(No Model.)

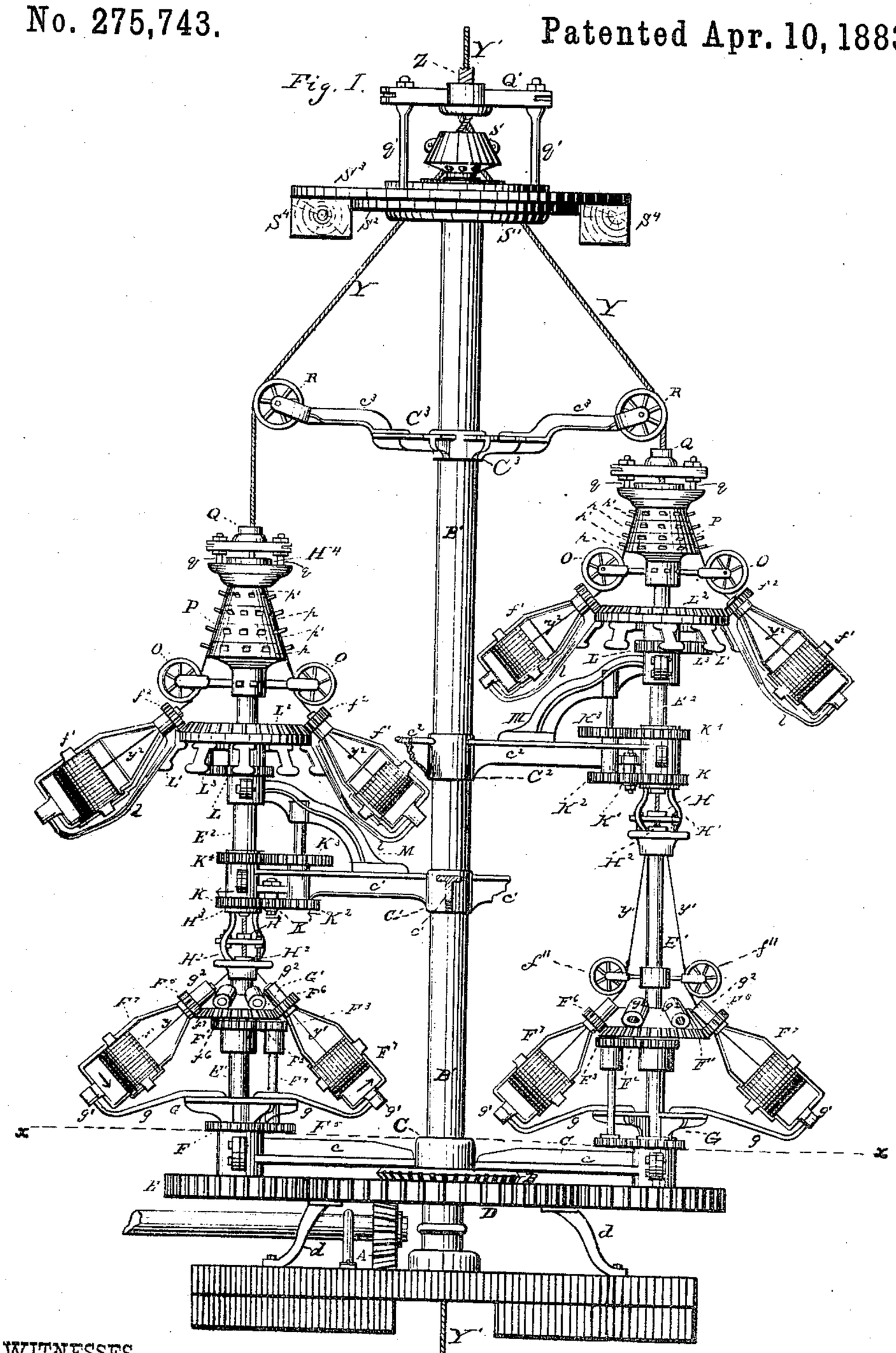
6 Sheets—Sheet 1.

M. M. ZELLERS.

MACHINE FOR MAKING ROPE, &c.

No. 275,743. Patented Apr. 10, 1883.

Fig. 1.



WITNESSES

W. Engel

Jno. Crowell Jr

INVENTOR

M. M. Zellers,

By Leggitt & Leggitt

ATTORNEYS

(No Model.)

6 Sheets—Sheet 2.

M. M. ZELLERS.

MACHINE FOR MAKING ROPE, &c.

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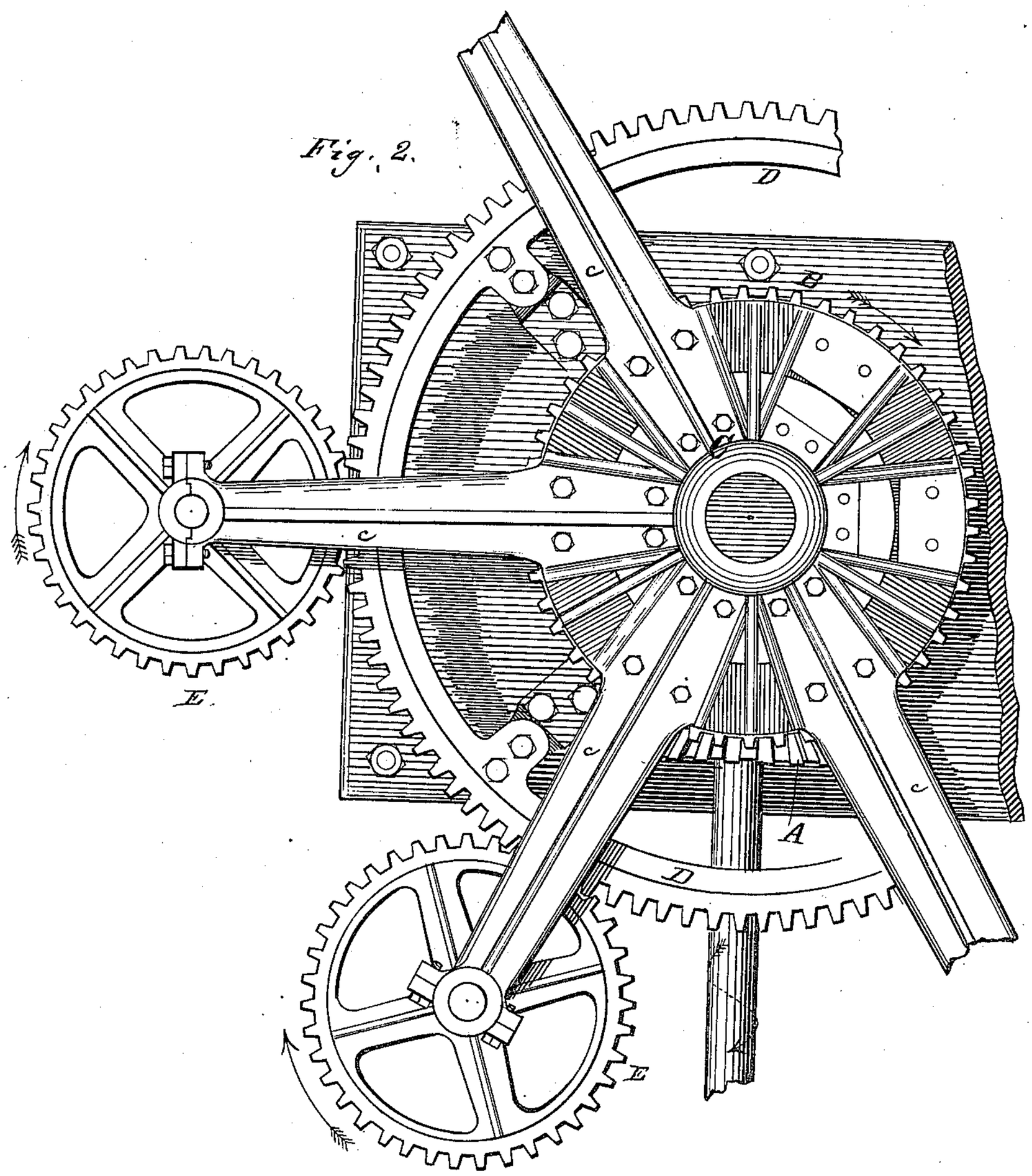
Fig. 2.



WITNESSES

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ATTORNEYS

(No Model.)

6 Sheets—Sheet 3.

M. M. ZELLERS.

MACHINE FOR MAKING ROPE, &c.

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Fig. 5.

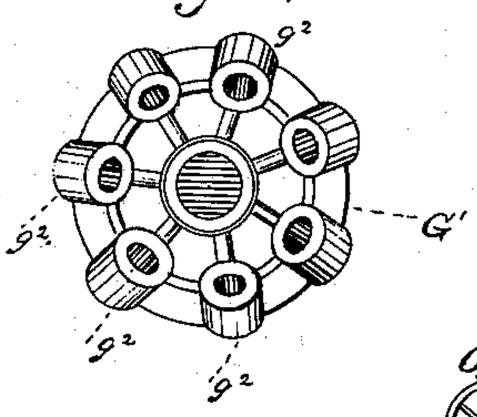

Fig. 3.

Fig. 4.

Fig. 3ª.

WITNESSES

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(No Model.)

6 Sheets—Sheet 4.

M. M. ZELLERS.

MACHINE FOR MAKING ROPE, &c.

No. 275,743. Patented Apr. 10, 1883.

Fig. 6

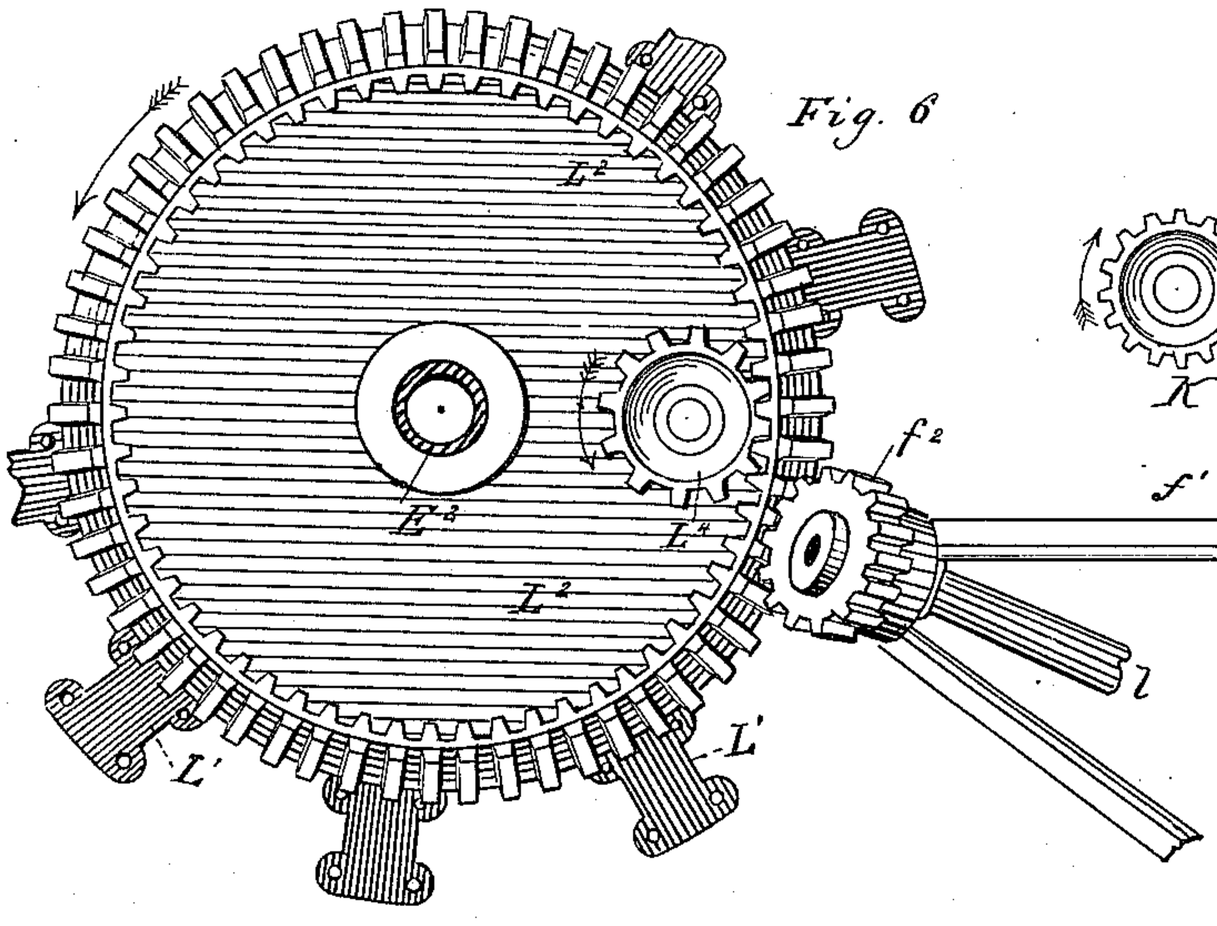


Fig. 10.

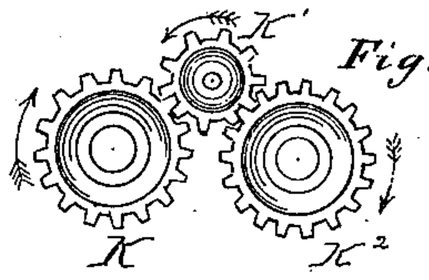


Fig. 8.

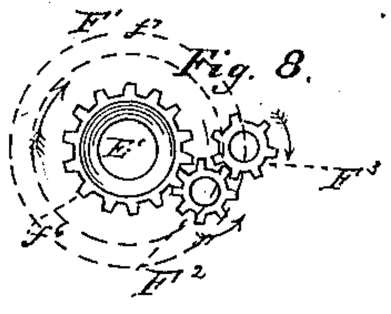


Fig. 9.

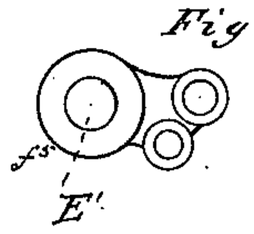


Fig. 7.

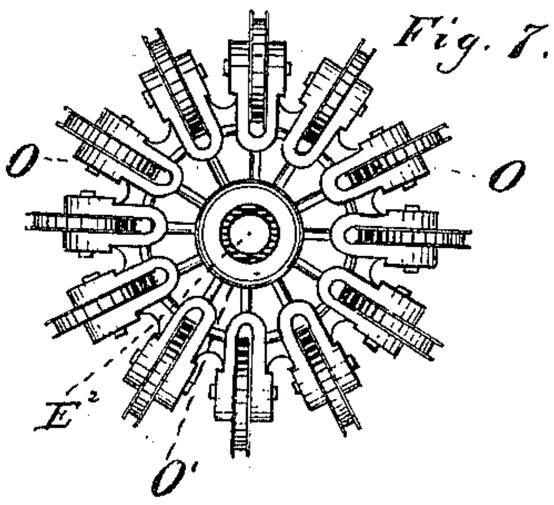


Fig. 11.

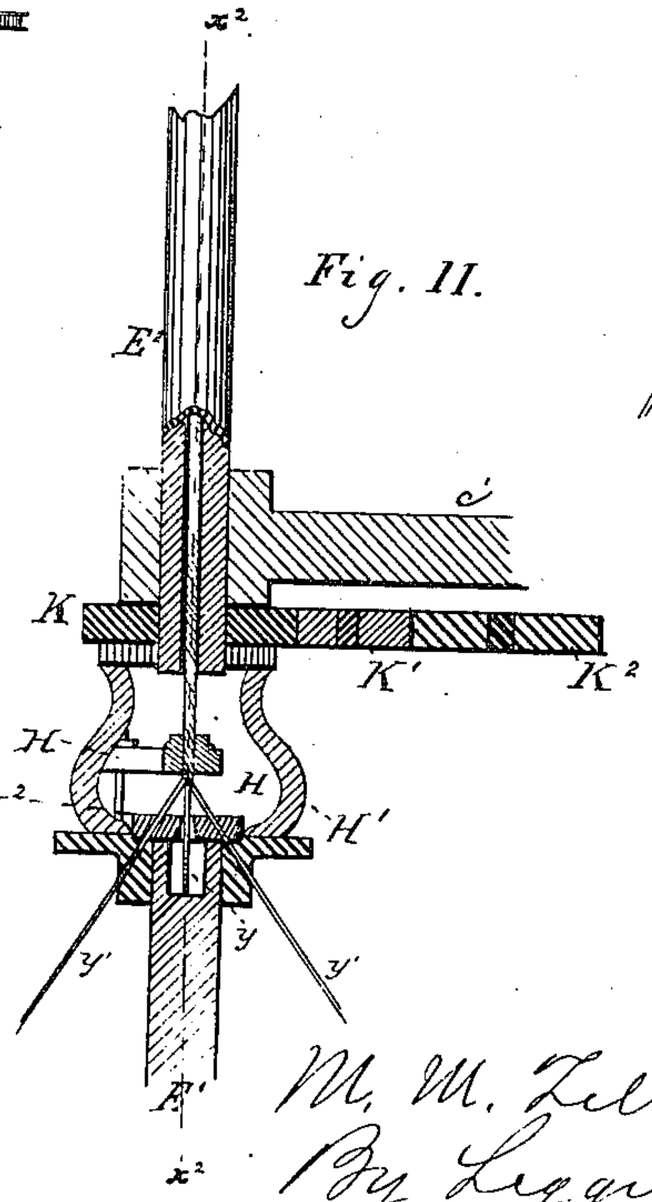
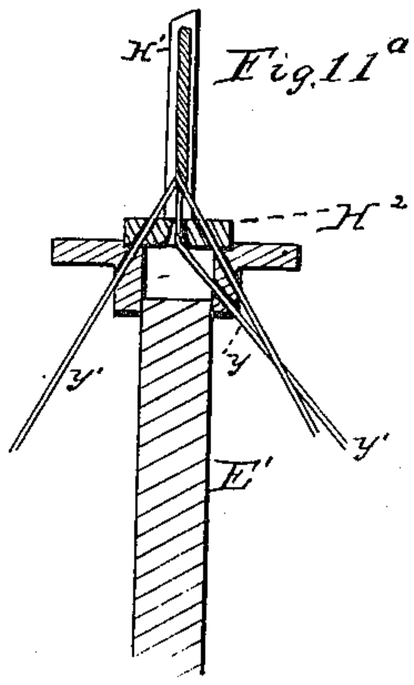


Fig. 11ª



WITNESSES

H. Engel

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ATTORNEYS

(No Model.)

6 Sheets—Sheet 5.

M. M. ZELLERS.

MACHINE FOR MAKING ROPE, &c.

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Fig. 14

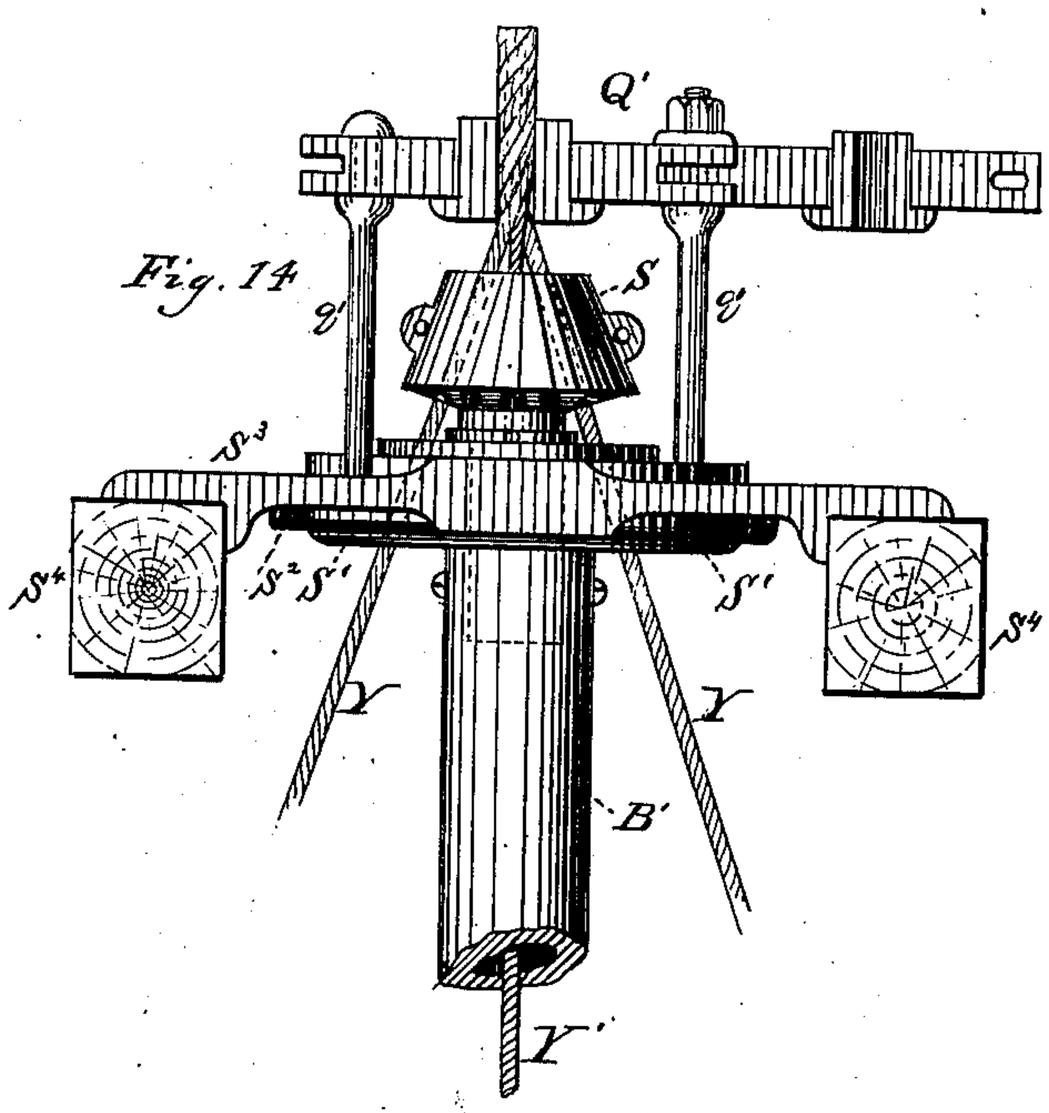


Fig. 13.

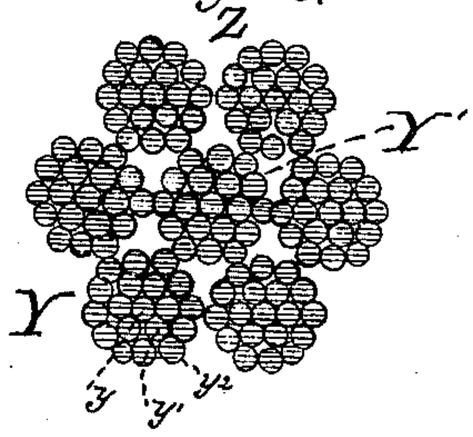
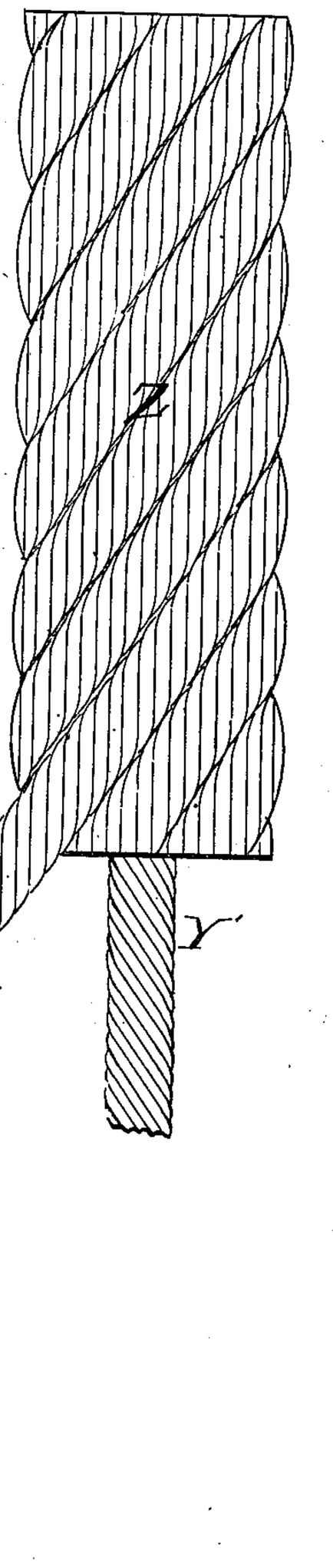


Fig. 12



WITNESSES

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ATTORNEYS

(No Model.)

6 Sheets—Sheet 6.

M. M. ZELLERS.

MACHINE FOR MAKING ROPE, &c.

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Fig. 16.

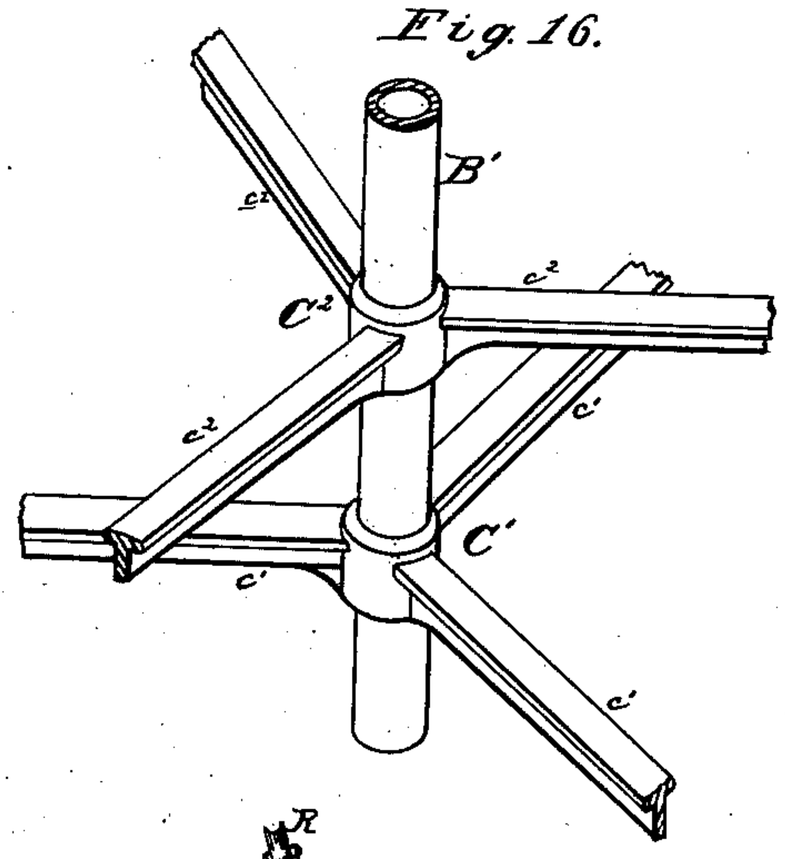


Fig. 17.

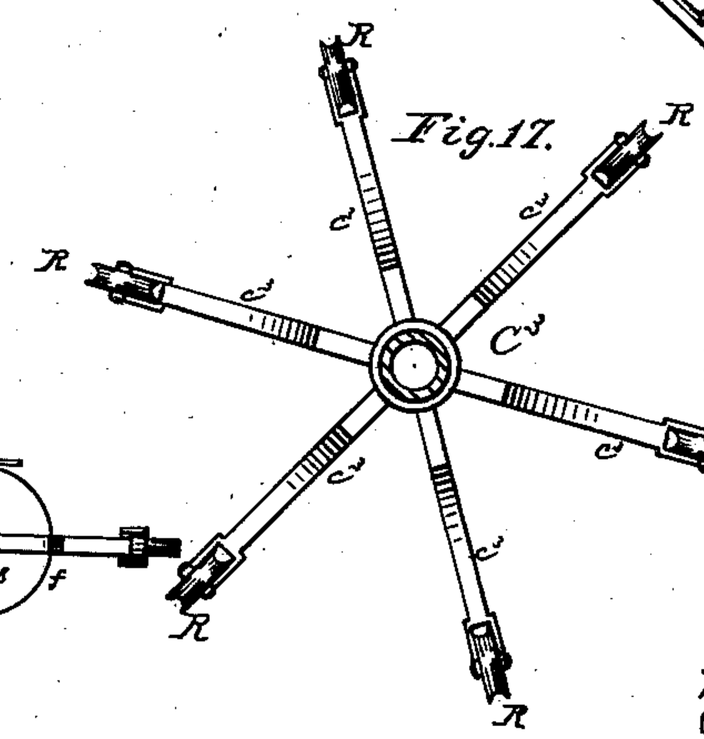


Fig. 18.

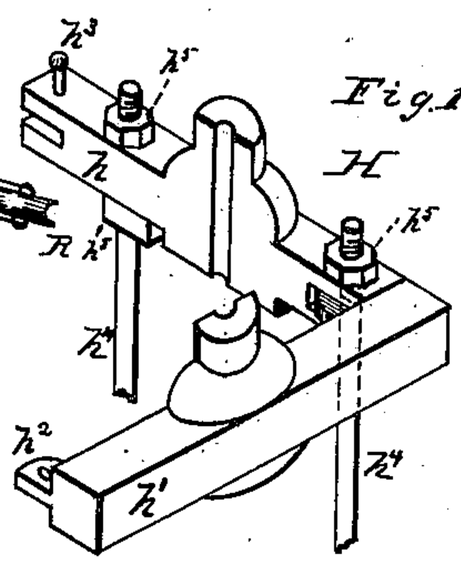


Fig. 19.

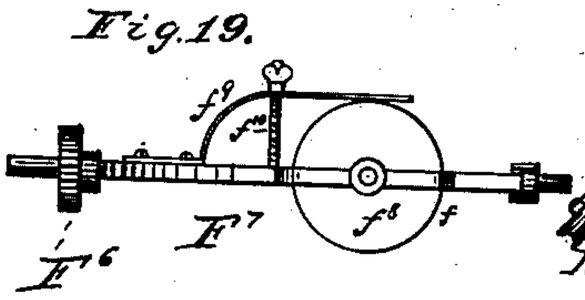
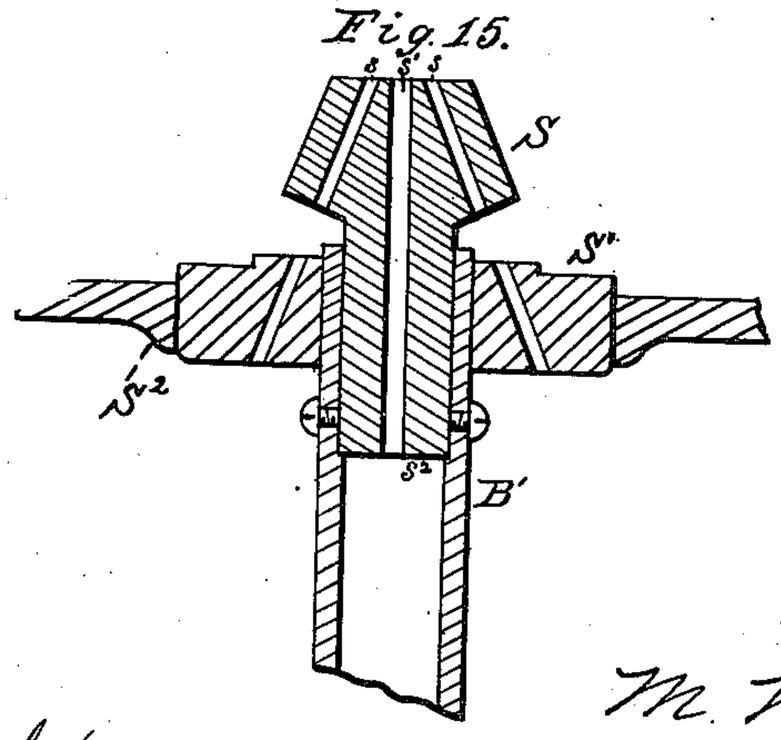


Fig. 15.



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Attorneys.

UNITED STATES PATENT OFFICE.

MAHLON M. ZELLERS, OF KENT, OHIO.

MACHINE FOR MAKING ROPE, &c.

SPECIFICATION forming part of Letters Patent No. 275,743, dated April 10, 1883.

Application filed November 28, 1881. (No model.)

To all whom it may concern:

Be it known that I, MAHLON M. ZELLERS, of Kent, in the county of Portage and State of Ohio, have invented certain new and useful Improvements in Machines for Making Rope, &c.; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use it, reference being had to the accompanying drawings, which form part of this specification.

My invention relates to machines for making ropes or cables of any desired length, without joint or splice, of that class in which the rope or cable is composed of strands each consisting of a core and layers of wire or threads wound around the same, the rope or cable itself having a core about which the strands are wound; and while the mechanism which I shall describe is such as is particularly adapted for the manufacture of wire rope or cable, I wish it to be understood that it is equally applicable without material modification for the manufacture of ropes, lines, or cables from any material suitable for the purpose.

My invention consists in the novel construction and combinations of devices which will be hereinafter particularly described and claimed.

In the drawings, Figure 1 is a view in elevation of my machine with some of the parts omitted to avoid confusion, the omitted parts being understood to be identical with those which are shown. Fig. 2 is a horizontal section on the line *x x*, Fig. 1, showing a partial plan view of the driving gear-wheel and the primary gear-wheel of the machine with which it meshes, also illustrating the construction of the lower main spider, and showing partially the fixed gear which meshes with the rotary main gear-wheels of the spider. Fig. 3 is an enlarged view of a portion of the machine, partly in section. Fig. 3ª is a longitudinal section of one of the spool-frames on the line *x' x'* of Fig. 3. Fig. 4 is a partial plan view of a spider which carries one of the lower sets of spool-frames. Fig. 5 is a plan view of the bearings for the upper journals of one of the lower sets of spool-frames. Fig. 6 is an enlarged plan view, showing the double-faced annular gear-wheel which imparts motion to one of the upper sets of spool-frames, and showing also the pinion which gives motion to said wheel, the spool-frame pinion, and part of the spool-frame. Fig. 7 is a plan view of one of the spiders carrying the anti-friction wheels which guide the wires from the upper sets of spool-frames. Fig. 8 is a plan view in detail of the gearing which transmits motion to the lower spool-frames. Fig. 9 is a plan view of the bracket carrying the bearings of the shafts of said gearing. Fig. 10 is a detail plan view of the pinions transmitting a reversed motion to the hollow shaft which supports the spider carrying one of the upper sets of spool-frames. Fig. 11 is a detail view, mainly in section, illustrating the lower wire-guide and adjacent parts. Fig. 11ª is a section of the guide and adjacent parts in line x^2 x^2, Fig. 11. Fig. 12 illustrates a rope such as manufactured by my machine, said rope consisting of a core and six strands wound thereupon, each strand consisting of a central core with two courses of wires, the inner course having six and the outer course twelve wires. Fig. 13 is a cross-section of the rope. Fig. 14 is a view of the devices for forming and guiding the finished rope. Fig. 15 is a vertical central section of the same at a right angle to Fig. 14. Fig. 16 is a fragmentary perspective view, illustrating the relative position of the arms of the two spiders which carry the upper spool-frames. Fig. 17 is a top view of the spider carrying the guide-wheels for the finished strands. Fig. 18 is a detached perspective view of one of the dies. Fig. 19 is a side view of one of the spool-frames, showing the spool-brake.

Referring to Fig. 1 of the drawings, the letter A indicates a bevel-gear driving-wheel fixed upon a shaft, which may receive its rotary motion in any convenient manner. This bevel-gear wheel meshes with a bevel-gear, B, which is rigidly keyed upon the vertical hollow shaft B', which is the main shaft of the machine, and carries the devices which produce the strands that are brought together and wound about a central core to form the finished rope. Upon the shaft B' are fixed a series of spiders which carry the strand forming and guiding devices, and these spiders and the sets of strand-forming devices will vary in number according to the special character of the rope

to be made. In the present instance I have shown the shaft B′ as provided with four spiders, C, C′, C², and C³, the lower spider, C, carrying the devices which place in position the cores *y* of the strands, Figs. 12 and 13, and wind about said cores the first course of wires, *y′*, and the two spiders C′ and C² carry the devices which apply the second courses of wires as shown at *y²*. The first course has six wires, and the second course twelve wires in the present instance, and the second is the outside course, though it will be understood that additional courses of wires may be applied, and the shaft B′ be provided with spiders carrying devices for that purpose. The spiders C′, C², and C³ are simply bands which surround the shaft and have radially-projecting arms *c′ c² c³*, respectively, which carry at their ends the devices which the spiders are intended to support. The lowermost spider, C, is composed partly by the bevel-wheel B, the spider-arms *c* having their inner ends secured in sockets or seats formed for them in the upper face of said wheel. The mechanism for forming the strands comprise, among other devices, revolving sets of spool-frames, in which are mounted the spools which deliver the wires for the cores and surrounding courses. These mechanisms will be hereinafter particularly described. The uppermost spider, C³, carries at the ends of its arms *c³* simply the outer friction grooved guide-wheels R, over which the completed strands pass to guide S above. The lowermost spider, C, has six arms, *c*, as indicated in Fig. 2, and, as before stated, carries all the devices for placing the strand-cores and winding thereon the first courses of wires; but for carrying the devices for applying the second courses of wires I have found it convenient to use two separate three-armed spiders—one above the other—and the arms of one projecting opposite the spaces between the arms of the other, as shown in Fig. 16. The reason for this arrangement is that the set of spool-frames for applying the outer course of wires to a strand carries twice as many spools as does the corresponding set of spool-frames below for applying the first course of wires about the core, and such upper circle of spool-frames has therefore twice the diameter of the lower. It is desirable that these upper and lower sets of spools shall be so arranged that the axis of each lower set shall be in line with the axis of the corresponding upper set, in order that the unfinished strand may pass from the lower guide directly to the hollow shaft of the upper set of spool-frames, and thus avoid the necessity of its being bent over guides. If the upper sets were all carried by a single spider, such spider would necessarily have very long arms, in order that its sets of spool-frames might be in a circle where they would have room to revolve clear of each other, and then the lower spider would have to be provided with arms of the same length as the upper spider, in order to bring its sets of spool-frames in a circle having the same diameter as that of the upper sets. By dividing the upper sets of spool-frames into two divisions, however, it will be seen that I avoid using spiders of such large size, the sets of spool-frames of one division having ample space to revolve in a different plane from those of the other division, while their centers are in vertical line with the centers of the respectively corresponding set of lower spool-frames. The shaft B′ has its upper and lower journals arranged in suitable bearings, and when it revolves of course revolves the spiders and the mechanism they support.

D is a fixed horizontal annular gear-wheel, surrounding concentrically the shaft B′ and rigidly supported by standards *d*, secured to the bed-plate or foundation of the machine. This fixed wheel meshes with rotary gear-wheels E, fixed upon the lower ends of vertical shafts E′, which have their lower journals supported in bearings formed in the ends of the arms *c* of the lower spider, C, and their upper ends loosely connected with the lower ends of vertical hollow shafts E², which have their lower bearings in the ends of the arms of the spiders C′ and C², respectively, and their upper bearings in the ends of brackets M, fixed upon said arms. The lower vertical shafts, E′, are connected with the upper shafts, E², by reversing-gearing, (shown at K, K′, K², K³, and K⁴, and which will be more fully hereinafter explained,) so that when the shafts E′ are rotated in one direction, as indicated by the arrows marked thereon, motion in a reverse direction will be transmitted, through the gearing referred to, to the shafts E², as also indicated by arrows. The shafts E′ carry spiders G, having at the extremities of their arms *g* bearings *g′* for the lower journals of the rotary spool-frames F⁷, in which are mounted the spools *f*, and said shafts also carry, at a suitable distance above the spiders, rings G′, upon which are formed the bearings *g²* for the upper journals of the said spool-frames. The spool-frames F⁷ are provided with pinions F⁶, and each, through its said pinion and gearing (shown at F F′ F² F³ F⁵) and shaft F⁴, receives a rotary motion about its axis, in addition to being carried around by the spider G and ring G′ when the shaft E′ rotates. The gearing for transmitting motion to the spool-frames will be presently described more particularly. The upper journals of the spool-frames F⁷ are tubular, as shown in Fig. 3ª, and through these journals the wires pass from the spools *f*, and thence directly through passages in a guide, H², as shown at the left in Fig. 1, and up through a die, H, arranged within a frame, H′, which forms the top portion of shaft E′. On the right-hand side of the machine, as shown in Fig. 1, the wires from the spool-frames F⁷ pass under guide-pulleys *f*¹¹, instead of directly to the guide H² above, said pulleys being mounted at the ends of arms projecting from the shaft E′ on that side which is longer than the corresponding shaft E′ at the left, this increased length being rendered necessary by the fact that the devices with which the

shaft at the right is connected at its top are carried by the arms of spider C^2, which is higher on shaft B′ than is the spider C′, for the reason already explained; the guide H^2 at the top of the right-hand shaft being at such a distance from the tubular journals of the spool-frames below, the wires issuing from said journals would rub against the inner edges of the upper ends of said journals if led directly to the guide H^2, and cause a considerable resistance to the turning of the spool-frames and a seriously detrimental wear of the wires and journals; hence the necessity of the guide-pulleys f^{11}, which guide the wires centrally from the tubular journals. The spider G has seven arms, as shown in Fig. 4, and carries seven spool-frames, the spool *f* of one of which supplies the core-wire for the strand, and the spools of the other six supply the wires for the first course. The guide H^2 has one of its passages, as shown in Figs. 11 and 11^a, formed to guide the core-wire, as shown at *y*, straight up through the center of the die H, while the passages for the other wires terminate at their upper ends in a circle about the passage for the core-wire, so that as the guide revolves the six wires from the outer passages will be wound upon the core-wire spirally, it being understood, and as will be hereinafter explained, that the wires are all drawn along together at a proper speed. From the die H, that part of the strand which is formed by the devices carried by shaft E′, and which consists of the core-wire and the first course of six wires wound thereon, passes straight upward through the tubular shaft E^2, and through the die Q carried at the top of said shaft, and as it passes through the die has applied to it the outer course of twelve wires, which are drawn from the spools carried by the spool-frames *f′*, which are supported by a spider, L′, carried by the hollow shaft E^2, and are revolved in a direction the reverse of the movement of the lower set of spool-frames, so that the outer course of wires is wound oppositely upon the inner course. A more detailed description of the devices for applying the outer course of wires will presently be given. The finished strands from all the dies Q of the machine pass over the respective grooved anti-friction guide-wheels R, which are mounted at the extremities of the arms of the upper spider, C^3, which is fixed upon the main shaft B′. The dies H and Q simply serve to hold the strand steadily, and their rotary motion results only from its being convenient to mount them upon the rotary shafts instead of constructing stationary supports for them. From the guide-wheels R the finished strands—six in number in the present instance—are converged toward a thick circular plate, S′, which is fixed upon and quite near the upper end of the main shaft B′, and forms an extended upper journal for said shaft, having its bearing S^2 formed in a fixed heavy top plate, S^3, which is supported by beams S^4, suitably arranged in the building in which the machine is erected.

This plate S′ has suitable openings, through which the strands pass to a guide, S, which is fixed upon the top of the shaft B′, and has six upwardly-converging passages, *s*, terminating at their upper ends in a circle about an axial passage, *s′*, the axis of which is in line with that of the bore or central passage of the shaft B′. The guide S has a hollow central shank, s^2, which projects from its lower face, and this shank fits into the upper end of shaft B′, where it is secured by suitable screws passed through the wall of the shaft and binding upon the shank. The strands Y pass upwardly from the guide S through a stationary die, Q′, which is supported by standards *q′ q′*, secured to the top plate, S^3, and as they pass through said die are, by the rotation of the shaft and guide S, laid spirally around a core-strand, Y′, which is drawn upwardly through the tubular main shaft B′ and central passage of the guide S, thus forming the complete rope Z. The completed rope, consisting of the core-strand and the six outer strands coiled thereon, passes from the die Q′ to a suitable take-up reel, (not shown in the drawings,) the speed of which is to be regulated in the ordinary manner employed for regulating the take-up reels of rope-making machines. The take-up reel may be located at any convenient point, and the rope pass to it over suitable guides.

I have not deemed it necessary to show in the drawings a reel for delivering the core-strand which passes upward through the tubular shaft B′, as it will be readily understood that such a reel may be arranged as required or convenient, and the strand guided to the open lower end of the shaft in the ordinary manner.

When by means of the driving-wheel A, which meshes with wheel B, rotary motion is communicated to shaft B′, the rotary gear-wheels E are caused to traverse the periphery of the fixed gear-wheel D and receive motion therefrom, this motion being in turn communicated through all the shafts E′ and E^2 to all the strand-making mechanisms, and the take-up reel winds up the completed rope.

The strand which forms the core of the completed rope may be similar to the outer strands, or may be of jute or any other desired material. This core-strand is of course manufactured prior to the commencement of the making of the rope by the machine, as described.

Having now given a general description of the construction and operation of my machine as a whole, I will describe with particularity and in detail the mechanism for making a single strand of the rope, it being understood, as already stated, that the several complete sets of strand-making mechanisms are identical in construction and operation.

As already stated, the vertical shaft E′ has its lower bearing in the end of one of the arms *c* of the lowermost spider, C, and has fixed upon its lower end, which projects below said bearing, a gear-wheel, E, which meshes with the fixed gear D. On the upper side of the end

of the arm *c* is rigidly fixed an annular gear, F, which surrounds the shaft E′, and immediately above this fixed gear is the spider G, before referred to as fixed upon said shaft and having seven arms, carrying the spool-frames F^7, each of said spool-frames having rotary motion about its axis as well as a revolving motion with the shaft E′. The fixed gear F meshes with a rotary gear-wheel, F^5, which is keyed upon the lower end of a short shaft, F^4, which has its lower bearing, f^4, carried by the spider G, and its upper bearing in a bracket, f^5, which is fixed upon the shaft E′. Upon the upper end of shaft F^4 is fixed a gear-wheel, F^3, which meshes with an intermediate pinion, F^2, mounted upon the bracket, and this pinion in turn meshes with the spur-gear f^6 of a double gear-wheel, F′, which is loosely mounted upon the shaft E′ above the bracket f^5, and has a bevel-gear face, f^7, which meshes with the pinions F^6, with which the spool-frames F^7 are provided. It will now be readily understood that as the shaft E′ revolves the spider G and bracket f^5 in the direction indicated by the arrows the gear-wheel F^5 will be caused to traverse the toothed periphery of the fixed gear F and receive motion therefrom in the direction indicated by the arrow on shaft F^4, and that motion in the same direction is caused in gear F^3, and through pinion F^2 to the loose double gear F′, the bevel-face f^7 of which turns the pinions F^6 and causes the spool-frames F^7 all to rotate about their axes in the direction indicated by the arrows marked thereon. The purpose of this rotation of the spool-frames about their axes will be presently explained.

Each of the spools *f* has one of its heads of greater diameter than the other, as shown at f^8, and this extended head has a broad periphery and enters a recess in the side of the spool-frame when the spool is in place on its spindle. Upon the edge of the spool-frame is secured one end of a finger-spring, f^9, the outer end of which bears upon the periphery of the spool-head, as shown in Fig. 19. Loosely through an intermediate portion of the spring f^9 passes a thumb-screw, f^{10}, which is tapped into the spool-frame, its head bearing upon the outer surface of the spring. By adjusting the screws the spring may be caused to bear with greater or less tension upon the head of the spool, and the spool may be thus prevented from giving off slack wire. The gearing for imparting the motion to the spool-frames about their axes is so timed or proportioned that each spool-frame F^7 shall make one complete rotation upon its own axis for every revolution it makes about the axis of the shaft E′, this being for the reason that otherwise the wire drawn from the spools would be twisted individually, and not only thereby weakened, but laid in the rope-strand under a strain that would cause the kinking of the strand and also of the finished rope.

As before explained, the shaft E′ carries the frame H′, which springs from the guide H^2, which is fixed to the upper end of the shaft proper, and this guide has its passages properly arranged to guide one of the seven wires straight up through the die H and the others to be coiled about it. The die H is composed of two bars, *h h′*, hinged together at one end, and the bar *h′* having at the other end a tongue, h^2, to enter a slot in the bar *h*, the tongue h^2 and bar *h* being provided with pin-holes, in which a pin, h^3, may be inserted to lock the two bars together. Each bar has formed in its inner face a semicircular cavity, and when the two bars are closed together these two cavities form the circular passage of the die through which the strand passes, and is thus kept to uniform size. The bars are supported by standards h^4 h^4, one of which preferably forms the hinge-pin. The standards are screw-threaded on their upper portions, and adjustable nuts h^5 h^5 are used to regulate the height of the die from the guide as desired.

Having now described the mechanism for placing the core and laying the first course of wires of the strand, I will proceed to describe the devices for laying the second course, which is to be wound in an opposite direction to the first course. To accomplish this reverse winding the tubular shaft E^2 is given rotation in an opposite direction to the rotation of shaft E′, and this opposite rotation is accomplished by the gearing shown at K, K′, K^2, K^3, and K^4, as follows:

K indicates a gear which is rigidly attached to the top plate, H^3, of the frame H′, which is carried by shaft E′, and this gear rotates with said shaft in the direction indicated by the arrows marked thereon. The shaft E^2 projects below its bearing in the end of the spider-arm which carries it, and its lower end passes through the central aperture of wheel K and top plate, H^3, thus forming a pintle about which the wheel K revolves.

The intermediate or reversing gear-wheel, K′, is mounted on a stud projecting from a bracket of the spider-arm *c′*, and meshes with wheel K, and also with the gear-wheel K^2, which is keyed to the lower projecting end of a vertical shaft which plays through a bearing formed in the arm *c′*, and has keyed to it, above said bearing, the gear-wheel K^3, which meshes with the gear-wheel K^4, which is keyed upon the shaft E^2. The gear K, through the intermediate gear, K′, imparts motion to the gear-wheels K^2 and K^3 in the direction of the arrows marked on said wheels, and the wheel K^3 turns the wheel K^4 and shaft E^2, upon which it is fixed, in the direction of the arrow on said shaft—that is, in a direction the reverse of the rotation of shaft E′.

The shaft E^2, as already explained, carries the spools which supply the wires for the outer course of the strand, and these spools are mounted in spool-frames *f′*, identical in construction and operation with the spool-frames F^7 already described. The mechanism, however, for imparting motion to the spool-frames *f′* is different from that described for moving the lower spool-frames.

A fixed wheel, L, is firmly secured to the end of an arm, M, projecting from arm c' and carrying the upper bearing of the shaft E^2, which rotates loosely in a central aperture of said wheel. A crown-spider, L′, is fixed upon shaft E^2, and is provided with downwardly and outwardly projecting arms l, having bearings l' and l^2, in which are mounted the journals of the spool-frames f'. Upon the top plate of the crown-spider L′ is mounted a double annular gear, L^2, surrounding the shaft E^2 and having its bearing on the margin of said top plate. This annular gear has an outer bevel-gear face which meshes with the bevel-pinions f^2 of the spool-frames f', and an interior spur-gear which meshes with a pinion, L^4, keyed to the upper end of a short vertical shaft which is mounted in a bearing formed in the spider L′, and has fixed to its lower end a pinion, L^3. When the shaft E^2 rotates in the direction indicated by the arrow marked thereon the pinion L^3 is caused to traverse the toothed periphery of the fixed gear L and receive therefrom motion, as indicated by the arrow, and the pinion L^4, moving in the same direction, drives the annular gear L^2 around on the top plate of spider L′, so that the outer bevel-face of this gear communicates a rotary motion to the spool-frames through their pinions f^2, this motion being in the direction indicated by the arrow on the pinion f^2 in Fig. 3.

The gearing which communicates motion to the annular gear L^2 is so arranged as to cause said gear to move more rapidly than the spider L′, so that said gear makes a complete revolution with the spider and an additional movement besides while the spider is making one complete revolution, the additional movement being sufficient to communicate to each spool-frame f' a complete rotation about its axis in the same time that it performs a revolution about the axis of shaft E^2. The rotation of the spool-frames on their axes is to prevent the wires from being individually twisted, as before explained with reference to the lower spool-frames. There are twelve of the spool-frames f', and the wires are led from the spools through the tubular upper journals of said frames the same as in the frames F^7, passing thence under grooved anti-friction wheels O, carried by the arms of a small spider, O′, fixed upon shaft E^2.

Upon the hub o of the spider O′ rests the first section of a tension device, P, which is a cone composed of sections which are alternately loose and fixed upon the shaft E^2, the sections p being loose and those marked p' being fixed. Projecting from these sections, respectively, are lugs or pins arranged in lines from base to top of the cone, there being a line of pins for each wire, and the wire is passed alternately on opposite sides of the pins in a line, and from the top pins all the wires pass through converging passages in the extended top section, which is fixed upon the top of shaft E^2. From the passages of this top section the wires pass through the converging passages of a guide-plate, H^4, fixed upon the top section and having a central larger passage which has its axis in line with that of the bore of the tubular shaft E^2.

It has already been explained that the partly-finished strand passes upward through the hollow shaft E^2. It passes out through the central passages of the top cone-section and the guide-plate H^4, and thence through the center of a die, Q, in all respects similar to the die H, heretofore described, but having a larger passage to accommodate the increased size of the strand. As the strand, in its unfinished state, passes through the die Q the revolution of the shaft E^2 causes the converging twelve wires from the upper spools, to be wound spirally about it in opposite direction to the first course of six wires, and the completed six strands which are to be applied to a main core to complete the rope all pass from the dies Q over the wheels R, and are converged through the main upper guide and applied to the main core in the main die Q′, as has been hereinbefore fully described.

It is obvious that I need not limit my invention to the use of any definite number of spool-frames in a set, nor to any definite number of the series of spool-frames, as this will be determined by the number of strands that a finished rope is to have, or to the number of courses of strands that a rope may have. For instance, if a rope is desired to have a central core and two courses of strands, the machine would require a corresponding number and series of strand-making devices and their actuating mechanism to accomplish the work.

It will be observed that by the use of my machine I can make a continuous unbroken rope of any length whatever, because when the wire upon any spool is exhausted the mere splicing of that single wire will not affect the strength of its strand or of the rope, and no two wires need break joints at the same place in a rope.

In practice, when a spool of wire has been exhausted I have been accustomed to braze the end of the wire to a fresh spool, and thus have in effect single unbroken wires in every strand.

Having fully described and explained the construction and operation of my invention, what I claim is—

1. The combination, with the fixed or stationary gear D, of the central rotary shaft, B′, the spiders carrying the lower and the upper strand-making devices, the vertical spool-frame shafts E′ and E^2, the gear-wheels E, carried by the shafts E′, and intermediate connecting-gears between said spool-frame shafts for transmitting rotation to the shafts E^2 from shaft E′, substantially as and for the purpose set forth.

2. The combination, with the continuous main central tubular shaft, the spiders carried thereby for supporting the strand-making devices, and means for rotating said shaft, of the series of spool-frame shafts E′ and E^2, having their axes in the same line and carrying

the separate series of spool-frames, means for communicating motion from the main shaft to the lower spool-frame shafts, intermediate connections for transmitting from said lower spool-frame shafts rotary motion to the upper spool-frame shafts, and suitable guides for the core and outer strands of the rope, substantially as set forth.

3. The combination, with the shafts E′ and E^2, and the intermediate connections for transmitting from the shaft E′ rotary motion to shaft E^2, of the spool-frame supported by said shafts, respectively, and intermediate devices for transmitting rotary motion from said shafts to said spool-frames, substantially as and for the purpose set forth.

4. The combination of the revolving series of rotary spool-frames F^7 with shaft E′, devices for transmitting the rotary motion to said spool-frames from said shaft, the guide carried by said shaft having its passages arranged to group the wire from all but one of said spool-frames about that one, the tubular shaft E^2, arranged in line with shaft E′, intermediate gearing for transmitting from shaft E′ rotary motion to said shaft E^2, the revolving series of rotary spool-frames carried by shaft E^2, a guide having a series of wire-passages grouped about a central passage and carried by said shaft E^2, and devices for transmitting from said shaft a rotary motion about their axes to the spool-frames which it carries, substantially as and for the purpose set forth.

5. The combination, with the fixed or stationary gear D, of the central rotary shaft, B′, the spiders carrying the lower and the upper strand-making devices, the vertical spool-frame shafts E′ and E^2, the gear-wheels E, carried by the shafts E′, and intermediate connecting-gears between said spool-frame shafts for transmitting a reversed rotation to the shafts E^2, substantially as and for the purpose set forth.

6. The combination, with the continuous main central tubular shaft, the rotating spool-frames, and means for rotating said shaft, of the series of spool-frame shafts E′ and E^2, having their axes in the same line and carrying the separate series of spool-frames, means for communicating motion from the main shaft to the lower spool-frame shafts, intermediate connections for transmitting from said lower spool-frame shafts rotary motion of opposite direction from their own to the upper spool-frame shafts, and suitable guides for the core and outer strands of the rope, substantially as described.

7. The combination, with the shafts E′ and E^2, and the intermediate connections for transmitting from the shaft E′ a reversed rotary motion to shaft E^2, of the spool-frames supported by said shafts, respectively, and intermediate devices for transmitting rotary motion from said shafts to said spool-frames, substantially as and for the purpose set forth.

8. The combination of the shaft E′, revolving series of rotary spool-frames F^7, carried thereby, devices for transmitting the rotary motion to said spool-frames from said shafts, and the guide carried by said shaft having its passages arranged to group the wires from all but one of said spool-frames about that one, with the tubular shaft E^2, arranged in line with shaft E′, intermediate gearing for transmitting to said shaft E^2 a reverse rotary motion from shaft E′, the revolving series of rotary spool-frames carried by shaft E^2, a guide having a series of wire-passages grouped about a central passage and carried by said shaft E^2, and devices for transmitting from said shaft a rotary motion about their axes to the spool-frames which it carries, substantially as and for the purpose set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

MAHLON M. ZELLERS.

Witnesses:
W. W. PATTON,
M. G. GARRISON.