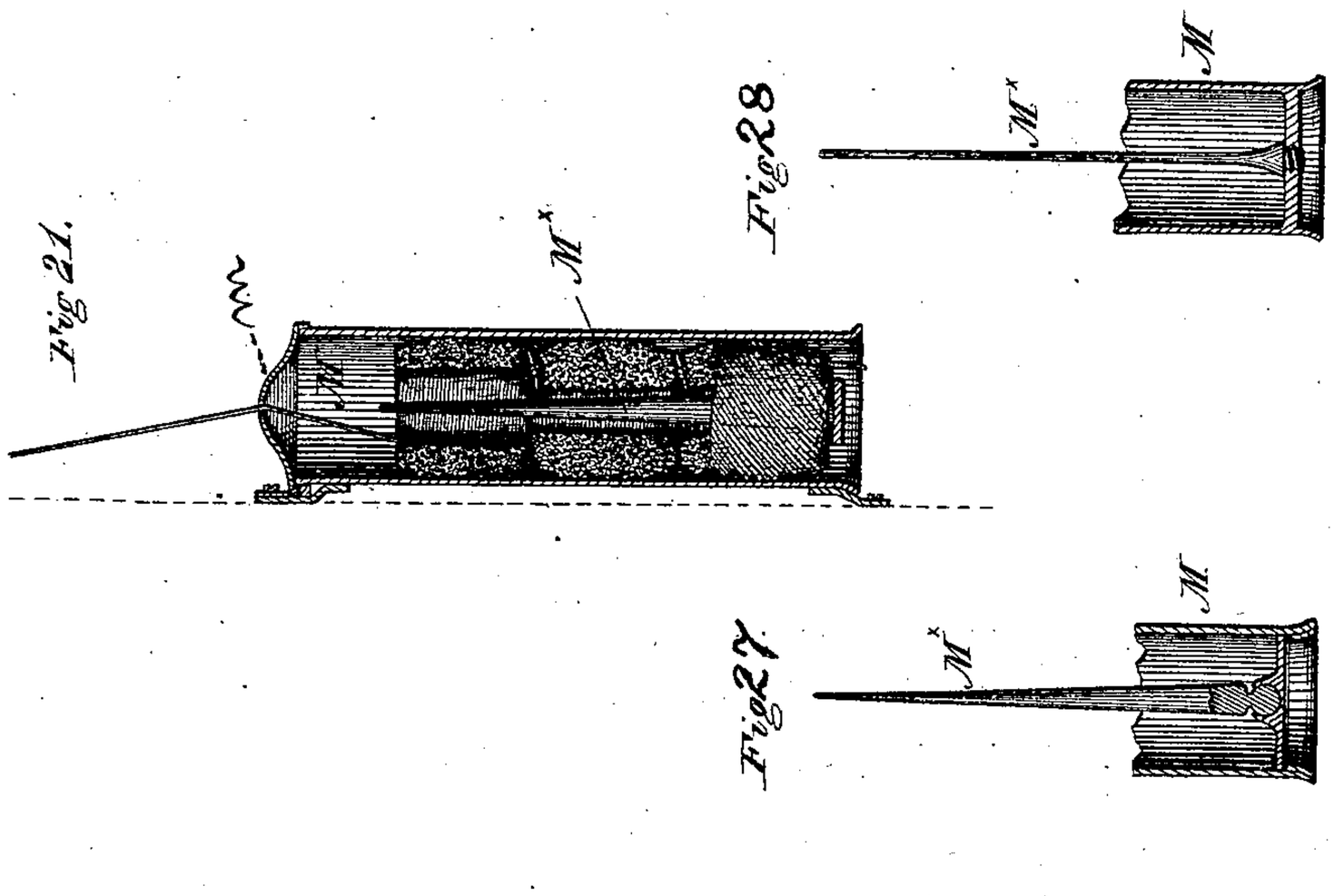

Fig 21.



Fig 28



Fig 27.

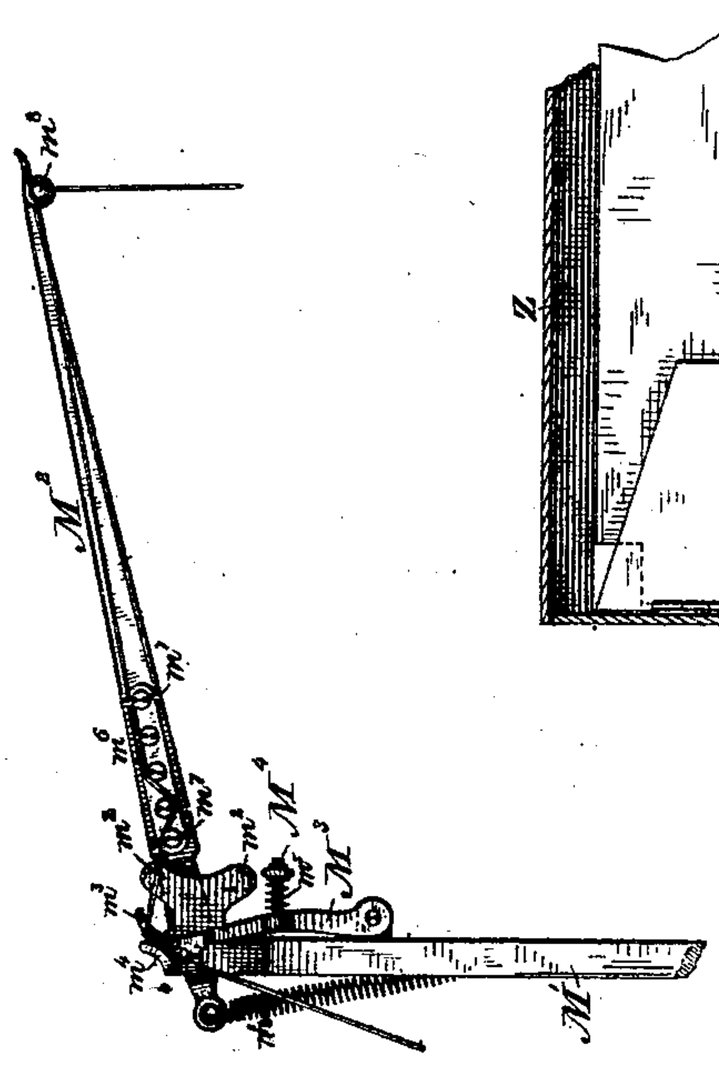

Fig. 20.

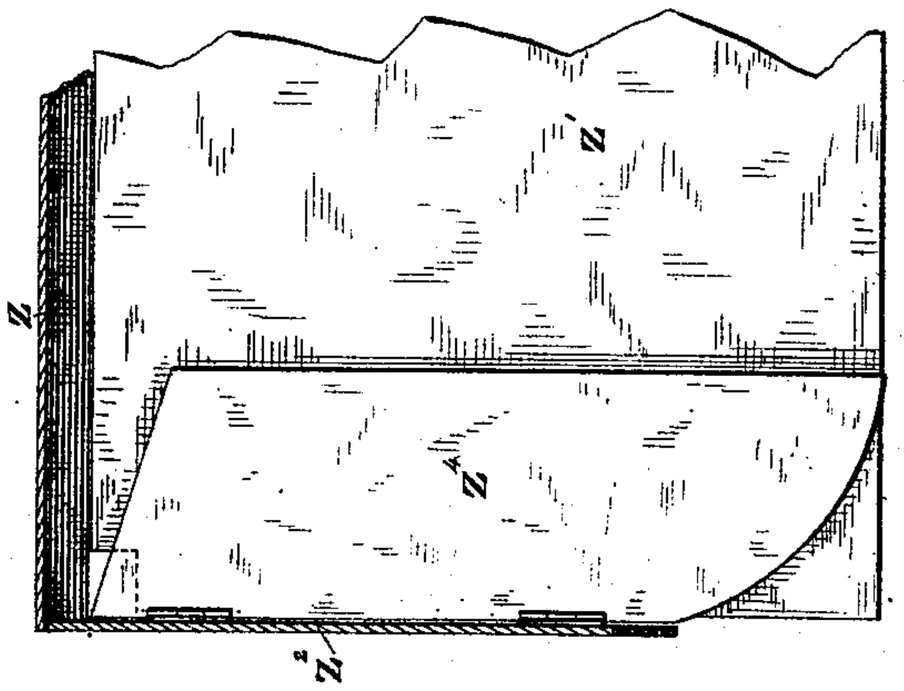

Fig. 22.

Witnesses:

Harry King

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Inventor.

Christopher C. Levalley

by H. A. Doubleday atty.

12 Sheets—Sheet 11.

# C. W. LEVALLEY.

## Grain-Binder.

No. 226,865. **Patented April 27, 1880.**

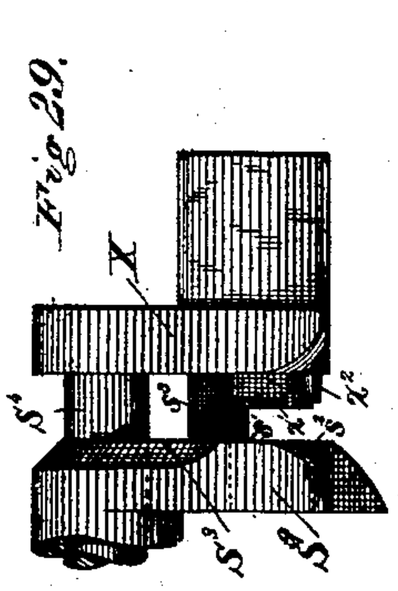


Fig. 23.




Fig. 24.

Witnesses

Harry King

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Christopher W. Levalley

by H. H. Doubleday atty.

12 Sheets—Sheet 12.

# C. W. LEVALLEY.

## Grain-Binder.

No. 226,865. Patented April 27, 1880.

Fig 31.

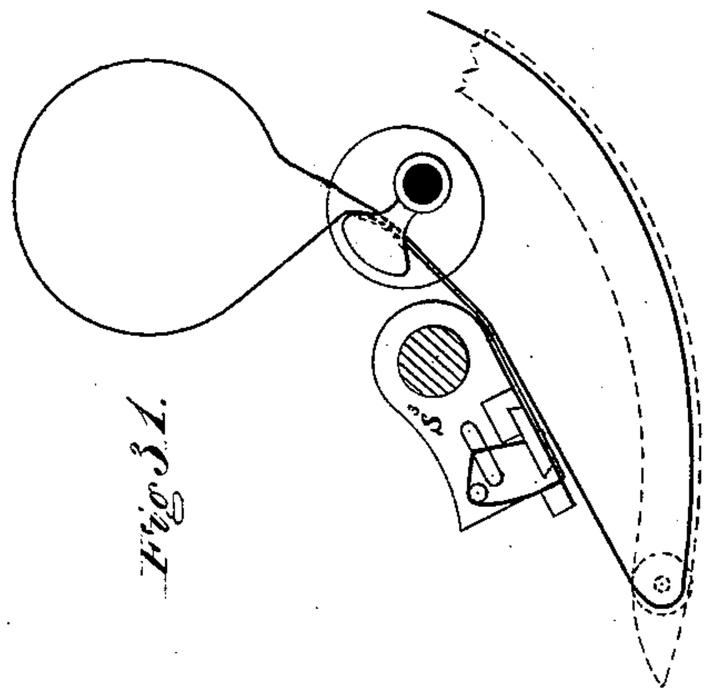


Fig 25.

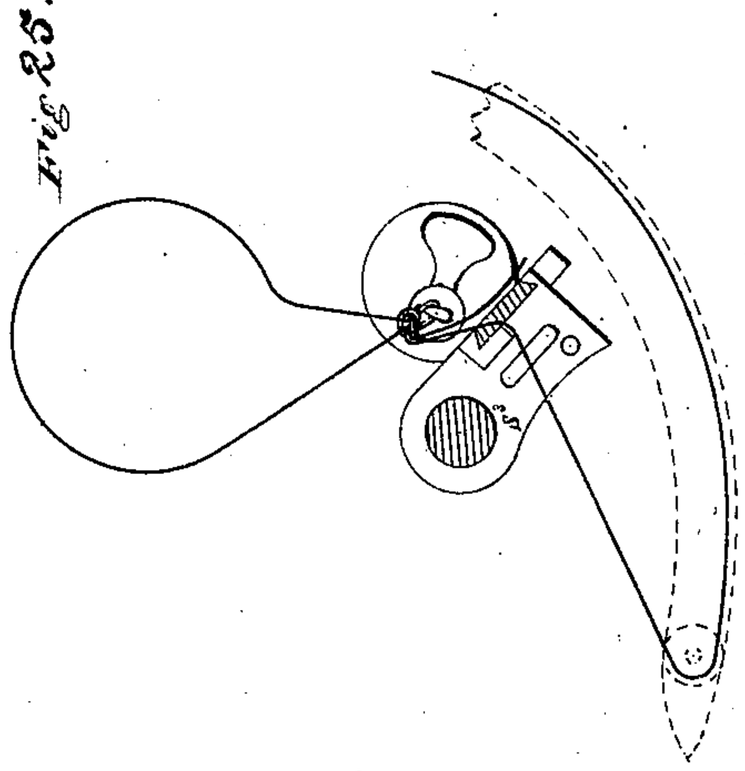


Fig 26.



Fig 32.

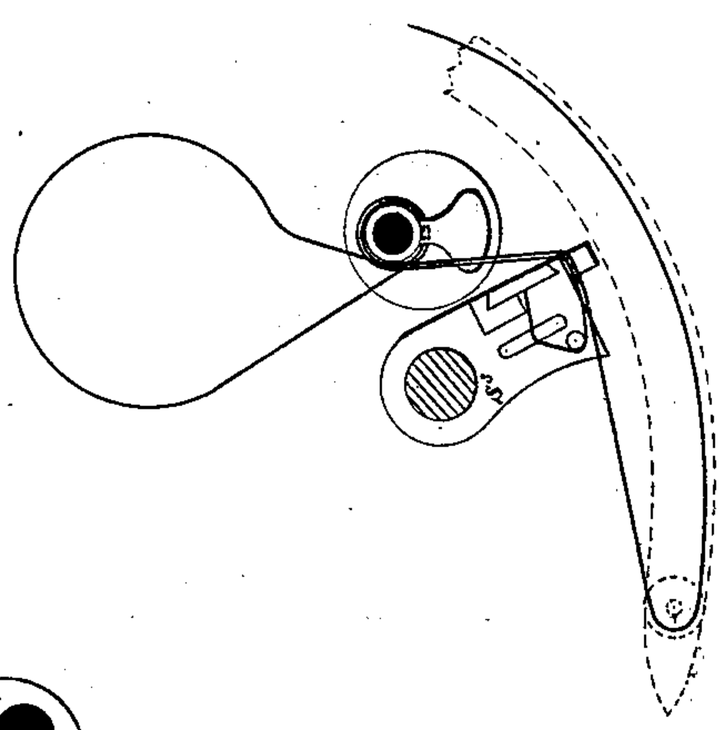


Fig 30.

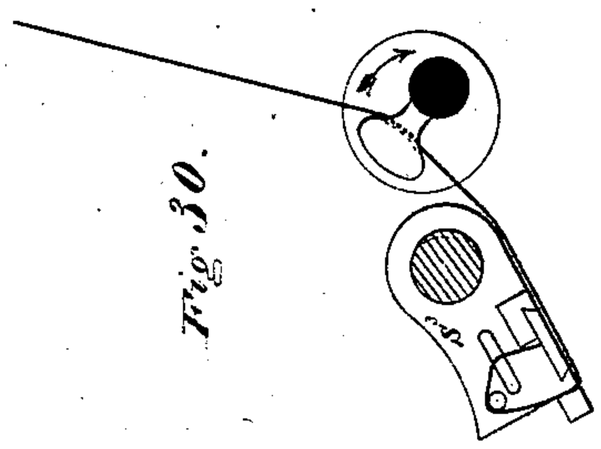
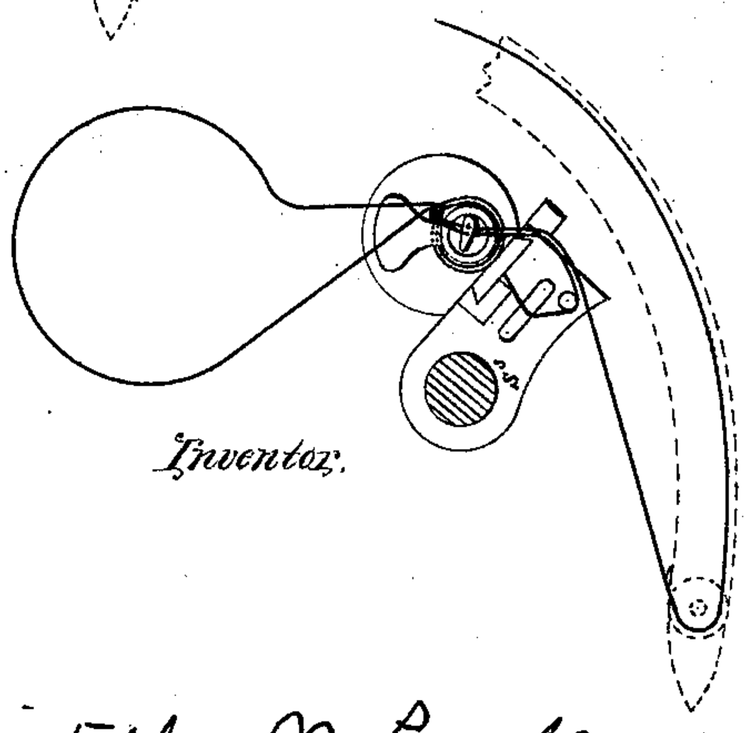


Fig 33.



Witnesses.

Harry King

H. H. Bliss

Inventor.

Christopher W. Levalley
by W. H. Doubleday atty

# UNITED STATES PATENT OFFICE.

CHRISTOPHER W. LEVALLEY, OF ST. PAUL, MINNESOTA.

## GRAIN-BINDER.

SPECIFICATION forming part of Letters Patent No. 226,865, dated April 27, 1880.

Application filed December 30, 1878.

*To all whom it may concern:*

Be it known that I, CHRISTOPHER W. LEVALLEY, of St. Paul, in the county of Ramsey and State of Minnesota, have invented certain new and useful Improvements in Grain-Binders; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

This invention relates to an improved machine for binding grain, and the various features of which it consists shall be hereinafter fully set forth.

Figure 1 is a real elevation of the machine. Fig. 2 is a front elevation. Fig. 3 is an end view of the devices that move the needle. Fig. 4 is a top-plan view of the looping and tying devices. Fig. 5 is an inside view of the main driving devices. Fig. 6 is a transverse section taken on line *w w*, Fig. 4. Fig. 7 is a sectional view on line *x x*, Fig. 4. Fig. 8 is an end view of the looping, tying, and griping devices. Fig. 9 is a top view of the knife-tripping lever detached. Fig. 10 is an enlarged view of the looping head and tube. Fig. 11 is a top view of the frame that supports part of the binding mechanism detached. Fig. 12 is a top view of the shifting-lever detached. Fig. 13 is a top view of the whole binder-frame. Fig. 14 is a detail view, showing the mode of attaching the binder-frame to the harvester. Fig. 15 is a section through the shaft of the cord-holder. Fig. 16 is a longitudinal section through the looping devices. Fig. 17 is a transverse section on line *y y*, Fig. 16. Fig. 18 is a bottom view of the cord-holder. Fig. 19 is a section on line *z z*, Fig. 18. Fig. 20 is a view of the tension devices and guide-arm detached. Fig. 21 is a vertical section of the cord-receptacle. Fig. 22 is a view of the bottom rear shield. Fig. 23 illustrates the various paths followed by the needle. Fig. 24 is an elevation of the needle-frame detached. Fig. 29 is a top view of the cord-holder enlarged. Figs. 30, 31, 32, 33, and 25 show the paths taken by the cord at successive stages in the operation of binding. Fig. 26 is a view of the band when tied and cut. Figs. 27 and 28 show modifications of the cord-spindle.

In the drawings, A represents the ground driving-wheel, which operates the various parts of the machine through appropriate gearing *a a' a²*. A' represents the main supporting-frame of the machine.

The grain-elevator frame is composed of the uprights $A^2$ $A^2$, secured to the frame A' A', the inclined supports $A^3$ $A^3$, and cross-pieces $A^4$ $A^4$. The cross-pieces $A^4$ $A^4$ are extended beyond the braces $A^3$ sufficiently to support the driver's plank or platform $A^5$, on which is mounted the seat $A^6$.

$a^3$ represents the lower elevator-roller, and $a^4$ the upper, operated in any ordinary or desired manner. $a^5$ $a^5$ are the wire rods ordinarily employed with elevators of this class.

A supplemental frame for the attachment of the binding mechanism is formed by extending the cross-pieces $A^4$ $A^4$, and by supporting said cross-pieces with uprights $A^7$, and by joining the two ends of the frame by a brace, $A^8$.

B B' are bracket-hooks attached to and extending upwardly from the frame $A^4$ $A^7$ $A^8$.

The binder-frame consists of the longitudinal bars C C' $C^2$, a rear bracket, $C^3$, a front bracket, $C^4$, and intermediate braces or supports, $C^5$ and $C^6$. (See Figs. 1, 2, 4, and 13.)

The upper bar, C, is mounted in the bracket-hooks B B' in such manner that the front bracket, $C^4$, shall be outside of the hook B', and the rear bracket, $C^3$, shall be inside of hook B. To permit this the bar C is extended a suitable distance beyond the bracket $C^3$, Fig. 13. The bracket pieces or frames $C^3$ $C^4$ $C^5$ $C^6$ are preferably made Y-shaped, and one of the legs of each is attached to each of the longitudinal bars C C' $C^2$.

*c* is a rack secured to bar C by means of collars, one of which is placed inside the hook B, the other outside, permitting the whole binder-frame to slide longitudinally the distance between said collars, as shown.

The lower part of the binder-frame is loosely attached to the main frame in such manner as to be held steady and firm, but at the same time permit a longitudinal shifting or adjustment of the binder relative to the main frame.

*c'* is a guide-piece projecting below the bar $C^3$ and behind the end sill or girt, $A^9$, of the

main frame. (See Figs. 1 and 2.) $c^3$ $c^3$ are friction-rollers mounted upon stud-shafts attached to the bar $C^2$.

D is a shaft mounted upon the rear end of the machine, its lower end having bearings in a socket in the hook-piece B, and its upper end passing through and rotating in a disk or circular head, D′, Figs. 1 and 13, which disk is notched upon its periphery, and is secured to the machine in any suitable manner, preferably by means of an arm (cast or made with the disk) which is bolted to the frame.

$D^2$ is a pinion keyed to shaft D, and meshing with rack *c*. *d* is a crank secured to the upper end of the shaft D, above disk D′, within convenient reach of the operator. By these devices the operator is enabled to instantly adjust the position of the binder relative to the elevator, so as to accommodate the mechanism to long or short grain, or to prevent the grain from being thrown (by the elevating of the machine at either end) so far to the front or to the rear as to not be properly surrounded by the cord.

*d′* represents a spring-lever and dog, wherewith the crank may be locked in any position upon the disk D′.

E, Figs. 1 and 12, is a short shaft mounted in an extension of the bracket-piece B, and at its forward end mounted in the bracket-frame $C^3$. E′, Figs. 1 and 12, is a sprocket-wheel mounted loosely upon this shaft, but adapted to engage with the shaft, and to rotate it by means of lugs or pins secured to the shaft and notches upon the hub of the sprocket-wheel which clutch said pins or lugs. Any ordinary or desired clutching device may be employed. The rear end of the hub of wheel E′ is grooved to receive the forked end of a shipping-lever, $E^2$. This lever is pivoted to the frame at $e'$, and at its inner end is connected by a link, $e^2$, to a bell-crank lever, which is actuated by the foot of the operator when he desires to throw the binding mechanism out of gear.

In order to keep the sprocket-wheel E′ engaged with the shaft E when they are not intentionally disengaged, a spring, $e^x$, may be employed in connection with the lever to force its outer end forward.

$e^3$ is a pin projecting through shaft E, and adapted to engage with a lug, $e^4$, on the end of the shipping-lever when the sprocket-wheel E is disengaged from its shaft, so as to lock the parts of the binding mechanism in the positions by them occupied at the instant of disengagement, and prevent their being thrown out of proper relation by the falling of the needle.

The necessity of this is well known to those practically acquainted with a grain-binding machine, as it has been found that the needle and needle mechanism will, by their weight, operate the binding mechanism after they are thrown out of gear.

$E^3$, Figs. 5 and 13, is a spur-pinion keyed to shaft E, meshing with and driving the spur-wheel F. It is secured to the shaft by means of a feather, so that the binder-frame is free to move back and forth without altering the position of pinion $E^3$ relative to the wheel F. This pinion is held in place against the wheel by means of a collar, $e^5$, extending from the bracket $C^3$, which prevents it from slipping in one direction, and by a flange, $e^6$, on its inner face, overlapping partially the inner face of wheel F, which prevents it from slipping in the other direction.

$E^4$ is a dog pivoted to bar C (see Fig. 13) or other suitable place, and engaging with the teeth of pinion $E^3$ in such manner as to prevent any backward rotation of the pinion, but to freely permit forward rotation, to prevent accident to the binding mechanism from a reversing of the movement of the pinion.

This spur-wheel F is the main driving-wheel of the binder. (See Figs. 1, 4, 5, and 6.) It is attached to the rear end of a shaft, F′, which is mounted at one end in the rear bracket, $C^3$, and at the other end in the bracket $C^6$. The wheel is furnished upon its outer periphery with a continuous gear meshing with pinion $E^3$, and is rotated continuously by said pinion when in operation. *f* is a segmental flange upon its inner face, between the ends of which flange there is placed a segmental gear, *f′*, of the same radius as the flange.

$F^2$ is a flange or rib on the inner face of the wheel, for a purpose to be set forth.

$F^3$ $F^4$ $F^5$ are cams or lugs on the inner face of the wheel for operating the various reciprocating parts of the binder. Of these the cam $F^3$ is nearest the center of the wheel, and the cam $F^5$ the nearest the periphery. The cam $F^4$ is at one end of the segmental flange or rib $F^2$.

I will now describe the devices by which the gavel or bundle of grain is formed and which hold the cord and pass it around the bundle.

The shaft F′ carries at its inner or forward end a mutilated gear-wheel, G, (see Fig. 2, full lines, and Fig. 4, dotted lines,) adapted to mesh with another similarly-mutilated wheel, G′, in such manner as to produce one revolution of wheel G′ at every revolution of the wheel G, and yet permit it to remain idle during part of said latter revolution. The wheel G′ is secured to and rotates a shaft, $G^2$, which is mounted at its forward end in and extends through the bracket $C^4$. $G^3$ (see Figs. 2 and 3) is a crank-arm upon the forward end of said shaft, having crank-pin $G^4$, provided with a friction-roller.

H is a bell-crank lever pivoted to the frame above the shaft $G^2$. The lower arm of the lever is provided with a peculiar curvilinear slot, $h^x$, in which the crank-pin $G^4$ reciprocates, assisted in its movements by the friction-roller. The upper arm of the bell-crank lever H is pivoted to a link, *h*, which, in turn, is pivoted to an arm, *h′*, of the needle-frame.

I is a bar or rod, pivoted to the crank-pin $G^4$, carrying at its upper end a cogged rack, *i*, which meshes with a spur-segment, I′.

$I^2$ is a guide-frame, (carrying a friction-roller,) adapted to hold the rack *i* firmly against the segment I′, so as to be in constant mesh therewith whatever be the position of said segment. This guide-frame is supported by an arm, *i′*, carrying at its lower end a sleeve or eye, $i^2$, through which the bar or rod I passes, and which permits the bar I and the arm *i′* to reciprocate relative to each other.

The segment I′ is adjustably secured to a shaft, K, which is mounted in a sleeve, K′, which is supported upon an oscillating frame as follows, reference being had to Figs. 1, 2, 3, and 24: $K^2$ is a bar mounted upon the shaft $G^2$ by means of eyes or sleeves *k k*. $K^3$ is an upright or bracket, carrying on its inner side the arm *h′*, to which the link *h* is pivoted, as above described, and at the top supporting the sleeve or shaft-support K′.

The parts K′, $K^2$, *k*, and $K^3$ are, in practice, cast in one piece of metal.

L is the binder-arm or needle, adjustably secured to the shaft K. Near its outer or point end it is provided with the usual eye and cord pulley, at *l*.

From an examination of the drawings it will be seen that one revolution of the main driving-wheel F will, through the wheels G G′ and crank-arm $G^3$, produce one forward-and-back oscillation of the frame K′ $K^2$ $K^3$ and one reciprocation of the rack *i* and segment I′, the whole operating to swing the needle forward and back once, and carry it down and up about shaft K once.

It will also be seen that, owing to the above-described peculiar conformation of wheels G and G′, the vibration of the needle-arm about shaft K is intermittent, and that the blank or mutilated parts of the said wheels are so related that the needle will be at rest—that is, will not be actuated by either the frame K′ $K^2$ $K^3$ or by the shaft K—when its point is at the end of its downward stroke, and, further, that the length of time the needle is at rest will depend upon the length of the blank or mutilated space on the periphery of said wheel G relative to its radius.

It will be further seen that when the needle is commencing its downward stroke the crank-pin $G^4$ is at the top of the slot $h^\times$, and will, on account of its shorter leverage on arm H, move the frame K′ $K^3$ through a greater arc than when the crank-pin $G^4$ is at the bottom of slot $h^\times$, and its leverage is longer—that is, the frame will carry the needle through a path when it is rising different from the path it (the needle) follows while descending, the path being clearly shown in Fig. 23.

This construction gives to the needle in its downstroke a dragging action upon the straw on the table, and in its upstroke causes it to withdraw smoothly without pushing or otherwise moving the straw.

Again, after the needle has entered the grain and is performing the first part of its outward movement, the crank-pin $G^4$ is moving in a slot substantially concentric to shaft $G^2$, and therefore the needle-frame must be at rest until the crank-pin moves in the lower part of slot $h^\times$, when it will force the frame outward, to assist the shaft K in causing the needle to gather the grain and form the bundle.

When the machine is in operation the cut grain is delivered over the elevator in a continuous stream upon the binder-platform, the straws being more or less tangled and interlaced. In order to separate the gavel completely from the loose straw I construct the needle of a peculiar shape, as shown in Fig. 1, having an angular projection or guard, L′, on the upper side, substantially L-shaped in its edge outline, the angle or bent part being so situated that when the needle is dragging forward the bundle it cuts off the stream of grain and forms a clear space behind the needle of a dimension suitable to prevent the straw from interfering with the gavel while it is being bound. This guard may be either a supplemental arm attached to the needle, as shown in Fig. 1, or it may be cast solid with the needle itself, if desired, either as a continuous web or as an open arm. Thus a single needle operates both to compress the gavel and as a "cut-off" or "separator."

In order to guide the needle accurately during its reciprocations I provide the machine with two guide-pieces, *l′* $l^2$, Fig. 13, extending a suitable distance above the grain table or platform and running from the chute-board Z to the outer edge of the binder-frame. These guide-pieces are held in proper relation to each other at their inner ends by means of a block or "spreader." If desired, they may be slightly "flared" at their upper ends, to insure that the needle shall always enter the guide; but I have found no difficulty with them when placed in vertical positions, as shown.

$L^3$, Figs. 4 and 13, is a V-shaped socket, secured to the bar C′ or other suitable part of the frame. When the point of the needle is at the lowest position—that is to say, when the tying devices are at work with the cord—the needle is held by the V-shaped socket from swaying or lateral movement, which might cause the cord to be jerked out of the desired position. (See Fig. 8.) This is a matter of great importance when the machine is being used upon rough or uneven ground.

A groove, $l^3$, (Fig. 4 in dotted lines,) is formed in the under face of the needle, to leave the cord free to move about the bundle when it is being drawn around it and to prevent any strain upon the cord.

M (see Figs. 2 and 21) represents the twine-holder, attached to the machine at any suitable point, preferably at the front end, upon a standard, M′.

Hitherto in the operation of grain-binders much difficulty has been experienced from the

fact that the twine must be wound upon spools or reels, which necessitates either the additional cost of the spools or a great amount of labor on the part of the operator to wind the cord on the spools.

Moreover, when the ordinary spools are used the twine is liable to be damaged by rain or other moisture, the effect of which is to soften the cord and render it unfit for use.

The twine-holder which I have devised and shown is preferably cylindrical in form, and it may be of any desired length, it being possible and practicable to make it of this form large enough to carry cord sufficient for a day's work. The bottom of the vessel is substantially open, there being one or more strips or cross-pieces to support the twine. It is made thus open at the bottom in order that any dirt that may enter can freely drop out, or straws or other foreign and undesired material.

The top of the holder is provided with a hinged cap or cover, *m*, through an aperture in which the cord passes out to the needle. In this receptacle several balls of cord are placed at once, the end on the outside of each ball being tied to the end on the inside of the ball next below. This enables the operator to employ twine as it is commercially prepared and sold in ordinary balls.

$M^{\times}$ is a rod or shaft passing through the balls and holding them together. It may, if desired, be cylindrical, and secured to the bottom cross-piece of the holder M by a ball-and-socket, Fig. 27, or other universal joint; or it may be made of some flexible material, Fig. 28, so that the shaft shall not be rigid, but have a flexible play at the top. When this rod is employed the cord unwinds evenly and smoothly from the ball without any tendency to form knots, or "kinks," or "wads," as will be readily understood without further explanation.

I have also shown and used for this purpose a loose tapering shaft with its larger and heavier end at the bottom.

The cord is passed from the twine-holder to the needle L through the rear end of a guide-arm, $M^2$, pivoted to the upright M′. (See Figs. 1, 2, and 20.) Requisite flexibility of movement is secured to the guide-arm by means of the spring *m′*.

$m^2$ $m^2$ are stops on the upper end of the upright M′ to limit the movements of the guide-arm $M^2$.

$M^3$ is a tension-arm pivoted to a lug or ear projecting from the inner side of the standard M′. It carries at its upper end a curved plate, $m^3$, provided with one or more apertures, through which passes the cord. The upper end of the standard M′ carries a fixed clamping-plate, $m^4$, and the cord passes between this and the movable plate $m^3$.

$M^4$ is a thumb-screw passing through arm $M^3$, engaging with a screw-threaded socket in standard M′. $m^5$ is a tension-spring bearing against the pivoted arm $M^2$ and the head of screw $M^4$. The operation of these last-described devices in adjusting the tension of the cord will be readily understood.

$m^6$ $m^6$ are pins projecting from the inner side of the guide-arm M′, which enables the operator to instantly increase or diminish the tension on the cord by passing it around or removing it from one or more of said pins.

At $m^7$ $m^7$ are shown cross-pins, passing through the pins $m^6$, to hold the cord securely thereon. These pins $m^6$ and $m^7$ operate also to straighten the twine if any kinks or twists should occur therein, and deliver it smoothly to the needle.

I will now describe the devices for grasping, looping, tying, and cutting the twine after it has been placed around the bundle. The frame upon which these devices are supported and mounted consists of a bed-plate, N, a cross-piece, N′, and standards $N^2$ $N^3$, (preferably cast in one piece,) attached at the front end to bracket $C^5$ and at the rear end to bracket $C^3$, Figs. 4 and 11.

Q′ R′ S′ are bent levers (shown in Figs. 4 and 6) for operating the reciprocating parts of the binding mechanism. They are pivoted to a rod or shaft, $R^4$, mounted at the rear end of the frame N N′.

The bent lever S′ is composed of the cam-arm T, pivoted to rod $R^4$, and the rocking bar T′, carrying at its outer end a vibrating arm, $T^2$, which is also pivoted to the rod $R^4$, the whole being so placed that the arm T shall be inside and the arm $T^2$ outside the operative parts of the tying and cutting mechanism.

The bent lever R′ is formed with a horizontal rocking bar, *u*, a leg, U′, pivoted on rod $R^4$, (outside the arm T,) a leg, $U^2$, pivoted to the inner end of rod $R^4$, a cam-arm, $U^3$, operated by cam $F^4$ on wheel F, and a vibrating arm, $u^4$, which operates the hooked tying-rod.

The lever Q′ is formed with a vibrating part, V, pivoted to rod $R^4$, a bent cam-arm, V′, operated by cam $F^3$ on wheel F, and a lug, $v^2$, by which it is connected with the looping-tube.

*v* is a pin projecting from the side of arm V′ beneath the arm $U^3$.

The cam-arms of these bent levers Q′ R′ S′ are furnished with friction-rollers at the points where they engage with their respective cams.

*y′* is a set-screw inserted in the arm $u^4$ at the point where it bears against the parts which it reciprocates, so that in case of wear in any of said reciprocated parts the point of contact may be adjusted to throw the reciprocating parts the necessary distance.

From an examination of the drawings it will be seen that while the drive-wheel F is performing that part of its revolution which occurs when the needle is rising and falling the ends of the arms T and $U^3$ are in the open space between the rib $F^2$ and flange *f* on wheel F, and at the same time the end of cam-arm V′ is on the inside of rib $F^2$. (See Figs. 5 and 6.) When wheel F has been turned sufficiently far, the innermost cam, $F^3$, will first engage with arm V′, throwing it up and pushing the

arm or lug $v^2$ back. The pin $v$ at the same time engages with arm $U^3$, so as to lift said arm $U^3$ high enough to engage with cam $F^4$. At the instant that the arm V′ is disengaged from cam $F^3$ the arm $U^3$ begins to engage with cam $F^4$ and to throw back arm $u^4$, the end of arm V′ being so much lower than the end of arm $U^3$ that said arm V′ will pass under cam $F^4$ and rib $F^2$. (See Figs. 5 and 6.)

As soon as arm $U^3$ is disengaged from cam $F^4$ it is thrown down, and at the same time arm T begins to be raised by cam $F^5$ and to throw forward the arm $T^2$. (See Fig. 6.) After the arm T disengages from cam $F^5$ it falls down again into the space between the flanges $f$ and $F^2$. To insure its complete return I place a spring, $t$, Fig. 6, between the rocking bar T′ and the bracket-frame $C^3$, bearing against the bar T′, so that uneven ground or other cause shall not accidentally cause the arm T to swing up.

Referring to Figs. 1, 4, 5, 6, 7, O is a shaft mounted in the frame, carrying at its forward end a perfect spur-pinion, O′, and at its rear end a mutilated wheel, $O^2$, having cogs of the same number as those in the segment $f'$ on wheel F, and having also a blank space on its periphery adapted to ride upon the flange $f$. Thus the wheel $O^2$ and shaft O receive one complete revolution at each revolution of the drive-wheel F.

P, Figs. 4, 7, and 16, is another shaft mounted in the standards $N^2$ $N^3$, and parallel to shaft O. It is rotated by means of a pinion, P′, meshing with the pinion O′, the pinion P′ having one-half the number of teeth that pinion O′ has, and therefore giving its shaft P two revolutions to every revolution of the wheel F.

Shaft P extends a short distance beyond bracket $N^2$, and carries an enlarged head, $p$. (See Figs. 4, 8, 10, and 16.)

$p'$ is a hook projecting eccentrically from head $p$. The free end of the hook is made concave, as shown.

Shaft P is hollow, and through it passes another hollow shaft or tube, Q, which is arranged to pass through the head $p$ eccentrically. (See Figs. 8 and 10.) When this tube or shaft Q projects through the head its outer face fits into the concave end of hook $p'$, and together they form a tight eye, as shown in Fig. 16, for holding the cord, as will be explained. At its rear end this shaft Q carries a collar or flange, $q$, and a cage or hollow cylinder, $q'$. Between the flange and cage a saddle, $q^2$, is secured to the shaft Q. This saddle carries an arm, $q^3$, which is bent around so as to be substantially parallel with shafts Q and P. The arm $q^3$ is attached to the lever-arm $v^2$.

It will be seen that by moving the rear end of the bent lever Q′ up and down the tube Q will be reciprocated in shaft P.

The saddle $q^2$ carries a rod, $q^4$, which crosses the plane of the needle-path, and which at its forward end is hooked or bent into a peculiar shape, as shown at $q^6$, to assist in guiding the cord into the hook $p'$. This guide-rod $q^4$ will, of course, be reciprocated with the tube Q.

R is a small inner rod reciprocating through tube Q. It is provided at its forward end with a hook, $r$, adapted to seize the cord and to pull it through the loop formed by hook $p'$ and tube Q. This rod extends back loosely through the collar $q$, the saddle $q^2$, and cage $q'$, and carries at its rear end an enlarged head, $r'$, to which is attached a dog, $r^2$, on the side opposite to the hook $r$, for a purpose to be specified. The head $r'$ rests against the vibrating arm $u^4$ of lever R′.

It will be seen that as the rear end of crank-arm R′ is raised or lowered the hook-rod R is reciprocated in tube Q.

$R^2$ is a coiled spring around the rod R, bearing against the head $r'$ and the cage $q'$. $r^3$ is a collar secured to the rod R within the cage $q'$, so that the rod can move a short distance back and forth independently of the tube Q, while the friction of collar $r^3$ against the front end of the cage $q'$ (when they are held in contact by spring $R^2$) will cause the rod R to revolve. $n$ $n'$ are stop-lugs on the frame N N′, one on each side of rod R, projecting up high enough to engage with the dog $r^2$. Lug $n$ prevents the hook $r$ from rotating after it grasps the cord, and lug $n'$ stops the hook in proper position to let the knot slip off readily.

S is a short hollow shaft supported in standard $N^2$ of frame N, and carrying on each side of the standard a collar or head, (shown at $S^2$ $S^3$,) which prevent the shaft from moving longitudinally. (See Figs. 4 and 18.) The head $S^3$ carries a plate, $S^9$, which is provided on its under side with a groove, $s$, preferably dove-tailed.

$s'$ is a slot through the plate $S^9$, and $s^2$ is a pin-hole formed in its inner face. This plate is one of the clamping-jaws that hold the loose end of the cord, and it is provided with an arm, $s^3$, projecting forward to guide the other clamping-jaw, to be described.

$S^4$ is a rock-shaft mounted in standard $N^2$, and extending through the hollow shaft S. It rotates the shaft S with it by means of the arm $s^3$, which permits it to reciprocate at proper time therein. $S^5$, Figs. 7 and 4, is a crank-arm secured to shaft $S^4$ by means of a feather, which preserves a constant engagement between them, but permits the shaft to reciprocate through the crank. $S^6$ is a pitman, pivoted at one end to crank $S^5$, and at the other to the pinion O′. These last-described parts are so related as to produce at every revolution of drive-wheel F an oscillation of shaft $S^4$, and with it the cord-holder, through an arc of about one hundred and twenty degrees.

The shaft $S^4$ is thrown forward by means of a bar, W, (see Fig. 6,) vibrating with the bent lever S′. It is thrown back by means of a coiled spring, $S^7$, bearing against the collar $S^2$ and a collar, $S^8$, rigidly attached to the shaft.

$y^2$ is a set-screw inserted in bar W, and operating analogously to the above-described screw $y'$.

At its forward end shaft $S^4$ carries a clamp-

ing-plate, X, Figs. 4, 9, 18, and 29, bearing against collar $S^3$, and to which the knife-holder is secured. There is a dovetailed groove on the under face, in one side of which the bar $s^3$ slides, and in the other side of which the knife is set, Fig. 18. When the two jaws or clamping-plates are together, the cutting-edge of the knife projects under the fixed plate $S^9$, against a pin, $x$. This pin is inserted in the under side of the fixed jaw, so as to enable the instant setting of the knife at the proper point without the necessity of experimental adjustment. The knife shears against the edge of the fixed plate to sever the cord.

$x'$ is a tenon projecting from the face of the moving jaw X, and is adapted to fit into the slot or mortise $s'$ in the fixed plate. This tenon grasps the cord after it has been cut, tending to push it into the slot or mortise in the fixed jaw. The end of this tenon and the edge of the knife should be so adjusted that on the one hand the cord shall not be cut so soon that the tenon cannot grasp it, and on the other that the tenon shall not bear against the tight cord too soon to permit the knife to operate.

$x^2$ is a pin projecting from the face of the movable jaw, fitting into the hole $s^2$ in the fixed jaw, and adapted to assist the tenon $x'$ in holding the cord which passes over this pin when the jaws are closed, Fig. 30. In order to prevent any gumming or other clogging of the faces of the clamping-jaws, I bevel the top edges, as shown in Figs. 18 and 29, so as to leave as little surface of contact as possible above the cord. The lower part of the faces of the jaws will be self-cleaning from the movement of the cord.

The bar W, which, as above described, pushes forward the shaft $S^4$, is pivoted to the bent lever S′, and has a horizontal heavily-weighted arm, W′, Figs. 6 and 9. This arm W is pivoted thus so that it can be disengaged from shaft $S^4$ when the machine is running empty, or at any other desired time. It is disengaged by the following devices: Referring to Figs. 4, 6, 7, 8, 9, $W^2$ is a tripping-lever pivoted to the under side of frame N N′. The front end is bent so as to form a crank-arm, $W^4$, the forward end of which lies across the plane of the needle-path, and, when the needle is down, just above its point. At its rear end it is bent to form another crank-arm, $W^5$, which engages with the weighted arm W′, and elevates it when the opposite end, $W^4$, is elevated. Elevating the arm W′ disengages bar W from shaft $S^4$, as will be readily seen in Fig. 9. In order to lock the bar in its inclined position I pivot a latch, $w$, to the vibrating bar $T^2$, which engages with a pin, $w'$, on bar W, to hold the bar away from the shaft $S^4$. At the proper time the latch is automatically raised by a pin, $y$. (See Figs. 6 and 4.) This pin is inserted into the frame N, and is inclined so that as the cam $F^5$ lifts arm T and throws arm $T^2$ forward the latch, which projects across the pin $y$, slides upon it upward until it is disengaged from the pin $w'$, whereupon the bar W is brought again into line with shaft $S^4$ by the weighted arm W′. Instead of a weight, a spring may be used to return the bar to a vertical position.

Z represents the chute-board for delivering the grain to the binder-platform. It is preferably hinged to the elevator-frame by means of a bar, $z$, and brackets $z'$ $z^2$.

Z′ represents the table or platform of the binder. $Z^2$ $Z^3$ are vertical shields hinged to the top of the elevator-frame, one at the front and the other at the rear. $z^3$ $z^4$ are slotted brackets, through which project screw-rods carrying set-screws, that bear against the brackets $z^3$ $z^4$, the whole adapted to adjust and hold the outer ends of the shields to the proper points for delivering the grain to the binding mechanism with precision.

$Z^4$, Fig. 22, represents a bottom piece hinged to the rear shield, for the purpose of perfectly covering the working parts of the binder when it is shifted forward.

$l^4$, Fig. 13, represents a shield secured to the upper edge of the rear guide-piece, $l'$, for the purpose of throwing or pushing any loose wisps or blades of straw away from the knotting mechanism and to the outside of the hook-bar $q^4$ $q^6$, which bar, when it moves forward, carries said stray material entirely away from the operative parts of the binder.

Having thus described the construction and operation of the various parts of the machine, I will now proceed to set forth their relative operations and the relative times of their movements.

When the parts are in the position shown in Figs. 1 and 6, the tying mechanism is at rest, because the blank part of wheel $O^2$ is riding on the flange $f$ of wheel F, and the cam-arms of the bent levers Q′ R′ S′ are respectively disengaged from the cams $F^3$, $F^4$, and $F^5$. At the same time wheels G and G′ are meshing together to operate the needle and needle-frame. The needle-frame is now at its outermost position, because crank-pin $G^4$ is at the top of slot $h^\times$, and the needle is at its highest point, because the rack $i$ is at the end of its upward throw. While in this position the cord may be passed through the eye of the needle, and if the free end of the cord is then held in the hand of the operator or secured at any convenient point the machine will thread itself, as will be seen.

Supposing the drive-wheel F to be rotated in the direction of the arrow, it will be seen that the crank-pin $G^4$ and lever H will be forced outward, throwing the needle-frame inward, as shown in Fig. 2, and at the same time rack $i$ begins to descend, carrying the needle down about shaft K. The frame is now, as shown in Fig. 2, at its innermost position, having thrown the needle forward so that the point shall descend close to the chute-board, and the frame will be at rest until the needle-point has fairly passed through the platform, because, as will be seen in Fig. 2,

the crank-pin $G^4$ is about to enter the curved part of slot $h^\times$, and while moving in said curved part of the slot it will not move the lever H.

Further revolution of drive-wheel F will carry the needle down until the point has entered the socket $L^3$, as shown in Fig. 8. At the time the point is secure in the socket the wheels G and G′ pass out of mesh, and their blank spaces begin to ride upon each other, holding the needle at rest, the crank-pin $G^4$ now being at the bottom of slot $h^\times$ and the rack $i$ at the end of its downward throw, as shown in Fig. 3, in which position they will remain until the wheels G and G′ again mesh. The path of the cord is now, as shown in Fig. 8 in full lines, from the guide-arm $M^2$ down along a groove in the back of the needle, then up through the eye of the needle, then back under the clamping-plates $S^9$ X, thence up, through hook $p'$, to the point where the free end is held.

At the time the wheels G and G′ disengage, the various parts of the looping and tying mechanism begin their respective movements, which will be shortly described; but I will set forth now only the movements necessary for the machine to thread itself.

When the drive-wheel has turned sufficiently to engage cam $F^5$ with arm T of bent lever S′, said arm is raised and the bar W is thrown forward, sliding the shaft $S^4$ through shaft S and opening the jaws of the cord-holder $S^9$ X, which has been swinging inward, so as to permit the cord between the needle-eye and the hook $p'$ to pass between the jaws and across the path of the knife-edge. When arm T is released from cam $F^5$ the spring $S^7$ forces shaft $S^4$ back, causing the knife to cut loose the outer end of the cord and the jaws to grasp the newly-cut end. The machine has now threaded itself and is ready to operate upon a gavel. After the cord has been grasped by the cord-holder in the manner described the looping and tying mechanism is thrown out of operation, and wheels G and G′ come into mesh. Further revolution of the drive-wheel forces inward the lever H and the rack $i$ upward, the first resulting in an outward movement of frame K′ $K^2$, the second in a simultaneous rising of the needle until crank-pin $G^4$ gets to the top of slot $h^\times$, when the parts are again in the position shown in Fig. 1. The path of the cord now taken is shown in Figs. 1 and 30.

From an examination of Fig. 23 (wherein the various positions and paths of the needle and its pivot or shaft are clearly shown) it will be seen that when the needle is descending its pivot is thrown forward in order to compel the needle to traverse the whole platform during its downward movement, but that when it is ascending its pivot is thrown backward, in order that it shall withdraw from the platform without any traversing movement. The needle now descends again into the straw, this time inclosing a bundle, which it surrounds with cord, (being assisted in the process of separation by the separator L′,) and carries it outward until its point again enters the socket $L^3$, where, as before described, it is left at rest by the disengagement of wheels G and G′. As the gavel is swept outward both ends of the loop of cord (the holder end and the needle end) are pushed together into the hook $p'$, as shown in Fig. 31.

At the instant that the needle-point enters socket $L^3$ and wheels G and G′ disengage, cam $F^3$ on wheel F begins to engage with arm V′ of bent lever Q′, raises it up, throws arm $V^2$ forward, and slides tube Q through head $p$, said tube forming, with hook $p'$, a tight eye around the strands of the cord. As soon as the cord is thus inclosed the pinion $O^2$ begins to mesh with segment $f'$, and, through pinions O′ P′, to rotate shaft P, which shaft carries with it hook $p'$ and tube Q, the teeth on the pinion being related, as before described, to produce two revolutions of the hook and tube at every revolution of pinion $O^2$. One revolution of the tube and hook forms a complete loop in the strands of the cord. (See Fig. 32.)

At the time that pinion O′ begins to rotate the tube and hook it also begins, through crank $S^5$ and pitman $S^6$, (see Figs. 4 and 7,) to swing the lower ends of the cord-holding jaws forward, thereby supplying the slack cord necessary to tie the knot without increasing the strain on the cord around the bundle, Figs. 32, 33, and 25.

As soon as the loop is formed the cam $F^4$ begins to engage with arm $U^3$, raising it up and pushing forward rod R until the hook $r$ projects through the inner end of tube Q. The hook-rod is rotated by friction with tube Q until the dog $r^2$ strikes the lug $n$, which holds the hook $r$ toward the two strands of cord it is to grasp—that is to say, toward the cord-holder and needle-eye. (Shown in Fig. 16.) Immediately after the hook $p'$ and tube Q have made their first revolution the two strands of the cord outside of the loop that has been formed slip from the outside of hook $p'$ (made sloping and smooth) into hook $r$, the cord-holder $S^9$ X swinging at the same time toward the knotting mechanism to guide the strands into said hook. (See Fig. 33.) At the same instant arm $U^3$ is disengaged from the cam $F^4$, and the spring $R^2$ forces back the hook $r$, dragging in with it the ends of the cord through the loop around the tube. As the rod R moves back it draws with it, by means of collar $r^3$, the tube Q, which, as it passes through head $p$, slips the loop from the end of the tube, which immediately tightens around the strands carried by hook $r$. Just before cam $F^4$ permits hook $r$ and tube Q to move back, the cam $F^5$ begins to engage with arm T and to throw forward bar W. This pushes forward shaft $S^4$ and opens the cord-holder, permitting the cut end of the cord to pass out with the gavel, and the strand that runs through the needle-eye then slips between the jaws across the path of the knife, as shown in Fig. 25.

The only step now remaining is to cut the cord, which is done, when the cam $F^5$ disengages from arm T, and the spring $S^7$ forces

the shaft $S^4$ back and pulls the knife along the bottom edge of plate $S^9$. After it is thus cut the cord, before it can spring out from between the jaws, is caught by the tenon $x'$ and clamped tightly between the jaws, passing over pin $x^2$.

As pinion $O^2$ has not yet quite passed out of mesh with the segment $f'$, it causes a part of a revolution of shafts P and $S^4$, the latter swinging the jaws $S^9$ and X out to the position shown in Figs. 4 and 30, and the former turning hook $p'$ so as to open inwardly and downwardly, as shown in Fig. 8, and also turning hook $r$ so that its point shall be up to readily permit the knot to slip off. The dog $r^2$ strikes against the lug $n'$, and insures that it shall stop with the point up. The wheel F has now revolved far enough to pass out of mesh with pinion $O^2$, thus leaving the tying mechanism at rest, and the wheels G and G′ come into mesh to again withdraw and elevate the needle. The complete bundle now drops from the table.

Inasmuch as the clamping-jaws swing inward to feed to the knotter the slack cord between the knotter and the jaws, and inasmuch as they let the cut end (which they have been holding) escape close up to the bundle, it will be seen that there can be no waste cord whatever, the complete knot being shown in Fig. 26.

If the machine should at any time run empty—that is, if the needle should at any time descend without a gavel—the clamping-jaws will not open to let the cut end of the cord escape, but will operate as follows: From an examination of Figs. 8 and 30 of the drawings it will be seen that the cord is held by the clamping-jaws so that it shall run out from their upper outside edge, and also that when the needle is entirely down, and when no gavel is being held, the line of the cord is around on the inner and under side of the needle, then up through the eye to the top of the clamping-jaws, (see Fig. 8, dotted lines,) and, further, that the crank-arm $W^4$ of the lever $W^2$ lies across the needle-path outside of the clamping-jaws, and hence that when the needle-eye carries the tightly-stretched cord out beyond the said lever-arm $W^4$, it (the cord) will raise the arm, as shown in dotted lines, Fig. 8, and, by the mechanism before described, throw the bar W out of the line of shaft $S^4$, so that during this revolution of wheel F the shaft will not be forced forward to open the clamping-jaws, but will only be swung forward and back by the crank $S^5$ and pitman $S^6$.

The swinging inward of the jaws lowers the line of the cord, so that it no longer holds up the tripping-lever, but the latch $w$ now holds the bar W away from the shaft $S^4$, and will retain it out of line until the bar W is thrown forward by cam $F^5$, when the pin $y$ will lift the latch and let the bar W fall into its vertical line, ready to push the shaft $S^4$ at the next operation. The needle rises again, the same end of the cord being still held by the jaws. But, on the other hand, when a gavel is being operated on, and the needle is down, it will be seen from Fig. 31 that the line of the cord is from the upper edge of the jaws down under the holder, up through the hook $p'$, around the bundle, down through the hook $p'$ again, thence under the cord-holder to the eye of the needle, and that neither of the strands of cord is high enough to lift the arm W away from shaft $S^4$, and hence that the cord will be cut at this operation, and a new end griped by the jaws.

The cord in full lines in Fig. 8 shows the path taken when the machine is threading itself. The needle has just come down, and the cord-holder is about to swing inward, open, cut, and grasp the cord. The dotted cord in the same figure shows the path taken after the machine is threaded, but when the needle has come down without a gavel, the cord lifting up arm $W^4$, and therefore preventing the opening of the cord-holder. When the needle has formed a gavel the thread takes the path shown in Fig. 31.

From the above description it will be seen that the binding-cord itself forms one member in the combination of parts which trip the weighted lever W′ to throw out of action the parts which open the jaw of the twine-holder and release the cut end of the twine, and that the position of that portion of the cord which engages with the arm $W^4$ of the lever $W^2$ is determined by the presence or absence of a gavel, so that the machine operates automatically to cut the binding-thread whenever the cord has been passed around a gavel, but retains a firm gripe upon the cut end of the cord when the machine is running empty—that is, when there is no gavel in proper position for binding. For this reason it may be properly said that the cutting and griping devices are actuated to release the cut end of the twine, and cut and sever the twine by reason of the engagement of the gavel with a portion of the mechanism which regulates automatically the operation of these parts.

By an examination of Figs. 10, 16, and 30 to 33, inclusive, and 25, it will be seen that the end of tube Q, which receives the loop of twine, is placed wholly upon one side of the center of the shaft P, and rotates about said center in the direction indicated by the arrow in Fig. 30; and it will be further understood by an examination of Figs. 30 to 33, inclusive, and 25, that as the tube Q is being thus rotated around the center of the shaft P it forms the loop almost exclusively from that portion of the cord which lies between the center of the shaft P and the cord-holder without materially increasing the tension of the cord around the bundle, this forming of the loop around said tube without increasing the tension upon the bundle being due to the swinging of the tube toward the cord-holder in an eccentric path, together with a corresponding movement of the twine-holder toward the tube, the position of the cord during the operation of tying being plainly shown in Figs. 30 to 33 and 25, the result being that I am enabled to tie a satisfac-

tory knot without undue strain upon any portion of the twine.

It is apparent that some of the advantages which are derived from the swinging of the looper toward the cord-holder in an eccentric path result from this movement, independently of the twine-holder being advanced toward the looper by a positive movement, and it is also apparent that the advance of the twine-holder toward the looper produces desirable results, independently of the swinging of the looper toward the twine-holder in an eccentric path. Hence I do not wish to be limited to the combination of these movements as shown, but reserve the right to use either of them independently of the other.

The guide-arm $M^2$ is bent at its outer or rear end, as shown at $m^8$, to form a hook or eye, through which the cord passes to the needle. This eye is open at the top, and permits the instant insertion of the cord when both ends are fastened at other points.

The saddle $q^2$ is preferably attached to the bent lever, which operates it by means of an eye-screw, $q^5$, that permits an adjustment of the parts which it reciprocates in a manner similar to that above described of the screw $y'$ and $y^2$.

I do not in this patent claim any features of construction except those which are specifically set forth in the claims, as I have filed another application as a division of this case, and reserve to myself the right to claim in such division already filed all patentable features shown herein but not specifically covered by the claims herein.

What I claim is—

1. The combination, with the binder-frame formed with the brackets $C^3$ $C^4$ and the inner bar, C, projecting beyond one of the brackets, of the main frame and hooks B B′ and the rack *c*, constructed and arranged substantially as set forth and shown, so that the front bracket shall be outside hook B′, and the rear bracket shall be inside of the hook B.

2. In a grain-binder, the combination of an oscillating frame, a needle pivoted to said frame, and mechanism which throws the needle-pivot through a greater arc while the needle is descending than while it is rising, substantially as set forth.

3. In a grain-binder, a crank-arm, $G^3$, and the needle-frame, in combination with the bell-crank lever H, arranged substantially as shown, whereby the crank-pin engages with the lever nearer the lever's pivot while the needle is descending than when it is rising, substantially as set forth.

4. The combination of the crank-arm $G^3$, bell-crank lever H, link *h*, and the needle-frame, substantially as set forth.

5. In a grain-binder, the combination, with the segment I′, the arm and rack I *i*, and crank-arm $G^3$, of the frame $I^2$ and arm *i′*, substantially as set forth.

6. As a means for supplying band to the needle of a grain-binder, a cord formed into convolutions, from which, when in operation, the inner convolutions are first delivered to the needle, in combination with a shaft or spindle which is free at the end from which the cord passes as it is unwinding, substantially as set forth.

7. In a grain-binder, a shaft arranged within the binding-cord, said shaft being free to vibrate at the end from which the cord is delivered, substantially as set forth.

8. In a grain-binder, a shaft or spindle which supports the cord and is secured at one end by a flexible joint, substantially as set forth.

9. In a grain-binder, the combination, with the spindle $M^\times$ and inclosing-cylinder M, of the cap or cover provided with a central opening through which the cord is delivered, substantially as set forth.

10. In a grain-binder, the combination, with the support M′, provided with the stops $m^2$ $m^2$, of a pivoted arm, $M^2$, and spring *m′*, substantially as set forth.

11. In a grain-binder, the combination of the support M′, provided with the stops $m^2$ $m^2$, the vibrating arm $M^2$, spring *m′*, and the tension-plate $m^3$, substantially as set forth.

12. The combination of an eccentrically-revolving loop-former, a holder which grasps the cut end of the cord, mechanism which moves the loop-former during part of its rotation toward the cord-holder, and mechanism which at the same time moves the cord-holder toward the looper, substantially as set forth.

13. The combination of the eccentrically-revolving loop-former, a cord-holder which grasps the cut end of the cord, mechanism which moves the looper during part of its revolution away from the cord-holder, and mechanism which at the same time moves the cord-holder toward the looper, substantially as set forth.

14. The combination of an eccentrically-revolving looper, a cord-holder which grasps the cut end of the cord, mechanism which moves the cord-holder toward the looper, and mechanism which severs the cord after the loop has been made, substantially as set forth.

15. In a grain-binder, the combination, with an eccentrically-revolving looper, of a hook arranged within the looper and rotated thereby, the looper also being rotated independently of the hook, substantially as set forth.

16. In a grain-binder, in combination with the loop-former, the hook *p′*, having its outer surface curved and adapted to pass the two strands of the cord to the hook *r*, substantially as set forth.

17. In a grain-binder, the combination, with the hook *p′*, of the longitudinally-reciprocating rod $q^4$, provided with the guide-hook $q^6$, and situated substantially parallel to the axis of said hook *p′*, substantially as set forth.

18. In a grain-binder, the combination, with the hook *p′*, of the reciprocating tube Q and the guide-arm $q^6$, reciprocating simultaneously with the tube, substantially as set forth.

19. In a grain-binder, the combination of

the tube Q, hook $p$ and hook-rod R, revolving with the tube, the tube also revolving independently of the hook, substantially as set forth.

20. In a grain-binder, the combination, with the loop-forming tube Q, of a reciprocating and revolving hook, $r$, and a stop which holds the point of the hook toward the point of the needle to receive the clamped end of the twine, substantially as set forth.

21. In a grain-binder, the combination, with the loop-forming tube Q, of a reciprocating and revolving hook, $r$, and a stop which locks the hook in position with its point upward, substantially as set forth.

22. In a grain-binder, the combination, with the hook-rod R, of the bent lever R′, pinion P′, hollow shaft Q, spring $R^2$, collar $r^3$, and dog $r^2$, adapted to engage with the stops, substantially as set forth.

23. In combination with the binding-cord, mechanism adapted to throw the knife out of action, substantially as set forth.

24. In combination with the binding-cord, the holder which grasps the cut end of the cord, and the devices which move a part of the cord-holder to release the cord, mechanism which throws said cord-releasing devices out of operation, substantially as set forth.

25. In a grain-binder, the combination of a cord-holder which gripes the cut end of the cord, mechanism which alternately opens and closes the cord-holder, and mechanism actuated by the cord to throw out of action the devices which open the cord-holder, substantially as set forth.

26. In a grain-binder, a cord cutting and clamping mechanism, one part of which carries an adjustable cutting-knife, the other part being provided with a fixed stop to determine the position to which the knife shall be adjusted, substantially as set forth.

27. The combination of the cam-wheel F, rock-shaft $S^4$, crank $S^5$, pitman $S^6$, bar W, bent lever S′, and returning-spring $S^7$, substantially as set forth.

28. In a grain-binder, the combination of a reciprocating tubular looper, a reciprocating knot-hook, and a cord-holder, one member of which is attached to the reciprocating shaft or bar, all of which parts reciprocate on substantially parallel planes, and are thereby adapted to be operated from the face of a single wheel which revolves in a plane at right angles to the planes in which they reciprocate, substantially as set forth.

29. In a grain-binder, the combination, with an eccentrically-revolving hook, of a reciprocating loop-former which closes the open end of the hook, thereby forming a tight eye, in which the cord is retained while the loop is being formed, substantially as set forth.

30. The combination, with the main frame and the hinged shields $Z^2$ $Z^3$, of the horizontally-projecting slotted bracket $z^3$ $z^4$ and the thumb-screw, substantially as set forth.

31. In combination with the shield $Z^2$, the supplemental shield $Z^4$, hinged thereto, substantially as set forth.

32. In combination with a cord-holder which grasps the cut end of the cord and devices which release the cord from the holder, mechanism which automatically throws the cord-releasing devices out of action and mechanism which automatically returns them into action, substantially as set forth.

33. In combination with a knife or cord-cutter and devices which cause said cutter to sever the cord, mechanism which automatically throws said cutter-actuating devices out of action and mechanism which automatically returns them into working relations with the cutter, substantially as set forth.

In testimony that I claim the foregoing as my own I hereto affix my signature in presence of two witnesses.

CHRISTOPHER W. LEVALLEY.

Witnesses:
H. H. BLISS,
H. H. DOUBLEDAY.