Nov. 27, 1928. 1,692,899

P. KETELSEN

HARVESTING MACHINE

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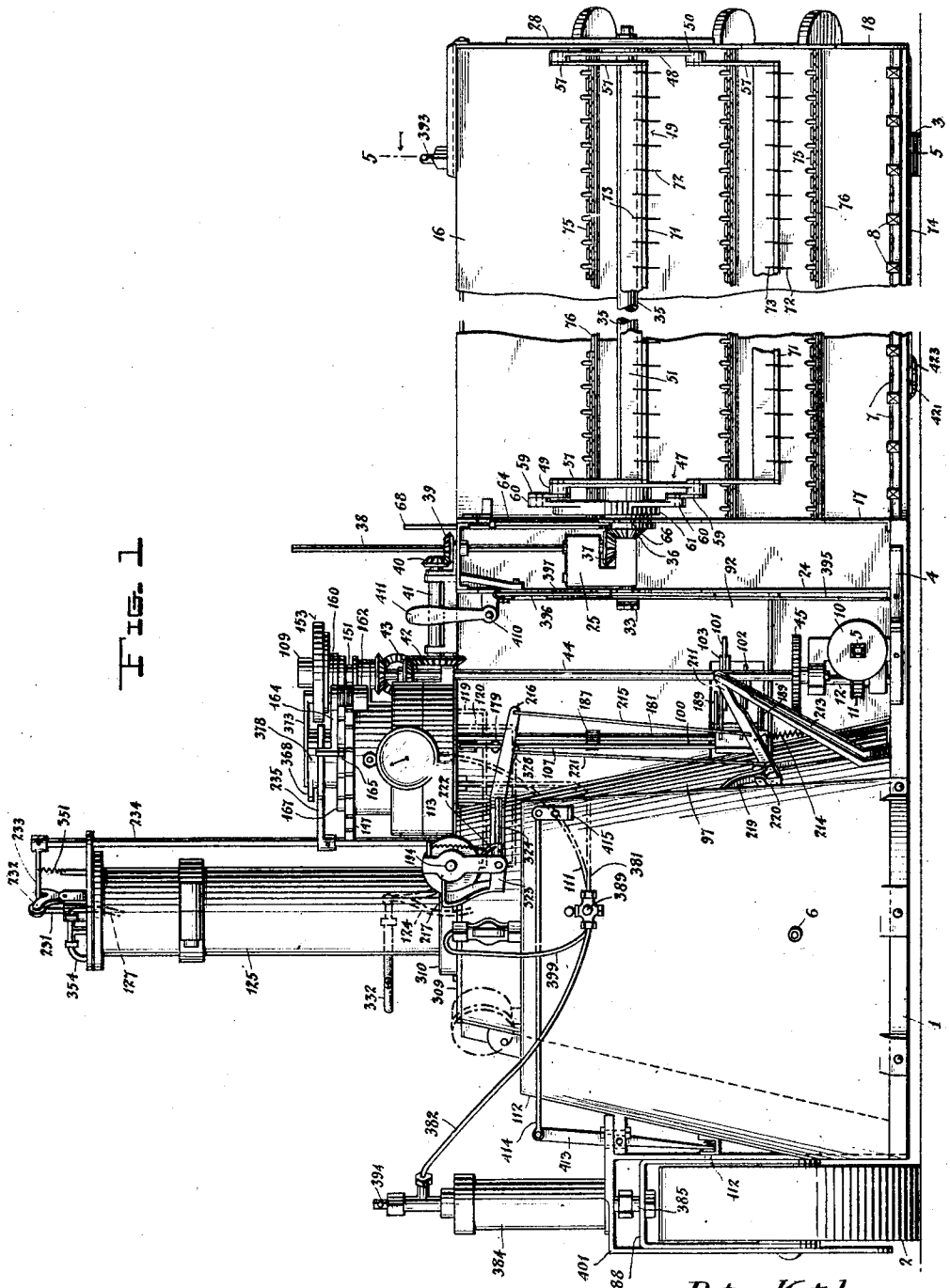


Fig. 1

Peter Ketelsen,

By James L. Norris

Attorney

Nov. 27, 1928. 1,692,899

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HARVESTING MACHINE

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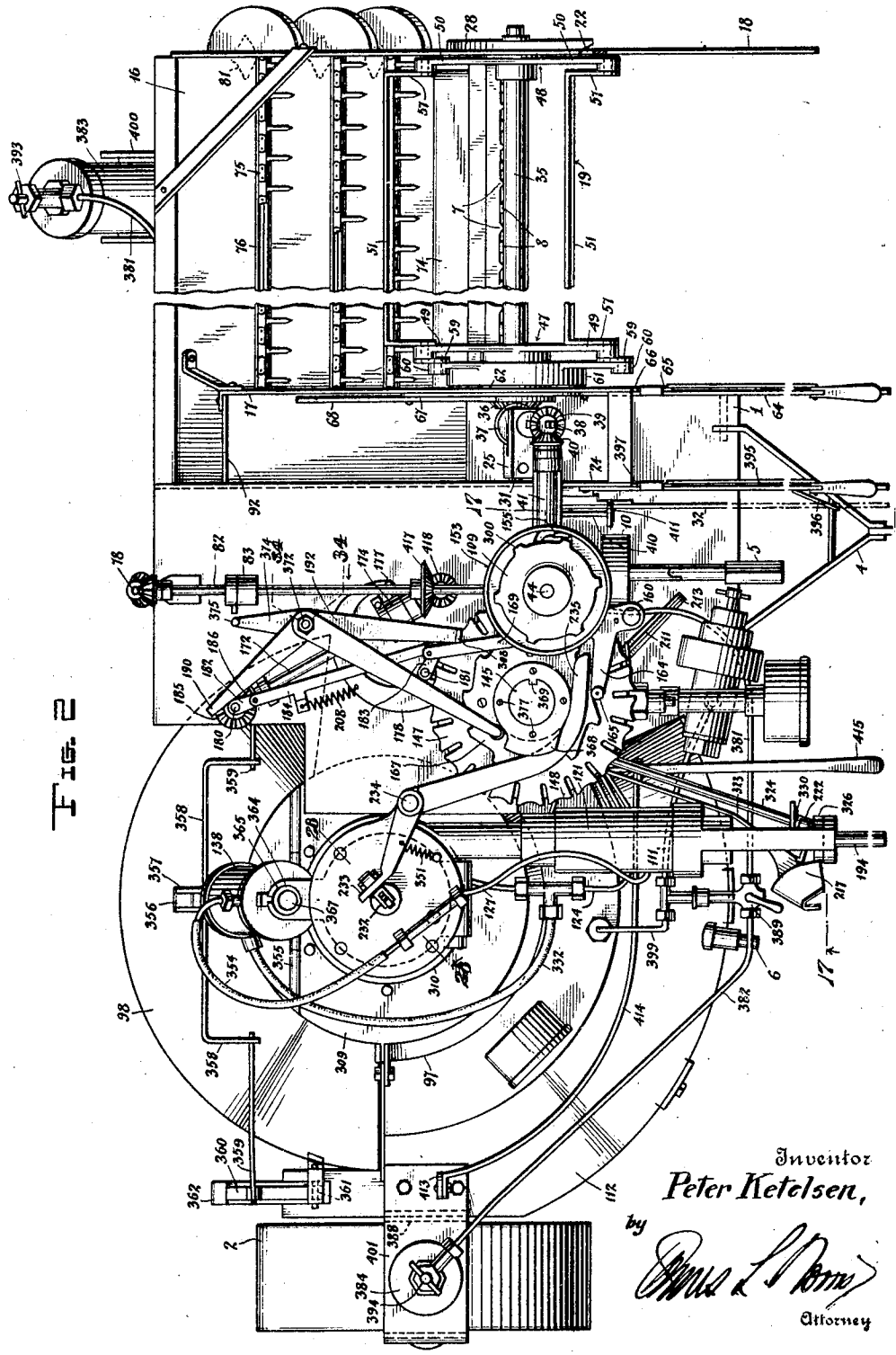


Fig. 2

Inventor
Peter Ketelsen,
by
Attorney

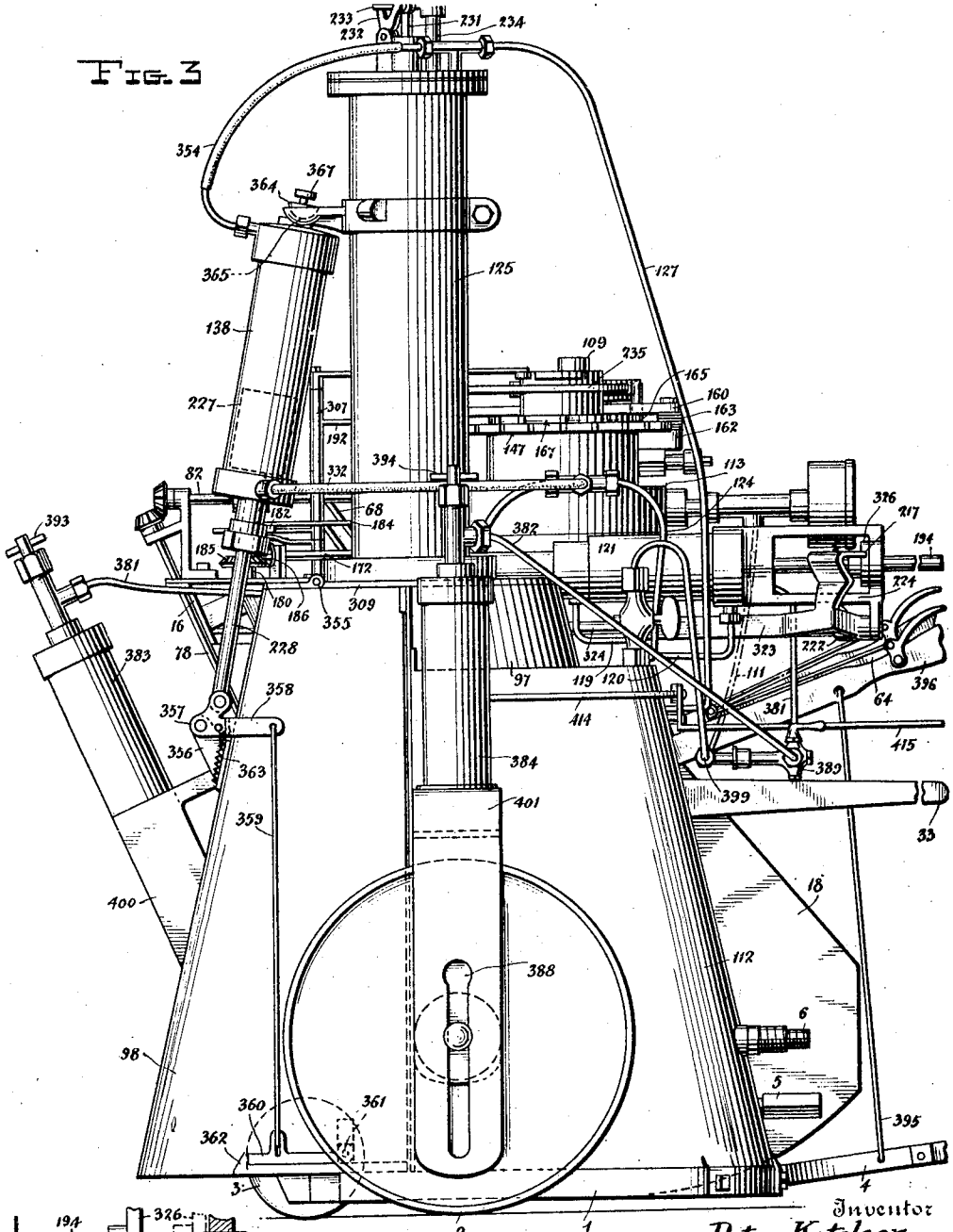
Nov. 27, 1928. 1,692,899

P. KETELSEN

HARVESTING MACHINE

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Fig. 3



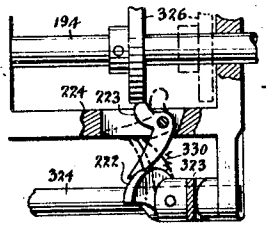


Fig. 36

Inventor
Peter Ketelsen,

By Charles L. Byrne

Attorney

Nov. 27, 1928. 1,692,899

P. KETELSEN

HARVESTING MACHINE

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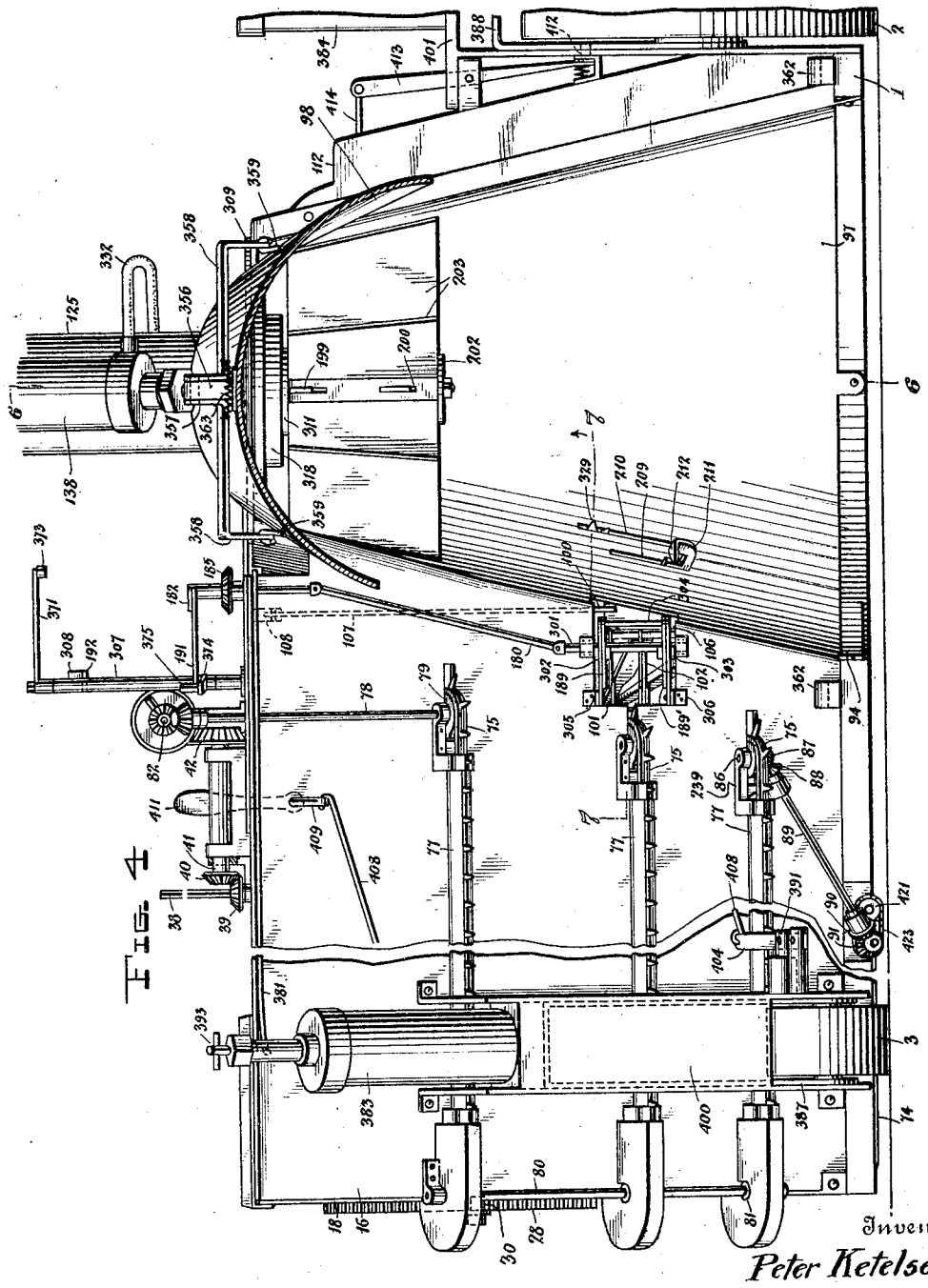


FIG. 4

Inventor
Peter Ketelsen,

By Thos L. Norris
Attorney

Nov. 27, 1928. 1,692,899

P. KETELSEN

HARVESTING MACHINE

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FIG. 5

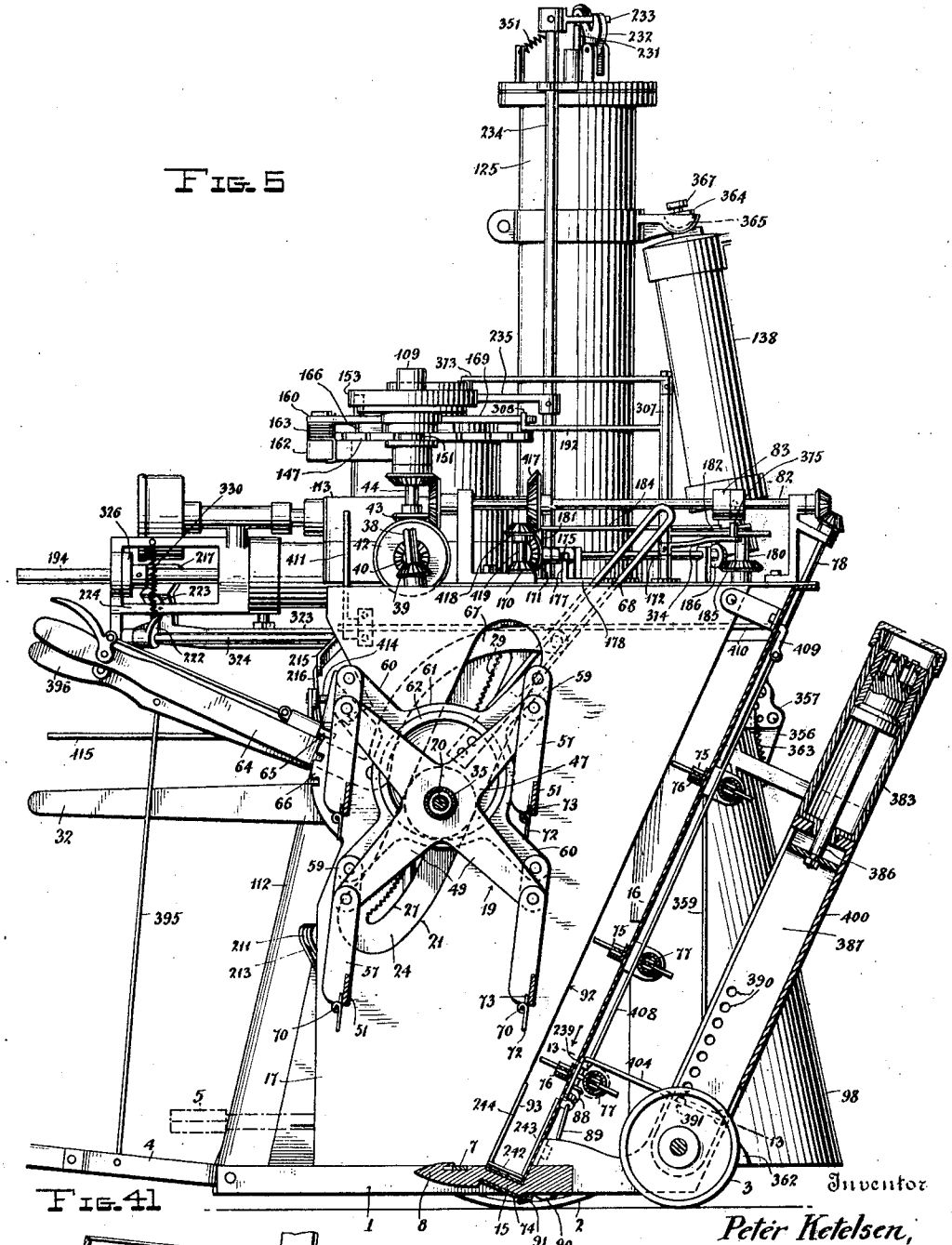
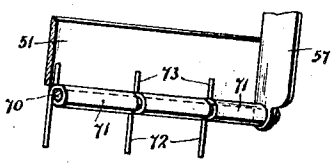


FIG. 41



Inventor

Peter Ketelsen,

By Amos L. Norris

Attorney

Nov. 27, 1928. 1,692,899

P. KETELSEN

HARVESTING MACHINE

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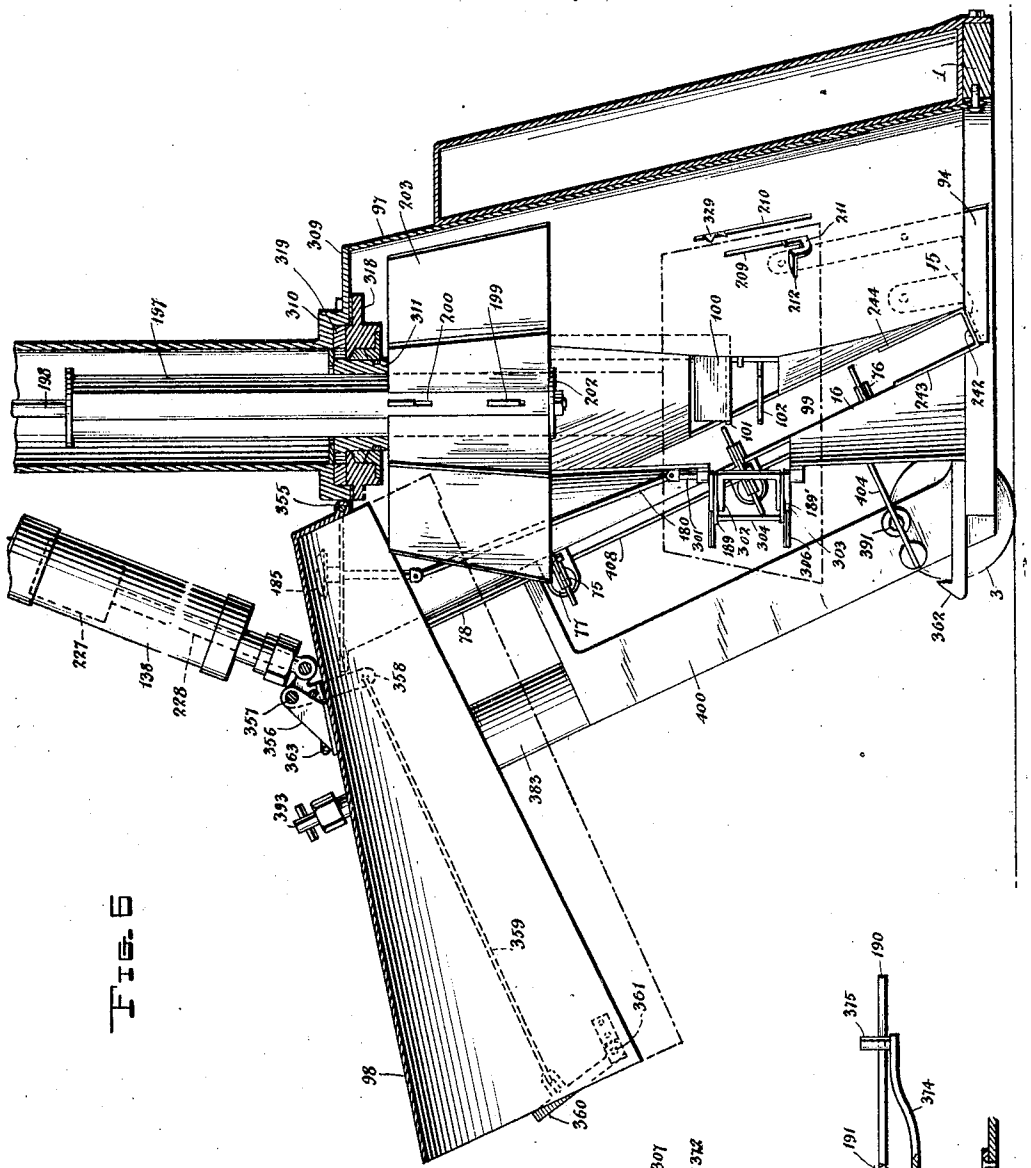


Fig. 5

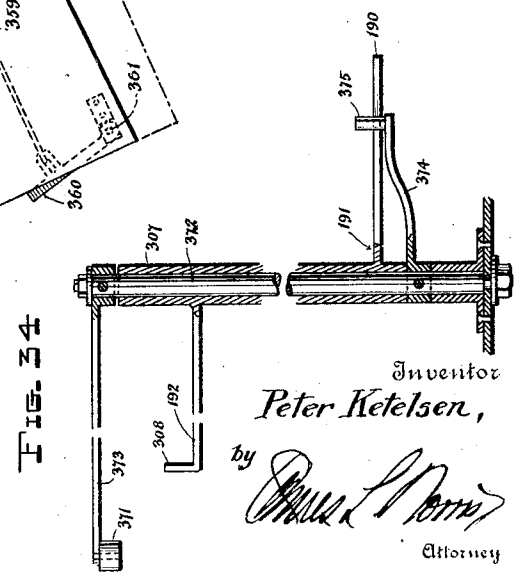


Fig. 34

Inventor
Peter Ketelsen,
by Paul L. Morris
Attorney

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HARVESTING MACHINE

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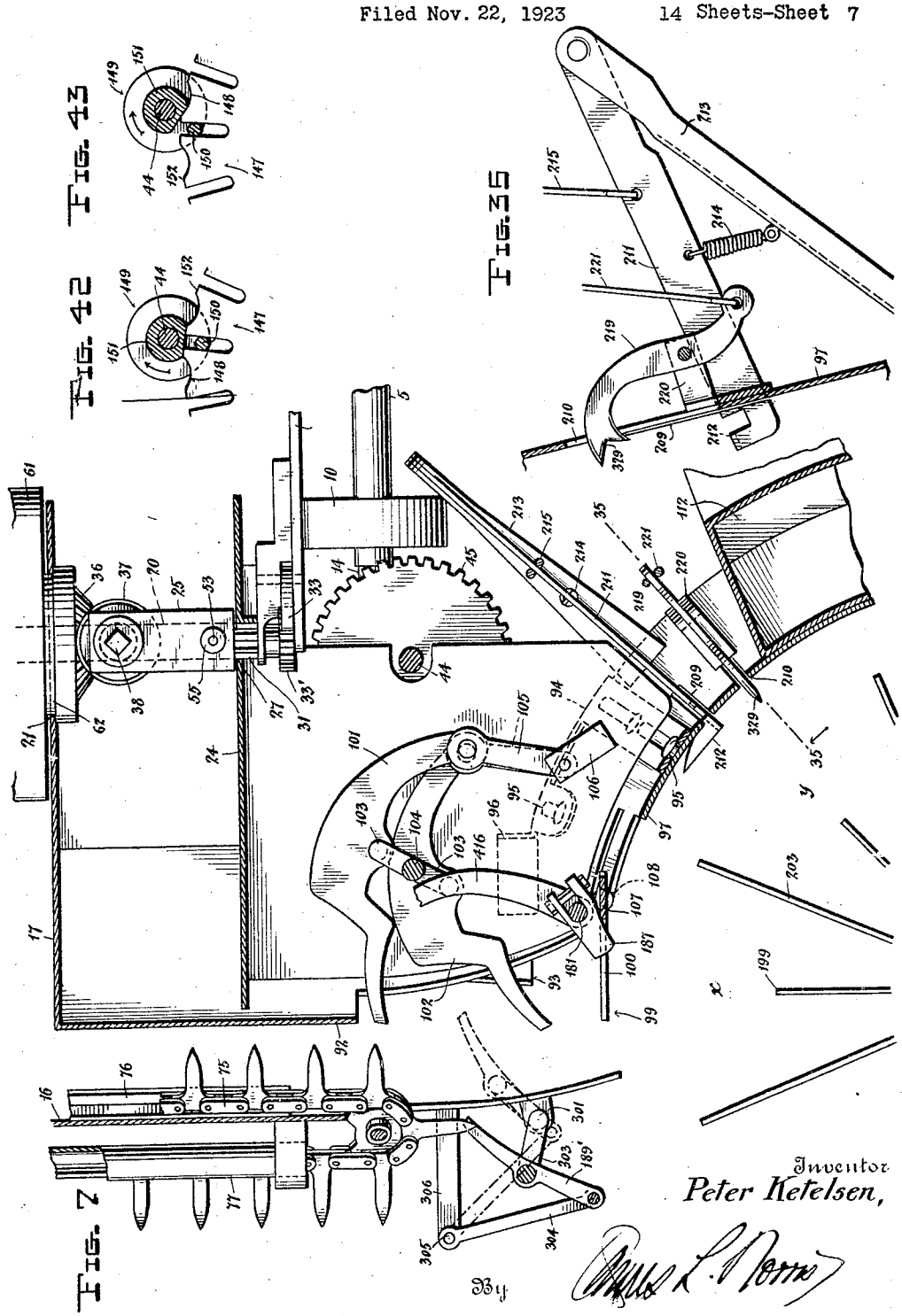


Fig. 43

Fig. 42

Fig. 35

Fig. 7

Inventor
Peter Ketelsen,
By
Attorney

Nov. 27, 1928. 1,692,899

P. KETELSEN

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Fig. 8

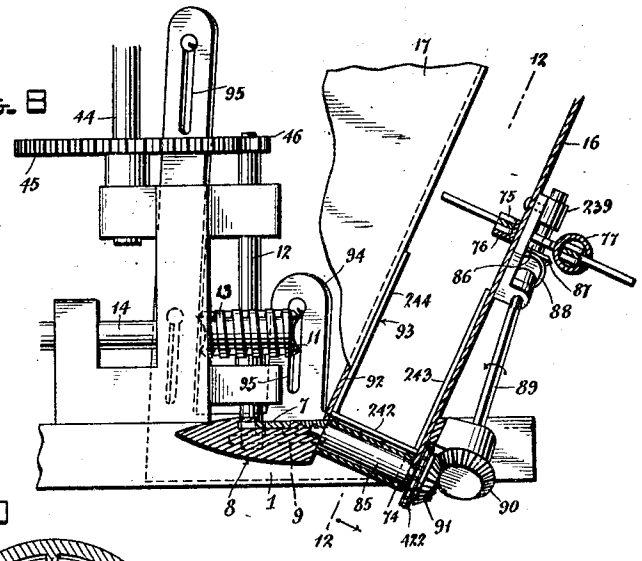


Fig. 10

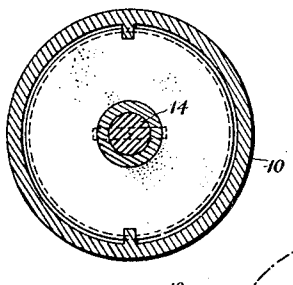


Fig. 9

Fig. 11

Inventor

Peter Ketelsen,

By

Attorney

Nov. 27, 1928. 1,692,899

P. KETELSEN

HARVESTING MACHINE

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FIG. 12

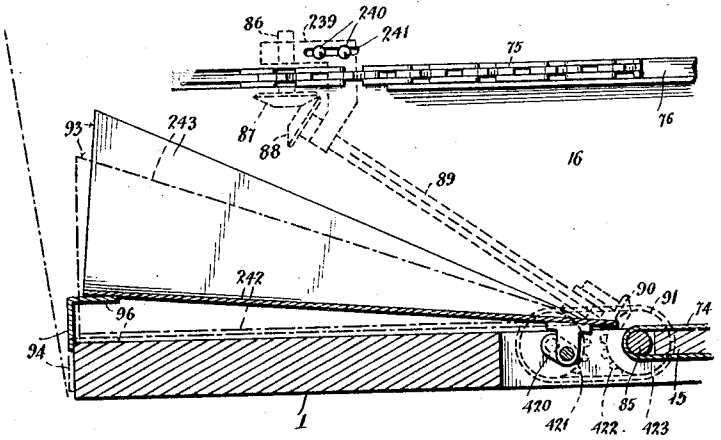


FIG. 13

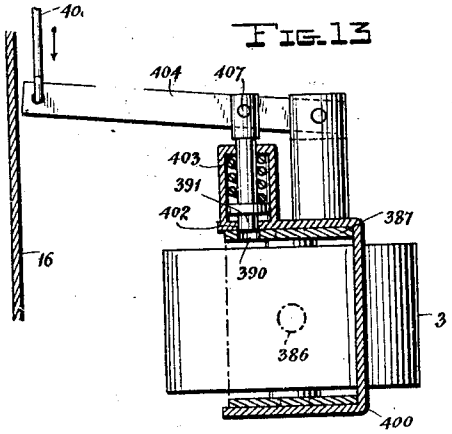


FIG. 15

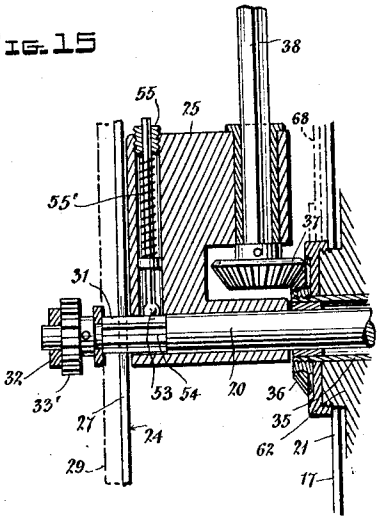


FIG. 14

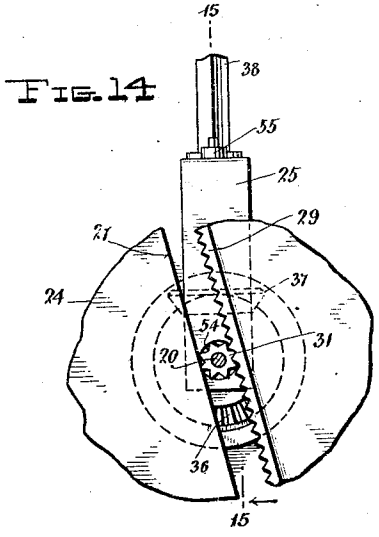
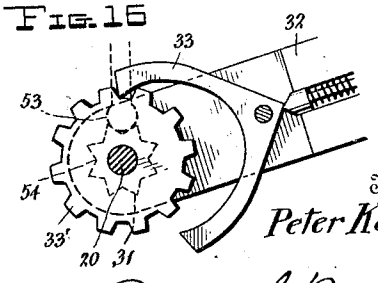


FIG. 16



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Peter Ketelsen,

By Attorney

Nov. 27, 1928.

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P. KETELSEN

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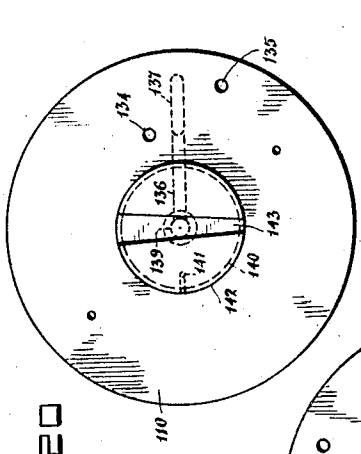


Fig. 20

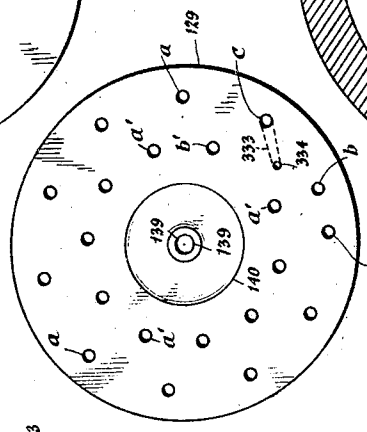


Fig. 18

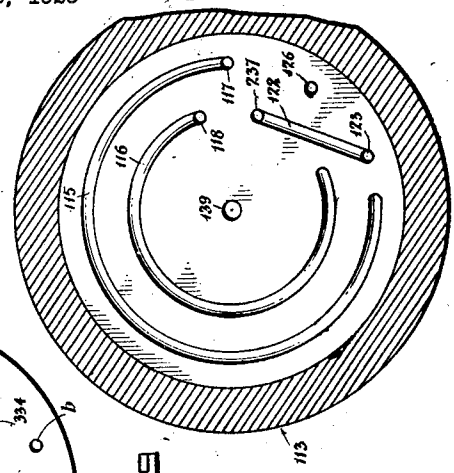


Fig. 19

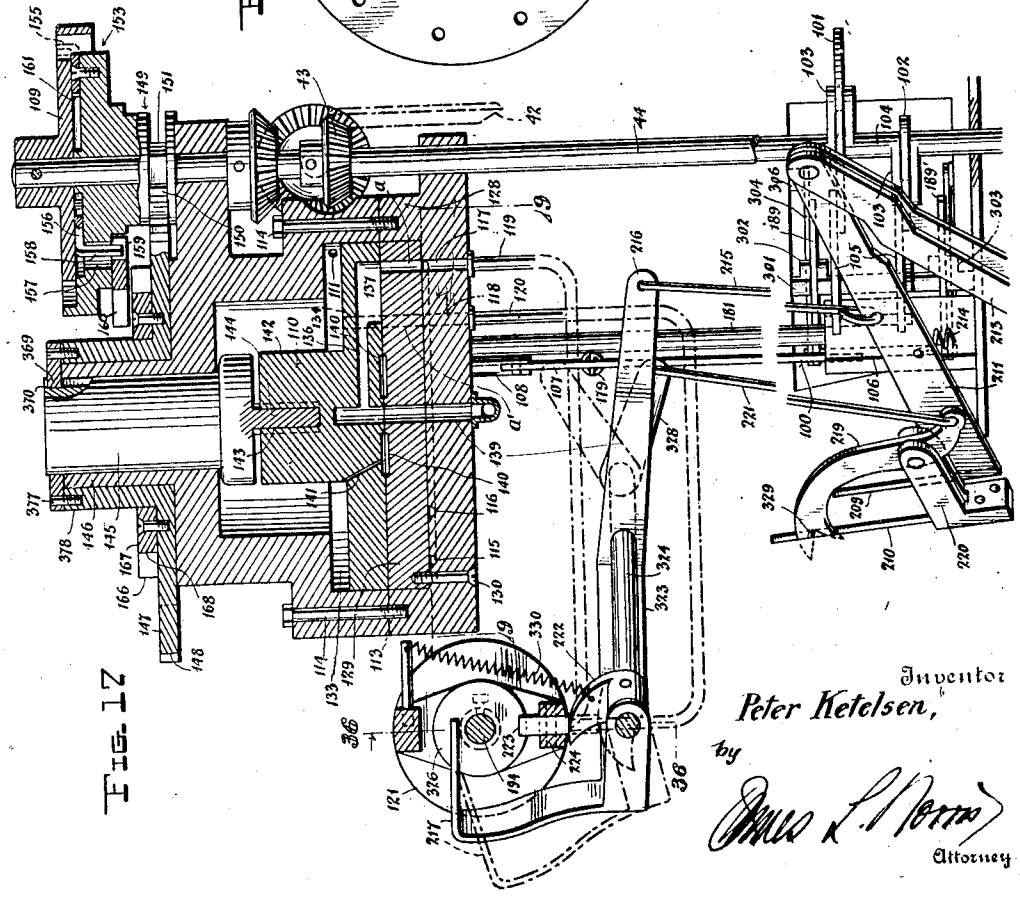


Fig. 17

Inventor

Peter Ketelsen,

by

Attorney

Nov. 27, 1928. 1,692,899

P. KETELSEN

HARVESTING MACHINE

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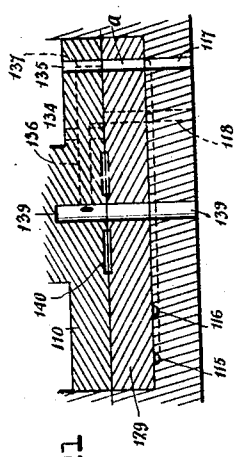


Fig. 21

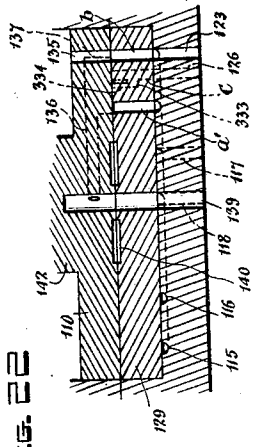


Fig. 22

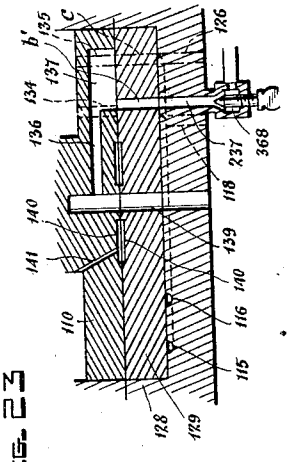


Fig. 23

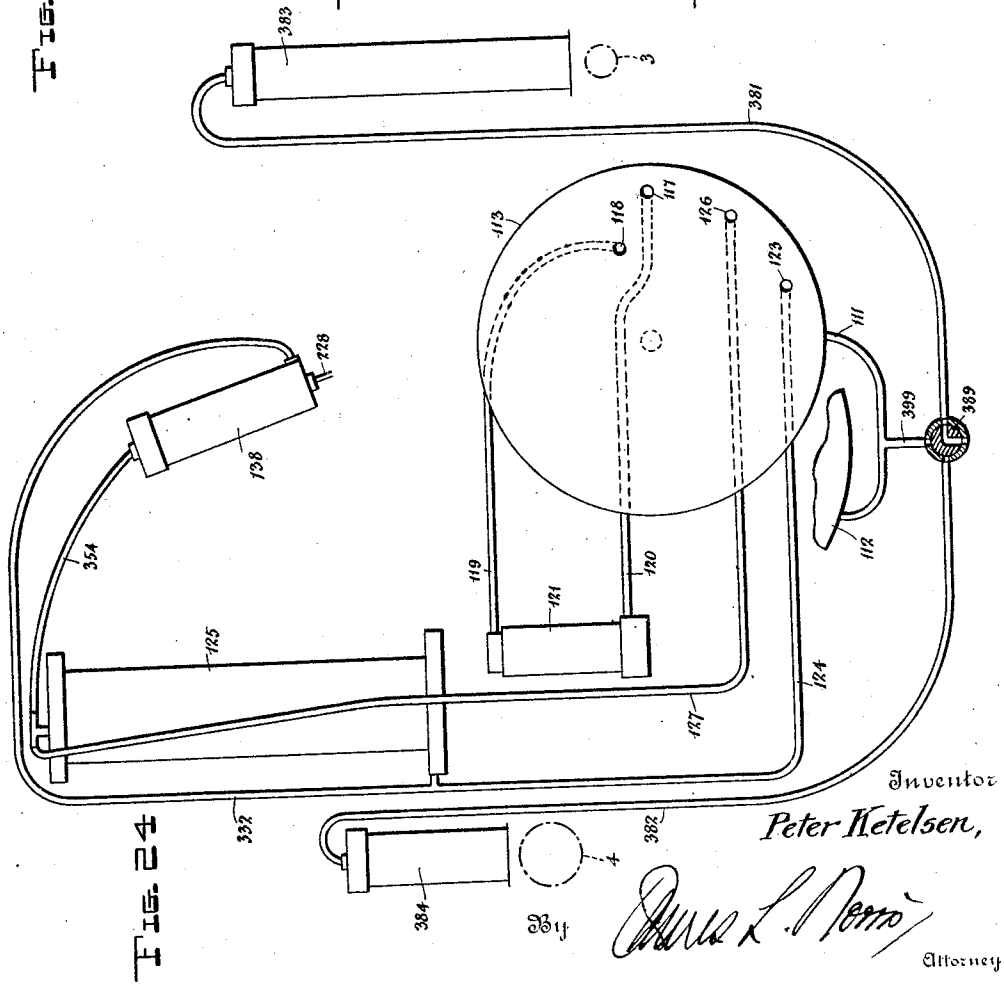


Fig. 24

Inventor
Peter Ketelsen,
By Charles L. Neeno
Attorney

Nov. 27, 1928.

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P. KETELSEN

HARVESTING MACHINE

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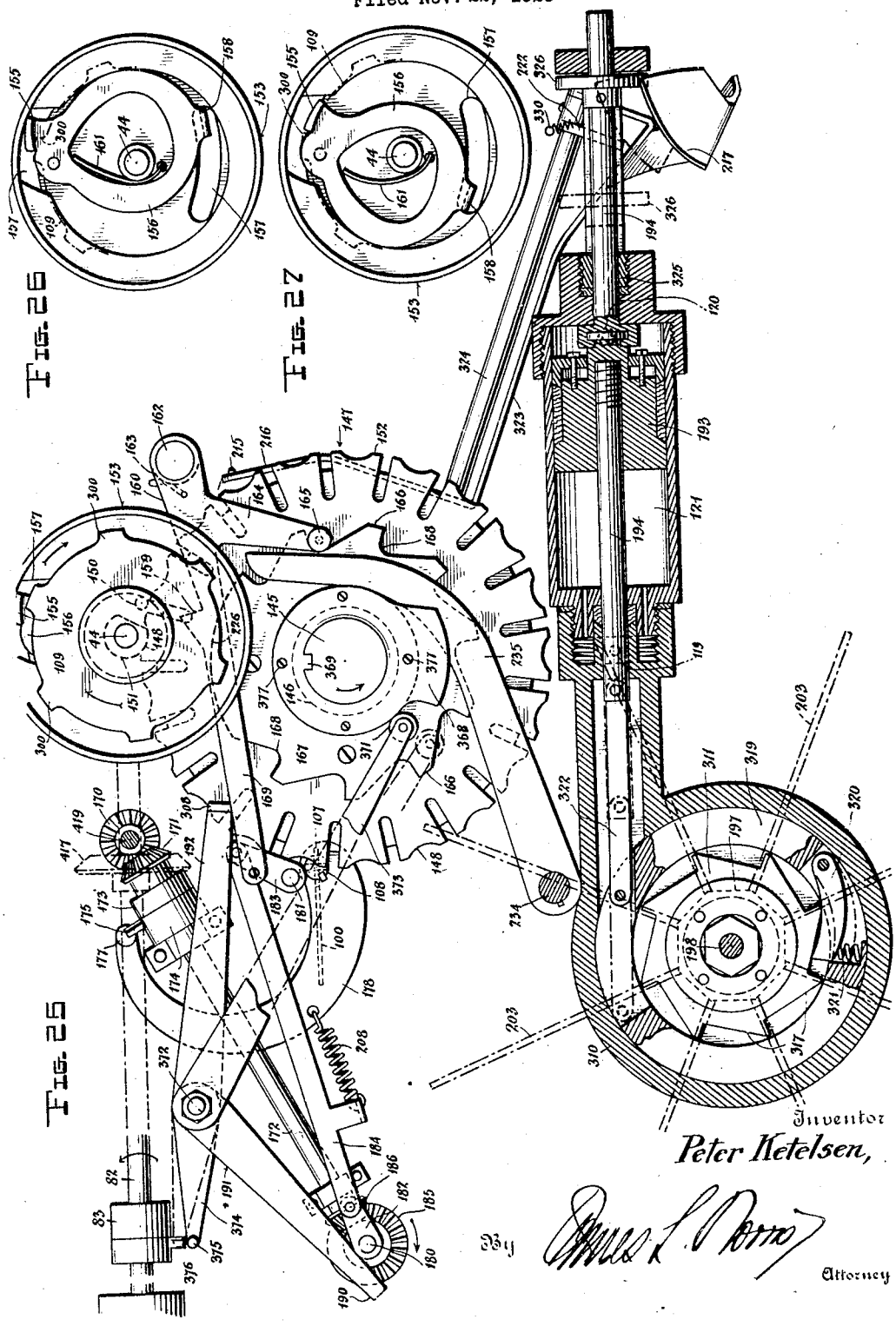


Fig. 26

Fig. 27

Fig. 25

Inventor

Peter Ketelsen,

By

Attorney

Nov. 27, 1928. 1,692,899

P. KETELSEN

HARVESTING MACHINE

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FIG. 28

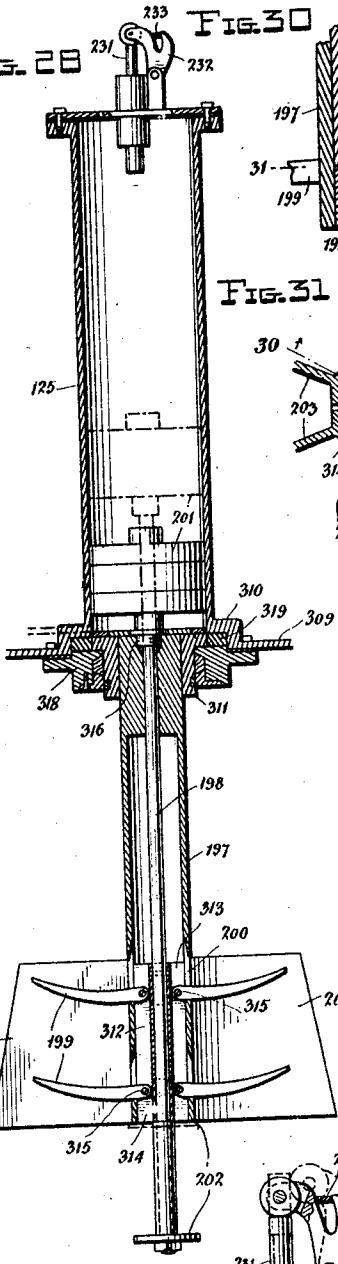


FIG. 30

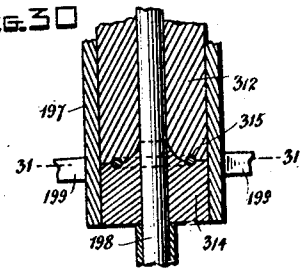


FIG. 31

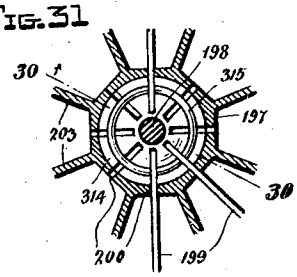


FIG. 29

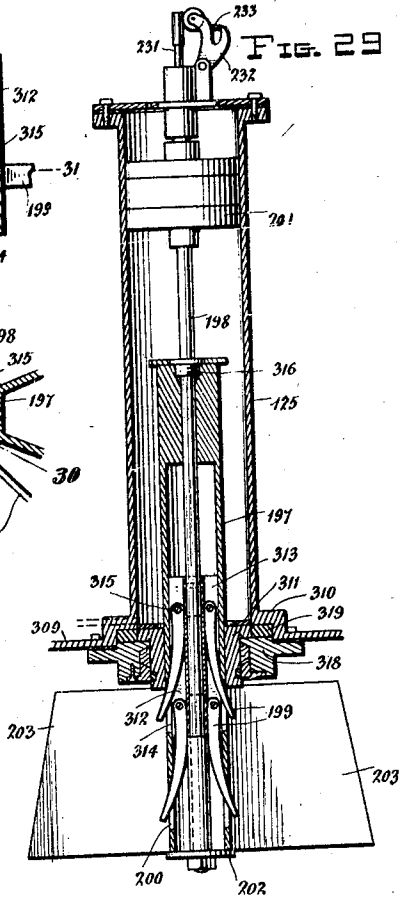


FIG. 33

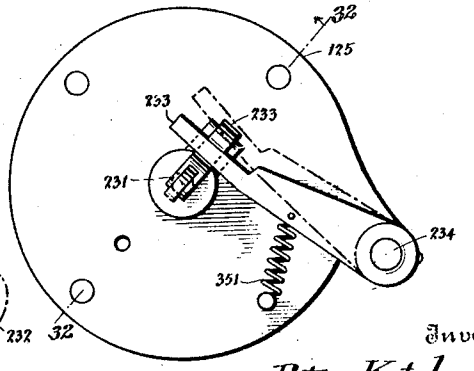
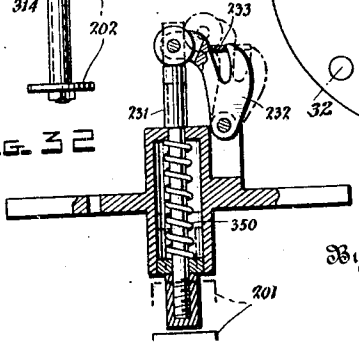


FIG. 32



Inventor

Peter Ketelsen,

By

Attorney

Nov. 27, 1928.

1,692,899

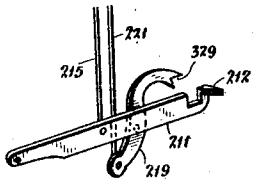
P. KETELSEN

HARVESTING MACHINE

Filed Nov. 22, 1923

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FIG. 37



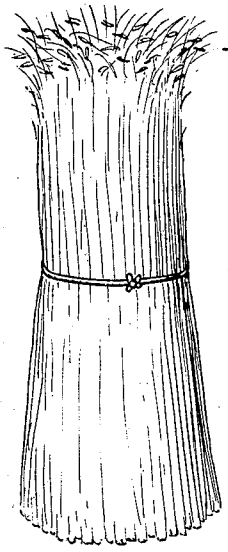


FIG. 38

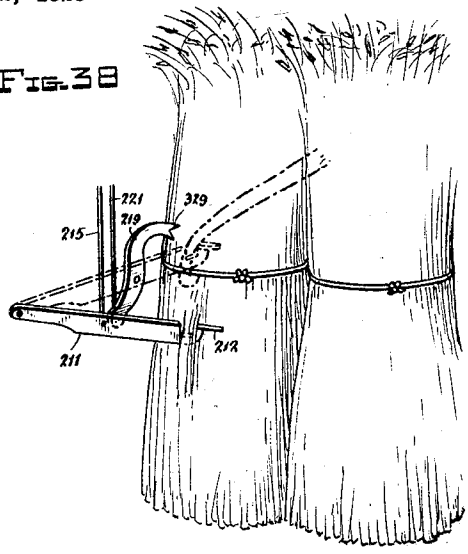


FIG. 39

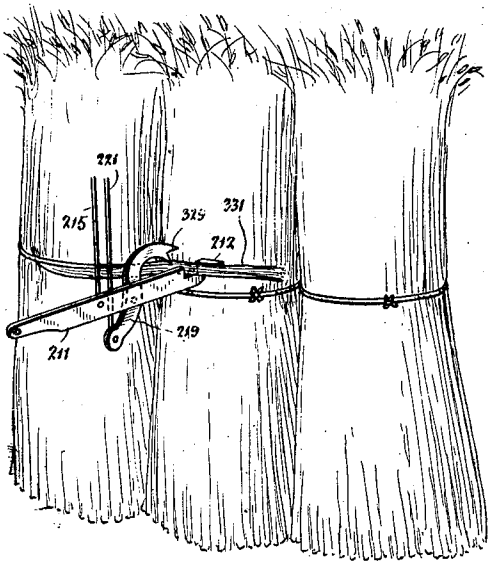
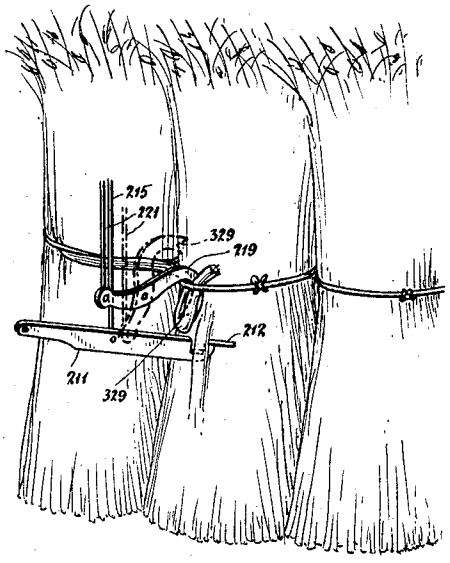


FIG. 40



Inventor

Peter Ketelsen,

By James L. Norris

Attorney

Patented Nov. 27, 1928. 1,692,899

UNITED STATES PATENT OFFICE.

PETER KETELSEN, OF DENVER, COLORADO.

HARVESTING MACHINE.

Application filed November 22, 1923. Serial No. 676,343.

This invention relates to harvesting machines and proposes the construction of a machine in which the grain is cut, bound, formed into a shock and delivered to the field, progressively and by automatic means, and normally without the necessity of human intervention.

The principal object of the invention is to produce a harvesting machine of the shock forming type in which the shock forming and delivering mechanism is operated by fluid pressure, whereby the functioning of the same is made more flexible than is possible with positively mechanically operated mechanism, to the varying conditions of the standing grain.

Other objects of the invention concern themselves with the novel combinations and sub-combinations of structural features which cooperate in the attainment of the desired result, and in the specific details of construction hereinafter described and included within the scope of the appended claims.

Figure 1 is a front elevation, of the shock-forming machine.

Figure 2 is a top plan view.

Figure 3 is an end elevation viewed from the side adjacent the shock-forming chamber.

Figure 4 is a rear elevation with the door of the shock-forming chamber raised and partly broken away.

Figure 5 is a section on the line 5—5 of Figure 1.

Figure 6 is a transverse section through the shock-forming chamber taken along the line 6—6 of Fig. 4.

Figure 7 is a sectional view taken through a portion of the shock-forming chamber in a plane just above the packing arms taken along the line 7—7 of Fig. 4.

Figure 8 is a transverse section through the shock bar showing details of the power transmission mechanism taken along the line 8—8 of Fig. 9.

Figure 9 is a top plan view partly in section of the structure shown in Figure 8.

Figure 10 is a cross section on the line 10—10 of Figure 9.

Figure 11 is a detail of the chute and chute-adjusting means.

Figure 12 is a section on the line 12—12 of Figure 8.

Figure 13 is a section on the line 13—13 of Figure 5.

Figure 14 is a detail of the reel elevating mechanism.

Figure 15 is a section on the line 15—15 of Figure 14.

Figure 16 is a detail of the reel elevating pawl and ratchet.

Figure 17 is a section through the rotary valve taken along the line 7—7 of Figure 2, showing also the straw-tie operating mechanism.

Figure 18 is a plan view of the fixed ported plate of the rotary valve.

Figure 19 is a horizontal section through the lower part of the valve casing taken along the line 19—19 of Fig. 17.

Figure 20 is a plan view of the rotary valve.

Figures 21, 22 and 23 show consecutively, the position assumed by the rotary valve parts when the air supply is in communication with the cylinder end 121, their position when the air supply is connected to the lower end of the cylinder 125, and their position when the lower end of the cylinder 125 is vented to the atmosphere through the exhaust passage.

Figure 24 is a diagrammatic view of the fluid pressure system.

Figure 25 is a section through the means for rotating the sheaf holding magazine, showing also in plan the rotary valve operating mechanism.

Figures 26 and 27 show plan views of the rotary valve clutch pawl respectively in positions of release and engagement.

Figure 28 is a section through the sheaf-holding magazine and operating cylinder with the magazine down taken along the line 28—28 of Fig. 2.

Figure 29 is a view of the same structure with the magazine raised.

Figure 30 is a section showing the attaching means for the impaling spurs taken along the line 30—30 of Fig. 31.

Figure 31 is a section on the line 31—31 of Figure 30.

Figure 32 is a section through the upper end of the cylinder shown in Figure 28 taken along the line 32—32 of Fig. 33.

Figure 33 is a plan view of the upper end of said cylinder.

Figure 34 is a detail view in section show-

ing the levers for actuating the clutch which is concerned in the operation of the rotary valve, and the clutch for severing the driving connection to the conveyer mechanism taken along the line 34—34 of Fig. 2.

Figure 35 is a section on the line 35—35 of Figure 7.

Figure 36 is a detail view of the trip for one of the straw-tie levers.

Figures 37 to 40 inclusive show the straw-tie levers in successive operative positions.

Figure 41 is a detail view of the grain-engaging forks of the reel mechanism.

Figures 42 and 43 are sectional views of the Geneva lock used in controlling the rotary valve.

Referring now in detail to the several figures, the numeral 1 represents a platform supported at its opposite ends by the vehicle wheels 2 and 3. Said platform may be made of any desired shape to suit the requirements of construction and use, but is here shown as comprising a broad portion on the left hand side, as viewed in Figure 2, for the support of the shock forming mechanism, and a narrow elongated portion extending to the right and constituting the frame of the sickle bar and a support for the other features of the harvesting mechanism. For the purpose of determining the width of the wheel base irrespective of the total width of the platform 1 one of the vehicle wheels, for instance the wheel 3, may be secured to said platform at an intermediate point as shown instead of at the end. The platform is provided in front with a hitch 4, affording means by which the machine may be attached to a tractor or other source of locomotive power, which hitch may be raised or lowered to meet the coupling of the tractor by means of a link 395, connected to a hand lever 396 which operates along a detent bar 397. The machine is also designed to obtain power from the tractor through the universal coupling 5. It is also adapted to obtain a supply of compressed air for the operation of the fluid pressure actuated features of the shock forming and delivering mechanism through a supply conduit 6 connected to a suitable air compresser, not shown, but preferably carried by and operated by said tractor.

The sickle bar is of usual construction, having the knives 7 which oscillate between guards 8 the latter being carried by the narrow portion of the platform. In the physical embodiment which forms the basis of the description of my invention, the sickle bar is driven by a crank 9, the latter being pivotally supported on the platform and fixed to a power shaft 12 which derives power from a worm wheel 11 meshing with a worm 13 carried by the shaft 14, which in turn is connected to the universal coupling 5. In order to prevent possible damage to the machine should the mechanism for any reason become jammed, the shaft 14 and the coupling 5 are connected by friction transmission means 10 adapted to afford slippage between the universal coupling and shaft 14 should an undue torque be developed in the operation of said shaft. That portion of the platform which carries the sickle bar is inclined downwardly toward the rear of the machine forming a ledge 15 upon which the butt ends of the cut grain stalks are adapted to rest. Said ledge is surrounded at the rear side and at the ends respectively by a back wall 16 and end walls 17 and 18 which may be formed of sheet metal of appropriate thickness, said walls together forming a rack for the support of the cut grain. The end walls also carry bearings for the reel 19, the specific construction of which will now be described.

Incidentally, it is to be understood that the precise nature of the elements relied upon in the construction of the present exemplary embodiment of the invention, and the particular arrangement of said parts, has been determined rather by the resources at the command of the model-maker than by the requirements of use, and that the invention may later be embodied in other equivalent structural assemblages and arrangements without departing from the inventive principle or principles defined in the appended claims.

The reel is freely mounted upon a rod 20 which passes through slots 21 and 22 formed respectively in the end walls 17 and 18 of the grain racks. Said slots extend in a plane or planes substantially parallel to the plane of the back wall of the grain rack, and are for the purpose of permitting the rod 20, and with it the reel 19 to be adjustably raised or lowered to suit the height of the straw and the condition of the grain to be cut. For instance, if the grain is blown over the reel must be set closer to the ground than would be necessary if the grain were erect. To alter the elevation of the reel involves the provision of means such as the block 25 which affords a bearing not only for the reel rod 20, but also for the shaft through which rotation is imparted to the reel. The block 25 is supported between the end wall 17 and a wall 24 which is arranged parallel to the wall 17 and spaced therefrom. The block is arranged to slide between said walls. The rod 20 is journalled in a bore in the lower portion of the block 25 and has the end 26 thereof extending beyond said block and through a slot 27 in the wall 24. The slot 27 is similar to the slot 22 in the end wall 18 in respect to its length, width, and the direction in which it extends. The slot 21, in the end wall 17, on the other hand, is of greater width, for a purpose which will presently appear. Toothed rack bars 28 and 29 are arranged on the outer faces of the walls 18 and 24 adjacent the slots 21 and 27, and the opposite ends of the rod

20 are provided with pinions 30 and 31 which mesh with the teeth on the respective rack bars. By rotating the rod 20 said pinions are made to roll along the rack bars thus lowering or raising the rod 20 in said slots and with it changing the elevation of the reel. Rotation of the rod 20 is accomplished by means such as the hand lever 32 which is pivotally mounted upon the end of the rod 20 and is provided with a reversible pawl 33 positioned so as to act operably upon the teeth of a pinion 33′ mounted on the inner end of the rod 20. Said rod is detained in any position of adjustment by means of a spring pressed plunger 53, housed in a bore in the block 25 and seatable in any one of the series of depressions 54 formed circumferentially in the surface of the rod 20. Tension of the plunger 53 is determined by adjusting the nut 55 against the spring 55′.

The reel 19 which, as hereinbefore stated is loosely mounted upon the rod 20, is fixedly carried by a sleeve 35 surrounding said shaft. Power is transmitted to said sleeve by intermeshing bevel gears 36 and 37, the former carried by the sleeve and the latter by a shaft 38 which is journally supported in the block 25. Since the block slides relative to the fixed part of the mechanism, power transmission means of variable length must be provided between the gear 36 and the drive shaft 41. This may be accomplished by making the upper part of the shaft 38 polygonal as shown, and passing it through a similarly shaped bore in the hub of the bevel gear 39 shown in Figures 1 and 2, said gear being suitably supported in intermeshed relation with a bevel gear 40 carried at the end of a shaft 41. The latter is driven by a train of gearing including, successively, the gears 42 and 43, the shaft 44, and the gears 45 and 46, the last mentioned gear being carried by the shaft 12 which is in driving relation to the drive shaft 14 in a manner that has already been noted.

The reel proper consists of a pair of spiders 47 and 48 fixed to opposite ends of the sleeve 35 and having radial divergent arms 49 and 50. Pivotally mounted at the ends of said arms are the links 57 between which reel blades 51 extend and to which they are rigidly attached. For a purpose which will soon be explained, the links 57 on one side of the reel, which are associated with the arms 49 of the spider 47, are each provided with a short arm 59 extending upon the opposite side of the pivotal connection of said links with their respective spider arms. Each of the reel blades consists of a flat member 51 having a pivot bar 70 mounted longitudinally thereof and slightly spaced therefrom. A series of dangling forks is mounted upon said pivot bar, with suitable supports 71 intercalated therebetween, said forks including a short arm 73 adapted to engage with said reel blade and a long arm 72 which is adapted to extend in straw raising relation toward the surface of the ground. By virtue of the unequal lengths of the arms 72 and 73 the forks assume a gravital position in which the short arm lies adjacent the reel blade rearwardly thereof, the blade acting as a stop to prevent movement of the fork around the pivot bar in one direction. The effect of this is that when the forks are moved against the grain by the rotation of the reel they are held rigidly in contact with the reel blade by the pressure of the grain, assisting in lifting the latter to the conveyer mechanism on the grain rack which will presently be described. But when leaving the grain near the upper portion of the path of rotation of the reel blades, the forks will be rocked in the act of pulling away from the grain, to an inclined position in which the long arms will leave the grain without dragging it forward into the reel.

It is highly desirable to have the reel blades travel in an oval path having the major axis in a vertical or substantially vertical relation so as to cause the reel blades to travel downwardly between the standing grain stalks without substantially disturbing their natural position, until near the bases of said stalks, when they move substantially transversely sweeping the butt ends of the grain toward the conveyer mechanism, then upwardly in substantial parallelism to the grain stalks, and transversely backward above the level of the grain heads. In order to produce this orbital path for the reel blades means are provided, for producing a simultaneous oscillatory movement of said reel blades about the pivotal axis of the crank levers. The means employed, in the present instance, consists of a ring 61 which is mounted to rotate eccentrically of the axis of rotation of the reel 19 by being carried upon the eccentric peripheral surface of a bearing block 62 through which passes both the sleeve 35 and the reel rod 20, said bearing block being supported by the walls of the slot 21 and rising or falling within said slot as the reel is adjusted to a higher or lower elevation by the means hereinbefore described. The ring 61 is provided with radial arms 60 to which the upper or short arms 59 of the links 57 are pivotally attached. Rotation is imparted to the ring 61 from the positively driven sleeve 35 through the arms 49 of the spider 47 and through the links 57. Since the ring 62 and sleeve 35 are not concentric there will be a relative displacement of the arms 49 and 60 of the spider 47 and ring 61 which gives rise to oscillation of the links 57 about their pivotal axes in the ends of the arms 49. The eccentric bearing block 62 is normally arranged with the point of greatest eccentricity vertical above the axis of rotation of the reel. This causes the orbit

of travel of the reel blades, which is the resultant of the revolution of the reel and the oscillatory movement of the crank levers, to be positioned with a substantially vertical major axis and horizontal minor axis, which fulfils the advantageous requirements above mentioned.

As the grain is not always encountered standing vertically, but frequently blown over so as to be inclined at various angles it becomes desirable to provide means for tilting the major axis of the orbit of travel of the reel blades so that they will handle the straw most efficiently. This is done in the present instance by rotating the bearing block 62 so as to shift the axis of greatest eccentricity. Means for accomplishing this is provided in the form of a lever 64 which is pivotally mounted upon the wall 17 and furnished with a pawl detent 65 engageable with a toothed rack 66 formed on said wall. The lever 64 is provided with an arm 67 engaging a slot in the link 68 which is secured to the eccentric bearing block 62. The slot in said link allows for the rise and fall of the reel when the latter is adjusted for elevation. The effect of shifting the axis of greatest eccentricity of the bearing block 62, is to shift the ring 61 in a translatory manner with respect to the arms of the spider 47 causing the links 57 to rock and so change the angularity of the plane of the flat faces of the reel blades without altering the position of relative parallelism in which they normally lie due to the fact that the crank levers are similar in shape to one another and the reel blades similarly located thereupon.

When the cut grain is laid upon the back wall of the grain rack through the action of the reel, it is engaged by the conveyer mechanism which may preferably be an endless belt 74 travelling along the ledge 15, assisted by a plurality of conveyer chains 75 which are preferably positioned one above the other against the back wall 16 of the grain rack. The endless belt 74 passes over rollers located adjacent the ends of the ledge 15 one of which is shown at 85. The conveyer chains are preferably supported both forwardly and rearwardly of the back wall 16 by guide members 76 and 77, and may be driven by any suitable means. The driving means here shown consists of a shaft 78 mounted upon the rear of the wall 16 and having a sprocket 79 which meshes with the uppermost chain. A shaft 80 is provided at the opposite side of the rear face of said wall, having a plurality of sprockets 81 affixed thereto, with which the several chains are in engagement. The uppermost chain is driven by the sprocket 79, through which power is transmitted to the shaft 80 and to the other chains. The transmission means between the shaft 44 and shaft 78 consists of an intermediate shaft 82 having bevel gears at its opposite ends which intermesh with complementary gears at the adjacent ends of the shafts 44 and 78. A clutch 83 is interposed in said transmission line for a purpose which will be disclosed at a later point in the description. In the present instance the endless belt 74 is driven by power transmitted from the lowermost chain to a stub-shaft 86 mounted upon the rear wall 16 of the grain rack through suitable mechanism including the interengaging bevel gears 87 and 88 and the shaft 89. There will naturally be considerable lost motion due to wear in the endless chains which necessitates that means be provided for taking up said lost motion. This is done in the case of the lowermost chain by shifting the bracket 239 which carries the bevel gears 87 and 88 and the chain sprocket bodily toward the left as viewed from Figure 12 and fixing it in its newly adjusted position by means such as the screws 240 which ply in a slot 241 formed in said bracket. To permit this shift of the gears 87 and 88 the shaft 89 is formed with a polygonal lower portion which splinably fits in a similarly shaped socket in the hub of the gear 90 the latter being likewise suitably supported in intermeshing relation with the gear 91 which operates the driving roller 85 of the endless belt.

As fast as the grain is collected upon the conveyer is passes toward the shock forming mechanism into a constricted passage formed between the back walls 16 of the grain rack and a fixed partition 92. Within said passage, and forming a part thereof is the chute 93. Said chute consists preferably of a flat bottom portion 242, Figures 11 and 12, inclined in substantially the plane of the ledge 15 and having tapering side walls 243 and 244 the height of which increases toward the rearward end of the chute. One end of said chute lies adjacent the belt or roller 85 while the other end is free, resting upon the nose 96 of a supporting bracket 94. Said bracket is adjustably secured by any suitable means such as screws, to a fixed part of the machine, for instance the wall of the shock forming chamber, and affords means by which the free end of the chute may be adjustably raised or lowered. That end of the chute which lies adjacent the roller 85 is pivotally carried by the eccentric pin of a crank 420, the latter being journalled in suitable bearings in the platform 1 and being driven by means such as the sprocket 421 on the crank shaft, and a cooperating sprocket 422 formed integral with or fixed to the bevel gear 91. A chain 423 transmits power to the crank, the rotation of the latter producing both an up and down movement and a forward and backward movement of the chute. These motions have the effect of assisting in adjusting the butts of the cut grain stalks and also facilitate the movement of the grain toward the shock

forming chamber. The object of the chute, as will hereinafter be shown, is to elevate the grain stalks so that the sheaves of grain will be uniformly tied at an intermediate portion regardless of the height of the growing grain. This is essential for the satisfactory performance of the shock forming operation. The bracket 94 is manually set to the proper position of elevation by the operator of the machine according to the degree of tallness of the grain that is to be harvested.

The free end of the chute constitutes a part of the bundle forming chamber in which the grain is collected and tied into a sheaf before delivery into the shock forming chamber. The latter lies adjacent the free end of the chute 93 and is preferably formed by a frusto-conical wall comprising a fixed front portion 97 and a rearward hinged portion forming a door 98 capable of assuming closed relation with respect to the fixed portion during the shock forming period, and of being opened thereafter leaving the shock upon the ground as the machine continues its forward travel, the platform 1 being so shaped as to leave the shock forming chamber bottomless. When the door 98 is closed there remains a permanently open passage 99 leading from the free end of the chute into the shock forming chamber, through which a sheaf, under certain conditions, may enter in order to take its place as part of the forming shock. A plate 100, however, normally projects across the passage 99 and acts as a barrier to the entrance of grain into the shock forming chamber until said grain has been formed into a sheaf of predetermined and uniform size.

The grain which falls upon the conveyer mechanism is progressively gathered against the plate 100 by the action of the packing arms 101 and 102. Said arms are arranged as superposed levers each pivotally mounted at an intermediate point to oppositely arranged cranks 103 on a shaft 104. The remote ends of said packing arms are pivotally connected to swinging links 105, the latter being pivotally mounted to a fixed part of the machine, such, for instance as, the block 106. Because of the connection of the packing arms to the cranks 103 and to said swinging links, rotation of the shaft 104 imparts to the free ends of said packing arms, which project through slots in the partition 92 into the path of the oncoming grain, a more or less elliptical motion so that each packing arm withdraws itself from the path of the grain when it reaches a point adjacent the plate 100 and remains retracted until it reaches a forward position when it is again projected operatively into the path of the moving grain. The opposite arrangement of the cranks 103 upon the shaft 104 gives an alternate movement to the packing arms.

The plate 100 forms the angular end of an upwardly extending bar 107, the top part of which is pivotally connected to a shaft 108 in such manner as to be capable of two motions, an oscillatory movement axially of the shaft 108, by which an oscillatory movement is imparted to said shaft, and a swinging motion relative to the shaft. The oscillatory motion of the bar 107 is performed when a fully formed and tied sheaf pushes, with predetermined pressure against the angularly shaped plate 100 and the swinging motion is performed through means which will presently be described, and has for its purpose to withdraw the plate 100 from the path of the sheaf when the latter has achieved sufficient proportions to be ready for admission to the shock forming chamber. It may be here stated parenthetically that the grain, impelled by the packing arms against the plate 100 runs into a loop of binder twine which lies across its path and is bound into a sheaf by the usual knotting mechanism. The latter not being a part of the present invention has been omitted from the drawings and description in the interest of clarity, with the exception of the element 416, shown in Figure 7, which represents the base of the needle which carries the binder twine, the rest of the needle being broken away.

Those parts of the mechanism of my improved harvesting and shock forming machine which are continuously and positively driven by purely mechanical means have now been described with the exception of the single clutch element 109 which is secured, in the illustrative embodiment of my invention shown in the drawings, at the top of the vertical shaft 44. This clutch element is provided peripherally with a plurality of teeth 300 and is adapted to cooperate with a complementary clutch element 153, at times which may be determined by any one of several instrumentalities associated with the shock forming machine and which will in due course be described. The clutch formed by these two elements controls means for driving the rotary valve 110 the purpose of which is to distribute fluid pressure to the various means, the functions of which coordinate in the performance of the shock forming operation. Fluid pressure is supplied to the upper face of the rotary valve through a conduit 111 leading from a compressed air storage tank 112. This tank, in practice, may be of any desired shape and located at any convenient point upon the machine but I have found it convenient in the present embodiment of the invention to form the tank as a jacket partially surrounding the outside of the wall of the shock forming chamber.

The rotary valve 110 is seated within a preferably two-part casing 113, said parts being secured together in any suitable manner as by cap screws 114. The lower part of said casing is formed with a pair of concentric

arcuate grooves 115 and 116 which terminate at one end in the respective apertures 117 and 118, said apertures passing through the lower part of the valve casing and being connected by the conduits 119 and 120 to the opposite sides of the plunger cylinder 121 the function of which will hereinafter appear. The lower part of the casing is provided also with an inclined groove 122 which terminates at its opposite ends in the produced circumferences of the grooves 115 and 116, but out of communication with said grooves. The outer end of the groove 122 terminates in an aperture 123 which extends through the lower part of the casing and is connected by a conduit 124 with the lower ends of the cylinders 125 and 138, the purpose of which will presently be explained. The opposite or inner end of the groove 122 is blind. The grooves 115, 116 and 122 open in the upper surface of the wall of the lower part of the casing, which is carefully machined. The lower part of the casing is also formed with an aperture 126 which extends clear through the wall of said casing part and is connected by conduit 127 and 354 with the upper ends of the cylinders 125 and 138. The aperture 126 is in the projected circumference of the groove 115, but isolated from any of the grooves or apertures heretofore mentioned.

The lower casing part is flanged as shown at 128, being thus formed with a depression in which is seated the relatively fixed ported plate 129. This plate is secured to the lower casing part in any suitable manner as by the screws 130 and is formed with concentric series of ports, one of said series registering with the groove 115 and with the apertures in the projected circumference of said groove and the other registering with the groove 116 and with the blind end of the groove 122. Eighteen of said ports, namely those designated by the reference characters *a* and *a'* are concerned with the operation of the cylinder 121. The ports marked *b*, *b'* and *c* figure in the operation of the cylinders 125 and 138. The ported plate is formed with a groove or channel 333 extending to a point intermediate the ports *b* and *c* and between the inner and outer series of ports, at which point it terminates in an exhaust port 334 opening in the upper face of said ported plate. The upper part of the casing 113 is formed with a valve chamber 133 which snugly fits the peripheral surface of the rotary valve 110 and guides it in its rotary movement. Said chamber is of such size as to afford an air space above said valve, with which space the compressed air supply conduit 111 communicates as shown in Figure 17. The rotary valve is formed with a pair of apertures 134 and 135 extending therethrough and so placed as to register respectively with adjacent ports in the inner and outer concentric series as the valve is rotated. An exhaust passage 136 is arranged in said rotary valve at equal radial angles between the apertures 134 and 135, said exhaust passage opening in the lower face of the rotary valve in the form of a slot 137 of sufficient length to lie in the path of both the inner and outer series of ports in the ported plate 129. The exhaust passage 136 communicates with a vertical discharge passage 139 formed by permanently registering bores in the rotary valve, ported plate, and lower part of the casing, and opening to the atmosphere. The rotary valve 110 is normally held in gas-tight relation against its seat upon the ported plate 129 by pneumatic pressure derived from the air in that part of the chamber 133 above said valve. In order to prevent said pressure exerting too great a frictional contact between the rotary valve and its seat, the abutting faces of said members, if desired, may be formed with registering annular grooves 140 communicating with the chamber 133 by a bleed passage 141, providing a counter-pressure upon the lower face of the rotary valve which may be designed to assume any desired value depending upon the area of the grooves 140. The rotary valve is provided with a boss 142 having a slot 143 in its upper face, said slot tapering longitudinally and being engaged by a similarly shaped interlocking projection 144 on the lower end of a coupling element 145. The object of the asymmetrical shape of said slot and the projection is to ensure that the rotary valve always shall be connected in the same relation to the coupling member when reassembling the parts, so that the synchronous operation of the valve with the other parts of the machine shall not be disturbed. The coupling element 145 makes a sealing fit with a hollow boss 146 formed on the upper part of the casing, and within which it is rotatable.

Secured in any suitable manner to the coupling element is a notched disk 147 which constitutes the means for rotating the rotary valve. Said disk in the present embodiment of the invention is provided with twenty-one notches, and between said notches the peripheral surface of the disk is formed with shallow arcuate depressions 148 which terminate short of said notches leaving slight projecting shoulders 152.

The shaft 44 arises adjacent the notched disk 147 and has freely mounted thereupon the actuating means 149 by which step by step rotation is imparted to the notched disk. Said actuating means includes a pin 150 arranged concentrically of the axis of rotation of said actuating means and which is adapted to fit into the notches of said disk and by its own rotation to cause the disk to progress through a predetermined angle. An arcuate barrel 151 is arranged concentrically upon the actuating means, being cut away adjacent the pin 150 to form a space between said pin

and said barrel to allow for the passage of the shoulders 152 while the actuating means and notched disk are rotating. Said arcuate barrel is formed with a curvature of such a degree as to permit it to fit into the curvilinear depressions of the notched disk between the rotative steps of the latter, affording a locking means to temporarily arrest any tendency on the part of the notched disk to move. During the period while the notched disk is locked the ports in the rotary valve are maintained in registry with ports on the ported plate 129. The cut-away portion of the barrel 151 permits passage of the shoulders 152 relative to said actuating device during the normal period of movement of the notched disk while the pin 150 is transversing the notches.

The actuating means 149 is fixed to the clutch element 153, previously mentioned, which freely rotates upon the shaft 44 and engages the clutch element 109, also previously mentioned, which is fixed to said shaft. The clutch element 153 is here shown as having the form of a flanged disk in which the fixed clutch element 109 is housed. The teeth 300 of said clutch element engage with the nose 155 of a pawl 156, the latter being pivotally mounted upon the clutch element 153 and having the nose 155 projecting above the plane of the teeth 300. The pawl 156 being mounted eccentrically to the axis of rotation of the fixed clutch elements, the nose 155 will travel radially outward when the pawl is swung in one direction, clearing said teeth, and inwardly when the pawl is swung in the other direction, into the path of said teeth. In this latter position the clutch elements are engaged, and a positive drive is imparted to the actuating means 149. The pawl is swung to clutch release position by the engagement of a lug 158, which extends angularly of said pawl through a slot 157 in the flanged disk, with a shoulder 159 on the clutch controlling lever 160, and said pawl is normally held in position of clutch engagement when not in contact with said shoulder by means of a leaf spring 161 or its equivalent. The latter position of the pawl is indicated in Figure 27.

The clutch controlling lever 160 is pivotally mounted upon a fixed part of the machine as shown at 162 and is normally spring-pressed, by the spiral spring 163, into a position in which the shoulder 159 engages the lug 158 of the pawl to hold the clutch in position of release, as aforesaid. Said lever comprises two arms, a shorter arm 164 which, in the illustrative embodiment of the invention is provided with a roller 165 adapted to progressively ride over the cam surfaces 166 formed on the cam member 167, or, alternately, to lie in the notches 168 formed between said cam surfaces. The cam member 167 may be formed integral with or attached rigidly to the notched disk 147. The longer arm 169 of the lever projects into the path of the sheaf actuating mechanism now to be described.

A gear 417 on the shaft 82 meshes with a gear 418 on the stub shaft 419, through which power is transmitted to the gear 170 on said stub shaft. The latter gear meshes with a complementary gear 171 sleeveably mounted upon the jack shaft 172. Said gear and said shaft are provided with the complementary clutch elements 173 and 174 which may be engaged, in driving relation by means of a pawl 175 on one of said elements engaging an internal element on the other, not shown. The pawl 175 is normally maintained in the position of clutch disengagement by abutting against a pin 177 carried adjacent the end of an arm 178, the latter being fixedly mounted upon the shaft 108 which, it will be recalled, is oscillated by the pressure of a sheaf against the plate 100 which forms the angular end of the bar 107 which is pivotally secured to the shaft 108 in such a way as to limit its oscillatory movement to a single plane. This may be understood from a study of Figure 25. The plate 100 and the arm 178 are normally held in inactive position with the pin 177 in contact with the pawl 175, by a spiral spring 179 which is anchored to a fixed part of the machine. When the parts are in this position the jack shaft 172 lies idle while the reel, conveyer and packing arms are being driven.

Upon the accumulation of a sheaf of suitable size against the plate 100 under the action of the packing arms 101 and 102, the pressure of said sheaf against the plate 100 oscillates the plate, the bar 107 and the shaft 108 against the tension of the spiral spring 179 causing the pin 177 to be moved away from the pawl 175. This throws the clutch elements 173 and 174 into engagement, and the jack shaft 172, previously inactive, begins to rotate. This puts into action a set of mechanism, also previously inactive, and consisting of a pair of shafts 180 and 181, which are provided respectively with the cranks 182 and 183, said cranks being joined by a link 184 pivotally connected thereto at their outer ends. The shaft 180 is furnished with a bevel gear 185 which is in mesh with a complementary gear 186 on the jack shaft 172 and by means of which the shafts 180 and 181 are driven. The shaft 181 is provided with an arm 187 which strikes the bar 107 and swings the plate 100 from its position across the passage which leads to the shock forming chamber opening the latter to the reception of the sheaf. The shaft 181 does not rotate but normally oscillates through a wide arc so that after the bar 107 has been swung outwardly by the arm 187 it returns to the normal position under the influence of the spiral spring 179 upon the recession of said arm, the angular plate 100 again barring access of

grain to the shock forming chamber. At or about the time the plate 100 is withdrawn from its normal closed position, the shaft 180 operates a pair of kicker bars 189 and 189′ which push the sheaf into the shock forming chamber. In the illustrative embodiment of the invention the shaft 180, which is shown in Figure 6 as being universally jointed to permit its opposite ends to lie in different axes, has the lower end 301 thereof formed with a pair of cranks 302 and 303 disposed in the same plane. The kicker bars 189 and 189′ are mounted at points intermediate their ends upon said cranks and have the back ends thereof pivotally connected to a crank 304 the latter being pivotally mounted at 305 to a bracket 306 carried by a fixed part of the machine. The combined effect upon the kicker bars 189 and 189′ produced by the rotation of the cranks 302 and 303 and the oscillation of the crank 304 is to project said kicker bars at intervals back of a sheaf as it lies against the plate 100 and to push the same into the shock forming chamber as the plate 100 is withdrawn. Between the formation of successive sheaves the kicker bars are withdrawn from the path of travel of the grain.

Immediately after the sheaf has entered the shock forming chamber, continued rotation of the crank 182 brings the end of the latter into contact with one arm 190 of a rocking lever 191, which is fixed to a sleeve 307, the latter being journalled in a vertical support which in this case is the rock shaft 372. This sleeve has another arm 192 the upturned end 308 of which is adapted to engage with the long arm 169 of the clutch lever 160 when the arm 190 is moved outward by said crank. When this engagement takes place the lug 158 of the pawl 156 is released, the tension of the spring 161 causing the end 155 of said pawl to swing inwardly into the path of the teeth 300 on the fixed clutch element 109. The arm 178 which carries the pin 177 is connected to the link 184 by means of a spiral spring 208, so that after the pin 177 has been moved from its position of engagement with the pawl 175 the outward movement of the link 184 produces a tensioning of the spring 208 which holds the pin 177 away from its engageable position until after the crank has made substantially a complete revolution and the link has receded again to its original position in which tension of the spring 208 is relieved.

It will be recalled that the shaft 44 and the toothed clutch element 109 which it carries are continuously driven, so that when the nose 155 of the pawl 156 has moved inwardly in the manner just described, it will be engaged by one of the teeth 300 in the course of the rotary movement of said teeth, locking the parts of the clutch together and causing rotation of the actuating means 149 so that the pin 150 enters into one of the notches of the notched disk 147, rotating said disk and with it moving the rotary valve 110 through a definite angle. When the pin has left the notch, the arcuate barrel 151 immediately registers with the adjacent arcuate depression 148 locking the notched disk temporarily against further movement in the manner already described.

Before tracing the sequence of events in the fluid pressure system which follow the successive positions assumed by the rotary valve, the description will proceed to the sheaf-holding magazine within the shock forming chamber. The cylinder 125 rests upon the upper wall 309 of said chamber axially thereof and is formed at the base with an off-set annular portion 310 which forms a housing surrounding an opening in said wall beneath said cylinder. A bushing 311 is rotatably but non-reciprocably mounted within said opening, the bore of said bushing being of polygonal shape. The stem 197 of the sheaf-holding magazine is of similar shape and adapted to slide non-rotatively through said bushing and into said cylinder. Said stem is provided at its lower end with a plurality of radially disposed partitions 203 sufficient in number to form compartments between them equal to the number of sheaves required to constitute a shock. In the present machine it is assumed that eight sheaves form a shock although the number is purely arbitrary and machines may be built for incorporating any number of sheaves into a shock without departing from the scope or spirit of the invention. The stem 197 is hollow for a portion of its length and a rod 198 passes longitudinally therethrough, said rod being provided with means for carrying pivotally mounted impaling spurs 199 which are adapted to project through slots 200 in the stem 197, said slots being arranged to open into each compartment. These means consist, in the present instance of an intermediate thimble 312 which freely surrounds the rod 198 and which cooperates both above and below with nuts or collars 313 and 314 the latter being pinned or otherwise rigidly secured to said rod. The abutting faces of the thimble 312 and the collars or nuts 313 and 314 are formed with registering annular grooves forming seats for metallic rings 315. Said thimble and said collars or nuts are longitudinally slotted in line with the slots 200 and the impaling spurs are strung upon the metallic rings and extend through said slots. The rod 198 is attached to a piston 201 which reciprocates within the cylinder 125 at proper times later to be designated, and upon its upper stroke substantially withdraws the impaling spurs into the stem 197, the upper ends of the slots 200 being appropriately inclined to permit this operation. The impaling spurs are preferably slightly curved so that when in retracted position the points thereof

are not withdrawn entirely within the stem. A stuffing box 316 surrounds the rod 198 where it passes through the upper end of the stem 197 and prevents leakage of fluid pressure from the lower end of the cylinder 125 at this point. The lower end of the rod 198 projects below the stem 197 when the impaling spurs are extended so that when said rod is drawn up its first function is to retract said spurs. A head 202 is formed or otherwise secured to the lower end of the rod 198 and is of sufficient size to engage the lower end of the stem 197 after the impaling spurs have been retracted to draw said stem upwardly into the cylinder 125. The stem 198 is of such length that when in extended position the partitions are maintained a desirable distance above the surface of the ground, the chute 93 cooperating with said partitions in a manner previously explained, to deliver the grain thereto at the proper elevation regardless of the tallness of the straw. The bushing 311 is formed at its upper end with a flange cut or shaped to form ratchet teeth 317. A stuffing gland 318 surrounds said bushing below said flange and forms with the off-set portion 310 an annular channel in which is seated an oscillatory ring 319. This ring is provided with a pawl 320 which is constantly urged into engagement with the ratchet teeth by means of a spiral spring 321, and the ring is pivotally connected to a link 322, which in turn is pivotally connected to a rod 194 which passes into the cylinder 121 and is connected to the piston 193. By this means step-by-step rotation is imparted to the stem 198 through the bushing 311 so that the compartments formed between the partitions 203 are brought successively into sheaf receiving relation to the kicker bars 189 and 189′ by which the sheaf is pushed into a compartment and impaled upon one pair of the spurs 199. The shock forming chamber being bottomless, the impaling spurs are relied upon as means for supporting the sheaves above the surface of the ground within the sheaf holding magazine. The stem 197 serves so that when the latter is discharged from the shock forming machine it is provided with a central opening or ventilating chimney.

From the structure which has been described so far it will now be possible to trace the functioning of certain parts of the fluid pressure system. Supposing that the sheaf which causes the shifting action of the clutch control lever 160 is the first sheaf to enter the shock forming chamber, the initial movement of the rotary valve under the action of the pin 150, over the angular distance of one step represented by the space between adjacent notches places the aperture 134 of the rotary valve over the first port designated as a' in Figure 18 at the right hand side of said figure. This port is in communication with the groove 116, the latter in turn communicating through the aperture 118 and conduit 120 with the inner end of the cylinder 121. Fluid pressure which is constantly on supply in the valve chamber 133 passes through the several passages thus put into registry and enters the inner end of the cylinder 121, forcing the piston 193 outwardly carrying with it the rod 194, and oscillating the ring 319 in a direction to cause the pawl 320 to engage with the abrupt sides of one of the teeth 317, thereby rotating the sheaf holding magazine an angular distance which places the first compartment and the sheaf therein contained in operative position with regard to the straw tying mechanism to be described later and the adjoining empty compartment in a position to receive the second sheaf upon the withdrawal of the plate 100. By doing this, the first and second sheaves are tied together by the action of the second inward stroke of the piston 193.

The shaft 44 rotates at such speed that it turns twice while the roller 165 on the clutch release lever 160 is traversing the distance of one notch, so that when the pin 150 enters the second of the notches in the notched disk 147 said roller is on one of the cam elevations 166, holding the lever 160 still in position of clutch engagement and permitting the pin 150 to move the rotary valve through another step of its angular movement. This places the port 135 of the rotary valve in communication with the first of the ports marked a, shown at the right of Fig. 18, which port is in permanent communication with the groove 115 and the aperture 117, the latter communicating with the conduit119 which leads to the outer end of the cylinder 121. At the same time, the exhaust passage 137 is in communication with the first of the ports a' venting the inner end of the cylinder 121 to the atmosphere. This causes the piston 193 to move inwardly, carrying with it the rod 194 and oscillating the ring 319 in a direction to cause the pawl 320 to ride freely across the sloping faces of the ratchet teeth 317. It will thus be understood that no movement of the sheaf holding magazine takes place on the inward stroke of the piston 193.

The straw-tying mechanism comprises two levers which are shown in detail in Figure 35 and the operation of which may readily be comprehended from an inspection of the series of figures from 37 to 40 inclusive. These levers have straw-tying extremities which project through vertical slots 209 and 210 formed in the wall of the shock forming chamber adjacent the position of the sheaf in the second stage of its step by step movement. One of these levers, 211 has a horizontally directed hooked nose 212 which is adapted to catch into the body of the sheaf below the encircling binder twine and to segregate a wisp from the body of said sheaf. The lever 211 is pivotally supported by suit-

able means such as the bracket 213 and is normally held downward by the spiral spring 214. A link 215 is pivotally connected to said lever at an intermediate point which link at its other end is pivotally joined to the arm 216 of a rocking lever 323 suitably supported to rock, being here shown as journally mounted upon the rock shaft 324 which operates the other straw-tying lever. The outer end of the rocking lever 323 is provided with a cam 217. The piston 193 is furnished with a rod 194 which projects through a stuffing gland 325 at the outer end of the cylinder 121, said rod being provided with a disk 326 for operating the straw-tying elements. When the piston is at the outer end of its stroke the disk 326 holds the cam 217 distantly from the rod 194, maintaining the rocking lever in a position in which the link 215 holds the lever 211 in the elevated position indicated in Figures 37 and 39. When the piston 193 moves inwardly, the slope of the cam 217 causes the latter to move toward the rod 194 permitting the lever 323 to fall and causing the link 215 to depress the lever 211 to the position shown in Figures 38 and 40.

The other straw-tying element consists of a lever 219 pivotally mounted intermediate its ends to a fixed support such as the bracket 220. Said lever is connected by a link 221 to an arm 328 on the rock shaft 324. Said rock shaft is provided at its outer end with a cam 222, shown in Figure 36, the latter being engageable by a trip 223 which is pivotally mounted intermediate its ends upon a fixed member 224 adjacent the disk 326. The upper end of said trip is engageable by said disk. When the latter moves inwardly the lower end of the trip is forced against the cam 222 and depresses the same, rocking the rock shaft 324 in a direction to raise the link 221 and to depress the forked end 329 of the straw-tying lever 219. When the disk 326 moves in the opposite direction it rides over the upper end of the trip 223 to the opposite side thereof permitting release of the cam 222 and a return of the rock shaft 324 to its normal inactive position in which the working end of the straw-tying lever 219 is elevated to the position shown in Figures 35 and 38. The rock shaft is urged to its return position by the tension of the spring 330.

The piston 193 first moves outwardly, the first sheaf at x, being moved to the position indicated by Y in Figure 7. At this time the collar 326 moves outwardly and engages the trip 223 at its upper end causing it to rock and after passing it to fall against cam 222 so as to become operative on the next inward stroke. While the piston 193 is making this first outward movement and the sheaf to the position indicated by Y in Fig. 7, a wisp of straw has been caught upon the hook end 212 of the lever 211. While the sheaf is being moved to this second position the straw-tying lever 211 is being forced upwardly due to the engagement of the disc 326 with the cam 217 near the end of its outward movement. The effect of this upward movement upon the straw is to raise the wisp horizontally to a position slightly above the binder twine. Previous to this on the inward stroke of the piston 193 and the rod 194, the lever 219 has been permitted to rise through release of the cam 222 on the rock shaft 324. On the next inward stroke of the piston the lever 219 is forced downward and into the sheaf in position at Y Fig. 7, this however being an idle stroke in so far as the tying of one sheaf to the other is concerned, but moving pawl 320 to a position to turn the sheaf holding magazine through another stage of its movement, a second sheaf being at the same time admitted to said magazine. Upon the next outward stroke of the piston, the lever 211 not only raises the wisp of straw of the first sheaf above the level of the binder twine as on the previous upward stroke but the rotation of the sheaf holding magazine carries the first sheaf to the third position, causing the hook end of the lever 211 to drag the wisp horizontally as shown at 331 in Fig. 39. There are now two sheaves in the magazine, the last one being at Y Fig. 7. Both are in a position to be tied together. On the second inward stroke of the piston 193, the lever 219 is forced downwardly, the hooked end 329 thereof engaging the wisp of straw and tucking it beneath the binder twine of the second sheaf. Simultaneously the lever 211 is depressed, burying itself in the loose portion of the second sheaf below the binder twine where it engages a wisp in readiness to elevate the same when the piston 193 performs its next outward stroke.

This action continues until each of the eight compartments of the sheaf-holding magazine contains a sheaf, which sheaves have been united into a continuous series in the manner described. It is to be understood that between every complete reciprocation of the piston 193, the roller 165 of the clutch release lever 160 drops into the bottom of one of the notches 168 in the cam carrying member 167 permitting the clutch release lever 160 to fly back under the influence of the spring 163 into the position of engagement with the pawl 166, releasing the clutch. The rotary valve therefore does not operate with any constant time periodicity but by step-by-step rotation, depending entirely upon the pressure of a sheaf of normal proportions against the plate 100, so that the periodic movement of the shock forming magazine and the straw-tying mechanism depends solely upon the time that it takes a sheaf to accumulate. Thus it matters not whether the harvester is travelling over a field of thin grain or one with a heavy stand of straw. In the former case the magazine rotates more slowly and the straw-ty-

ing operation is performed at commensurately longer intervals.

The first sixteen notches in the notched disk 147 are concerned with the performance of the first sixteen strokes of the piston 193 which are necessary to rotate the magazine through a complete revolution, during which cycle it has received and tied in series eight sheaves. It now becomes necessary for the piston 193 to reciprocate out and in once more for the purpose of performing the straw tie between the eighth sheaf and the first sheaf, uniting the series of sheaves into the endless circle which constitutes the shock. It is of course desirable that no sheaf be permitted to enter the shock forming chamber during the performance of the final straw-tying, while the magazine is already full, so that instead of the magazine awaiting the formation of another sheaf before being tripped thereby to rotate another step, the rotary valve is relieved from control of the sheaf operating mechanism and is placed under an independent control by means of the broad cam 226 on the cam member 167, adjacent the series of notches 168. This cam holds the roller 165, and consequently the clutch control lever 160 away from the lug 158 on the pawl 156 preventing the latter assuming the clutch release position. Therefore while the roller 165 rises upon the surface of said broad cam, the rotary valve will be advanced with constant and rapid periodicity, depending solely upon the rate of rotation of the shaft 44 without awaiting the formation of a completed sheaf against the plate 100. Special provision has been made by the action of broad cam 226 and cam 368 to keep the straw from accumulating in the bundle forming chamber while the shock is being discharged from the magazine. The broad cam 226 and cam 368 take control immediately after the engagement of the 15th notch in the series of notches 168. This is described more fully later.

The first two steps in the movement of said valve while the clutch control lever is held out by the broad cam 226 places the air admission apertures 134 and 135 successively in registry with the last of the series of ports designated as a and a' in Figure 17, and in communication with the respective sides of the piston 193 producing the last step in the rotation of the magazine and at the same time actuating the straw-tying levers 211 and 219 which tuck the wisp of straw drawn out from the eighth sheaf behind the binder twine of the first sheaf.

The shock is now ready to be discharged from the magazine. The clutch control lever still rides upon the broad cam 226 and the rotary valve performs its step by step movement once again with constant periodicity independent of the sheaf actuating mechanism. This time the air supply aperture 135 comes into registry with the port designated at b in Figure 18, and with the aperture 123 which extends through the lower part of the valve casing and is connected by the conduit 124 with the bottom of the cylinder 125 and also with the bottom of the cylinder 138 as has been previously stated. This admits air to the lower end of the cylinder 125 causing a movement of the piston 201 toward the upper end thereof, elevating the rod 198 and thereby first telescoping the impaling spurs 199 and then drawing up the stem 197 with the partitions 203. These two actions are performed so nearly simultaneously as to deposit the shock on the ground free from all mechanical association with the shock forming machine. At the same time that air is admitted to the lower end of the cylinder 125 it is vented from the upper end of said cylinder through the conduit 127 which communicates with the aperture 126 in the lower casing member and through the port designated as c in the stationary ported member by way of the groove 333 and port 334 to the exhaust passage 137. The restricted size of the port 334 causes a retardation in the exhaustion of air from the upper end of the cylinder 125 producing a cushioning effect at the upward limit of movement of the piston 201. The upper end of the cylinder 138 is vented by the same means and in a similar manner.

When the air supply aperture 135 registers with the port b the roller 165 has arrived at the abrupt shoulder on the right hand side of the broad cam 226, as viewed in Figure 25 and is about ready to fall into the first notch adjacent said shoulder. Should it descend into said notch the clutch control lever would be returned to release position, throwing the rotary valve out of action and causing said air aperture and port to remain in registry, continuing the air supply to the lower end of the cylinder 125. This is occasionally, but not generally very useful, for it sometimes happens that straw may inadvertently get into the hollow of the stem 197 or become entangled upon the impaling spurs, throwing an undue load upon the piston 201, thereby retarding its speed of upward travel. In such case where the air supply to the lower end of the cylinder not continued by placing the clutch in release position and thereby maintaining the air passage open, the downward stroke of the piston 201 might occur before the upward stroke were completed and the shock fully discharged, so that the latter might be crushed beneath the descending sheaf-holding magazine before the shock-forming machine could move a sufficient distance away from it. But normally, no such retardation of the upward stroke of the piston 201 is expectable, therefore means are provided for defeating the release of the clutch by preventing the roller 165 falling into the

first notch. These means consist of a rod 231 which passes through a stuffing box at the top of the cylinder 125 and the lower end of which is in position to be engaged by the piston as the latter reaches the top of its stroke. A rocker arm 232 is positioned in the path of the upper end of this rod but normally out of contact therewith, said rod being formed with a bifurcation which embraces an arm 233 fixed to a rock shaft 234. Said rock shaft is provided at its lower end with another arm 235 which is adapted to engage the roller 165 of the clutch control lever 160 and so to hold said lever out in the position of clutch engagement when the rock shaft 234 is actuated. While the piston 201 is below its top position in the cylinder 125 the rod 231 will be out of contact with the rocker arm 232 being normally retracted by the spiral spring 350, and the arm 235 on the rock shaft will remain in an inactive position withdrawn from the roller 165. Should said arm be in withdrawn position when the roller 165 falls from the abrupt shoulder of the broad cam into the first notch, the air supply aperture 135 and the port *b* will remain in registry as aforesaid, but if the piston 201 reaches the top of the cylinder 125 immediately upon the registration of said aperture and said port, as it usually does, the arm 235 will be moved outwardly before the roller 165 falls into the first notch, said arm forming a continuation of the broad cam and bringing the space of said first notch so that the rotary valve continues to function under the constant rotation of the shaft 44. The next phase of its movement brings the air supply aperture 134 in registry with the port 237 which also is connected to the port 123 which leads to the lower end of the cylinder 125, by a groove 122. In this manner a second air impulse is delivered to the piston 201, which at this time is already at the top of its cylinder, holding it there so as to give the shock forming machine a chance to travel out of the way of the shock before the sheaf-holding magazine is lowered. It seems preferable to provide a needle valve 368 for adjustably varying the area of the port 237 so as to retard at will the flow of air into the lower end of the cylinder 125 both for the purpose of regulating the length of time that the piston 201 shall remain in the top of its cylinder and also to retard the exhaustion of air from the lower end of the cylinder to provide a cushioning effect for the descent of the sheaf-holding magazine.

Before being released from the control of the broad cam 226 and its adjunctive member, the arm 235, the rotary valve performs one other function, which is to place the exhaust passage 137 in registry with the port 237. At the same time the air supply aperture 135 is placed in registry with the port marked *c* in Figure 18 and with the passage 126 leading through the bottom of the lower casing member and communicating by a suitable conduit 354 with both the upper end of the cylinder 125 and with the upper end of the cylinder 138. As soon as the piston 201 starts to recede from the top of the cylinder 125 the rod 231 is retracted causing the return of the rock shaft 234 and arm 235 to inactive position in response to the pull of the spiral spring 350 and 351. The roller 165 is then free to drop into the second notch of the cam carrying member 167 at which time the clutch is released and the device is returned to the control of the sheaf actuated mechanism.

It has been stated that the conduits 124 and 127, which lead respectively to the lower and upper ends of the cylinder 125 communicate also respectively with the lower and upper ends of the cylinder 138 so that the piston 227 functions synchronously with the piston 201, opening the door 98 when the sheaf-holding magazine is raised and closing said door as said magazine descends. The door is hingedly mounted upon a stationary portion of the shock forming machine at 355 and is formed with a bracket 356 to which is pivotally mounted a bell crank 357 one arm of which is pivotally connected to the piston rod 228. The bell crank is provided with bifurcated arms 358 embracing the door and connected by a link 359 to a hingedly mounted latch 360. Said latch is secured to the door in any suitable manner, one such way being indicated at 361 in Figure 3, and the free end thereof engages behind a detent 362 extending rearwardly from the fixed portion 97 of the shock forming chamber. The latch 360 is normally maintained in position of engagement with respect to said detent by means of the spiral spring 363 which normally draws the arm 358 of the bell crank downward. When the latch is in this position the door is closed. The initial pull of the piston rod 228 in the door opening act, raises the latch 360 out of the detent 362 releasing the door so that it may be opened. As the piston rod 228 necessarily oscillates in the opening movement of the door, the cylinder 138 is mounted in an oscillatory manner, having a hemi-spherically curved bearing 364 adjacent its upper end which rests in a spherical socket 365, fixedly supported. The speed of opening and closing of the door may be regulated by a needle valve 367 by means of which the upper end of the cylinder 138 is vented.

In an earlier paragraph of the specification it was stated that the shaft 82 which provides a driving connection between the constantly and positively driven shaft 44 and the conveyer shaft 78 is provided with a clutch 83 so that the driving connection between the shock forming machine and the conveyer mechanism can be severed. The object of this is to afford means to prevent the accumulation of a sheaf against the plate 100 during

the shock discharging period. It will be recalled, from what has been stated above with regard to the operation of the piston 201 by which the sheaf-holding magazine is elevated, that said piston and the magazine associated therewith may be detained at the top of the cylinder 125 normally for an appreciable interval due to the two successive admissions of air to the lower side of the piston 201, and occasionally for an indefinite time should the upward travel of the piston be impeded and the roller 165 fall into clutch release position holding the air admission passage to the lower end of the cylinder 125. It is obvious that it would be disastrous to the satisfactory working of the machine to have a sheaf delivered to the shock forming chamber before the sheaf-holding magazine had returned to a position ready to receive it. To prevent such occurrence a cam 368 is secured to the upper end of the coupling element 145 by means of the spline 369 which rests in a vertical groove 370 in said coupling element. Said cam acts upon a roller 371 at the end of the arm 373, the latter being fixed to the upper end of the rock shaft 372 upon which the sleeve 307, previously described, is mounted. Adjacent the lower end of said rock shaft another arm 374 is secured, the end 375 of which is adapted to engage a pawl 376 which forms part of the clutch 83. When said pawl is thus engaged while the shaft 82 is rotating in the direction shown by the arrow in Figure 25, the clutch is released and the drive to the conveyer mechanism interrupted. The cam 368 is so oriented with respect to the broad cam 226 as to hold the end 375 of the lever 374 in clutch release position during an interval beginning with the first admission of air to the last a' port and continuing until port 135 in rotary valve 110 comes in line with port 126 which returns piston 201 to normal position. The cam 368 is shown provided with screws 377 by which it is secured to the sleevelike portion 378 of the notched disk 147, thus affording a convenient means by which the rotary valve is driven through the coupling element 145.

The shock forming machine is supported upon the ground, as previously stated, by means of the traction wheels 2 and 3 and may be raised to a greater or lower height by pneumatic pressure supplied from the air reservoir through a main conduit 399 to the branch conduits 381 and 382 which lead respectively to the cylinders 383 and 384 in which are pistons, not shown. The piston rods 385 and 386 are secured to the lower ends of the pistons and project downwardly, being made fast at their lower ends to forks 387 and 388 which embrace the respective wheels and support the axles thereof. The forks preferably are slidable in fixed guideways 400 and 401, said guideways affording supports for the cylinders 383 and 384. A four-way valve 389 arranged between the main air conduit and the branch conduits permits the admission of air either simultaneously to the upper ends of both cylinders, to raise the machine from the ground to equal distance, or to permit the air to be supplied selectively to one or the other of the cylinders in order to raise the shock forming machine to an unequal height at each end.

The fork 387 is provided along one side with a series of vertical apertures 390 which are adapted to register selectively with a single aperture 402 formed in the adjacent side of the guideway 400. A stop 391 is arranged to normally project through the aperture 402 under the urge of the spring 403. When the fork 387 is depressed by pneumatic pressure the stop 391 springs into one of the apertures 390 when the latter is brought into registry with the aperture 402. Said stop is withdrawn from engagement with the fork 387 by means of a lever 404 which is attached to the guideway 400. The stop 391 is pivotally connected to said lever at 407. The outer end of the lever 404 is connected by an inclined link 408 to an arm 409 fixed to a rock shaft 410 the latter being suitably supported upon brackets on a fixed part of the machine and extending forwardly to a convenient position with respect to the operator of the shock forming machine at which point it is provided with a handle 411. By appropriate manipulation of this handle the stop 391 may be selectively inserted in any one of the apertures 390 when the latter has been brought into registry with said stop by pneumatic pressure, thus positively locking the platform 1 at a desired elevation above the surface of the ground.

The fork 388 and guideway 401 are similarly provided with registering apertures through which the stop 412 operates to hold the fork 388 mechanically at a desired elevation. In this instance the stop 412 is pivotally secured to the lower end of a rock lever 413, fixedly supported upon the shock forming machine the upper end of said lever being attached to a link 414 which curves around the shock-forming chamber to a forward position within convenient reach of the operator at which point it is connected with the operating lever 415. For the operation of this stop the lever 415 is manipulated precisely similar to that of the lever 411.

It is not necessary, however, to rely upon this mechanical support, for if desired the shock-forming machine may be supported upon the wheels entirely by the pneumatic cushions afforded by the air in the cylinders 383 and 384, the stops being maintained in retracted position.

Needle valves 393 and 394 in the upper ends of the cylinders 383 and 384 do not control the vacuum in these cylinders at any time. They are directly connected in the

air line and regulate the rate at which air is admitted and discharged and consequently the speed at which the machine is raised and lowered.

From a consideration of the invention, one illustrative embodiment of which I have above described, it may be deduced that I have succeeded in producing means for cutting, binding and shocking the grain, which are sufficiently flexible to be practically operative under all ground and grain conditions, that a novel method is carried out by the several instrumentalities concerned in the production of the finished shock, and that the product of the invention is, itself, a highly improved shock in which the sheaf-units are bound in an annular body of loose coherence which adapts it to rest upon irregular ground without risk of the shock over-turning, and in which the hollow central portion of the shock affords a natural ventilating stack or chimney, effectively relieving the shock from dampness.

It will be understood that the invention may be exemplified in numerous other alternative constructions, and I accordingly reserve the right to adopt all such legitimate changes as may be fairly embodied within the spirit and scope of the appended claims.

Having described my invention what I claim as new and desire to secure by Letters Patent, is:—

1. A shock forming machine including a plurality of fluid pressure actuated instrumentalities cooperating in the formation of a shock, a distributing valve for supplying fluid under pressure to said instrumentalities, continuously operating driving means, a clutch forming a driving connection between said driving means and said distributing valve, and sheaf actuated means for controlling the operation of said clutch.

2. A shock forming machine including a plurality of fluid pressure actuated instrumentalities cooperating in the formation of a shock, a distributing valve for supplying fluid under pressure to said instrumentalities, continuously operating driving means, a normally released clutch forming a driving connection between said driving means and said distributing valve and sheaf actuated means for causing the engagement of said clutch.

3. A shock forming machine including fluid pressure actuated instrumentalities cooperating in the formation of a shock, a distributing valve for supplying fluid under pressure to said instrumentalities, continuously operated driving means, a clutch forming a driving connection between said driving means and said distributing valve, means actuated by said clutch for imparting step by step movement to said valve and sheaf actuated means for controlling the operation of said step by step movement imparting means.

4. A shock forming machine including fluid pressure actuated instrumentalities cooperating in the formation of a shock, a distributing valve for supplying fluid pressure to said instrumentalities, continuously operating driving means, a clutch forming a driving connection between said driving means and distributing valve, sheaf actuated means for controlling said clutch during part of the operative cycle of said valve, and means to thwart the control of said sheaf actuated means during another part of the operative cycle of said valve.

5. In a shock forming machine a sheaf-holding magazine, pneumatic means for imparting step-by-step rotary movement to said sheaf-holding magazine, a valve having a plurality of positions in which air is supplied to said pneumatic means to actuate the same, means for imparting step-by-step rotation to said valve, including continuously operating driving means and a clutch affording a severable driving connection between said driving means and valve, sheaf actuated means for periodically connecting said clutch with said driving means to rotate said valve through a succession of said air supplying positions, to supply air for the repeated actuation of said pneumatic means, and means for holding said clutch in connected relation to said driving means and valve independently of said sheaf actuated means, for moving said valve consecutively to another air supplying position to actuate said pneumatic means again and thereby rotate said shock-holding magazine through another step of its movement.

6. In a shock forming machine a sheaf-holding magazine, a piston for imparting partial rotation to said magazine on each stroke thereof in one direction, a fluid pressure system for said shock forming machine including a source of supply and suitable connections, a valve intercalated in said system having a plurality of positions in which air is alternately supplied to the opposite sides of said piston to cause its reciprocation, means for imparting step-by-step rotation to said valve including continuously operating driving means and a clutch affording a severable driving connection between said driving means and valve, sheaf-actuated means for periodically connecting said clutch with said driving means and valve to rotate the latter through a succession of said air supplying positions for repeatedly actuating said pneumatic means a predetermined number of times, and means operative after the completion of said predetermined number of actuations for holding said clutch in connected relation to said driving means and valve independently of said sheaf-actuated means, for moving said valve successively to other air supplying positions for reciprocating said pneumatic means once again and thereby rotating said sheaf-holding magazine through another step of its movement.

7. In a shock forming machine, a sheaf-holding magazine, a piston for imparting partial rotation to said magazine on each stroke thereof in one direction, a fluid pressure system for said shock forming machine including a source of supply and suitable connections, a valve intercalated in said system having a plurality of positions in which air is alternately supplied to the opposite sides of said piston to cause its reciprocation, means for imparting step-by-step rotation to said valve including continuously operating driving means and a clutch affording a severable driving connection between said driving means and valve, a lever normally engaging an element in said clutch to hold the latter released, sheaf actuated means for periodically moving said lever to a position permitting said clutch to connect said driving means and valve to rotate the latter through a succession of said air supplying positions for repeatedly actuating said pneumatic means a predetermined number of times and means operative after the completion of said predetermined number of actuations for holding said clutch in connected relation to said driving means and valve independently of said sheaf actuated means, for moving said valve successively to other air supplying positions for reciprocating said pneumatic means once again and thereby rotating said sheaf-holding magazine through another step of its movement.

8. In a shock forming machine, a sheaf-holding magazine, a piston reciprocable to impart partial rotation to said magazine on each alternate stroke, a fluid pressure system for said shock forming machine including a source of supply and suitable connections, a valve intercalated in said system having a plurality of positions in which air is alternately supplied to the opposite sides of said piston to cause its reciprocation, means for imparting step-by-step rotation to said valve including continuously operating driving means and a clutch affording a severable driving connection between said driving means and valve, a lever normally holding said clutch in released position, sheaf actuated means for periodically tripping said lever, permitting engagement of said clutch, to rotate said valve through a series of alternate positions in each of which air is supplied to the piston to actuate the latter to perform its inactive stroke with respect to the sheaf-holding magazine, and means carried by said valve for holding said lever in each of the tripped positions initiated by the sheaf actuated means a period of time sufficient to permit the valve to rotate to a position in which air is supplied to the opposite side of the piston to actuate the latter to partially rotate said magazine.

9. In a shock forming machine, a sheaf-holding magazine, a piston reciprocable to impart partial rotation to said magazine on each alternate stroke, a fluid pressure system for said shock forming machine including a source of supply and suitable connections, a valve intercalated in said system having a plurality of positions in which air is alternately supplied to the opposite sides of said piston to cause its reciprocation, means for imparting step-by-step rotation to said valve including continuously operating driving means and a clutch affording a severable driving connection between said driving means and valve, a lever normally holding said clutch in released position, sheaf actuated means for periodically tripping said lever, permitting engagement of said clutch to rotate said valve through a predetermined number of alternate positions in each of which air is supplied to the piston to actuate the latter to perform its inactive stroke with respect to the sheaf-holding magazine, means carried by said valve for holding said lever in each of the tripped positions initiated by the sheaf-actuated means a period of time sufficient to permit the valve to rotate to a position in which air is supplied to the opposite side of the piston to actuate the latter to partially rotate said magazine, and means operative after said valve has passed through said predetermined number of positions, for holding said clutch in connected relation to said driving means and valve independently of said sheaf-actuated means, to move said valve successively to other air supplying positions for reciprocating said piston once again and thereby rotating said shock-holding magazine through another step of its partial rotation.

10. In a shock forming machine, a sheaf-holding magazine, a piston reciprocable to impart partial rotation to said magazine on each alternate stroke, a fluid pressure system for said shock forming machine including a source of supply and suitable connections, a valve intercalated in said system having a plurality of positions in which air is alternately supplied to the opposite sides of said piston to cause its reciprocation, means for imparting step-by-step rotation to said valve including continuously operating driving means and a clutch affording a severable driving connection between said driving means and valve, a lever normally holding said clutch in released position, sheaf actuated means for periodically tripping said lever, permitting engagement of said clutch to rotate said valve through a predetermined number of alternate positions in each of which air is supplied to the piston to actuate the latter to perform its inactive stroke with respect to the sheaf-holding magazine, means carried by said valve for holding said lever in each of the tripped positions initiated by the sheaf actuated means a period of time sufficient to permit the valve to rotate to a position in which air is supplied to the oppo-

site side of the piston to actuate the latter to partially rotate said magazine, and means carried by said valve and operative after the latter has passed through said predetermined number of positions, for holding said clutch in connected relation to said driving means and valve independently of said sheaf actuated means, to move said valve successively to other air supplying positions for reciprocating said piston once again and thereby rotating said shock-holding magazine through another step of its partial rotation.

11. In a harvesting machine, sheaf forming means and a shock forming chamber, a yielding barrier between said sheaf forming means and said chamber, said barrier being arranged to yield under pressure of a fully developed sheaf, a sheaf-holding magazine within said chamber, pneumatic means for imparting step-by-step rotary movement to said magazine, a valve having a plurality of positions in which air is supplied to said pneumatic means to actuate the same, means for imparting step-by-step rotation to said valve including continuously operating driving means, and a clutch affording a severable driving connection between said driving means and valve, a lever normally holding said clutch in released position, means for periodically tripping said lever permitting engagement of said clutch to rotate said valve through a succession of positions, to supply air for the repeated actuation of said pneumatic means, actuating means for said lever tripping means comprising a continuously driven connection including a clutch, and means carried by said yielding barrier for normally holding said second mentioned clutch in released position, said last named means moving with said barrier when the latter yields, to a position permitting engagement of the second mentioned clutch, thereby setting into motion the actuating means for the lever tripping means.

12. In a harvesting machine, a sheaf forming means and a shock forming chamber communicating by a sheaf-travelled passage, a shaft, a barrier arranged across said passage between said sheaf forming means and chamber, said barrier being mounted to oscillate with said shaft under pressure thereagainst of a fully developed sheaf, and to swing relative to said shaft in an axial plane, a second shaft mounted adjacent said barrier actuated shaft, means on said second shaft for swinging said barrier out of the sheaf-travelled path, a crank on said second shaft, a sheaf-holding magazine within said chamber, pneumatic means for imparting step-by-step rotary movement to said magazine, a valve having a plurality of positions in which air is supplied to said pneumatic means to actuate the same, means for imparting step-by-step rotation to said valve, including continuously operating driving means, and a clutch affording a severable driving connection between said driving means and valve, a lever normally holding said clutch in released position, means for periodically tripping said lever permitting engagement of said clutch to rotate said valve through a succession of positions to supply air for the repeated actuation of said pneumatic means, actuating means for said lever tripping means comprising a continuously driven connection including a clutch, means carried by the barrier actuated shaft for normally holding said second mentioned clutch in released position, said last named means moving with said barrier when the latter yields, to a position permitting engagement of the second mentioned clutch, thereby setting into motion the actuating means for the lever tripping means, a second crank, set in motion by the engagement of said clutch for engaging with and thereby actuating the lever tripping means, and a link connecting said cranks, the latter being relatively so set that the crank on the shaft adjacent the barrier actuated shaft swings the barrier in the manner aforesaid, prior to the engagement of the second crank with the lever tripping means.

13. In a harvesting machine, sheaf forming means and a shock forming chamber communicating by a sheaf-travelled passage, a shaft, a barrier arranged across said passage between said sheaf forming means and chamber, said barrier being mounted to oscillate with said shaft under pressure thereagainst of a fully developed sheaf, and to swing relative to said shaft in an axial plane, a spring to return said barrier to normal position, a second shaft mounted adjacent said barrier actuated shaft, means on said second shaft for swinging said barrier out of the sheaf-travelled path, a crank on said second shaft, a sheaf-holding magazine within said chamber, pneumatic means for imparting step-by-step rotary movement to said magazine, a valve having a plurality of positions in which air is supplied to said pneumatic means to actuate the same, means for imparting step-by-step rotation to said valve including continuously operating driving means, and a clutch affording a severable driving connection between said driving means and valve, a lever normally holding said clutch in released position, means for periodically tripping said lever permitting engagement of said clutch to rotate said valve through a succession of positions to supply air for the repeated actuation of said pneumatic means, actuating means for said lever tripping means comprising a continuously driven connection including a clutch, means carried by the barrier actuated shaft for normally holding said second mentioned clutch in released position, said last named means moving with said barrier when the

latter yields, to a position permitting engagement of the second mentioned clutch, thereby setting into motion the actuating means for the lever tripping means, a second crank, set in motion by the engagement of said clutch for engaging with and thereby actuating the lever tripping means, and a link connecting said cranks, the latter being relatively so set that the crank on the shaft adjacent the barrier actuated shaft swings the barrier in the manner aforesaid, prior to the engagement of the second crank with the lever tripping means, and a spring connecting said means for releasing the second clutch, to said link, said spring acquiring tension by the movement of said link in a barrier-swinging direction, for the purpose of holding said second clutch-releasing means away from said second clutch after return of the barrier to normal position, to keep said second clutch engaged for driving the lever tripping mechanism which initiates the engagement of the first clutch.

14. In a shock forming machine, a sheaf-holding magazine, a piston reciprocable to impart partial rotation to said magazine on each alternate stroke, a fluid pressure system for said shock forming machine including a source of supply and suitable connections, a valve intercalated in said system having a plurality of positions in which air is alternately supplied to the opposite sides of said piston to cause its reciprocation, means for imparting step-by-step rotation to said valve including continuously operating driving means and a clutch affording a severable driving connection between said driving means and valve, a lever normally holding said clutch in released position, sheaf actuated means for periodically tripping said lever, permitting engagement of said clutch to rotate said valve through a predetermined number of alternate positions in each of which air is supplied to the piston to actuate the latter to perform its inactive stroke with respect to the sheaf-holding magazine, means carried by said valve for holding said lever in each of the tripped positions initiated by the sheaf-actuated means a period of time sufficient to permit the valve to rotate to a position in which air is supplied to the opposite side of the piston to actuate the latter to partially rotate said magazine, means operative after said valve has passed through said predetermined number of positions, for holding said clutch in connected relation to said driving means and valve independently of said sheaf-actuated means, to move said valve successively to other air supplying positions for reciprocating said piston once again and thereby rotating said shock-holding magazine through another step of its partial rotation, and straw-tying means positioned in operative relation to said sheaf-holding magazine and actuated by said piston to perform a straw-tying operation at each partial rotation of said magazine.

15. In a shock forming machine, a rotary sheaf-holding magazine, sheaf forming means provided with a sheaf-travelled passage leading to said magazine, a barrier in said sheaf-travelled passage, normally barring access of a sheaf to said magazine, said barrier being actuated by the pressure of a fully developed sheaf, to retract in order to admit the sheaf to said magazine, means for packing the forming sheaf against said barrier, means for transferring said sheaf to said magazine after retraction of the barrier, and means responsive to the actuation of said barrier for imparting step-by-step rotation to the sheaf-holding magazine to progressively present different peripheral portions thereof to said sheaf forming means to receive a number of sheaves therefrom.

16. In a shock forming machine, a shock forming chamber, a rotary sheaf-holding magazine within said chamber, sheaf forming means provided with a sheaf-travelled passage leading to said magazine, a barrier in said passage normally barring access of a sheaf to said chamber, said barrier being actuated by the pressure of a fully developed sheaf to retract in order to admit the sheaf to said chamber, means for packing the forming sheaf against said barrier, means for transferring said sheaf to said chamber for retraction of the barrier, means responsive to the actuation of said barrier for imparting step-by-step rotation to the sheaf-holding magazine to progressively present different peripheral portions thereof to said sheaf forming means to receive a number of sheaves therefrom, and straw-tying means positioned in operative relation to the sheaves in said sheaf-holding magazine and actuated by said rotation imparting means.

17. In a harvesting machine, sheaf forming means, including binding mechanism, and a shock-forming chamber, a sheaf-holding magazine within said chamber, arranged in receptive relation to said sheaf forming means, a sheaf support carried by said magazine, a chute leading from said sheaf forming means to said chamber, having an elevatable floor, and means for adjusting the elevation of said floor so that sheaves of different height, traveling thereon may be received by the magazine with the binding elements thereover at the same level relative to the sheaf support.

18. In a harvesting machine, sheaf forming means including binding mechanism, and a shock forming chamber, a sheaf-holding magazine within said chamber arranged in receptive relation to said sheaf forming means, an impaling spur for supporting a sheaf, carried by said magazine, a chute leading from said sheaf forming means to said chamber, having an elevatable floor, means for adjusting the elevation of said floor so

that sheaves of different height traveling thereover may be received by the magazine with the binding elements thereof at the same level relative to the impaling spur, and means for forcing a sheaf upon said impaling spur.

19. In a harvesting machine, sheaf forming means including binding mechanism and a shock forming chamber, a rotatable sheaf-holding magazine within said chamber positioned in receptive relation to said sheaf forming means, a plurality of sheaf supporting impaling spurs arranged radially of said magazine, a chute leading from said sheaf forming means to said chamber having an elevatable floor, means for adjusting the elevation of said floor, so that sheaves of different height traveling thereover may be received by the magazine with the binding elements thereof at the same level relative to the impaling spur, means for imparting step-by-step movement to said magazine to present the impaling spurs successively toward said chute and means for forcing the sheaves successively upon said spurs as they are presented.

20. In a harvesting machine, sheaf forming means including binding mechanism and a shock forming chamber, a rotatable sheaf-holding magazine within said chamber positioned in receptive relation to said sheaf forming means, a plurality of sheaf supporting impaling spurs arranged radially of said magazine, a chute leading from said sheaf forming means to said chamber having an elevatable floor, means for adjusting the elevation of said floor so that sheaves of different height travelling thereover may be received by the magazine with the binding elements thereof at the same level relative to the impaling spur, means for imparting step-by-step movement to said magazine to present the impaling spurs successively toward said chute, means for forcing the sheaves successively upon said spurs as the latter are presented and common sheaf actuated means for actuating said magazine rotating means and sheaf forming means.

21. In a shock forming machine, a sheaf-holding magazine including a reciprocable stem having a hollow portion, the latter being slotted in a plurality of radial planes, a reciprocable rod extending through said stem, impaling spurs affording a support for a group of sheaves, normally projecting through said slots and pivotally connected to said rod, said spurs being retractible within the hollow part of said stem upon reciprocation of said rod, means on said rod engaging the end of said stem to elevate the latter subsequent to the beginning of the retractive movement of said spurs, and fluid pressure means for actuating said rod.

22. In a shock forming machine, a sheaf-holding magazine including a reciprocable stem having a hollow portion, the latter being slotted in a plurality of radial planes, a reciprocable rod extending through said stem, impaling spurs affording support for a group of sheaves, normally projecting through said slots and pivotally connected to said rod, said spurs being retractible within the hollow part of said stem upon reciprocation of said rod, means on said rod engaging the end of said stem to elevate the latter subsequent to the beginning of the retractive movement of said spurs, a cylinder, a piston in said cylinder secured to said rod, fluid pressure means communicating with said cylinder to actuate said piston and means projecting into said cylinder and actuated by said piston, controlling said fluid pressure means.

23. In a shock forming machine, a sheaf-holding magazine including a stem mounted for both reciprocatory and step-by-step rotary movement, sheaf actuated means for imparting a complete step-by-step rotation to said stem, means supplanting said sheaf actuated means for imparting an additional step of rotation to said stem, and said latter means sequentially controlling the reciprocatory movement thereof.

24. Shock forming mechanism including a stem serving as a core for the formation of a shock therearound, means for supporting a plurality of sheaves around said stem in annular formation, and means for tying said sheaves together in an endless bundle or shock, said stem, supporting means, and tying means being each withdrawable from said shock to effect its discharge.

25. In a shock forming machine, a sheaf-holding magazine including a stem, separate fluid pressure motors for respectively imparting reciprocatory and step-by-step rotary movements to said stem, a fluid pressure system including conduits connected with said fluid pressure motors, a valve in said conduits, said valve being ported to supply pressure to said motors and to vent the same to enable the performance of the following functions by the following instrumentalities, sheaf actuated means controlling said valve to move the stem through a complete step-by-step rotation, means supplanting the control of the sheaf actuating means for rotating said stem through another step, said last named means continuing its control of the valve a sufficient length of time to cause reciprocatory movement of said stem.

26. In a shock forming machine a sheaf-holding magazine including a stem, fluid pressure motors for imparting reciprocatory and step-by-step rotary movements to said stem, a fluid pressure system including conduits communicating with said motors and a valve in said conduits, said valve being ported to supply fluid pressure to said motors and to vent the same to enable the performance of the following functions by the following instrumentalities, sheaf actuated means for controlling said valve to move said stem

through a complete step-by-step rotation, means carried by said valve and supplanting the control of the sheaf actuated means for rotating said stem another step, said last named means being constructed to continue its control of the valve a sufficient length of time to cause reciprocatory movement of the stem in one direction, and means actuated incidentally to the approach of the stem to the limit of its reciprocatory movement, for controlling the valve to cause a reciprocatory movement of said stem in the opposite direction.

27. In a shock forming machine, a sheaf-holding magazine including a stem, fluid pressure motors for imparting reciprocatory and step-by-step rotary movements to said stem, a fluid pressure system including conduits communicating with said motors, a valve in said conduits, driving means therefor, said valve being ported to supply fluid pressure to said motors and to vent the same to enable the performance of the following functions by the following instrumentalities, sheaf actuated means for controlling said valve to move said stem through a complete step-by-step rotation, means carried by said valve and supplanting the control of the sheaf actuated means for rotating said stem another step, said last named means continuing its control of the valve a sufficient length of time normally to cause reciprocatory movement of the stem in one direction in a predetermined time interval, means normally inactive, but operating if said reciprocatory movement of the stem in one direction is not completed within the predetermined time interval, to release said valve from its driving means, maintaining it in position to continue to supply fluid pressure to the motor which actuates the stem reciprocatorily, until said stem reaches the limit of said reciprocatory movement in one direction, and means actuated incidentally to the approach of the stem to the limit of its reciprocatory movement in said one direction for so controlling the valve as to cause the reciprocatory movement of the stem in the opposite direction.

28. In a harvesting machine, a shock forming chamber having a door, a fluid pressure motor for actuating said door, a sheaf-holding magazine within said chamber including a stem, fluid pressure motors for imparting a reciprocatory and step-by-step rotary movement to said stem, a fluid pressure system including conduits communicating with said motors, a valve in said conduits, said valve being ported to supply fluid pressure to said motors and to vent the same to enable the following instrumentalities to perform their functions, as described, sheaf-actuated means for controlling said valve to move said stem through a complete step-by-step rotation, means carried by said valve and supplanting the control of the sheaf-actuated means for rotating said stem another step, said last named means being constructed to continue its control of the valve a sufficient length of time to permit the latter to assume a position in which air is supplied to the motor which reciprocates the stem, causing the reciprocatory movement of the latter in one direction, air being simultaneously supplied to said door actuating motor for opening the door, and means actuated incidentally to the approach of the stem to the limit of its reciprocatory movement for controlling the valve in a manner to cause a reciprocatory movement of the stem in the opposite direction and a simultaneous closing of the door.

29. In a harvesting machine, a shock forming chamber, a door therefor, a fluid pressure motor for actuating said door, a sheaf-holding magazine within said chamber including a stem, fluid pressure motors for imparting reciprocatory and step-by-step rotary movements to said stem, a fluid pressure system including conduits communicating with said motors, a valve in said conduits, driving means therefor, said valve being ported to supply fluid pressure to said motors and to vent the same to enable the following instrumentalities to perform their functions as described, sheaf-actuated means for controlling said valve to move said stem through a complete step-by-step rotation, means carried by said valve and supplanting the control of the sheaf-actuated means for rotating said stem another step, said last named means continuing control of the valve a sufficient length of time to permit the latter to assume a position in which air is supplied to the motor which reciprocates the stem, normally causing a reciprocatory movement of the latter in one direction in a predetermined time, air being simultaneously supplied to said door actuating motor for opening the door, means normally inactive, but operating if said reciprocatory movement of the stem in one direction is not completed within the predetermined time interval, to release said valve from its driving means, maintaining it in position to continue to supply fluid pressure to the motor which actuates the stem reciprocatorily, until said stem completes said reciprocatory movement in one direction, and means actuated incidentally to the approach of the stem to the limit of its reciprocatory movement for controlling the valve to cause a reciprocatory movement of said stem in the opposite direction and to simultaneously initiate the closing movement of the door.

30. In a harvesting machine, a shock forming chamber, a door therefor, a fluid pressure motor for actuating said door, a sheaf-holding magazine within said chamber including a stem, fluid pressure motors for imparting reciprocatory and step-by-step rotary movements to said stem, a fluid pressure system

including conduits communicating with said motors, a valve in said conduits, driving means therefor, said valve being ported to supply fluid pressure to said motors and to vent the same to enable the following instrumentalities to perform their functions as described, sheaf-actuated means for controlling said valve to move said stem through a complete step-by-step rotation, means carried by said valve and supplanting the control of the sheaf-actuated means for rotating said stem another step, said last named means continuing control of the valve a sufficient length of time to permit the latter to assume a position in which air is supplied to the motor which reciprocates the stem, normally causing a reciprocatory movement of the latter in one direction in a predetermined time, air being simultaneously supplied to said door actuating motor for opening the door, means normally inactive, but operating if said reciprocatory movement of the stem in one direction is not completed within the predetermined time interval, to release said valve from its driving means, maintaining it in position to continue to supply fluid pressure to the motor which actuates the stem reciprocatorily, until said stem completes said reciprocatory movement in one direction, means actuated incidentally to the approach of the stem to the limit of its reciprocatory movement for controlling the valve to cause a reciprocatory movement of said stem in the opposite direction and to simultaneously initiate the closing movement of the door, and an adjustable exhaust for said door actuating motor for determining the duration of the closing movement of said door.

31. In a harvesting machine, grain-cutting means and a shock forming chamber, a conveyer for transferring cut grain from said grain-cutting means to said shock forming chamber, driving means for said grain-cutting means and driving means for said conveyer, the latter driving means including a clutch, means for releasing said clutch, a sheaf-holding magazine within said chamber including a stem, fluid pressure motors for imparting reciprocatory and step-by-step rotary movements to said stem, a fluid pressure system including conduits communicating with said motors and a valve in said conduits, said valve being ported to supply fluid pressure to said motors and to vent the same to enable the following instrumentalities to perform their functions as described, sheaf-actuated means for controlling said valve to move said stem through a complete step-by-step rotation, means carried by said valve and supplanting the control of the sheaf-actuated means for rotating said stem another step, said last named means being constructed to continue its control of the valve a sufficient length of time to cause reciprocatory movement of the stem in one direction, means carried by said valve cooperating with said clutch release means for holding the clutch released during the reciprocatory movement of said stem in said one direction, and means actuated incidentally to the approach of the stem to the limit of its reciprocatory movement in said one direction for controlling the valve to cause a reciprocatory movement of said stem in the opposite direction.

32. In a harvesting machine, grain-cutting means and a shock forming chamber, a conveyer for transferring cut grain from said grain-cutting means to said shock forming chamber, driving means for said grain-cutting means and driving means for said conveyer, the latter driving means including a clutch, means for releasing said clutch, a sheaf-holding magazine within said chamber including a stem, fluid pressure motors for imparting reciprocatory and step-by-step rotary movements to said stem, a fluid pressure system including conduits communicating with said motors, a valve in said conduits, driving means therefor, said valve being ported to supply fluid pressure to said motors and to vent the same to enable the following instrumentalities to perform their functions as described, sheaf-actuated means for controlling said valve to move said stem through a complete step-by-step rotation, means carried by said valve and supplanting the control of said sheaf-actuated means for rotating said stem another step, said last named means continuing its control of the valve a sufficient length of time normally to cause a reciprocatory movement of the stem in one direction in a predetermined time interval, means normally inactive, but operating if said reciprocatory movement of the stem in one direction is not completed within the predetermined time interval, to release said valve from its driving means, maintaining it in position to continue to supply fluid pressure to the motor which actuates the stem reciprocatorily until said stem reaches the limit of said reciprocatory movement in one direction, means carried by said valve cooperating with said clutch release means for holding the clutch released during the reciprocatory movement of said valve in said one direction and during its stay at the limit of said reciprocatory movement, and means actuated incidentally to the approach of the stem to said limit for so controlling the valve as to cause the reciprocatory movement of the stem in the opposite direction.

33. In a shock forming machine, a sheaf-holding magazine, a piston for imparting partial rotation to said magazine on each stroke thereof in one direction, a fluid pressure system for said shock forming machine including a source of supply and suitable connections, a valve intercalated in said system having a plurality of positions in which air is alternately supplied to the opposite sides of

said piston to cause its reciprocation, means for imparting step-by-step rotation to said valve including continuously operating driving means and a clutch affording a severable driving connection between said driving means and valve, a lever normally engaging an element in said clutch to hold the latter released, sheaf actuated means for periodically moving said lever to a position permitting said clutch to connect said driving means and valve to rotate the latter through a succession of said air supplying positions for repeatedly actuating said pneumatic means to move said magazine through a complete step-by-step rotation, means for delivering a sheaf to said magazine at each step of its rotation, means operative after the completion of said step-by-step rotation for retaining said clutch in connected relation to said driving means and valve, independently of said sheaf-actuated means, for moving said valve successively to other air supplying positions for reciprocating said pneumatic means once again, thereby rotating said shock-holding magazine through another step of its movement, and straw-tying mechanism actuated by said pneumatic means upon each reciprocation of the latter in a magazine-rotating direction for uniting the sheaves carried by said magazine into an endless shock.

34. In a shock forming machine, for uniting a plurality of sheaves including means for binding each sheaf with binder twine, and means for rotating a number of sheaves so bound successively in operative proximity to shock-tying means, the latter comprising means for segregating a wisp of straw from one sheaf and means for tucking it beneath the binding loop of an adjacent sheaf.

35. In a machine for uniting a plurality of sheaves means for binding each shock with binder twine, sheaf holding means and straw-tying means for holding an endless series of sheaves, so bound, one of said means being movable to progressively bring each sheaf into operative relation to the straw-tying means, the latter comprising means for segregating a wisp of straw from one sheaf and holding it during the relative movement between the sheaf holding and straw-tying means until the adjacent sheaf is in operative position, and means for tucking said wisp beneath the binding element of said adjacent sheaf.

36. In a machine for uniting a plurality of sheaves each of which is bound with a loop of binding material, into an endless annular shock, a sheaf-holding magazine and a straw-tying device, reciprocatory means for imparting step-by-step rotation to said sheaf-holding magazine to bring the sheaves held thereby into operative position with respect to said straw-tying device, said reciprocatory means being arranged to impart motion to said magazine on each stroke in one direction and having an idle return stroke, said straw-tying device including means for segregating a wisp of straw from one sheaf and holding it during one step in the rotation of said magazine, means for tucking said wisp beneath the binding element of the adjacent sheaf, and means operated by said reciprocatory means for actuating the segregating means positively on the magazine-rotating stroke of said reciprocatory means and for positively actuating the tucking means on the idle stroke of said reciprocatory means.

In testimony whereof I have hereunto set my hand.

PETER KETELSEN.