(No Model.) 4 Sheets—Sheet 1.

F. H. M. DAVIS.

HORSE POWER PUMPING MACHINE.

No. 571,993. Patented Nov. 24, 1896.

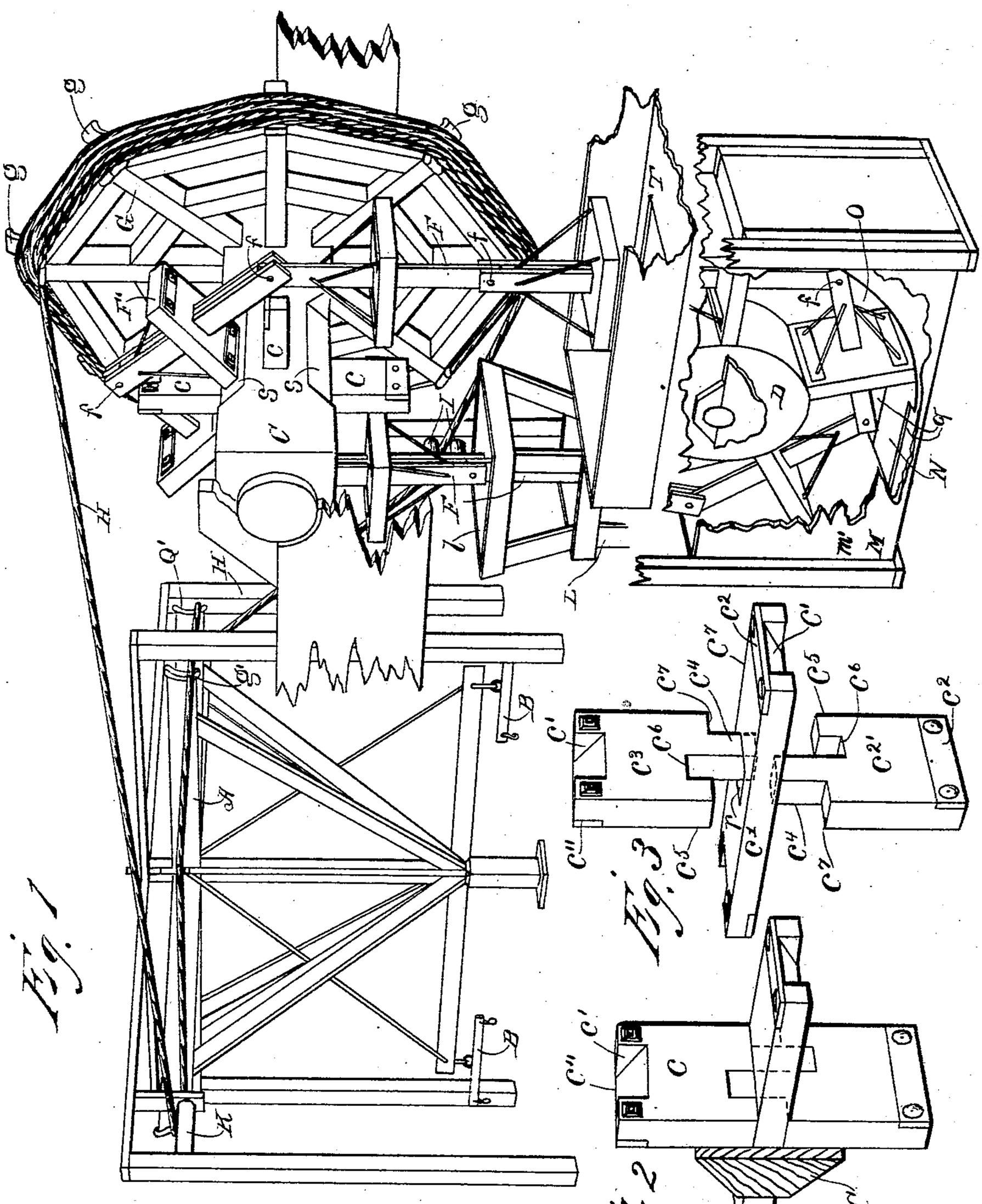

Fig. 1

Fig. 3

Fig. 2

Witnesses
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(No Model.) 4 Sheets—Sheet 2.

F. H. M. DAVIS.

HORSE POWER PUMPING MACHINE.

No. 571,993. Patented Nov. 24, 1896.

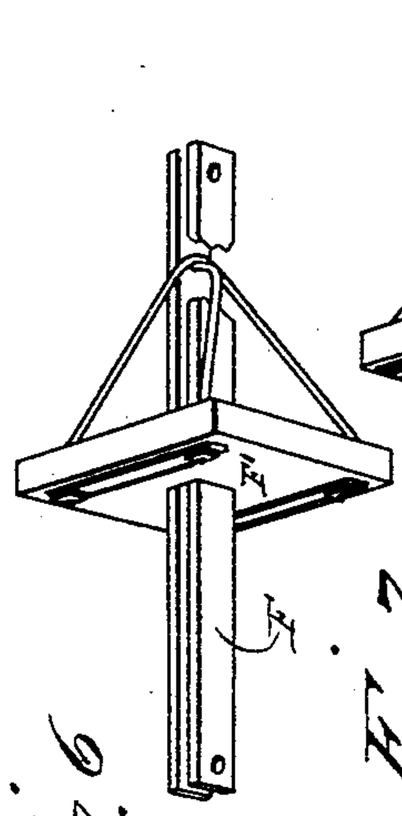


Fig. 6

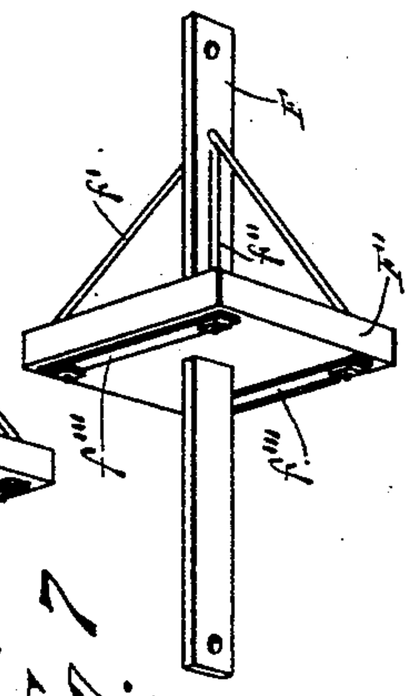


Fig. 7

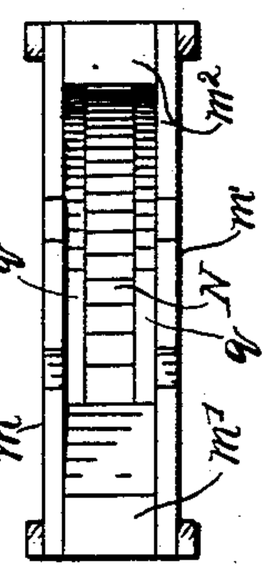


Fig. 5

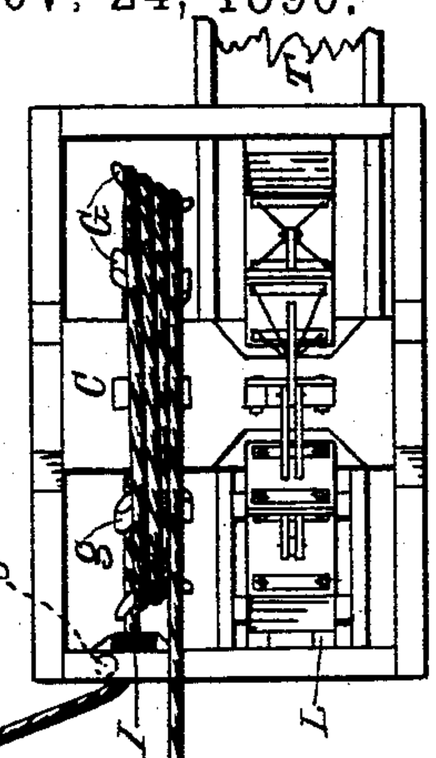
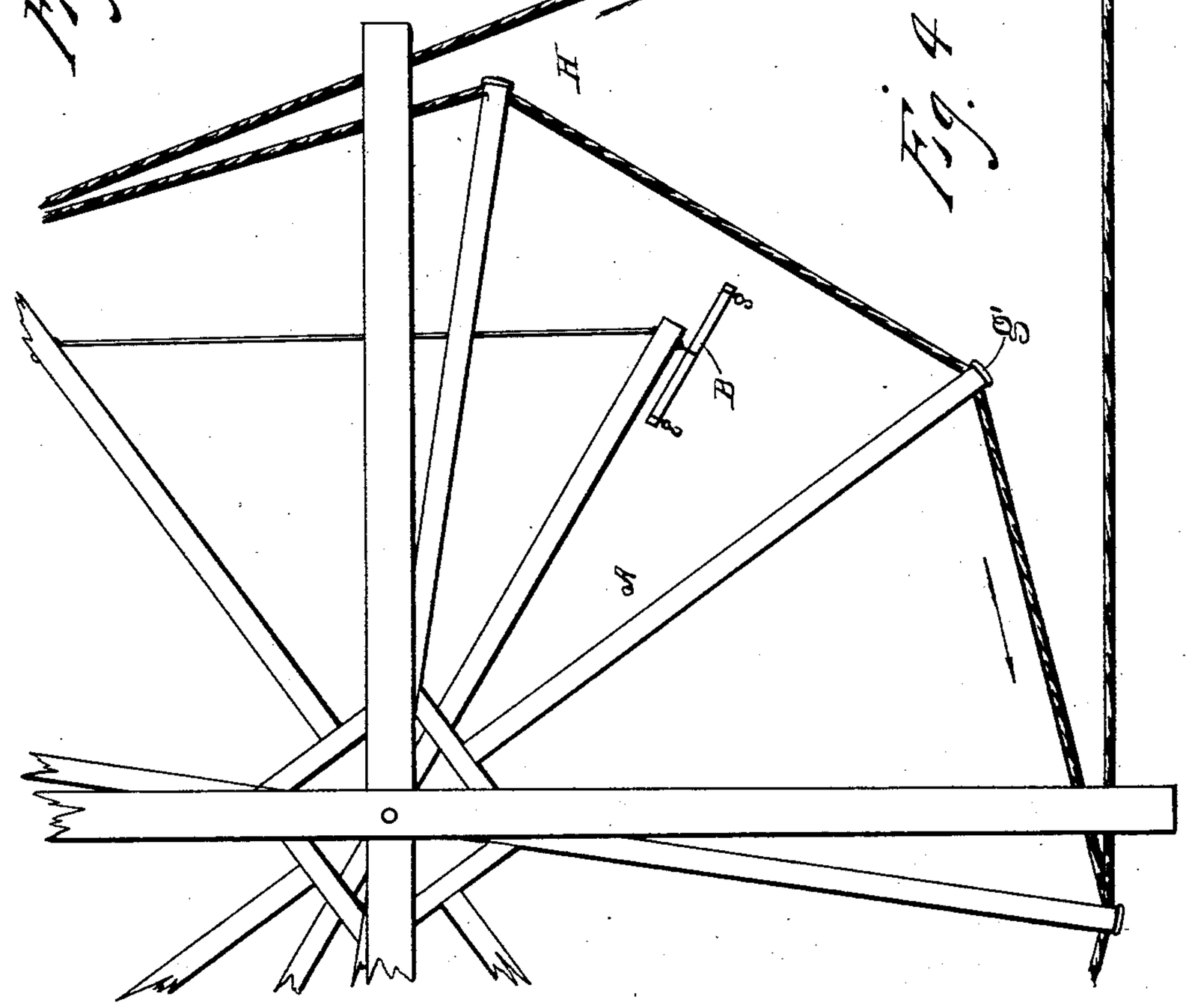


Fig. 4



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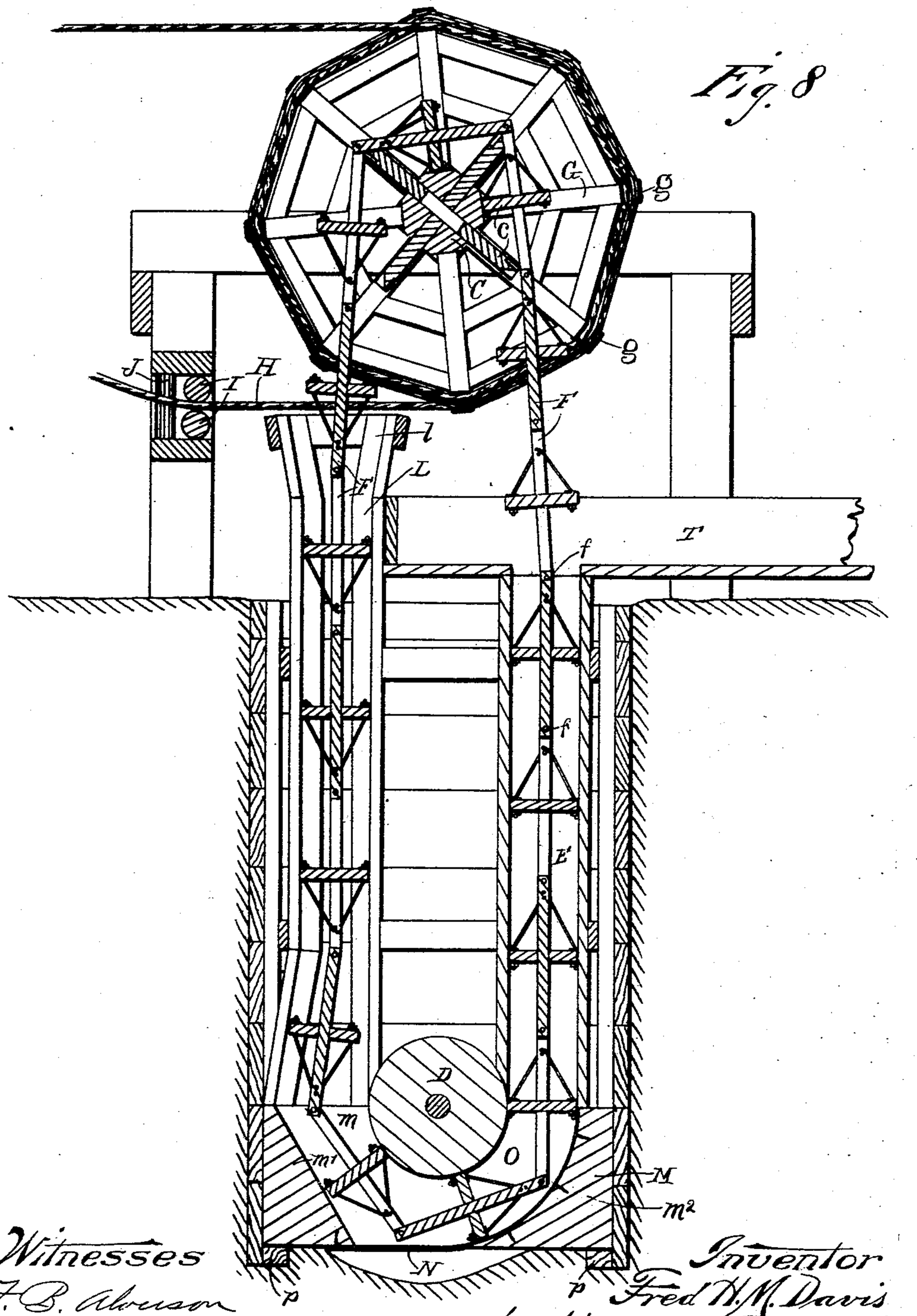
(No Model.) 4 Sheets—Sheet 3.

F. H. M. DAVIS.

HORSE POWER PUMPING MACHINE.

No. 571,993. Patented Nov. 24, 1896.

Fig. 8



Witnesses
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(No Model.) 4 Sheets—Sheet 4.

F. H. M. DAVIS.

HORSE POWER PUMPING MACHINE.

No. 571,993. Patented Nov. 24, 1896.

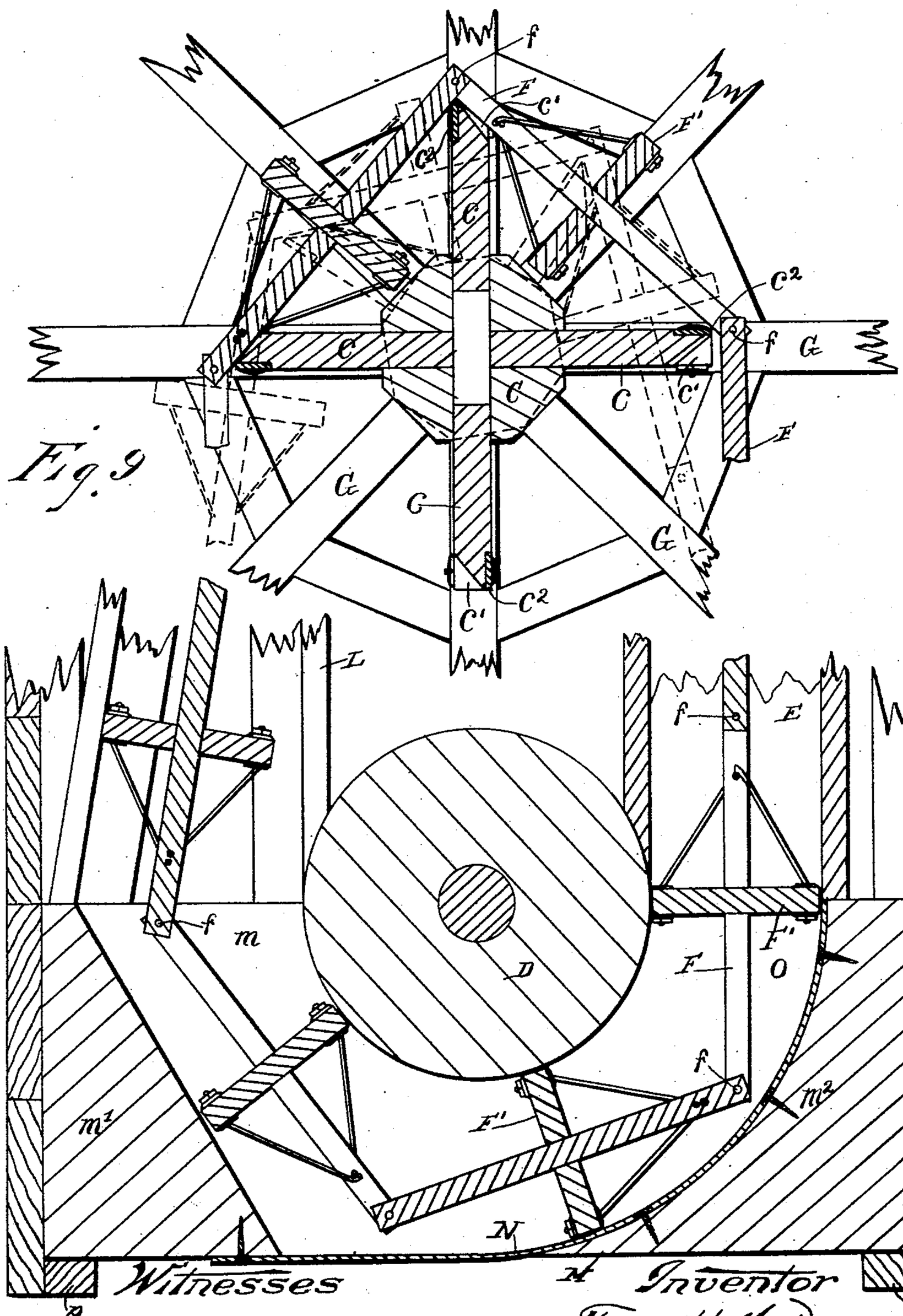

Fig. 9

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UNITED STATES PATENT OFFICE.

FRED H. M. DAVIS, OF LOS ANGELES, CALIFORNIA.

HORSE-POWER PUMPING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 571,993, dated November 24, 1896.

Application filed November 15, 1894. Serial No. 528,902. (No model.)

To all whom it may concern:

Be it known that I, FRED H. M. DAVIS, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, having invented a new and useful Horse-Power Pumping-Machine, of which the following is a specification.

My invention relates to water-elevators in which a chain composed of piston-rods provided with intermediate pistons and pivoted together at their ends is trained over a spur-wheel; and one object of my invention is to greatly economize the power and to increase the efficiency of this class of devices; also, to draw the water from the lowest point.

My water-elevator hereinafter fully described enables me to lift with a given power a very much greater volume of water than can be lifted by any pump heretofore known to me.

My invention comprises a chain pump in which a chain formed of piston-rods jointed together and provided with intermediate pistons is trained over a chain carrying and driving wheel having only four spurs, the ends of which spurs contact with the chain at the joints thereof.

I am aware of the pump in which a chain is trained over a wheel having eight spurs, the chain being formed of piston-rods jointed together and the spurs arranged to engage the chain at the joints thereof, while the pistons are chambered between the spurs; but my invention differs in principle from such construction in that I use only four spurs, with the object in view to throw the piston as close to the axis of the wheel as possible and to use a long piston-rod and a large piston with a small wheel; that is to say, a wheel having short spurs, compared to the length of chain, which will be moved by each spur each time it acts upon the chain. With my improvement I cheapen the pump by reducing the length of spurs and size of wheel and the number of joints in the chain for a wheel of given size and a pump of given capacity, and I also reduce the frequency of contact and the consequent friction and wear. I am able to give a very rapid motion to the chain and carry the water upward toward the pump-stock continuously with very great speed and with few contacts and jars of parts, and I am enabled to lift a remarkably great quantity of water with a very small amount of power in a given time and with a minimum of wear and friction.

By my invention I bring the line of direction of the loaded belt or chain as close to the axis of the chain carrying and driving wheel as possible, and at the same time I move as great length of chain as possible by each operation of the spur upon the chain.

An object of my invention is to use a long piston-rod and a large piston and yet apply the lifting force close to the axle, and yet to draw the water from the well when the surface of the water is below the piston-rods.

One object of using as long a piston-rod and as large a piston as possible is to avoid unnecessary wear and friction in operation and unnecessary expense of construction.

With my invention each spur is made to act upon the chain to draw it up through the pump-stock during a quarter of the revolution of such spur, and the quadrant through which the spur passes while pulling upon the chain is above the axle—one half at the rear of a vertical from the axis and the other half at the front of such vertical—thereby causing the weight of the loaded chain to be borne by the upper quadrant of the wheel formed by the spurs, and the line of direction of the loaded chain is brought close to the axle and the load is more nearly balanced upon the axle and is therefore taken off from the power. This will be better understood by reference to Figures. 8 and 9 of the drawings, in which it will be observed that when any two rods are at right angles with each other they lock upon the end of the spur which is in contact with their joint, and that any spur can act to pull a piston-rod only when such rod and the rod to which it is pivoted are locked upon such spur, and that this occurs only while the spur moves from one inclination of forty-five degrees over past the vertical to the other angle of forty-five degrees.

It is to be observed that when a spur contacts with a rod its first action is to swing the chain away from the axis at the same time that the preceding spur is pulling the chain in the other direction; but, since the preceding joint is locked over such preced-

ing spur, the chain cannot slip on the wheel, and the rearward movement of the joint causes an upward movement of the lower part of the chain until the spur reaches the horizontal position, after which the chain swings forward again until the next spur engages it.

My invention is peculiarly adapted for use for pumping water supplied by Artesian wells which do not rise to the height required for irrigation purposes or in cases where it is desired to increase the flow of Artesian wells. The flow of Artesian wells diminishes in volume as the height increases until the flow ceases. In order to increase the flow, I sink a cistern or supplementary well near the Artesian well and connect the Artesian well with the bottom of the cistern and then apply my machine to draw water from the cistern. The volume of the flow into the cistern at the bottom thereof is much greater than at a distance above the bottom, and the increase of flow gained by one foot of depth at the bottom of the cistern is equal to that gained by three or four feet (more or less) of depth at the top of the cistern or well, depending upon the total depth of the cistern. In addition to this construction the expense of digging the cistern increases as the depth increases, so that it is desirable to draw the water from as near the bottom as possible; and by means of my invention I am enabled to draw the water practically from the bottom of the cistern, the apparatus being so arranged that water is drawn from the bottom of the machine.

My invention in this relation consists in providing below the spur or carrying wheel a receiving-chamber of peculiar construction which connects with the pump-stock and through which the chain passes at the bottom of the well or cistern, as hereinafter more fully described.

I am aware of the construction proposed in the United States Patent to North and Sheldon, No. 336,256, patented February 16, 1886, in which a pulley is provided at the bottom of the pump-stock; but my invention is distinguished from the device shown in that patent. In that patent one side of the tube through which the water is carried is a belt which rests against and is carried by the pulley, and the pistons project from one side only of the belt, so that when the piston is loaded with water it will act as a lever and will pry upon its fastening, and thus bend the belt and tighten it upon the pulleys around which it is trained, and thus increase the resistance of the machine to the power which operates it. An object of my invention is to avoid these difficulties. In my invention the pulley or curved guide itself forms a part of the downward extention of the tube through which the water is elevated, and it does not touch the belt or chain which carries the pistons. My invention in this regard embraces a chain pump comprising a pump-stock, a chain carrying and driving wheel arranged above the pump-stock, a curved downward extension of the pump-stock, the upper curved wall of which consists of a curved guide for the pistons of the pump, and the chain trained over the wheel and through the stock and its extension and composed of piston-rods jointed together and each provided with a piston which projects on both sides of its rod and is so arranged that when the chain is driven the pistons will contact with the curved guide, which forms the upper wall of the said downward-curved extension of the pump-stock. By this arrangement I am able to draw water from the lowest point and yet the weight upon the piston is equally balanced on both sides of the piston and all prying action of the piston on the belt is avoided. My machine will draw the water although the surface of the water is below the piston-rods, and as soon as the water has been drawn up into the upright tube of the pump it will flow, so as to cover the piston evenly and will balance evenly on both sides of the piston-rod. The pull upon the piston is at the center thereof and there is but little friction upon the curved guide. In fact the pistons will not always engage the guide when passing beneath it, but will swing freely beneath and come in contact with it only at intervals.

A very important function of the guide is to form the upper wall of the curved downward extension of the tube through which the water is drawn.

In certain sections of the country, say, for instance, in Southern California, there are arid lands which will produce bountifully when irrigated, and Artesian water has been discovered beneath such lands, but not having sufficient head to flow. An object of my invention is to provide a pumping appliance which will be sufficiently economical of power to raise a sufficient volume of water from wells of this class to profitably irrigate these lands.

In order to raise the large volume of water which is required for irrigation, a large pump-stock is required, and in case of deep wells the same would be very expensive if it were required to be strong enough to stand the pressure of the column of water the whole length of the stock; and another object of my invention is to provide a pumping apparatus in which a large pump-stock can be made of ordinary boards nailed together and will be practical for wells of considerable depth.

My improved horse-power for driving my water-elevator comprises the combination of the reel arranged to revolve in a horizontal plane and provided at intervals with narrow vertically-disposed rope-receiving faces arranged oblique to the plane of rotation of such reel, a power-receiving wheel arranged to revolve in the vertical plane and provided at intervals with rope-receiving faces arranged oblique to the plane of rotation of such wheel, a rope wound more than once

around the vertical wheel and carried by the said faces of such wheel and running off of such wheel at the top of the wheel but at the inner ends of the oblique faces, thence to the upper edge of the rim of the reel and wound more than once around such reel and carried by the oblique faces of the reel, and thence off of the same at the lower edge of such rim, and thence to the bottom of the vertical wheel and onto the oblique faces thereof at the outer ends thereof, a guide arranged to guide the rope onto the upper ends of the faces of the reel, and the guides to guide the rope from the reel to the outer ends of the faces of the wheel at the bottom of the wheel.

Stated in general terms, the object of my invention is to provide simple, cheap, and effective means of superior character for elevating a great volume of water for irrigation and for other purposes at a minimum expense of power and to arrange the machine to be driven by horse-power; also, to provide a superior horse-power for the operation of the pump, and also to take the water from the lowest point of the path of the pistons of the chain. I accomplish these objects by means of the device described herein and illustrated in the accompanying drawings.

My invention comprises the combination of a pump-stock and a piston-guide arranged parallel therewith, a curved guide forming a semicircular connection between the lower ends of the inner faces of the adjacent wheels of the pump-stock and piston-guide, a chain carrying and driving wheel composed of an axle and only four spurs projecting at right angles and of such length that when any two of the spurs are horizontal their ends will respectively extend to the center of the stock and guide, respectively, and a chain trained around the chain carrying and driving wheel and curved guide and through the stock and piston-guide, and composed of piston-rods pivoted together, and arranged to contact at its joint with the ends of the spurs, and provided with pistons respectively arranged at the middle of their respective rods and projecting on all sides thereof and arranged to contact at their inner edges with the curved guide.

My invention also includes other parts and combinations, herein described and claimed.

Fig. 1 is a perspective view showing my horse-power irrigating-pump in position for operation. The horse-power device is drawn on a smaller scale than the rest of the view and the water-elevating device is broken, so as to show on the same sheet the parts which are at the top and also at the bottom of the well. Fig. 2 is a perspective detail showing the spurs which carry the pistons. A fragment of the spur-shaft is shown. Fig. 3 is a detached detail of the spurs removed from the shaft and partially separated from each other. Fig. 4 is a fragmental plan of my invention as shown in Fig. 1, except that in this view the relative proportions of the parts are maintained. Fig. 5 is a plan of the base from which the bottom guide or roller has been removed to expose the interior of the base-box. Fig. 6 illustrates one of the pistons having a double rod, which is partly broken to show the construction. Fig. 7 shows a piston having a single rod. Fig. 8 is a vertical section showing the spurs and pistons in the position nearly opposite that shown in solid lines in Fig. 9, the purpose being to indicate by the two views the advantages gained in leverage as compared with the speed of the pistons. Fig. 9 is a fragmental vertical section of the water-elevating contrivance. Dotted lines indicate another position of the spurs and pistons.

My machine as a whole consists of the reel A, arranged to revolve in a horizontal plane and provided with suitable means B for attaching a horse thereto to rotate the same, and having the faces of the ends of its spokes oblique to the plane of rotation of the reel; a revolving axle or shaft C, provided with a series of spurs *c*, arranged to rotate in a vertical plane; a curved piston-guide D (preferably a pulley) arranged below the spurs; a pump-stock E, extending upward from the curved guide; a series of piston-rods F, respectively provided with intermediate pistons F′, and pivoted together at their ends by pivots *f* to form an endless belt trained under the curved guide, through the stock, and around the spur-axle over the spurs, and arranged with such relation to the spurs that when the spur-axle is rotated the ends of the spurs will contact with the belt at the joints thereof; a power-receiving wheel composed of a series of spokes G, mounted on the spur-axle C, and arranged to rotate therewith and having their ends provided with the rope-receiving faces *g*, arranged oblique to the plane of rotation of the spokes; an endless rope H, trained around the horse-power reel A and the spur-wheel formed by the spokes G, and seated on the rope-seating faces of such wheel and reel, respectively; rope-guiding rollers or pulleys I J, arranged near the bottom of the wheel formed by the spur-axle spokes G to guide the rope and direct it upon the outer sides of the oblique faces of the spokes, and the guide-pulley K, arranged near the horse-power reel A, to guide the rope and direct it to the outer side of the oblique faces of the ends of the spokes. L indicates a piston-return guideway arranged extending from below the spurs to the base M, upon which the curved guide or belt-pulley D is mounted. The guideway L is provided with the flaring mouth *l*, so that the pistons returning from the spurs will not be stopped by their contact with the return-guideway L.

N indicates an iron face-plate arranged beneath the pulley to direct the pistons as they begin their ascent, after passing the bottom pulley or guide D, into the stock E. The base

M is provided with the curved runway O, which forms a downward extension of the bore of the stock E.

In practice the receiving-chamber or base-box M is formed, essentially, of two side boards m m', the piston-guide D, and two end blocks m^1 m^2, secured between the side boards. These end blocks are slightly greater in thickness than the width of the pistons and provide a chamber between the side walls m and m' about a quarter of an inch wider than the pistons, so that the pistons will pass therethrough without touching the side walls. The bore of the pump-stock is also about a quarter of an inch greater in diameter than the width of the pistons, so that the pistons move freely through the stock, and when the pistons are at rest the water will run freely down through the stock to the well. The curved piston-guide is preferably a pulley or roller, as shown at D, but is not necessarily so. Its principal purpose is to form the upper inner curved side of the runway O, which is practically a downward extension of the stock. The object of this curved downward extension of the stock is to cause the machine to draw the water from the bottom of the machine. By reference to Figs. 8 and 9 it will be seen that this runway extends fully to the bottom of the base-box, which rests upon the sills p, which in practice are two inches thick, so that the water is drawn from within two inches of the bottom of the well. It is to be understood, however, that the sills can be let into the earth at the bottom of the well, so as to bring the bottom of the box almost flush with the floor of the well. When such floor is of earth, the operation of the pump will soon excavate the earth beneath the center of the box and thus permit full flow into the box. In Fig. 8 the sills are shown entirely sunk into the floor of the well, and a hollow is shown in the floor beneath the inlets at the bottom of the box.

The water in the machine, as shown, is admitted through the bottom of the base-box through inlets q q between the side walls m m' and the curved face-plate or guide N. The guide N, as shown, is narrower than the end blocks m^1 m^2. In the machine illustrated the face-plate or guide N is four inches wide, while the space between the walls is seven inches, thus leaving a space on each side of the face-plate one and one-half inches wide to admit the water.

The spurs c are provided with the notches c' on the rear side of the spurs, respectively, and the other side of the spur is faced with the metal plate c^2, which contacts with the belt at the joints thereof. This affords a narrow bearing edge extending across the end of the spur to contact with the inner faces of the links of the chain at the joints thereof, so that when a link is carried over the top of the wheel the weight of the water-bearing portion of the chain will be borne by the link resting upon the narrow bearing edge and the chain will bend over such bearing edge at right angles, so as to form a perfect lock for holding the chain without any slipping, and the wheel and chain will run smoothly and without jar.

I am aware that a chain for a chain-pump has heretofore been carried by a wheel having four spurs, and I do not herein broadly claim such a construction; but in such chain-pump the chain was borne by the pivots which connect the links and the same were arranged to rest in crotches on the ends of the spurs. In such structure there is greater friction than in my newly-invented combination above specified, for the pivots had to turn in the crotches and there was a greater liability to wear and break.

I have shown a belt formed of alternate double and single piston-rods, but it is to be understood that I do not limit my claim to the exact construction of belt shown, the purpose of the construction shown being convenience of manufacture. However, it is important that the pistons be pivoted to each other by the transverse pivots and that the spurs contact with the piston-rods at the pivoted joints at the ends of the pistons.

It is very desirable that a machine for irrigating, as suggested above, should be as cheap in construction as possible. My invention is adapted for using an ordinary rope as belt for communicating the horse-power to the pump. One difficulty of using the rope is its liability to stretch and become loose and slip. To obviate this slipping, I wind the rope more than once around the wheel which drives the axle C a greater or less number of times, depending upon the height of the lift and the size of the bore of the stock, and in order to do this I arrange the faces of the ends of the spokes oblique to the plane of the wheel, so as to cause the rope to slip from the upper side of the wheel to the lower side of the wheel, so that as the wheel turns the rope can be taken on at the higher side and taken off at the lower side. The horse-power reel is constructed in the same way. The end faces of the arms of the reel slope downward and inward and the rope is wound more than once around the reel and taken onto the reel at the upper end of such faces and is taken off at the lower and inner end of such faces. g g' indicate steel plates or faces for the ends of the arms of the reel and spokes of the wheel. These plates allow the rope to slip freely from one side of the end of the arm of the wheel to the other side thereof. The several guide-pulleys are arranged so as to guide the rope to the higher side of the arms of the reel and spokes of the wheel, and as the reel and wheel are rotated the rope is passed around the wheel and reel, respectively, and taken off without crossing. I have shown the rope wound three times around the wheel formed by the spokes G and two times around the horse-power reel. The horse-power reel, being much larger in diameter, affords much greater friction to the rope

than the smaller wheel of the elevator. The rope thus wound around the reel and around the wheel of the water-elevator is bent across the ends of the spokes at greater or less angles, thus giving greater friction than would be given by a wheel having a circular rim. The pistons or buckets are supported by steel rods or braces f' f'', passed through the piston-rods and secured at their ends to the corners of the pistons. f''' indicates iron straps provided to reinforce the buckets and form a firm stay for the ends of the braces which are secured to the pistons.

By my improvement in the form of the reel on which the rope is wound I have attained security against slipping of the rope around the wheel, and have combined with that great facility of slipping along the wheel, so that the friction is applied where required for driving the pump and is dispensed with where not required, and by this combination the machine works with great efficiency and with no unnecessary loss of power.

As shown, the machine is designed to make twenty revolutions of the axle per minute when driven by a horse walking at an ordinary gait. This would discharge eighty bucketfuls in a minute.

A flume T is provided at the top of the stock, and is of such size as to fully accommodate the discharge from the stock when the pump is running. The space which I have provided on each side of a seven-inch stock is eight and a half inches, the flume being seven inches deep and the stock being set eight and one-half inches from the closed end of the flume, but with this construction the discharge from the stock has at times been too great for the capacity of the flume, depending on the speed of the horse. The flume should be large enough to fully accommodate the desired discharge.

In practice, when the machine is in position for operation, a horse is hitched to the reel and driven to rotate it, thus rotating the water-elevator wheel, the spurs, and driving-belt or pistons. The water at the bottom of the wheel is carried upward through the pump-stock by the pistons. Each piston carries the volume of water which is between it and the next piston above. The distance between pistons in the machines that I have constructed is fifteen inches, so that each piston carries a weight of a body of water about fifteen inches in height and equal in cross-section to the surface of the piston. I have found that when my machine is in operation the water will not leak out of any small holes which may be in the pump-stock, but, on the contrary, I have found that in instances where there were nail-holes through the boards which formed the pump-stock the air flowed in through such holes with considerable force when the pump was in operation, thus showing that there was no pressure from within to force the boards apart, and that instead of there being an outward pressure to burst the stock there was an inward pressure of air against the stock; and it is also a fact that when the machine is altogether at rest with the pump-stock full the air is still drawn into the pump-stock until the water has flowed down the pump-stock and passed the hole through which the air entered the pump-stock in which the experiment was made.

In the drawings I have not shown a well of great depth, and in practice the deepest well in which I have applied my invention is thirty-six feet in depth, but I have reason to believe from my experience that the pump-stock can be applied to wells at much greater depth. It is to be understood, however, that in providing belts of such depth the piston, pivots, and their bearings should be made of proper size and strength to resist the additional weight of the water. I have noticed, however, that an increase of depth of well or lift does not proportionally increase the weight of the lift. On the contrary, there seems to be but little more power required to keep the pump running when the surface of the water in the cistern is brought nearer the bottom of the cistern than is required when the cistern is full of water. I believe this can be accounted for on the theory that the speed of the pistons is much greater than that which would be attained by water falling through the space between the pistons, and that the principal amount of force required in addition to overcoming friction is that which is necessary to give the initial speed to the water between the pistons, and that when the water has been started up the stock its weight or downward pull on the belt is practically *nil* because counteracted by the upward momentum, and only a small amount of force is required to continue the water in its upward course. Since the belt travels continuously the inertia of the water needs only to be overcome once, and since the pistons fit the stock quite closely there is but little if any downward escape of water in the stock while the pump is running. I believe there is none whatever.

It is to be observed that the rectangular pistons I use not only enable me to construct a very cheap pump-stock but that they are cheaper to construct than other forms and also give greater economy of space, allowing a greater cross-sectional area of pump-stock to be used effectively with a shorter spur than would be practical with a round piston or bucket. It might be found desirable to make the pistons and pump-stock oblong instead of square, as shown, but at present I prefer the square form.

In practice I make the spokes G four feet long from center of axle C and the spurs ten inches long from center of axle, so that the apparent advantage of the wheel over the lift of the spurs on the piston is three feet and two inches, but I believe that in such machine the actual advantage of the wheel over the lift of the spur is three feet and

five inches. I think this can be understood by noting that in Fig. 8 the line of direction of the pull or lift is much closer to the center of the axle than the ends of the spurs are. Fig. 9 indicates in solid and dotted lines differences in the line of direction of the pull.

In Figs. 1, 4, and 8 the spokes are shown shorter in proportion to the spurs than actually used by me, as above mentioned, such proportions not being of the essence of my invention.

In order to provide a very cheap arrangement for driving the pistons, I construct the spurs and their axle of wood, and the manner of doing this will be understood by reference to Figs. 1, 2, 3, and 9. The axle is mortised at right angles to receive the cross formed by the spurs, as shown in Fig. 2. These spurs comprise three pieces of wood, one of which (marked c' in the drawings) is provided with a mortise r midway its length. The other two spurs are formed of two sections (marked $c^{2\prime}$ and c^3) which are duplicates and are each provided with a tenon c^4 and a stud c^5, the offset c^6, and the shoulder c^7. The mortise r is arranged to receive and seat both of the tenons c^4, one being inserted from one side of the piece of timber c' and the other from the other side, and when so inserted the ends of the tenons c^4 of each spur respectively fit in the offset or socket c^6 of the opposite spur and the shoulder c^7, and the end of the studs c^5 respectively fit upon the opposite faces of the piece of timber c'. The tenons and offsets or sockets are preferably of such length that they do not extend to the outside of the axle and the axle is thick enough to seat about two inches of the spurs on each side of the offsets. By this construction very great strength of spur and axle is secured.

I chamfer the axle, as at s, Fig. 1, in the path of the piston to allow the use of as large axle and large pistons with as short spurs as possible.

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

1. The combination of the reel arranged to revolve in a horizontal plane and provided at intervals with narrow vertically-disposed rope-receiving faces arranged oblique to the plane of rotation of such reel; a power-receiving wheel arranged to revolve in a vertical plane and provided at intervals with rope-receiving faces arranged oblique to the plane of rotation of such wheel; a rope wound more than once around the vertical wheel and carried by the said faces of such wheel and running off of such wheel at the top of the wheel but at the inner ends of the oblique faces, thence to the upper edge of the rim of the reel and wound more than once around such reel and carried by the oblique faces of the reel and thence off of the same at the lower edge of such rim and thence to the bottom of the vertical wheel and onto the oblique faces thereof at the outer ends thereof; a guide arranged to guide the rope onto the upper ends of the faces on the reel; and guides to guide the rope from the reel to the outer ends of the faces of the wheel at the bottom of the wheel.

2. The combination of the axle mortised at right angles to receive the cross formed by the spurs; the spurs comprising three pieces, one provided with a mortise midway its length, and the other two each being provided with a tenon and a stud, an offset and a shoulder, and arranged to seat in the mortise in the first main piece substantially as described.

FRED H. M. DAVIS.

Witnesses:
ALFRED I. TOWNSEND,
WINIFRED L. DAVIS.