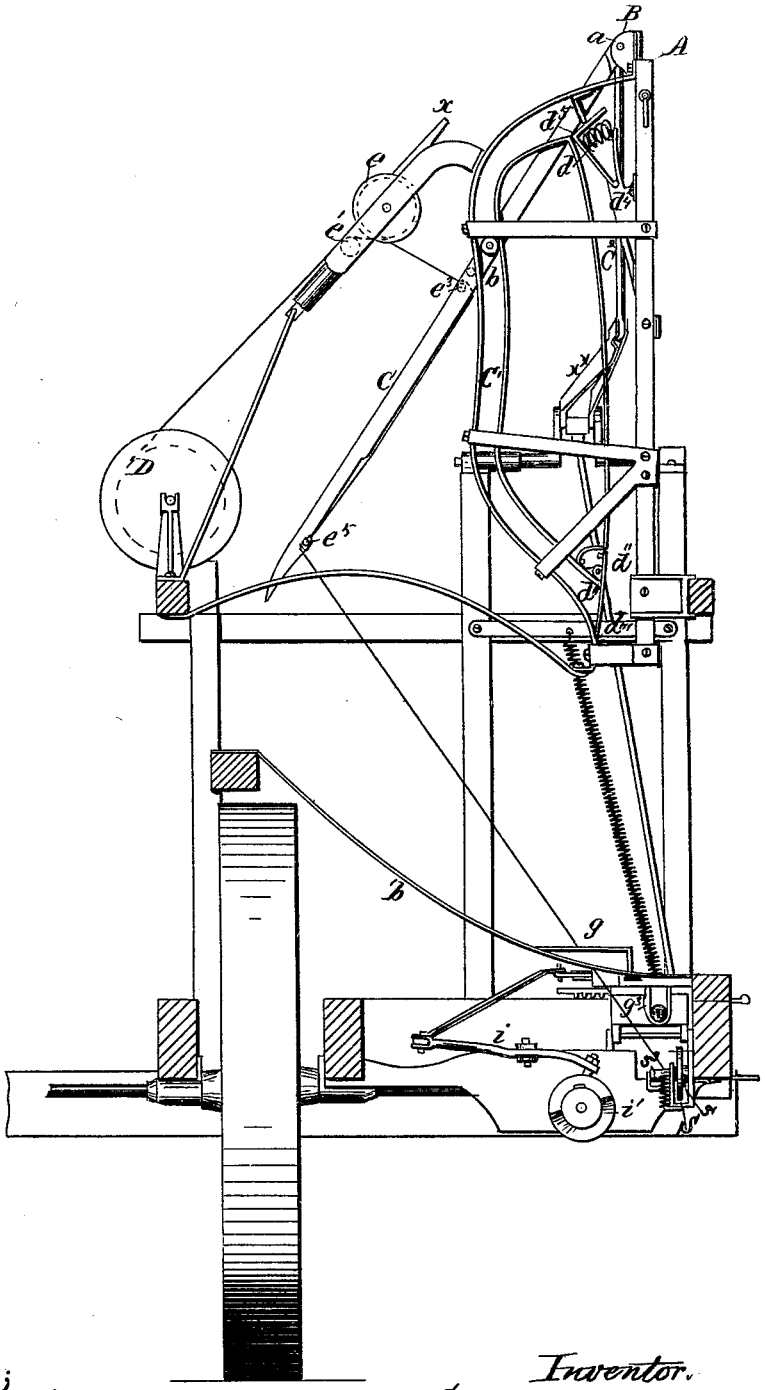
5 Sheets—Sheet 1.

E. HEATH.

GRAIN-BINDER.

No. 188,629. Patented March 20, 1877.



Witnesses;
Grenville Lewis
M. Church

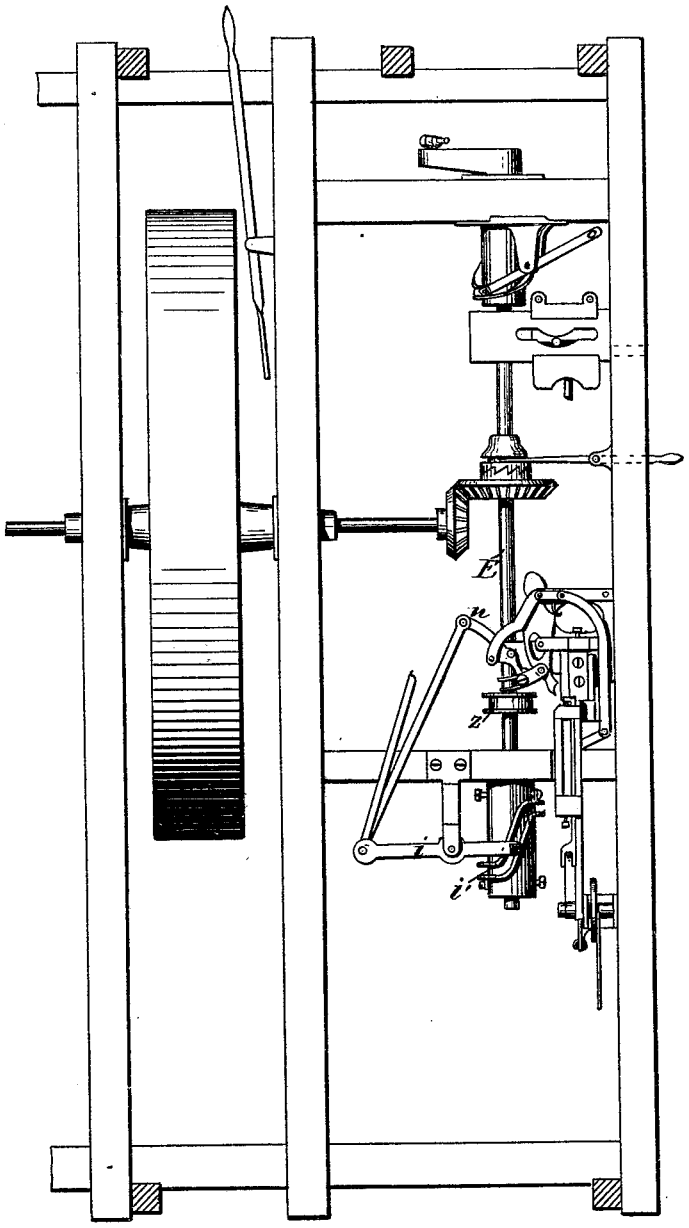
Inventor.
Edward Heath.
M Hill, Ellsworth & Spear.
His attys.

5 Sheets—Sheet 2.

E. HEATH.

GRAIN-BINDER.

No. 188,629. Patented March 20, 1877.



Witnesses;
Granville Lewis
M. G. Church

Inventor.
Edward Heath.
By Hill, Ellsworth & Spear
His attys

5 Sheets—Sheet 3.

E. HEATH.

GRAIN-BINDER.

No. 188,629. Patented March 20, 1877.

Fig. 1

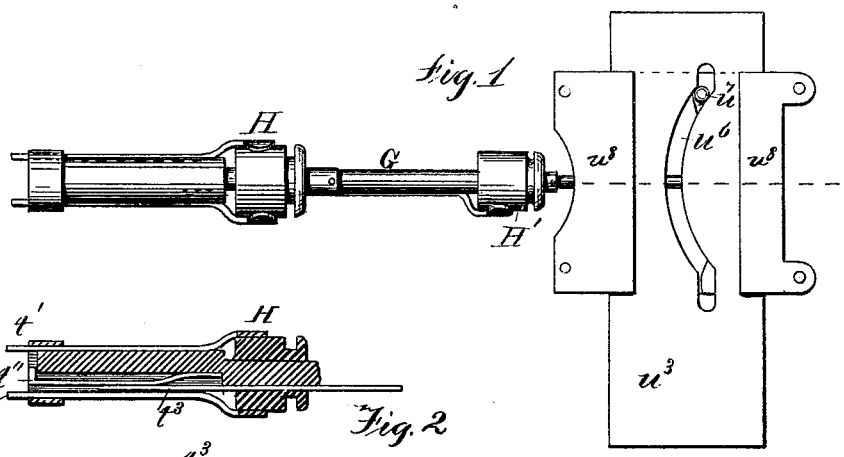
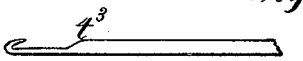


Fig. 2



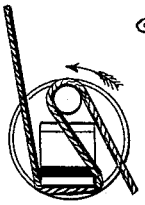
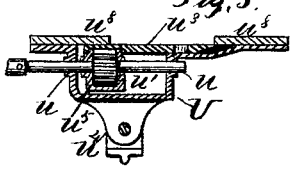


Fig. 3

Fig. 5.



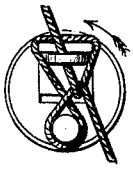


Fig. 4

Fig. 6.

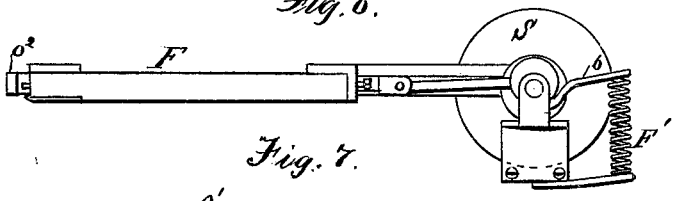
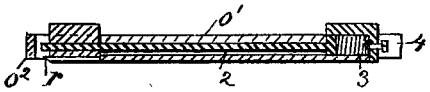


Fig. 7.



Witnesses
Granville Lewis
M. Church

Inventor.
Edward Heath
By Hill, Sumner & Spear
His attys

5 Sheets—Sheet 4.

E. HEATH.

GRAIN-BINDER.

No. 188,629. Patented March 20, 1877.

Fig. 2.

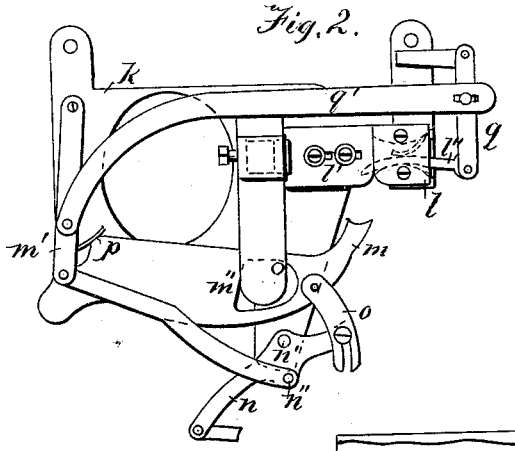


Fig. 1

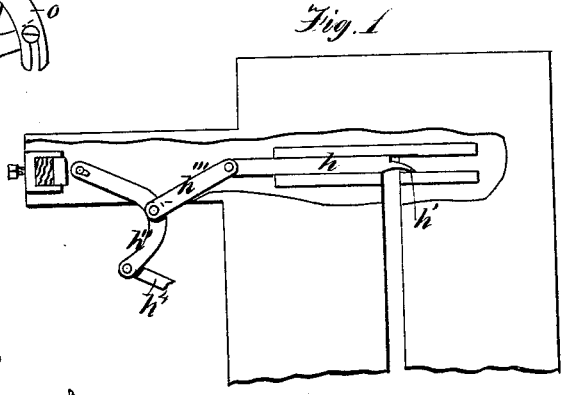
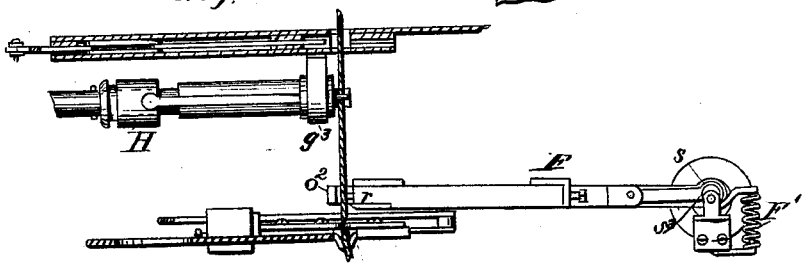


Fig. 3



Witnesses
Granville Lewis
A. Church

Inventor
Edward Heath
By Hill, Ellsworth & Spear
His attys.

5 Sheets—Sheet 5.

E. HEATH.

GRAIN-BINDER.

No. 188,629. Patented March 20, 1877.

Fig 1.

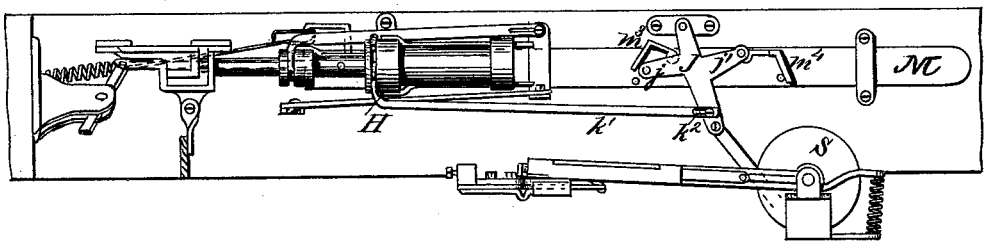
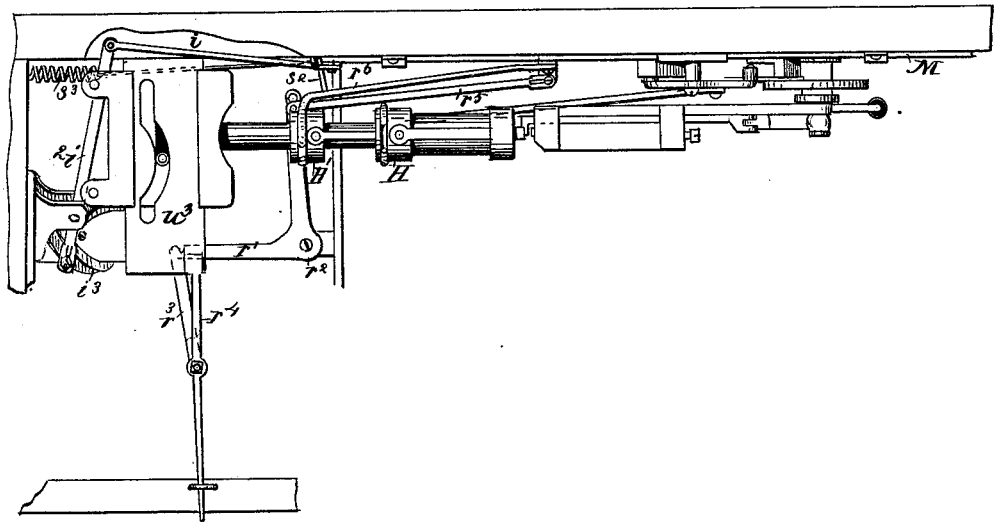


Fig. 2



Witnesses
Grenville Lewis.
M. Schmeckebier

Inventor
Edward Heath
By Hill, Ellmore & Spear
His Attys.

UNITED STATES PATENT OFFICE.

EDWARD HEATH, OF FOWLERVILLE, NEW YORK.

IMPROVEMENT IN GRAIN-BINDERS.

Specification forming part of Letters Patent No. **188,629**, dated March 20, 1877; application filed November 3, 1876.

To all whom it may concern:

Be it known that I, EDWARD HEATH, of Fowlerville, Livingston county, New York, have invented an Improved Grain-Binder, of which the following is a specification:

This invention relates to automatic grain-binders, which are attached to a harvesting-machine, and binds the grain as the machine moves along. The leading features or principles of operation in my improved machine, as well as the details necessary to carry those principles into operation, are set forth fully in this specification, and pointed out particularly in the claims.

In the drawings, Sheet 1 shows an end elevation of the machine; Sheet 2, a plan of the same. Figures 1, 2, 3, 4, 5, Sheet 3, represent detached views of tying mechanism; Figs. 6 and 7, detached views of the cutting and clamping bar. Fig. 1, Sheet 4, is a plan view of the upper clamping mechanism; Fig. 2, a plan of the lower clamper, and Fig. 3 a section of the upper and lower clamps, with the intermediate tying, and cutting, and clamping mechanism in place. Fig. 1, Sheet 5, is a side elevation of the mechanism for working the cutting and clamping and tying mechanism. Fig. 2 is a plan of the same.

In Sheet 1 of the drawings the grain-binding apparatus is represented as mounted on a suitable frame in such relation to a driving-wheel and the main frame, and other parts of a harvester-machine, as is most convenient, and as will be readily understood.

The figure shows more particularly the arm by which the twine is carried around the bundle, and the bundle compressed, as well as the devices by which the said arm is moved and guided.

This arm (marked in the drawing C) is pivoted at the upper end in a block, B, which block, as it slides vertically in guides A, imparts to said arm its vertical motion. The guides A are fixed at a proper point on the frame of the machine. The block is made to slide by means of a lever, *x x*, of the third order, the end of it being pivoted on the frame, and the lever lifted by a pitman, connecting it, at an intermediate point, to a crank-arm on the main shaft below. A spring may be used to assist and render certain the downward stroke of the arm.

This is shown in the drawing; but I do not consider it of importance, as the means for moving the sliding block which carries the arm may be varied indefinitely.

I have now described the means employed to give the vertical movement to the arm which carries the twine.

In order that this arm may have also the proper horizontal motion to separate the gavel, and form, compress, and bind it into a sheaf, I have made a camway, as shown also in the figure, Sheet 1. This is marked in the drawing C^1. It has a vertical part, C^2, in which the arm is guided in its upward movement by means of two studs, (marked *b*,) on which are small friction-rollers, and which travel in the camways.

The vertical or upward guide inclines inward at its upper end, so that the lower end of the binder-arm, in the upper part of its movement, is carried to the left, as represented on Sheet 1. At the upper end of this inclined part of the camway is a gate, *d*, pivoted at d^4, and resting against the corner, where the upward and downward ways meet at d^5.

The upper face of this gate, when the gate is closed, forms a continuation of the downward way. The gate is kept normally closed by a small spring, and is opened by the studs as they rise with the arm.

The upper part of the downward camway is nearly at an angle of forty-five degrees, to throw off the arm, in order that it may, in its downward stroke, compass enough of the grain to form a gavel. Thence the camway bends, as represented in the drawing, so as to guide the arm, and cause it to compress or gather the bundle and bring the point of the arm carrying the thread to the tying mechanism.

At the termination of the downward passage in the camway is another gate, marked d^1, pivoted above, hung so as to be normally closed, and operating to allow the guiding-studs to pass out in the downward motion, and to close when they have passed, and then guide them into the vertical part of the way. The parts are so arranged and proportioned that the arm descends vertically a distance

after leaving the inclined way, for reasons which will hereafter be explained. These cam-guides, it will be observed, are fixed to the same standards that guide the block which moves the arm.

Recurring now to this binder-arm, it will be observed that the twine is carried to it at the point e^3, where it passes through the arm between two friction-pulleys. Thence it passes down inside the arm through a groove therein, and behind a friction-roller, e^5, pivoted in the groove far enough from the point to leave a projecting part beyond the thread, sufficient to pass through the body of the grain, and separate the gavel from the mass.

The twine from this point passes to the tying mechanism, as shown in Sheet 1, where it is held by devices to be hereinafter described.

A drum, marked D, mounted to revolve on the frame at a suitable point opposite the arm which carries the twine, supplies this twine to the machine.

The said twine is led first over a small pulley, e^1, thence under and over a friction-pulley, e, passing from beneath to the arm at the point e^3, as before described. This friction-pulley is provided with a spring and suitable tightening devices, by which it may be made to revolve with more or less freedom, depending on the tension it may be desirable to put upon the twine. The tightening device, in this case, consists of a set-screw on the pivot of the pulley, prolonged outside the bearings, with a spring underneath pressing against a lever, x, which is also hung on the same pivot, and has a cam-face, so that a depression of the lever applies friction and retards the motion of the pulley. The drum which supplies the twine may also be provided with means for applying friction thereto.

It will be observed that the twine being held by the tying mechanism, as shown in Sheet 1, the arm, as it reaches inward toward the grain, and descends through it, and thence moves outward and downward, gathering and compressing the gavel, carries also the twine at another part thereof, back to the tying mechanism. This tying mechanism, with devices for holding and cutting the twine, I now proceed to describe.

The binding-arm, as it descends, gathering the grain for the bundle, passes through the slotted apron or guideway b', at the end of which slot it descends vertically, pushing the bundle along on the inclined way, and then drawing the twine tightly around it. Obviously, as the binding-arm passes down it draws the two ends of the twine together, one end being attached to the point of the arm, the other having been previously attached to the clamps below, as will hereafter be more fully explained. In the loop or bight between these two ends the bundle is held, being drawn closely to the apron.

In order that this bundle may not interfere with the operation of the twine and the upper clamp, by keeping the twine pressed against the arm, I have provided upon the inclined ways two guards, $g\ g$, which project at their vertical faces a little beyond the binder-arm when it has reached its lowest or vertical position. These serve to hold off the bundle and prevent the interference referred to above.

Immediately beneath the horizontal part of the plate which forms the guide-apron is an upper clamp, which holds the two strands of the twine nearest the bundle. This clamp consists of a sliding bar, marked in the drawings h, (Fig. 1 of Sheet 4.) The sliding bar is square at its forward end, and is provided on that side next the binder-arm with a pointed finger, h', which, as the bar advances past the binder-arm, picks up the twine therefrom, and, carrying it aside, presses it firmly against a clamp, and thus holds it in place.

At the same time this bar holds, in like manner, the other part of the twine, which comes from the other side of the bundle, and passes down through the same slot as that first described.

This clamping is performed after the binder-arm has drawn down that part of the twine which it carries, so that, by the action of the parts, the twine is bound tightly around the sheaf, and clamped and held closely thereto.

This sliding and clamping bar receives its motion directly from the lever h'', to which it is connected by a pitman, h'''.

The lever h'' is moved by a rod, h^4, connected at its outer end and carried forward to a lever, i, the opposite end of which is actuated by a pin fixed upon it and traveling in the camway i' on the shaft E, Sheet 2. The inner end of the lever h'' is pivoted to a block which is allowed some slight movement, but rests against a rubber or spring, behind which is a set-screw for the purpose of adjustment.

This spring causes the bar h to act with a slightly-yielding pressure upon the twine, which it clamps and holds, and thus more effectually secures it in place.

The spring is located in a box open in front. At one side of this the block to which the lever is attached is pivoted, and the block is pressed back against the rubber. This mechanism, which operates the upper clamping device, may be varied materially, and the bar still be made to operate as effectually.

Operated from the same lever i is another clamp, located below, and shown in Sheet 2 in place, and also detached and on a larger scale at Sheet 2 on Fig. 4. This clamping mechanism consists of a metallic frame, marked in the drawing k. To this is screwed, on the upper side, one jaw of the clamp, marked l. Opposite this jaw is another and movable jaw, secured to the frame k by screws, which pass through slots, in order to allow some slight movement toward and from the face of the opposite fixed jaw.

This movable clamp, which is marked l', rests at the rear against a spring, which is ren-

dered adjustable by means of a set-screw behind it, so that the pressure of the spring upon the movable jaw can be regulated at pleasure.

The clamps are composed of two plates, an upper and lower, with a space between for the admission of the arm which pushes in the twine, and the outer edges of their jaws are slightly beveled, in order that the twine may be readily pressed between them, the movable clamp yielding slightly to admit it. This pressure is applied by means of an arm, *m*, which is pivoted at its rear end or on an oscillating bar, *m'*. Its movement is guided and limited by means of a pin working in an opening, *m''*. Motion is imparted to this arm by means of the lever *n*, which is pivoted at *n'* on the frame *k*.

The short arm of this lever is connected to a slotted arm, *o*, pivoted near the forward end of the arm *m*.

Another connecting-bar is pivoted on the lever *n* at *n''*, and to the arm *m* on the same pivot that connects the said arm to the oscillating bar at the rear. The lever *n* is connected to the lever *i* in the manner described above, so as to be moved simultaneously with the rod which moves the upper clamp, so that the two operate together.

Manifestly a forward movement of the rod drawing upon the lever end will move forward the arm *m*, and at the same time, by means of the slotted arm, press down the finger of the arm *m* toward the clamps. These clamps are so made and connected to the frame *k*, and the parts are so adjusted to each other, that the notched or fingered end of the arm *m*, when it is pressed toward them, will pass in between the upper and lower plates which compose the clamps, and exactly at the point of the junction of the two clamps, so as to press the twine in between them, leaving it to be firmly held. The junction of these clamps is exactly opposite the point at which the binder-arm enters with the twine, so that the arm *m* can seize with readiness the twine as it is brought to this point. The reverse motion of the arm *m* is assisted by a small spring, *p*.

An additional clamp, *l''*, is provided, operated by means of the arms *q q'*, connecting it to the oscillating arm on the other side of the frame.

This, however, is not absolutely essential. Located just above this clamp is an arm, F, which is pivoted forward upon the frame so as to allow some limited upward movement against a spring, F', which bears on a prolongation of the bar F. This is shown on Sheet 3, Figs. 6 and 7, and also on Sheet 4, Fig. 3.

In this arm is a sliding bar, o^1, which is provided at the end which projects out of the arm with a head or offset, o^2, formed at right angles with itself.

This projects over the end of the arm, and is formed so as to be drawn back against the end of the said arm, and just above the edge of a knife, *r*.

This arm is so placed that, when the sliding rod is extended so as to leave a space between the offset and the end of the arm, this space will come directly opposite the line of downward movement of the twine, as it is brought by the binder-arm. It results from this that the slight sidewise movement which is imparted to the arm by the flanged wheel Z, Sheet 2, as well as the action of the arm *m*, brings the twine between the offset and the clamp in the end of the arm.

The twine is therefore cut and then held, since the offset first passes over the edge of the knife in contact therewith, acting upon the twine as shears, and then closes against the yielding clamp in the end of the bar F.

The sliding rod receives its motions for these purposes from an eccentric at s^3, which is moved by means of the pitman s^1, connected by a wrist-pin to a circular face-plate, S, on the same shaft with the eccentric, and indirectly to the sliding bar M, as will be hereinafter more fully described.

The connection of the pitman is represented as on the lower part of the disk, and its reciprocating movement, received from the bar M, rocks the shaft and eccentric, and opens or closes the cutting and clamping head.

The face of the clamp in the arm F, against which the offset presses the twine, is formed by means of a bar, 2, sliding within the arm, and resting at its rear end against a spring, 3, which is made adjustable by means of a set screw, 4.

Above this holding and cutting apparatus is located the tying mechanism.

This is shown detached in Figs. 1, 2, 4, and 5 of Sheet 3, and in Fig. 3, Sheet 4, in its proper place. It consists of a shaft, G, the rear end of which is pivoted so as to allow the head to rise and fall slightly, hung in a loop, g^3, just underneath the platform on which the bundle rests. The face of this loop is beveled, in order to more effectually guide the twine thereto, and is long enough to allow the proper rising and falling motion to the head.

The peculiar construction of this shaft is shown more clearly in the figures referred to. In the forward end thereof is, upon one side, a sliding bar, *t*, made flat and elastic, (so that it may slightly press inward,) and upon the other side a round rod, marked *t'*.

These are carried forward and backward by a sleeve, H, to which they are attached, and which slides on the main shaft.

Opposite the flat bar, and within the head of the shaft, is a spring-bar, *t''*, which presses toward the bar *t*.

Between the bar *t* and the spring-bar *t''* slides a hook, *t'''*, the rear end of which is connected to a second sliding sleeve marked H'. The connections by which these sleeves are moved will be set forth hereinafter.

The tying-shaft is hung at the rear, so as to have a rotary, oscillating, and longitudinal movement. The means by which this is accomplished are shown in Figs. 1 and 5 of Sheet 3. A smaller prolongation of the shaft of the tying-head passes through bearings *u u* in such a manner as to have a slight reciprocal movement longitudinally in said bearings.

The bearings *u u* are in the sides of a box, U, which is pivoted at u^4 below, transversely of the shaft, on which pivot the said shaft rocks to allow the head to rise and fall.

Upon the shaft, and within the walls, is fixed a pinion, u^1. Through this, rotary motion is imparted to the shaft, by means of a rack-bar connected to the frame or plate u^3, which slides in the box transversely of the shaft F.

This transversely-sliding frame carries also lateral flanges, which fit over and inclose the upper edges of a box, u^5, which incloses the pinion on the shaft of the tying-head.

The transversely-sliding frame or plate u^3, to the under side of which the rack-bar is fixed, is made with a curved slot, u^6, in which moves a pin, u^7, having a friction-roller thereon. This pin rises from the box U, so that, as the frame u^3 is moved back and forth, under flanges u^8 u^8, across the line of the shaft, it also moves laterally, the slotted plate having lateral space under the flanges for this purpose.

This movement, through the agency of the box which incloses the pinion on the shaft between the bearings *u u*, imparts to the head the longitudinal motion required in the operation of tying.

The rack-bar on the under side of this plate, at the same time acting on the pinion, gives the tying-head the necessary amount of rotary motion.

A more particular description of these movements in connection with the twine is given in recounting the operation of the tying-head. The purpose of the parts just described, namely, those in the tying-head, and those which impart motion to the head, and the relative order of the movements, are as follows:

When the binder-arm has descended, taking with it the twine that binds the sheaf, and this twine has been carried into the clamps, and in front of the end of the tying-shaft, the points of the bars *t t'* are thrust slightly forward and out of the head. As they advance they pass on each side of the double twine, so that when rotated one point will strike the twine above and one below.

This is shown in Fig. 3 of Sheet 4. The rotation or partial rotation of the shaft which immediately follows, winds the twine upon the points, as shown in Fig. 3, Sheet 3.

As the double twine is held fast in the immovable clamp above the twine and freed from the immovable clamp below, being cut and held by the cutting and clamping head next below the binding-head, it follows that the rotation of the head as it winds the twine upon the points, will raise the cutting and clamping head as well as the tying-head toward and (in respect to the latter) in proximity to the apron on which the sheaf rests. After the first partial rotation, which brings the twine upon the points, as shown in Fig. 4 of Sheet 3, the head is slightly drawn back and the rotation continued in the same direction. The slight retraction of the tying-head causes the twine which was caught on the first partial rotation by the points to slip by the ends on the second, and thus cross each other. The continued rotation carries the head around in relation to the strands of twine until they are drawn from the crossing thereof in a nearly opposite direction, as shown in Fig. 4, Sheet 3, only a single twine being represented, for greater clearness.

The lower end, which comes up with the cutting-clamp, moves around until it is drawn straight over the middle of the triangular space formed by the flat bar and the loop formed thereon, and also across the end of the flat point. The hook emerges after the strands have crossed, and in season to meet the lower strand as it comes across the end of the flat point. It is thus caught by the hook and drawn partially in with a spring, when the cutting-clamp below releases its hold. Then the points are drawn in, leaving the tying-head clear, and the partially-formed knot lying thereon. Afterward the hook is drawn farther back between the springs, drawing the end through the loop, thus completing the knot. The friction of the springs tends to hold the twine, so that, as the hook moves inward, it draws upon the twine until the end thereof passes over the hook. This draws the knot tight, and the amount of tension on the twine for this purpose may be regulated by the pressure of the springs.

The partial rotation of the tying-shaft is accomplished, as has been pointed out, by the rack-bar and pinion, and the longitudinal movement by the curved slot in the sliding plate.

This latter device may be changed for any suitable means for the purpose. The sliding plate or frame is connected to the main driving-shaft by means to be hereinafter described.

The upper and lower clamps are connected, as has been described, to the same lever, worked by the cam-groove on the forward end of the main driving-shaft.

I now proceed to describe the mechanism for operating the cutting and clamping head, and for imparting the various motions to the tying-shaft, and to the points and hook which are in it.

In suitable guides in the frame of the machine is a sliding bar, M, connected by a pitman, *i*, to the lever, the other end of which is moved by the camway i^3 on the revolving shaft. This bar and its immediate connection here described are shown in Figs. 1 and 2 of Sheet 5.

On the bar M, at a proper point in relation to the shaft and eccentric of the cutting and clamping head, are two movable cams, m^3 m^4, pivoted to the sliding bar at their upper and inner ends. Just above these is pivoted, on the frame, a lever J, in the form of the ordinary bell-crank lever, but with two arms, j j', in the ends of which are pins and friction-rollers projecting inwardly, so as either to ride over or pass under and lift the movable cams.

The lower end of the lever J is connected by a pitman to a wrist-pin on the wheel S, the partial rotation of which rocks the shaft and the cam which moves the cutting and clamping device, as before described. The double bell-crank lever receives its motion from the two movable cams on the sliding bar, in the manner described as follows:

As the sliding bar moves forward, the movable cam m^3 strikes against the pin in the forward arm, and lifts the said arm, thereby throwing the foot of the lever toward the wheel, or front of the machine.

This rocks the shaft of the wheel S, turns back the cam from the cutting and clamping head, causing it to cut and clamp the twine.

It also, by means of another pitman, k^1, pivoted at k^2, and connected by its forked end to the sleeve H, draws out the points of the tying-head.

This pitman is connected to the pin on the lever at k^2 by a slot, so as to allow the motion of the cutting-head to begin before that of the points.

The adjustment of the parts is such that this action follows immediately the descent of the binder-arm, and precedes the action of the tying-head. While the forward arm j' is rising on the forward cam the pin on the other arm passes under the other cam, which swings on its pivot, and rises to let the said pin pass thereunder.

Next in order is the rotating of the tying-head. The immediate mechanism by which this is accomplished has been already described. The rack and plate, which rotate the tying-head, and move it back and forth, are connected to each other and move together.

They are moved by means of a bell-crank lever, r^1, pivoted at r^2, and connected at one end by means of a connecting-rod, r^3, to an arm, r^4, which extends from the slotted plate to a guide on the frame. The other end of the bell-crank lever is connected to the sliding bar M by a pitman, r^5. This pitman has also a slotted connection, to allow the head to stand still during the motion through the slot, while the double lever operates on the cutting-bar and the points.

Near this connection is another pitman, r^6, the forked end of which embraces the sleeve which moves the hook, and this operates at the same time to advance the hook, while the parts described above rotate the head. Upon the forked end of the pitman r^6 is a pin, s^2, to which is connected a spring, s^3, which serves to give the first movement to the hook heretofore described in the operation of tying.

The pitman r^6 is slotted like the others, so as to allow the hook to stand still while the cutting and clamping parts begin to operate, and also to allow the spring to act in giving the first motion to the hook in drawing it in.

So far only the forward movement of the bar M, and its effects, have been referred to. The operations of the cutting, clamping, and tying mechanisms, which have been heretofore fully described, are completed by the reverse movement of the bar. The first effect of this movement is to open the cutting and clamping device, and to draw back the points. The continuation of this reverse movement completes the drawing back of the hook, thereby finishing the knot, and takes the head back to its original position.

The reverse movement of the lever i, Sheet 2, opens the upper clamp, just beneath the apron and the bundle. The knot, having been tied, is thus released and thrown off.

In respect to the order of operation of the parts which have been described, some further explanation may be necessary. It has been shown that the upper and lower griping or clamping devices by which the twine is held operate simultaneously, and as soon as the binder-arm has reached its limit of descent. The intermediate clamp, which also cuts and then yields the severed ends of the two threads to the tying apparatus, acts subsequently to the other two.

The upper and the lowest differ in their action in this respect. The upper holds intermittently, the clamping-arm withdrawing to allow the binder-arm to descend, and also to relinquish its hold upon the twine in order that the tied sheaf may be dropped.

The lower clamp acts constantly. It holds at every stroke the two strands of twine—one the end which it had held at the beginning of the movement of the arm in the operation of binding the sheaf, the other the strand brought back to the same place by the return of the binder-arm, and pushed into the clamp by the arm m. When the strands, therefore, are severed above this lowest holder, there is left therein a short bit, folded in by the operation of the arm m, as described, and also the end of the twine which is left in the binder-arm. This is held for a second operation, precisely the same as the first, while the bits of twine remaining between the jaws are gradually crowded out on the other side.

On the shaft which carries the cam-grooves is a flanged pulley, z, placed directly opposite the mouth of the lower clamps for the purpose of guiding the binder-arm, and holding it in proper place.

To briefly recapitulate, the action of the parts is as follows:

Supposing the arm to be down at its limit, the twine which comes from the reel over the friction-pulley, and down through and along

the arm, terminates in the lower clamp, and is held thereby. As the arm rises the twine is payed out, carried tightly around the gavel, and brought back again to the clamps, where it is seized both above and below. The upper clamp holds the bundle, the lowest, the two strands, one of which extends below to the arm, through which it reaches back to the reel.

Immediately after the upper and lower, the intermediate cutting-clamp acts, and with it the tying mechanism.

When the knot is tied, the upper clamp releases its hold, and the bundle tightly bound is thrown off.

The devices which move the binding-arm, and which guide it, may be greatly modified. So, also, the precise construction of those connections which carry the power from the main motor of the machine to the clamping and tying apparatus may be materially changed without any essential change in the parts last named.

Nor do I limit myself to the special form of harvester to which this apparatus may be applied, nor to any special manner of application. The twine I prefer to use is the common wool twine; but any other fibrous material, but not metal, may be used.

I claim as my invention—

1. In a grain-binding machine, mechanism for tying a knot in the cord or band, and clamping mechanisms above and below it operating in relation to each other and in the described relation to the mechanism which carries the twine, and suitable severing mechanism, as set forth.

2. An upper clamp acting intermittently, and a lower clamp acting with constant pressure, in combination with the mechanism for tying a knot in the cord or twine, and with the cutting mechanism, as set forth.

3. The combination of upper and lower clamps, a rotating tying mechanism, and a yielding arm, which clamps and cuts the twine, as set forth.

4. The lower clamp, consisting of the two jaws, under constant pressure, in combination with the arm by which the twine is forced from the binder-arm into the clamp, as set forth.

5. The combination of the two jaws l l', and spring behind l', arm m, and oscillating lever m', lever n, and slotted arm o, as set forth.

6. In combination with the oscillating lever on which the arm m is pivoted, the additional clamp l'', and arms q q', as set forth.

7. The arm F, with its sliding bar and offset, constructed as described, and arranged to close against the head of the bar and over the knife, as set forth.

8. In combination with the bar F, hung so as to yield in an upward direction the cutting and clamping bar, and mechanism by which the latter is moved upon the head or offset o^2, as and for the purpose set forth.

9. A tying mechanism consisting of a rotating shaft, points sliding in head of said shaft, and a sliding hook partaking of the motion of the shaft, as set forth.

10. A tying mechanism consisting of a head adapted for rotary and reciprocatory motion, in combination with sliding points and hook, partaking of the motion of said shaft, as set forth.

11. A tying mechanism consisting of a rotating and reciprocating head, provided with points and hook, as described, the shaft of said head being so hung as to permit upward motion in the act of tying, as set forth.

12. The combination, with the head of the shaft G, of the bars t t', spring t'', and hook t^3, as set forth.

13. The shaft G, sliding in oscillating bearings u u, and carrying pinion w', in combination with the rack-bar for rotating the shaft, and mechanism for imparting thereto a reciprocating movement, as set forth.

14. The combination of the pinion w^1, the rack-bar on the sliding frame, and the box w^5, the sliding frame operating the parts specified, and being itself operated by means of the slot and pin, as set forth.

15. The box U, having bearings for the shaft G, and pivoted transversely to said shaft, in combination with mechanism for rotating and reciprocating the same, as set forth.

16. The clamping-arm h, in combination with the yielding lever h^2 and the pitman-connections to the lever i, as set forth.

17. The combination of the upper and lower clamps and their connecting-levers with the lever i, as set forth.

18. The guards g g, in combination with the slotted apron, the binder-arm, and upper clamp, as set forth.

19. In a grain-binding machine, a binder-arm, adapted to carry the twine around the gavel, and having a further movement in a different direction to compress the bundle, as set forth.

20. In a grain-binding machine, a binder-arm, adapted to separate the gavel and carry the twine around it, and also having a further movement in a different direction to tighten the twine, in combination with a clamp holding the end of the twine, and receiving the part brought back by the said arm and suitable cutting and tying mechanism, as set forth.

21. In combination with the binder-arm, the guideways, gates, and operating levers, as set forth.

22. The longitudinal shaft E, in combination with the levers i i, the upper and lower clamps, and the bar M, as set forth.

23. The combination of the bar M, pitman v, and operating-lever, with the levers that move the cutting, and clamping, and tying mechanism, as set forth.

24. The bell-crank lever r^1, connected with the sliding frame w^3 and with the bar M, by the slotted pitman, as set forth.

25. The combination of the head H′, bar M, and the slotted pitman r^6, as set forth.

26. In combination with the head H′, and hook attached thereto, and with the slotted connection, the spring s^3, as set forth.

27. The lever J pivoted to the frame, in combination with the movable cams on the bar M, as set forth.

28. The lever J, moved as described, in combination with mechanism which operates the cutting and clamping head, as set forth.

29. The combination of the lever J, the mechanism which moves the cutting and clamping devices, and the points in the head H, as set forth.

30. The combination of the lever J, wheel S, and pitman connecting the two slotted pitmen k^1, connected to the head H, as set forth.

EDWARD HEATH.

Witnesses:
THEODORE MUNGEN,
H. A. DANIELS.