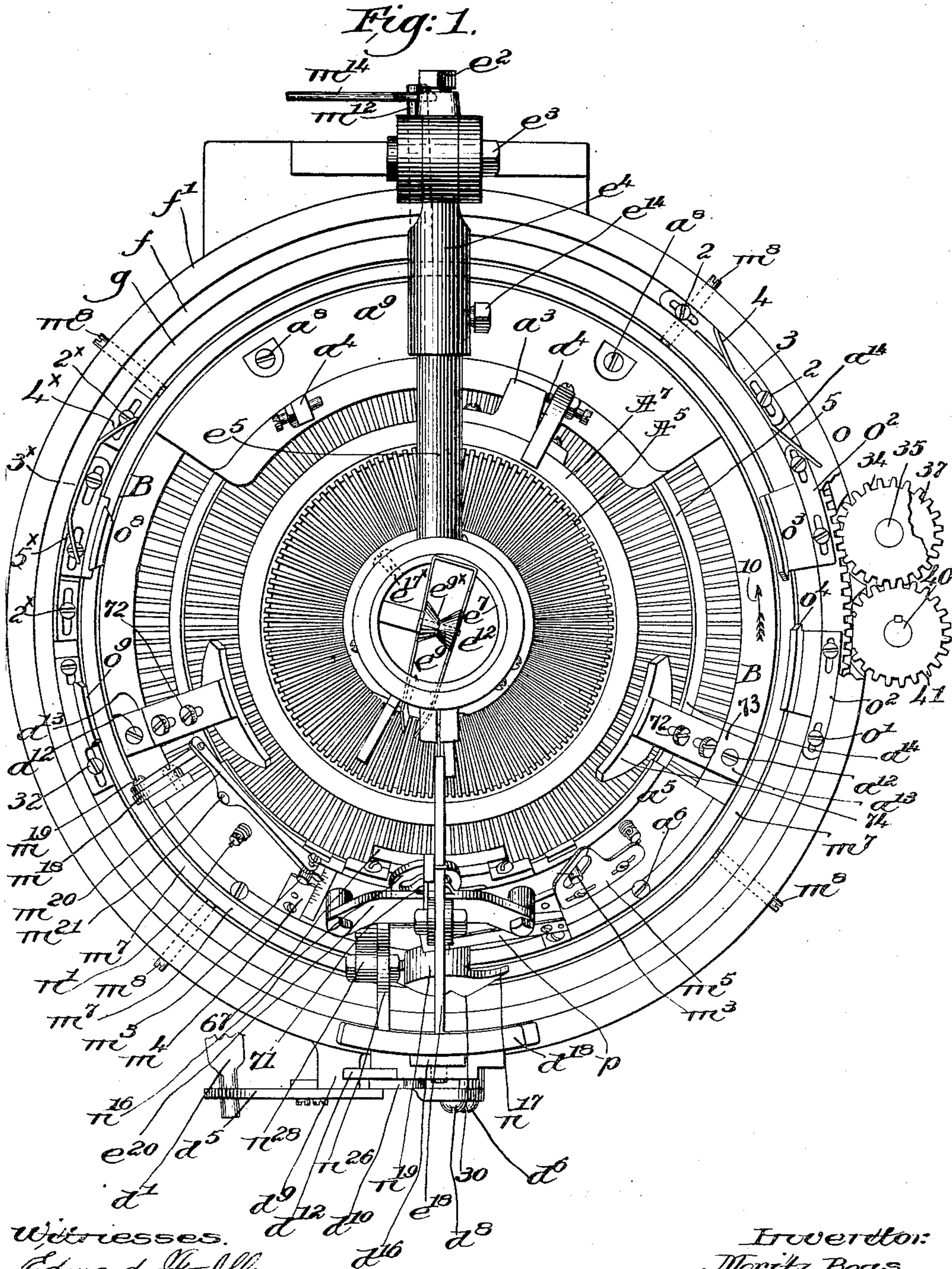


No. 824,403.

PATENTED JUNE 26, 1906.

M. BOAS.  
KNITTING MACHINE.  
APPLICATION FILED NOV. 29, 1897.

5 SHEETS—SHEET 1.



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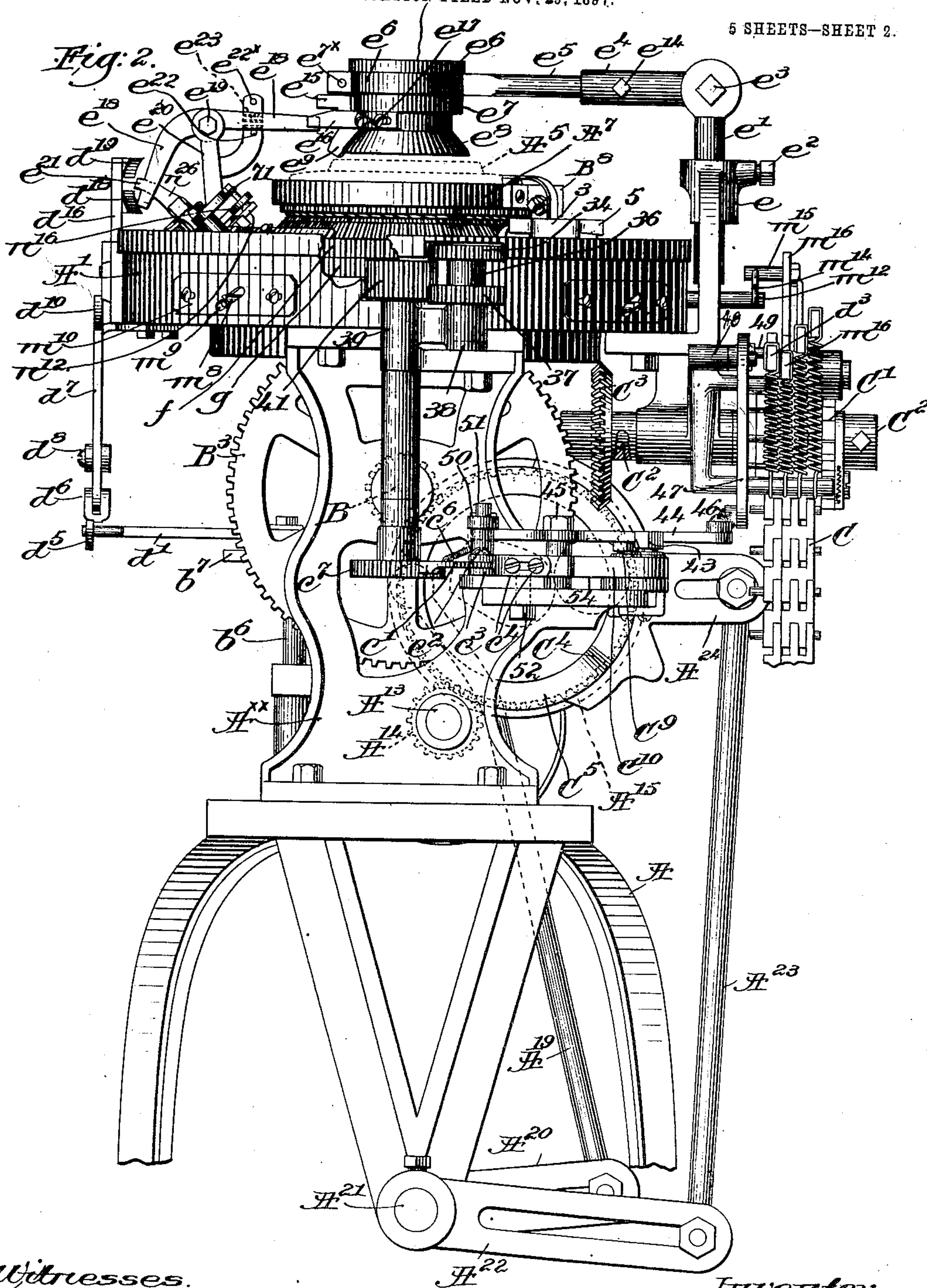
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5 SHEETS—SHEET 2.



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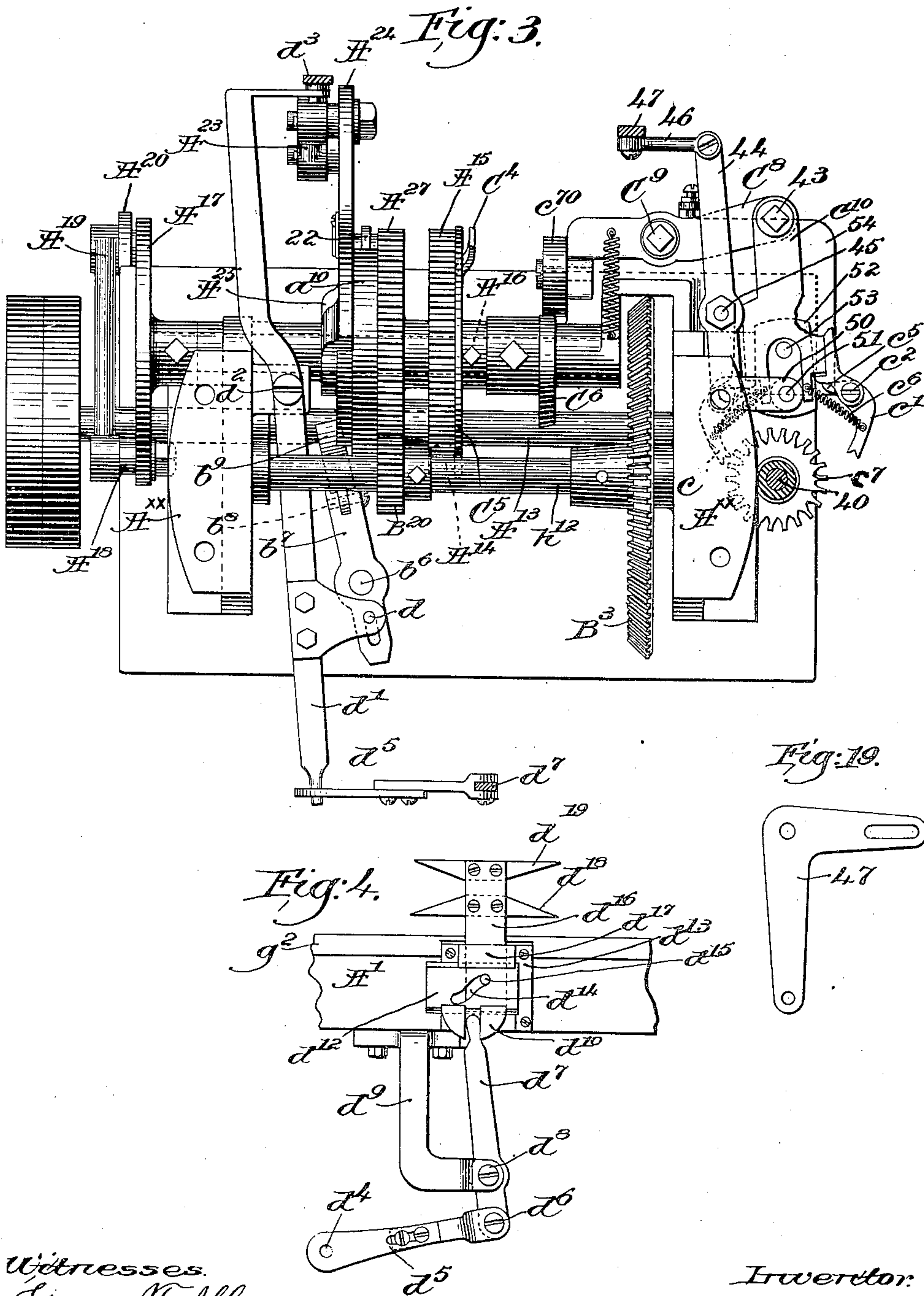
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5 SHEETS—SHEET 3.



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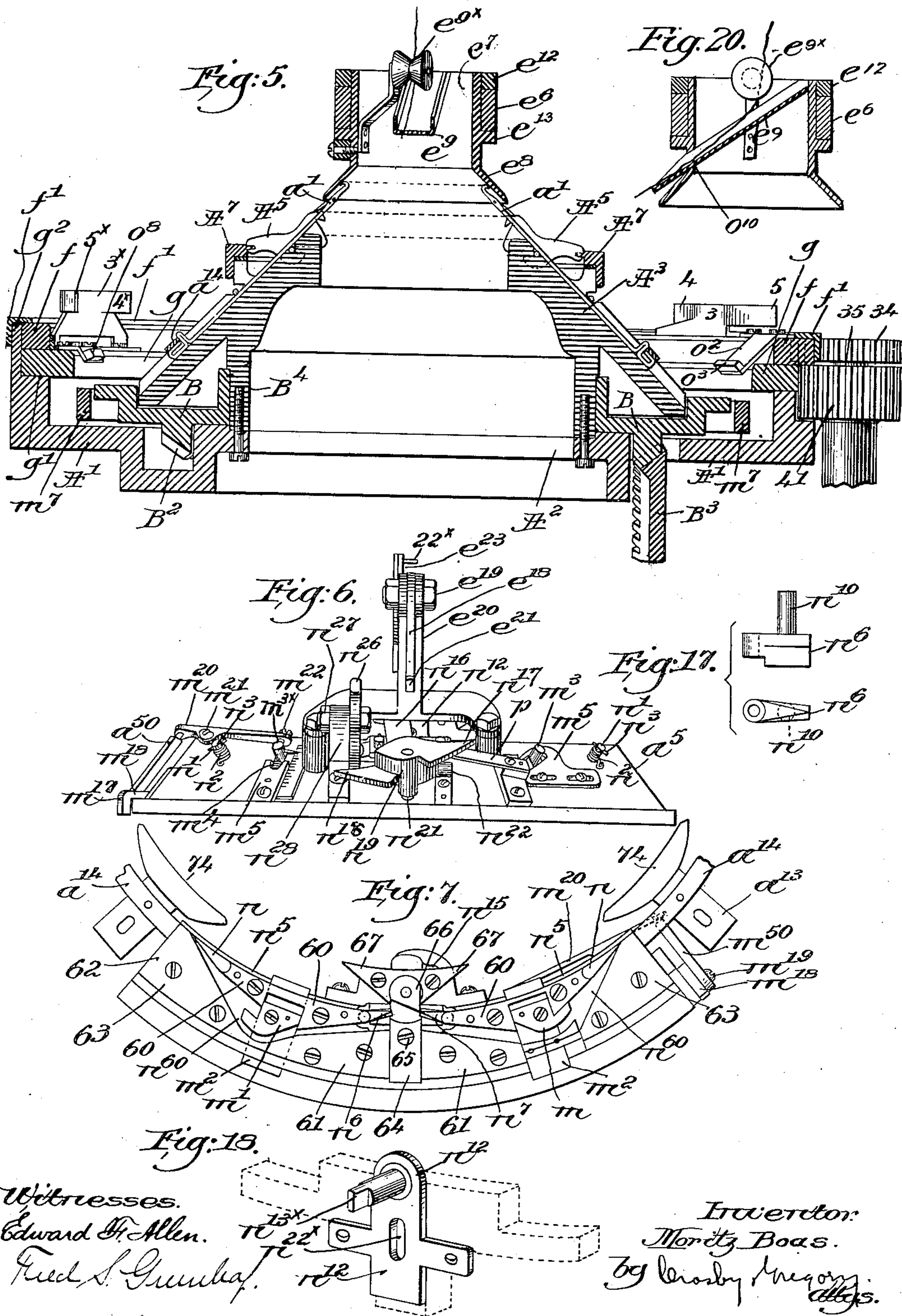


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5 SHEETS—SHEET 4.

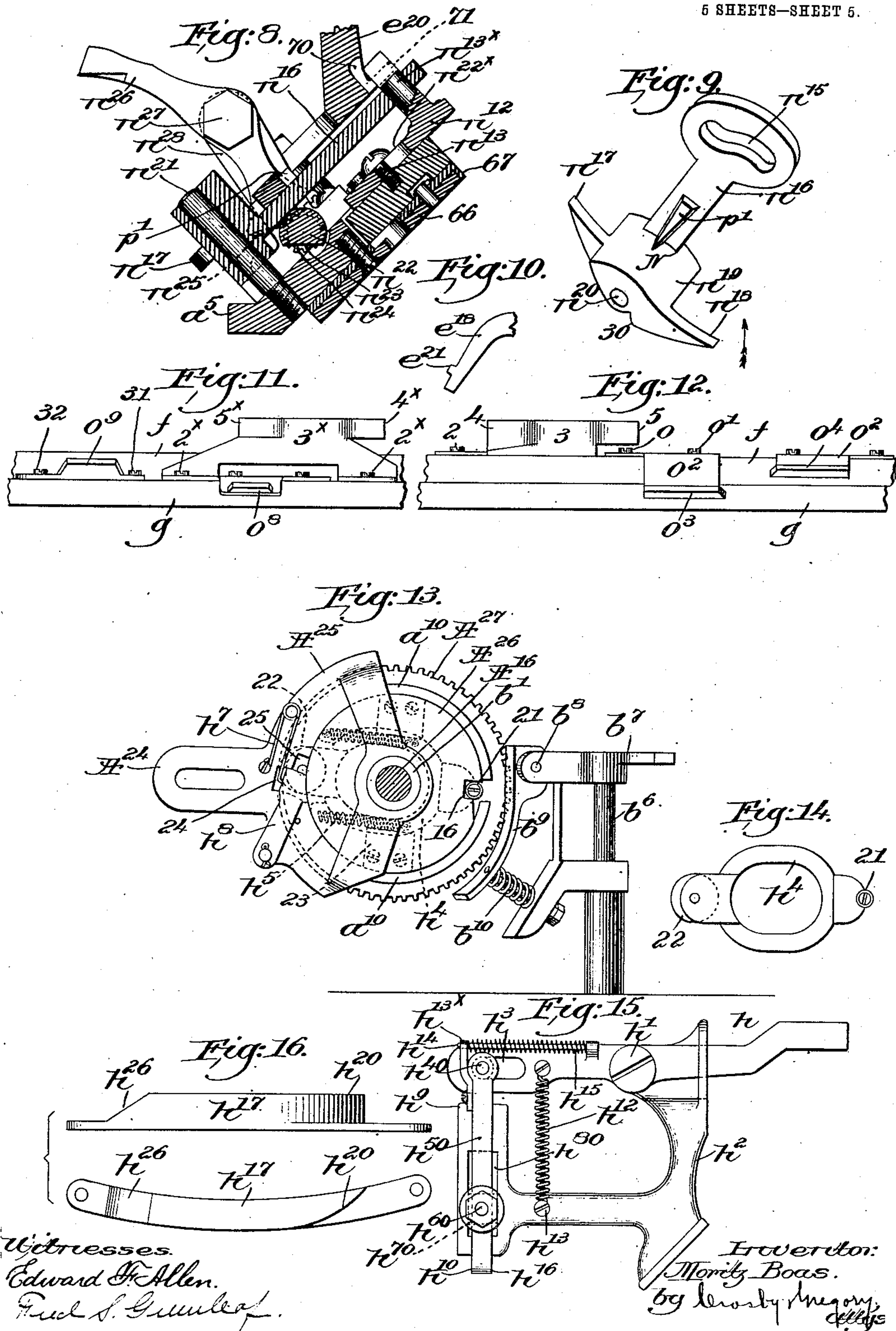


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5 SHEETS—SHEET 5.



Witnesses.  
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# UNITED STATES PATENT OFFICE.

MORITZ BOAS, OF ST. HYACINTHE, CANADA.

## KNITTING-MACHINE.

No. 824,403.

Specification of Letters Patent.

Patented June 26, 1906.

Application filed November 29, 1897. Serial No. 660,108.

*To all whom it may concern:*

Be it known that I, MORITZ BOAS, a subject of the Queen of Great Britain, residing at St. Hyacinthe, in the Province of Quebec, Canada, have invented an Improvement in Knitting-Machines, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

This invention has for its object to improve and simplify the construction of the various parts of a circular-knitting machine adapted for circular and reciprocating knitting. In this class of machine as now made the thread-carrier when reciprocating knitting is being done for narrowing and complementary widening, as in the production of heels and toes of stockings, has imparted to it a uniform throw, said throw being for a distance of more than one-half of the circumference of the machine, and hence during reciprocating knitting a take-up has to be employed, said take-up being automatically or otherwise thrown into working position to control the slack thread between the end-most needles used in reciprocating knitting and the stopping-point of the thread-carrier, and the length of this slack thread which must be taken care of varies continually during reciprocating knitting.

One part of this invention, therefore, comprehends devices to stop the thread-guide during reciprocating knitting substantially at or opposite the last needle fed by the thread-guide in its reciprocating stroke, and consequently no slack thread is made, and therefore a take-up and its actuating mechanism, always more or less complicated and delicate in operation, become unnecessary.

In my invention the thread-guide is stopped close to the needle last fed by it in circular knitting, and as said needle is the first one to be fed for reciprocating knitting it will be readily understood that there is no unnecessary slack tread, and the thread is delivered constantly to the needles throughout reciprocating knitting under the same conditions and a perfectly made heel is insured, and so, also, by dispensing with the take-up yarns of less strength may be safely used in the machine.

The machine which I have chosen herein to illustrate my invention is of that class wherein when the change from circular to reciprocating knitting is to take place the points or switches of the knitting-cams are so changed

in their positions as to pass under and not actuate the needles which are not to be used in reciprocating knitting, the said cams engaging and depressing the first of the series of needles to be used for the reciprocating course then to be knitted, the number of needles so depressed being more or less, according to the length of the course. The needles of any reciprocating course having been called into operation and having been moved to knit in that course are then all returned into the mass of needles, and for the next reciprocating course only the number of needles to be used therein are depressed, and they are again returned into position with all the needles. Machines of this general type are represented in an earlier patent, No. 453,059, granted to me on the 26th day of May, 1891, and also in a patent, No. 479,986, dated August 2, 1892, said latter patent being an improvement on the former one.

The points or switches of the knitting-cams occupy one position for circular knitting, and when reciprocating knitting is to be done said points are lowered between two needles in the space at the junction of the non-knitting and the knitting groove, one of said needles being in the knitting-groove immediately under the point, the lowered point being thus put into position to allow the next needle to the one under its point, and those following it while said point is depressed to pass over said point and continue in the non-knitting groove, and by the time that the last needle to pass under the said point into the knitting-groove arrives in the non-knitting groove the first needle to pass over said point follows it in line in the non-knitting groove. Putting all the needles in the non-knitting groove during the last stroke for circular work leaves the needles in position to commence reciprocating knitting for narrowing and widening, and to do this the actuating mechanism of the cam-ring is changed so that its reciprocating motion commences, and in this first reciprocating stroke the points are raised at just the proper time between two needles, as stated, so as to engage the butt of the first needle to be used for knitting in the reciprocating course, said points remaining in such condition until it has taken from the non-knitting groove enough needles, more or less, for that reciprocating course, said needles so taken from the non-knitting groove being run through the knitting-groove, and then the points are immediately



again lowered between two needles, as stated, which prevents the taking of any more needles than those actually needed from the non-knitting groove, and the motion of the cam-ring is continued until all the needles put into the knitting-groove have arrived again in the non-knitting groove. This operation is repeated for each reciprocating course until the narrowing and widening has been effected.

To automatically move these points or switches, I employ a toe-cam having an oscillating movement about a fulcrum or pin and a vertical movement on said pin toward and from the needle-supporting bed or cone.

The pin on which the toe-cam turns forms part of what may be designated as the "cam-ring" of the machine, said toe-cam when in its lowered position nearest the needle-bed being adapted to meet and be turned in one and then in an opposite direction by suitable lugs carried by rings which have only a to-and-fro movement intermittingly in a circular path, said toe-cam having a slotted arm which directly engages a stud connected to and extended upwardly from a plate fitted to slide transversely in a guideway formed in the outside of the cam-ring. The plate referred to is for convenience and lightness made T shape and has two holes for the reception of pins extended outwardly through the cam-lock from the backs of the said points or switches, the said plate being moved in one and then in the other direction, as required, to put said points or switches in the desired positions by the slot in the cam connected with or forming part of the said toe-cam.

I have also provided the machine with novel means by which to automatically control the working position of the stitch-cam, and consequently the length of the stitch, the adjustment of the position of the said stitch-cam being useful in fashioning the goods.

I have also simplified the means employed to both rotate and reciprocate the cam-ring, I having reduced the size and number of parts commonly used for that purpose, and consequently have reduced the weight of the parts, thereby cheapening the construction of the machine and lessening the operative space required for it.

I have also devised a novel means for imparting circular movement to the means instrumental in determining when the points are to be changed in position, said means including rings having lugs and lying one above the other and presenting peripheral teeth which are engaged, respectively, each by one of a pair of pinions, one of the pinions of the pair imparting movement to the other pinion of the pair, both pinions consequently being actuated by one pair of pawls directly under the control of a suitable pattern-surface, the pawl-carrier being in this instance of my invention moved continuously both dur-

ing reciprocating and circular knitting; but its pawls are so controlled that they may be put into and out of operative position. The pawl-carrier is actuated from a cam carried by a slow-moving shaft, (the shaft which controls) the reciprocating motions of the machine, the machine when circular knitting is being done being run at a higher speed, as commonly practiced in machines of this type.

The thread-carrier is also a latch-guard, and its hollow central hub is embraced frictionally by a ring located centrally over the conical bed in which the needles are reciprocated. This hub may be and is herein shown as so supported that it may be turned up away from the frame of the machine and from above the latches of the needles to enable the use of a transferrer and the application of work to the needles, or it may be turned down into working position, so as to cover and protect the hooks and latches of the operating-needles. This hub has a suitable arm or arms which may be struck by a tappet or projection moving with the cam-ring, and this latter tappet is under the control of a suitable cam whereby its acting end may be put in position to either meet and move the arm or arms attached to said hub or to retire from said arm or arms and leave said hub at rest just as soon as the said thread-guide has fed the last needle to be used in knitting the course just then completed.

Figure 1 is a top or plan view of a sufficient portion of a knitting-machine containing my improvements to enable my invention to be understood. Fig. 2 is a right-hand side elevation thereof. Fig. 3 is a plan view below the bed supporting the cone and cam-ring. Fig. 4 is a detail chiefly to show the devices for putting into and out of operative position the toe-cam and also to start the lever employed to move the thread-carrier with the cam-ring, so that said lever will be put under the control of the automatic devices for moving it during reciprocating knitting. Fig. 5 is a vertical section taken across the bed or cone in which the needles reciprocate and some of the surrounding cooperating parts. Fig. 6 is an enlarged detail view of the cam-lock removed from the cam-ring. Fig. 7 is an under side view of Fig. 6, with part of the narrow ring  $a^{14}$ . Fig. 8 is an enlarged sectional detail of the toe-cam and some of its operating devices. Fig. 9 shows in perspective the toe-cam. Fig. 10 is a detail showing part of the lever which cooperates with the thread-carrier to move it continuously or intermittingly, as may be required. Figs. 11 and 12 are details showing parts of the circularly-moving rings and their cams, to be described. Fig. 13 is a detail in side elevation of some of the devices employed for effecting the change from circular to reciprocating knitting, and vice versa. Fig. 14 shows the



sliding plate  $h^4$  detached. Fig. 15 shows a modified form of device by which to move the thread-carrier a variable distance. Fig. 16 shows one of the cams on one of the cam-rings for actuating said modified construction of parts. Fig. 17 is a detail showing one of the points or switches detached. Fig. 18 shows, detached, the sliding plate employed to move the points or switches. Fig. 19 shows the lever 47 detached. Fig. 20 is a section of the hollow cylinder or thread-carrier, showing the thread-guiding device and the opening in the body of the cylinder for the passage of the thread to the outside of the cylinder.

The framework of the machine consists, essentially, of legs A, standards  $A^{xx}$ , erected thereon, said standards having fixed to their upper ends a bed-plate  $A'$ , the shape of which is shown best in Fig. 5, said plate being provided with a central opening  $A^2$ , through which the knitted work passes, said plate having secured thereto the shank  $B^4$  of a conical needle-bed  $A^3$ , provided with suitable grooves for the reception of a series of latched needles  $a'$ , the upper end of said conical bed having a suitable pivot or rest for a series of jacks or sinkers  $A^5$ , moved by a sinker-actuating ring  $A^7$ , having a projecting ear  $a^3$ , (see Fig. 1,) which when circular knitting is being done is acted upon continuously by one of two like studs  $a^4$ , carried by a plate  $a^9$ , to be described, said plate having two such studs to act alternately on said ear to move the ring  $A^7$  back and forth for reciprocating knitting. The shank  $B^4$  of said conical bed is surrounded loosely by a cam-carrying ring B, said ring having teeth  $B^2$  to be engaged and moved by the teeth of the bevel-gear  $B^3$ . This ring B has attached to it by suitable screws  $a^6$  (see Fig. 1) the cam-lock  $a^5$ , said cam-lock being shown detached in Figs. 6 and 7. Said ring also at a point opposite said cam-lock has attached to it by screws  $a^8$  the plate  $a^9$  before referred to, the weight of the plate  $a^9$  being such as to form a balance for the weight of the cam-lock  $a^5$ . The ring B, it will be seen, thus becomes a cam-carrying ring, because it carries the cam-lock  $a^5$ , to be described. The bevel-gear  $B^3$  is adapted, as will be described, to be rotated at times for rotating the cam-ring during circular knitting and at other times to reciprocate it for reciprocating knitting. The cam-ring B has attached to it by screws  $a^{12}$  flat feet  $a^{13}$  of a narrow ring  $a^{14}$ , the upper edge of which forms a continuation of the under line of a non-knitting groove. The cam-ring so made is a skeleton ring, and its weight is so greatly reduced that its motion may be reversed without straining the machine to overcome its momentum, and the lighter the weight of the cam-ring the less the expenditure of power to drive it.

The shaft  $h^{12}$ , carrying the gear  $B^3$ , has fast

on it a pinion  $B^{20}$ , which is at all times engaged by the teeth of a gear  $A^{27}$ , loosely mounted on a main or slow-motion shaft  $A^{10}$ , said shaft having fast on it a toothed gear  $A^{15}$ , which is engaged and rotated positively at all times by a pinion  $A^{14}$ , fast on the power or driving shaft  $A^{13}$ , said shaft in practice being provided with any usual devices by which to rotate it at a fast speed for circular knitting and at a slower speed for reciprocating knitting; as commonly done in this class of machine.

The gear  $A^{27}$  has at one side a rim  $a^{10}$ , (see Figs. 3 and 13,) which is cut away at diametrically opposite points, as shown in Fig. 13, for the passage through said rim of the opposite ends of a sliding plate  $h^4$ , (shown detached in Fig. 14,) said plate having at one end a roller 22 and at its other end a small roller-stud 21, suitable springs  $h^5$  acting normally to cause said roller 22 to stand with its periphery outside said rim, suitable guides 23 acting against the side edges of the plate to direct its movement, said springs also tending to normally keep the roller-stud 21 in a notch 16 of a plate  $A^{26}$ , fast on the slow-motion shaft  $A^{10}$ .

The hub  $b'$  of the disk  $A^{26}$  has loosely mounted on it a spider  $A^{25}$ , having a projecting slotted arm  $A^{24}$  and carrying a pivoted dog  $h^8$ , acted upon by a spring  $h^7$ . The dog has at its free end a lug which normally stands in a notch 24 in the spider, said notch being enlarged at 25 next the end of said lug.

The framework of the machine has a vertical stud  $b^9$ , (see Figs. 3 and 13,) on which is pivotally mounted a lever  $b^7$ , upon one end of which is pivoted at  $b^8$  a shoe  $b^9$ , having a concaved face, said face standing normally during circular knitting at one side of the rim  $a^{10}$ , so that the roll 22 as said gear is rotated does not strike the shoe.

When the plate is under the control of its springs and the shoe is not in the path of movement of the roll 22, then the roller-stud 21 stands in the notch 16 of the disk  $A^{26}$  and locks said gear  $A^{27}$  to said shaft  $A^{10}$ , and the gear  $A^{27}$  is rotated continuously through said disk for circular knitting; but when reciprocating knitting is to be done the said shoe is turned automatically into position so that the roll 22 may strike said shoe, and the sliding plate is moved in a direction to cause the roller-stud 21 to leave the notch of the disk  $A^{26}$ , fast on said rotating shaft, thus detaching the gear  $A^{27}$  from the disk and leaving the gear free to be moved by some other source, said roller-stud 21 moving with the gear  $A^{27}$ , entering the notch 25 at the end of the dog  $h^8$  in the spider  $A^{25}$ , and as said spider is always reciprocating, as will be described, said spider at once, by engaging said stud, becomes the moving device for said gear  $A^{27}$ , and this gear will be reciprocated, and the cam-cylinder will also be reciprocated for re-



reciprocating knitting as long as said shoe remains in position to act on said roller 22, the roller in the reciprocating movements of the gear A<sup>27</sup> traveling only from one to the other end of said shoe.

The slotted arm A<sup>24</sup> of the spider has connected with it a link A<sup>23</sup>, adjustably attached to a slotted arm A<sup>22</sup>, fast on a rock-shaft A<sup>21</sup>, said rock-shaft having an attached second arm A<sup>20</sup>, to which is adjustably attached a link A<sup>19</sup>, (see Fig. 3,) in turn fitted at one end over a stud A<sup>18</sup>, carried by a disk A<sup>17</sup>, also fast on said continuously-rotating slow-motion shaft A<sup>16</sup>.

The shoe b<sup>0</sup> is supported at one end by a suitable spring b<sup>10</sup>.

The lever b<sup>7</sup> is (see Fig. 3) slotted at one end, and said slot receives a pin d, extended from a lever d', pivoted at d<sup>2</sup> on a lug of the standard A<sup>xx</sup>. The lever d' (see Fig. 3) has connected to it at one end an elbow-lever d<sup>3</sup>, (shown in section in Fig. 3,) the upper end of said lever (see Fig. 2) being acted upon to move it at desired times by a suitable projection of the pattern-chain C, which is carried by a cylinder C', fast on a shaft c<sup>2</sup>, which has secured thereto at one end a toothed wheel c<sup>3</sup>. The wheel c<sup>3</sup> is actuated intermittently or step by step to thus turn the cylinder C' and move the pattern-chain by means of a cam-arm C<sup>4</sup>, extended laterally from the plate C<sup>5</sup>, secured to the gear A<sup>15</sup>, before described. As the gear A<sup>15</sup> rotates the cam-arm C<sup>4</sup> engages the teeth of wheel C<sup>3</sup> and turns it, as will be obvious, and such movement will be intermittent, depending upon the character of arm C<sup>4</sup> and number of revolutions of gear A<sup>15</sup>. The opposite end of said lever d' is shaped to enter a hole d<sup>4</sup> (see Fig. 4) in an adjustable link d<sup>5</sup>, jointed at d<sup>6</sup> to the lower end of a lever d<sup>7</sup>, pivoted at d<sup>8</sup> on a stand d<sup>9</sup>, depending from the bed-plate A', the upper end of the lever d<sup>7</sup> entering a slot in an ear d<sup>10</sup> of a carriage d<sup>12</sup>, fitted to slide in ways of a block d<sup>13</sup>, fast on said bed-plate, said carriage having a cam-slot d<sup>14</sup>, in which is entered a pin d<sup>15</sup>, extended from a slide-bar d<sup>16</sup>, fitted in a guide d<sup>17</sup> and provided at its upper end with two controlling-cams d<sup>18</sup> d<sup>19</sup>, said cams occupying their uppermost position (see Figs. 2 and 4) when circular knitting is being done and being moved into their lowermost position when reciprocating knitting is being done.

The bed-plate A' has supported thereon a suitable hub e, which receives a post e', made adjustable in said hub by a suitable set-screw e<sup>2</sup>, to thereby adapt the machine to the size of cone used. This post has pivoted upon it at e<sup>3</sup> a socketed arm e<sup>4</sup>, in which is entered and held adjustably by a set-screw e<sup>14</sup> an arm e<sup>5</sup>, having at its outer end a split collar e<sup>6</sup>, which may be clamped together by a suitable screw e<sup>7x</sup>, said split collar entering an annular groove at the outside of the thread-carrier,

shown as composed of a hollow cylinder e<sup>7</sup>, having at its lower end a flaring shield e<sup>8</sup>, which serves as a thread-rest and a latch-guard. The cylinder has located centrally in it a thread-guiding device e<sup>9x</sup>, shown as a roller, to not only lessen friction, but also to facilitate the easy introduction of the thread. The body of this cylinder below the split collar is provided with a suitable opening o<sup>10</sup> to permit the passage of the thread from the center of the cylinder to the outer side of the latch-guard or shield on its way to the needles, said thread in its passage from the thread-guiding device e<sup>9x</sup> to the needles running through some suitable guide, as e<sup>9</sup>, the said guide in this present instance of my invention being represented as a funnel or chute, and the delivery end thereof is shown in Fig. 2 and Fig. 20. Locating the thread-guiding device e<sup>9x</sup> centrally with relation to the cylinder and leading the thread out from the lower end thereof enables said cylinder to be either rotated continuously or to be reciprocated without liability of the thread catching improperly in any stationary part of the machine, and hence this central location of the thread-guide becomes an essential feature of this invention. The particular eye or device which directly delivers the knitting-thread to the machine from the shield is immaterial, and instead of the eye or chute shown I may employ any other usual or suitable thread-guiding device commonly employed in knitting-machines. In this instance of my invention the outer portion of cylinder e<sup>7</sup> (see Figs. 1, 2, and 5) has a flange e<sup>13</sup> and above it a collar e<sup>12</sup>, attached thereto by a suitable screw e<sup>17x</sup>, and loosening said screw the collar may be adjusted up or down on said cylinder e<sup>7</sup>, so that it may be made to act with more or less friction against the said split collar; but ordinarily the adjustment of the split collar will be all that will be requisite. The cylinder, it will thus be understood, constitutes the thread-guide—that is, the thread is taken into the hooks from the projecting end of the guide e<sup>9</sup>, whence it passes to the needles under the adjacent edge of the cylinder e<sup>8</sup>.

By adjusting the post e' up or down in the socket e the shield and latch-opener e<sup>8</sup> may be put in exactly the proper position with relation to the upper ends of the needles and the size of the cone used.

The socketed arm e<sup>4</sup> and the thread-guide may be turned up when it is desired to employ a transferer to put a top or other device on the hooks of the needles, they being then arranged in a circle; but when knitting is being done the said arm and thread-guide will occupy the position shown in Figs. 2 and 5.

The cylinder e<sup>7</sup> has attached to it arms e<sup>15</sup> and e<sup>16</sup> by suitable like screws e<sup>17</sup> passing through slots made in the curved shanks of the arms e<sup>15</sup> e<sup>16</sup>, both shown in Figs. 1 and 2,



said arms being preferably made adjustable toward and from the point where the thread is delivered to the needles, to thereby secure accurate movements for the thread-guide with relation to the needles used. In the instance of my invention shown in Figs. 1 and 2 the said arms are located in different horizontal planes, and when circular knitting is being done, the thread-carrier being then rotated continuously, the arm  $e^{16}$  is acted upon continuously by the end of a suitable lever  $e^{18}$ , pivoted at  $e^{19}$  on a stand  $e^{20}$ , erected on the cam-lock  $a^5$ , a lug  $e^{21}$  at the outer curved end of said lever at such time passing freely between the acting faces of the toe-cams  $d^{18}$  and  $d^{19}$ , they occupying their uppermost position. One side of the lever  $e^{18}$  is shown as acted upon by a friction device  $e^{23}$ , composed, as herein shown, of a spring-steel arm erected on the stand  $e^{20}$ , it having an attached friction-face, which may be of leather, said face being represented by dotted lines behind said lever in Fig. 2, said arm also having two stops  $e^{22}$   $e^{22x}$  to limit the extent of movement of said lever.

The bed-plate has fitted within it two rings  $f$  and  $g$ , adapted to slide therein, the latter ring  $g$  resting on a shoulder  $g'$ , forming part of the said bed-plate, and the ring  $f$  rests on the ring  $g$ , both rings lying within and being guided externally by the upturned wall  $g^2$  of said bed-plate, the upper ring  $f$  being partially overlapped by a flanged ring  $f'$ . The ring  $f$  has attached to it at its upper side by suitable screws 2 (see Figs. 1 and 12) a steel plate, a portion 3 thereof being bent upwardly above the plate and the ring  $f$ , and the said upwardly-bent plate is split, so that its ends may be bent, as at 4 5, to constitute cams. The lower ring  $g$  has attached to it by suitable screws  $2^x$  (see Figs. 1 and 11) a suitable steel plate  $3^x$ , having cam-shaped ends  $4^x$   $5^x$ .

During circular knitting the rings  $f$  and  $g$  remain at rest, and the cams 4 5 and  $4^x$   $5^x$  are at their farthest distances apart, and the lever  $e^{18}$  rests against the lower stop  $e^{22}$ , and the end of said lever lies in contact with the arm  $e^{16}$ , as shown in Fig. 2, and the thread-carrier is rotated in unison with the cam-ring. Now when reciprocating knitting is to be commenced the cams  $d^{18}$  and  $d^{19}$  are automatically depressed by or through the pattern-surface, as described, causing the upper cam  $d^{19}$  to meet the lug  $e^{21}$ , which slightly depresses the outer end of the lever  $e^{18}$ , thus putting it in such position that said lever in its movement with the cam-ring will meet the end 5 of the plate 3 of ring  $f$ , which will turn said lever  $e^{18}$  far enough to raise its inner end from contact with the arm  $e^{16}$ , thus immediately leaving the thread-carrier at rest, so that it will no longer travel in unison with the cam-ring, the latter continuing and completing its usual movement, this disengagement

of the lever and arm being made just after the thread-carrier has fed its thread to the needle next to take a thread in a reciprocating course next to be made, and by stopping this thread-guide in this way the formation of slack thread is avoided. This thread-guide, it will be understood, will be stopped at different points with relation to the reciprocating stroke of the cam-ring to thus adapt the thread to the number of needles used in any course, and it will be understood that the thread-guide will be stopped at the end of each reciprocating course in either direction. This may be done through the two plates 3 and  $3^x$ , having the cams described and carried by the two rings  $f$  and  $g$ , said rings just when or after reciprocating knitting is to be done being started by means to be hereinafter described, and moved intermittently with respect to each other after the completion of each stroke during narrowing, and when the narrowing has been completed the said rings are moved intermittently in the opposite direction to thus again separate said spring-plates and their cams so that they operate the lever  $e^{18}$  at a later period in the stroke of the cam-ring until the widening has been completed and circular knitting is to be again commenced, at which time the cams  $d^{18}$   $d^{19}$  are put into their uppermost position, and on this movement of the said cams the lever  $e^{18}$  is again put against stop  $e^{22}$ .

It has been stated that the thread-carrier during reciprocating knitting will be moved for a greater or less distance according to the length of the reciprocating course being knitted, such movement being effected through the lever  $e^{18}$ ; but in order that said lever shall so operate it must contact when the cam-ring goes in one direction with, say, the arm  $e^{16}$ , and in the opposite direction with the arm  $e^{15}$ , and the time that the said lever engages one or the other of the said arms must be automatically controlled. This is effected by or through the cam-plates 3 and  $3^x$ .

Let it be assumed that the last course of circular knitting is being made and that the cam-ring B is at that time moving in the direction of the arrow 10, (see Fig. 1,) and at this time, it will be remembered, the cams  $d^{18}$  and  $d^{19}$  are automatically lowered preparatory to reciprocating knitting, so that cam  $d^{19}$  meets the lug  $e^{21}$ , which depresses somewhat the outer end of the said lever  $e^{18}$  and lifts the inner end thereof somewhat with relation to the arm  $e^{16}$  with which it is in engagement. Now in the further rotation of the cam-ring in the direction of the arrow 10, Fig. 1, the lower end of said lever strikes the incline 5, which immediately further turns the said lever, lifting its inner end above the path of the arm  $e^{16}$ , so that as the cam-ring continues its motion the said lever  $e^{18}$ , elevated from contact with the arm  $e^{16}$ , will leave the thread-carrier at rest. The cam-



ring continues its motion to the full end of its stroke and is then reversed, and as it comes back the elevated inner end of the lever  $e^{18}$  meets the end of the arm  $e^{15}$ , located in a higher plane than the arm  $e^{10}$  and immediately picks up and moves the thread-carrier in unison with it; but when said thread-carrier has been moved so as to feed the thread to the desired number of needles to be used in that reciprocating course the outer end of the lever  $e^{18}$  strikes the cam incline  $5^x$  on the outer side, which lifts the outer end of said lever, moving its inner end downwardly away from the arm  $e^{15}$ , and the cam-ring continues its movement to the end of its stroke, leaving the thread-carrier at rest. On the return stroke of the cam-ring the depressed inner end of the lever  $e^{18}$  in line with the arm  $e^{15}$  meets said arm and picks up and moves the thread-carrier with it until the outer end of the lever  $e^{18}$  again meets the inner side of the incline 5, when the inner end of said lever  $e^{18}$  is again lifted to pass above over and away from the arm  $e^{15}$ .

The spring-plates 3 and  $3^x$  have been described as provided with inclines or cams 4 and  $4^x$ ; but these inclines or cams do not in the operation of the machine perform any work; but they are offset, as shown, in order that the outer end of the lever  $e^{18}$ , after the same has been moved by one of the inclines 5 or  $5^x$ , may on the return movement of the cam-ring and lever act to position the end of the lever correctly with relation to the central part 3 or  $3^x$  of the spring-plates should the said lever from any reason either due to centrifugal force or shock be turned somewhat on its pivot  $e^{19}$  accidentally.

The arms  $e^{15}$  and  $e^{10}$  are located close to the thread-delivery, one at one and the other at the opposite side thereof, and by adjusting these arms toward or from the line of thread-delivery the thread may be led to the needles of any cone correctly to enable any desired needle to be the first one fed for reciprocating knitting.

I believe myself to be the first to provide the cam-lock or cam-ring of a circular-knitting machine with a lever or other moving device substantially such as herein described under the control of suitable cams, lugs, or projections by which said lever device may be moved into one and then into another position to engage and disengage at desired times an arm or projection extended from or connected with a thread-carrier; so that said thread-carrier may be, as it were, detached from and left by the moving cam-ring at any desired point in its stroke, and therefore this invention is not limited to the exact lever or device  $e^{18}$  herein shown; but said lever or device may be variously modified—as, for instance, see Fig. 15, where is shown a lever  $h$ , pivoted at  $h'$  on a stand  $h^2$ , which may be erected on the cam-lock—and this

lever may cooperate with one arm—for instance, arm  $e^{10}$ —extended from the thread-carrier, it meeting first one and then the other side of said arm, said arm  $e^{10}$  in such modification being located immediately above said thread-delivery. The lever has, at one end a slot, as  $h^3$ , in which may be placed a roller or other stud  $h^{40}$ , connected with a link or foot  $h^{50}$ , pivoted at  $h^{60}$  on a block  $h^{70}$ , free to slide up and down in a slot of an arm  $h^9$  of said stand  $h^2$ . The lower end  $h^{10}$  of the link or foot is normally kept depressed below the lower end of the arm  $h^9$  by a suitable spring  $h^{12}$ , connected in this instance with a stud  $h^{13}$ , fixed to the stand and to a screw or stud fixed to the lever  $h$ . The upper end of the link  $h^{50}$  has a projection  $h^{13x}$ , provided with a hole which embraces the end of a rod  $h^{14}$ , connected with the lever  $h$  and surrounded by a suitable spiral spring  $h^{15}$ , the said spring acting normally to keep the said link in upright position. This link may be acted upon at suitable times by the inclined ends  $h^{20}$  of cam-lugs  $h^{17}$ , which may be fixed to two rings having circular movement, as described, of the rings  $f$  and  $g$ , and said rings may be either constructed as shown in this application or said cam-lugs may be applied to a ring which has imparted to it not only a circular motion, but a rising-and-falling motion, as in United States Patent No. 542,055, dated July 2, 1895. The upward movement of the leg  $h^{10}$  by one of the said cam ends depresses the inner ends of the lever  $h$  to remove it from contact with one side of the single arm extended from the thread-carrier with which it cooperates, and as soon as the leg passes off of the end of the said cam the spring  $h^{12}$  immediately acts to elevate the inner end of the lever  $h$ , again putting it in the path of the arm extended from the thread-carrier, and the cam-ring continues its movement to the end of its stroke. On the return stroke the end of the lever  $h$  must meet the opposite side of the arm extended from the thread-carrier in order to move the thread-carrier in the opposite direction, and in order that the end of the lever may remain in its elevated position and not be depressed by the cam referred to the inner edge  $h^{10}$  of the leg  $h^{50}$  meets an inclined portion  $h^{20}$  of said cam, which turns the leg on the pivot  $h^{60}$ , so that the said leg is not lifted, as it was when it passed the cam in its stroke in the other direction, and consequently the roller-stud  $h^{40}$  moves in the slot  $h^3$ , and the inner end of the lever is not at all disturbed, but remains in contact with the arm extended from the thread-carrier and moves the thread-carrier until the lower end of the leg  $h^{50}$  meets a second like cam end  $h^{20}$  on the other ring, by which it is elevated, as just described, so that the inner end of the lever  $h$  is depressed below and passes beyond the arm extended from the thread-guide, thus again leaving the



thread-guide at rest, and this operation will be repeated at each stroke of the cam-ring during reciprocating knitting.

The cam-lock  $a^5$  (shown best in Figs. 6 and 7 and in the section Fig. 8) has two stitch-regulating cams  $m$   $m'$ , two being used because the machine is to knit on the reciprocating stroke. These cams are carried by suitable slide-blocks  $m^2$ . The carriage  $m^2$ , carrying the cam  $m$ , has a stud  $m^{3x}$ , which is extended outwardly through a slot  $m^4$  in the cam-lock  $a^5$ , said lock having adjustably secured to it a plate  $m^5$ , which is set for the longest stitch to be made in heel and toe work, and the cam  $m$  is adjusted to normally stand in the same position by or through the lowest projection of the pattern-surface; but when a longer stitch is to be made in circular work, as toward the upper end of the leg, said cam  $m$  is depressed by or through a projection on the pattern-surface acting upon a ring  $m^7$ , (shown in section in Fig. 5 and in elevation in Fig. 1,) said ring having suitable pins or studs  $m^8$  extended from it through the bed-plate  $A'$  underneath the rings  $f$  and  $g$ , the ends of said pins or projections entering suitable slots  $m^9$  (see Fig. 2) in a series of adjustable plates  $m^{10}$ , fixed on the bed-plate  $A'$ . To lift this ring and render it available to lengthen the stitch, as described, it must be turned, and to do this I have provided the ring with an arm  $m^{12}$ , (see Figs. 1 and 2,) which is extended through a suitable hole in the outer upright wall of the bed-plate, where it is acted upon by a hook  $m^{14}$ , carried by a stud  $m^{15}$  on an elbow-lever  $m^{16}$ , having one of its arms extended over and so as to be acted upon by a projection of the pattern-chain, the said projection turning the said lever  $m^{16}$ , so that the hook  $m^{14}$ , acting on the rod  $m^{12}$ , draws the said rod in a circular path, causing the projections  $m^8$  to slide upwardly in the inclined slots  $m^9$ , thus raising the ring. The upper side of the ring as it is raised contacts with a foot  $m^{17}$  of a slide or lever  $m^{18}$ , suitably pivoted at the outer end of the cam-lock  $a^5$ , said lever having jointed to it a link  $a^{50}$ , which engages one end of a lever  $m^{20}$ , pivoted at  $m^{21}$ , the opposite end of said lever having an adjusting-screw  $m^{22}$ , which acts upon the stud  $m^{3x}$ , extended outwardly from the slide  $m^2$ , carrying the said cam  $m$ . The cam-lock also has two like fly-cams  $n$ , each of which has a right-angled stud  $n'$ , which is extended outwardly through a hole in the cam-lock where said stud is surrounded by a suitable spring  $n^2$ , one end of said spring being connected with the cam-lock and the other with a suitable pin or projection  $n^3$ , extended through or connected with said stud, so that said spring normally acts to keep the fly-cam pressed against the blocks 62 and 63.

The plate of the cam-lock has attached to its inner side, as herein shown, by suitable screws a series of blocks 60, 61, 62, and 63, the

blocks 60 being in duplicate, and they are so shaped at their under sides and so located with relation to the blocks 61, 62, and 63 as to leave between them what I designate as the "knitting-groove"  $n^{60}$ , the said knitting-groove intersecting the lower edge of the cams  $m$  and  $m'$  before described. The outermost ends of the blocks 60 have pivoted on them the fly-cams  $n$  described, and to the inner ends of said blocks are pivoted the points or switches  $n^6$   $n^7$ . The central part of the block 61 is provided with a recess to receive a block 64, it being attached to the block 61 by a screw 65. Above the concaved upper edge of the block 64 is pivoted a directing-cam 66, said cam occupying a position between said points or switches  $n^6$   $n^7$ , the directing-cam depending in a space between the lower edges of a guide-plate 67.

The top edges of the blocks 60, 62, and 63 and the fly-cams  $n$  and the top of the block 64 and the upper edge of the ring  $a^{14}$  constitute one side of what is designated as the "non-knitting groove"  $n^5$ , the only opposed side being the small guide-plate 67 and the directing-cam. In the patents referred to the non-knitting groove had a continuous top wall extended entirely about the cam-ring; but for cheapness of construction and to lessen the wear on the butts of the needles when in said non-knitting groove and to also leave the butts of the needles in said groove free to be seen I have done away with most of the upper wall of said non-knitting groove.

The fly-cams normally stand in position to close the knitting-groove and prevent the entrance of needles therein at that point; but they are free to rise and permit the passage of the butts of the needles from the knitting-groove into the non-knitting groove  $n^5$ .

Substantially midway between the stitch-cams  $m$  and  $m'$  I have located the needle-selecting devices, composed, essentially, of the two points or switches  $n^6$   $n^7$ , represented as pointing one toward the other, and a directing-cam 66, loosely pivoted and lying between the said points or switches, said directing-cam being free to be struck by the butts of the needles when the cam-ring is moving in either direction, so that if the free ends of the said points or switches are elevated will insure the passage of the butts of the needles under the points or switches into the knitting-groove  $n^{60}$ ; but if the free ends of said points or switches are depressed then the butts of the needles on arriving under the directing-cam pass beyond it over the tops of the free ends of the points or switches and remain in the non-knitting groove and do not knit. In Fig. 17 I have shown one of these points or switches detached, and it will be seen that it has extended from its back a stud  $n^{10}$ . The studs extended from these points or switches enter each a hole in a sliding plate  $n^{12}$ , entering a suitable groove in the



cam-lock, said plate having a slot  $n^{22x}$ , which is entered by a suitable screw  $n^{13}$ , said plate also having attached to it a stud  $n^{13x}$ , which passes through a cam-slot  $n^{15}$ , made in an arm  $n^{16}$ , extended from what I herein designate as a "toe-cam" N, said toe-cam having two toes  $n^{17}$   $n^{18}$ , extended from a hub  $n^{19}$  in opposite directions and in different planes. The hub of the toe-cam has a hole  $n^{20}$ , which is passed over a stud  $n^{21}$ , rising from the cam-lock. The arm  $n^{16}$  of the toe-cam rests at its under side upon a rock-shaft  $n^{22}$ , a portion of which is slabbed off or cut away at  $n^{23}$  (see Fig. 8) to leave a secant surface. This rock-shaft has connected to or forming part of it a gear  $n^{24}$ , which is engaged by a segmental rack  $n^{25}$  at one end of a lever  $n^{26}$ , pivoted at  $n^{27}$  on a stand  $n^{28}$ , erected on the cam-lock, the outer or left-hand end of said lever, viewing Figs. 2 and 8, being so located as to pass between the two cams  $d^{18}$   $d^{19}$  when the said cams are in their uppermost position and circular knitting is being done; but when reciprocating knitting is to be done and the said cams  $d^{18}$   $d^{19}$  are depressed, as stated, the uppermost cam  $d^{19}$  meets the upper side of the lever  $n^{26}$  and depresses that end, turning the rock-shaft until the secant surface  $n^{23}$  comes immediately under the arm  $n^{16}$ , thus letting the toe-cam drop and put the toes  $n^{17}$   $n^{18}$  in position to strike against the devices, which at each stroke of the cam-ring in reciprocating knitting act to turn the said toe-cam to thereby cause its slotted portion  $n^{15}$  to act at the proper time through the stud  $n^{13x}$  to thereby move the plate  $n^{12}$  to either elevate the said points or switches to pull down the needles from the non-knitting groove into the knitting-groove for knitting either in continuous circular courses or for reciprocating courses, as in narrowing and widening, or to depress said points or switches to retain the butts of said needles in the non-knitting groove. I have previously described in the preamble of this specification the action of these points or switches in their elevated and depressed positions, and their action is as common in the patents previously referred to so need not be herein further described; but I will now describe how the toes of the toe-cam are acted upon and moved at the proper times.

Referring now to Figs. 1, 5, 11, and 12, the rings  $f$  and  $g$  before referred to are therein represented, and the ring  $f$  has secured to it by suitable screws  $o$  and  $o'$  suitable rack-plates  $o^2$ , each having suitable depending lugs, as  $o^3$   $o^4$ , the contiguous ends of said lugs being oppositely beveled, as best represented in Fig. 12, and it will also be noticed in Fig. 1 that the said lugs stand in different circles, and in Fig. 12 they stand at different levels viewed from a horizontal plane. Supposing, again, that the cam-ring B is moving in the direction of the arrow 10, Fig. 1, in its last course of circular knitting preparatory to being re-

versed for reciprocating knitting and that the cams  $d^{18}$   $d^{19}$  have been depressed to put the toe-cam down, as described, with its toes  $n^{17}$   $n^{18}$  in working position. During the last part of the last circular course the under side of the toe  $n^{18}$  meets the beveled end of the lip  $o^3$ , and the toe-cam is turned to depress the points or switches  $n^8$   $n^7$  between the two needles, as described, so that thereafter no more needles will enter the knitting-groove  $n^{60}$ , but will follow over the tops of the point or switch just turned under it into the non-knitting groove, and by the time that the last needle passes the fly-cam  $n$  and enters the non-knitting groove the first needle to pass over the point will be found in position alongside the last needle and the butts of all the needles will be in the non-knitting groove. Now the machine is in condition to be reversed, and as soon as the points or switches in the first reciprocating stroke of the machine opposite the arrow 10 arrives in a position to have a point or switch elevated between two needles to thus grab and pull down into the knitting-groove the first of the series of needles to be used for a narrowing or widening course the shoulder 30 of the toe  $n^{17}$  meets the inclined end of the lug  $o^4$ , which immediately turns the toe-cam in the direction of the arrow near the toe  $n^{17}$  in Fig. 9 and again lifts the points or switches into position to engage and depress the first needle to be used in that reciprocating course, and the points or switches remain up until all of the needles to be used in that reciprocating course have been taken from the non-knitting groove and put into the knitting-groove to knit, and when the last needle of said course has completed its operation the toe  $n^{18}$  of the toe-cam meets the beveled end of a lug  $o^8$ , fast on the ring  $g$ , said lug again turning the toe-cam, causing the points to be depressed between two needles, and thereafter the butts of the needles in the non-knitting groove pass over the points or switches, while the butts of the needles then in the knitting-groove pass out of said knitting-groove into the non-knitting groove in front of the needles traveling in the non-knitting grooves until the butts of all the needles are again in mass in the non-knitting groove. The cam-ring completes its reciprocating course and comes back, and as soon as it arrives opposite the needle to be again depressed for the first needle of that reciprocating course a like cam projection of the toe  $n^{17}$  meets the beveled end of a lip  $o^9$ , extended upwardly from the ring  $g$ , which again turns the toe-cam to elevate the points or switches so that the needle to be the first of that course is immediately drawn down into the knitting-groove.

The lugs  $o^8$  and  $o^9$  are directed, respectively, one down and the other up, (see Fig. 11,) and the plates carrying said lugs are suitably confined to the ring  $g$  by screws 31 32.



The plates  $o^2$ , carrying the lugs  $o^3 o^4$ , and the plates carrying the lugs  $o^8 o^9$  may be adjusted as required to thus insure the tipping of the toe-cam at exactly the proper position with relation to the needles and the cam-ring to enable the points or switches to pass between the butts of any two needles, one of which it is desired to select and depress as the first needle of a reciprocating course and also to enable a point or switch to pass between the butts of any two needles, one of said needles being the last one to be used in the reciprocating course. It will be understood that the lugs  $o^3 o^4$  on one side of the machine and the lugs  $o^8 o^9$  on the other side of the machine stand at their farthest distances apart when reciprocating knitting is commenced and that at the end of each stroke of reciprocating knitting the said pair of cams are moved intermittently one toward the other until the narrowest course of reciprocating knitting is being made, and then they will be gradually moved intermittently in the opposite direction back for widening into their starting position. I will state, however, that these rings are not in this particular machine moved at the first two strokes of reciprocating knitting, I not moving them, because I have found that by laying in two courses of reciprocating knitting before commencing to narrow it is possible to make a better junction of the narrowed part with the circular part than would be the case if the rings carrying the lugs were moved with the first narrowing course. I will now describe how these rings  $f$  and  $g$  are moved intermittently in opposite directions. I have devised a very simple means for this purpose, my means containing but very few parts of light weight, low cost, and easily actuated. Each of these rings is provided with teeth at its periphery, the said teeth extending substantially halfway around each ring, and the toothed parts of these rings extend through a slot in the upper vertical wall  $g^2$  of the bed-plate, as seen at the right in Figs. 1 and 5. The upper ring  $f$  is engaged by a pinion 34, connected with a sleeve 36, having at its lower end a pinion 37, said two pinions and sleeve being loose on a shaft 35, held in a suitable bearing 38, connected with the bed-plate. The bed-plate has another suitable bearing 39, in which is mounted a shaft 40, (see Fig. 1,) provided at its upper end with a toothed pinion 41, the pinion being of sufficient thickness from top to bottom to not only engage the teeth of the ring  $g$ , but also to engage the teeth of the pinion 37 referred to, so that in the rotation of the pinion 41 it acts to move the ring  $g$  in one direction and, acting through the pinions 37 and 34, causes the pinion 34 to move the ring  $f$  in the opposite direction, each being moved at exactly the same time in opposite directions without any possibility of slip or lost motion to thereby disarrange the relative po-

sitions of the cam-lips and devices carried by said rings. The lower end of the shaft 40 has attached to it a pinion or ratchet-wheel  $c^7$ , (see Figs. 2 and 3,) and said ratchet-wheel is turned in one or the other direction by one or the other pawls  $c$  or  $c'$ , the pawl  $c'$  being shown in Fig. 3, each of said pawls being mounted on a like set-screw  $c^2$ , mounted in a like ear  $c^3$ , adjustably connected by screws  $c^4$  with a pawl-carrier  $C^{10}$ , said pawl-carrier being jointed at 43 with one end of an elbow-lever  $C^8$ , pivoted at  $C^9$  and provided at its opposite end with a suitable antifriction-roll  $c^{70}$ , which is acted upon by a cam  $C^6$ , fast on a slow-motion shaft  $A^{16}$ , said cam moving said pawl-carrier once during each rotation of said shaft. Each pawl  $c$  and  $c'$  has a like toe  $c^5$ , which butts against a projection of the ear  $c^3$  and is kept there in a yielding manner by a suitable spring  $c^6$ , the toe  $c^5$  limiting the inward movement of the pawls  $c$  and  $c'$ .

To provide for the pawls  $c$  and  $c'$  contacting with the ratchet-wheel  $c^7$  to move the shaft 40, I have provided a lever 44, pivoted at 45. One end of said lever has jointed to it a link 46, connected to the lower end of an elbow-lever 47, pivoted on a stud held in a boss 48 (see Fig. 2) of the framework, the short horizontal arm of said elbow-lever being slotted, (see Fig. 19, where said lever is shown in detail,) the said slot receiving a pin 49, extended laterally from the elbow-lever  $d^3$ , before described, so that when said lever is elevated or moved by the pattern-surface the lever 47 is consequently moved. The front end of the lever 44 referred to has connected to it a link 50, which embraces loosely a stud 51, carried by a plate 52, pivoted on a stud 53, erected on a plate 54, fast to or forming part of the standard  $A^{xx}$ . (See Fig. 2.)

The pawl-carrier  $C^{10}$ , before described, in its forward and back reciprocation is guided by the plate 52, before described, and the forked end of the carrier slides back and forth on or about the stud 51, and when it is desired to place one or the other of the pawls  $c$  or  $c'$  in engagement with the ratchet-wheel  $c^7$  the lever 44 must be moved.

Now assuming that it is desired to place the pawl  $c$  in engagement with the ratchet-wheel  $c^7$ , then in such case the pattern-surface will automatically at the proper times move the inner or short arm of the lever 44 to the left, viewing Fig. 3, and will carry the plate 52 and the pawl-carrier laterally, thus putting the pawl  $c$  in engagement with the teeth of the ratchet-wheel, and said pawl will remain in engagement with said teeth and in the reciprocations of the pawl-carrier will move said teeth and the shaft 40 as long as the rings are to be moved in the direction for narrowing, and, the narrowing completed, the lever 44 will be again moved in a direction to insure the placing of the pawl  $c'$  in position to engage the ratchet-wheel  $c^7$  and turn



it and the shaft 40 in the opposite direction, said pawl remaining in action until the widening is completed, when said pawl is disengaged and both pawls are left out of action while circular knitting is being done and until narrowing is to be again commenced.

The plate  $a^9$  is connected to the same narrow ring which carries the cam-lock  $a^5$ , and in addition to carrying the said lugs  $a^4$  it also serves the important function of a balance for said cam-lock  $a^5$ , which is essential in a high-speed machine.

The employment of the narrow ring B enables the weight of the cam-ring to be greatly decreased, and owing to its light weight the stroke due to momentum in quick change of motion, as for reciprocating knitting, is avoided, and consequently the machine, owing to this light-weight cam-ring, may be run during reciprocating knitting much faster than with a heavier ring such as heretofore used.

When the rock-shaft having the secant surface is turned so that the toe-cam may descend, the descent of the toe-cam is insured by the action of a spring  $p$ , the free end of which acts on a projection  $p'$  of the lever  $n^{16}$ . The stud  $B^x$  of the plate  $n^{12}$  after passing through the cam-slot of the lever  $n^{16}$  enters a straight or vertical slot 70 in an ear 71, connected to the stand  $e^{20}$ , said stud and slot serving as an additional guide for the said plate.

The feet  $a^{13}$  may in practice have secured to them by suitable screws 72 the shanks 73 of guard-cams 74, the lower edges of said guard-cams lying substantially in the line of the under side of the cam part 67 before described, said guard-cams being located substantially above the fly-cams  $n$  and acting to prevent a needle leaving the knitting-groove from being elevated too high into the space designated as the "non-knitting" groove.

The guard-cams are supported independently of the cam-lock, so that said cam-lock may be removed and be easily replaced with the needles in the non-knitting position.

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

1. A circular-knitting machine containing the following instrumentalities, viz: a needle-bed to contain needles; a thread-guide; a cam-ring, means to revolve it to actuate the needles for circular knitting, means to impart to said cam-ring a uniform length of stroke during reciprocating knitting; thread-guide-actuating means between said cam-ring and said thread-guide; and devices to automatically control said thread-guide-actuating means when reciprocating knitting is being done, to leave said thread-guide at rest in a variable position with relation to the needles used in reciprocating knitting, the ends

of the successive reciprocating strokes of the cam-ring maintaining the thread carried by the thread-guide without slack in order that said thread may be supplied immediately to the needles when the said thread-guide is started at each succeeding reciprocating stroke.

2. A circular-knitting machine containing the following instrumentalities, viz: a needle-bed to contain needles, a cam-ring having cams to actuate said needles, means to revolve said cam-ring that it may actuate said needles for circular knitting, and means to uniformly reciprocate said cam-ring for reciprocating knitting, a circularly-moving thread-guide, means to support said thread-guide centrally with relation to the circle of needles, thread-guide-actuating means carried by said cam-ring, and devices to move said thread-guide-actuating means in unison with said cam-ring to feed the needles with thread during circular knitting, and actuating means also operating said thread-guide for a part of each stroke during reciprocating knitting, said actuating means being arrested at different points of its stroke automatically during each reciprocating stroke of the cam-ring of uniform length, to thereby leave said thread-guide at rest over different needles of the series of needles varying in number during narrowing and widening, in order that the thread carried by said thread-guide may be in position to start without slack at the next reciprocating course, and be delivered only to the needles to be used in said course.

3. In a circular-knitting machine, the combination with a needle-cylinder and needles therein, a thread-guide formed as a cylinder having an open passage-way therethrough for the thread said cylinder having an attached shield and latch-guard, and an arm to support said thread-guide centrally with relation to the circular series of needles, substantially as described.

4. In a circular-knitting machine, a thread-guide made as an open cylinder having at its lower end a latch-guard and shield, said open cylinder being provided with thread-sustaining means to receive and guide the thread through the cylinder and deliver it to the needles.

5. In a circular-knitting machine, the following instrumentalities, viz: a conical needle-bed to contain a series of needles, a cam-ring to actuate said needles, a thread-guide made as an open cylinder having at its lower end a latch-guard, thread-sustaining means located within said thread-guide and delivering the thread at the exterior of the latch-guard portion thereof, and means independent of the cam-ring to support the shank of said thread-guide loosely above the center of motion of the cam-ring.

6. In a circular-knitting machine the following instrumentalities, viz: a thread-guide



made as an open cylinder having a passage from its interior to its outer side, said cylinder having an attached latch-guard, combined with a supporting-arm pivoted on a fixed part of the frame and adapted to be turned up away from the needle-bed so as to uncover the needles, substantially as described.

7. In a circular-knitting machine, a thread-guide formed as a cylinder and having a passage-way therethrough, a latch-guard disposed at the lower end of the cylinder, and an arm adjustable in length supporting said cylinder to thereby enable the thread-guide to be centered accurately with relation to the series of needles.

8. In a circular-knitting machine the following instrumentalities, viz: a conical needle-bed to contain a series of needles, a cam-ring having cams for reciprocating said needles, a thread-guide disposed centrally above said needle-bed and having an open central passage-way and provided at its lower edge with a projecting surface to sustain the thread being fed to the needles, means to loosely and rotatably support the thread-guide above the needle-bed, two engaging projections extended from the thread-guide and separated by a horizontal space to give lost motion, a lever carried by the cam-cylinder and means to cause said lever to engage one of said projections to thereby move the thread-guide during circular knitting and to alternately engage each of the said projections and move the thread-guide during a portion of the movement of the cam-cylinder during reciprocating knitting.

9. A needle-bed adapted to contain a series of needles, a cam-ring having cams to actuate said needles, an open centered thread-guide provided at its lower end with a thread-supporting surface, a device to sustain said thread-guide loosely centrally above the series of needles, and means between said cam-ring and said thread-guide to actuate the latter, the thread-guide at all times sustaining the thread and delivering it directly to the needle the hook of which is covered by the thread-supporting surface of the thread-guide, whereby the thread in the thread-guide is at all times prevented from contacting with any of the stationary parts of the machine.

10. In a knitting-machine, a thread-guide support located centrally above the series of circular needles, and a combined thread-guide and latch-opener made as a cylinder open at its center throughout and provided with a passage-way from its center to its outer side above the lower end of the thread-guide, whereby the thread is delivered to the needles from the upper side of the latch-opening portion of the thread-guide.

11. In a circular-knitting machine the following instrumentalities, viz: a needle-bed to

contain a series of needles, a cam-ring having a series of cams to actuate said needles, a rotatable thread-guide mounted centrally with relation to said needle-bed and above the said bed, a clamping-ring to receive the shank of said thread-guide, and means to close said ring about and hold said thread-guide frictionally, and means between said cam-ring and said thread-guide to move the latter with the cam-ring, substantially as described.

12. In a circular-knitting machine, a conical needle-bed to contain a series of needles, a cam-ring to actuate said needles, a thread-guide mounted loosely and centrally above said needle-bed and presenting at its lower end a cone-shaped latch-guard, said thread-guide receiving the thread in its open end and delivering it externally above the lower end of said latch-guard, and connecting devices between said cam-ring and thread-guide to move the latter from the cam-ring.

13. In a circular-knitting machine, a conical needle-bed to contain a series of needles, a cam-ring having cams to reciprocate said needles, a thread-guide formed as an open cylinder and located centrally above the said needle-bed, an adjustable supporting-arm for said thread-guide, said thread-guide having projecting arms, means to support said thread-guide, a lever interposed between the cam-ring and said thread-guide, and means to automatically move said lever during reciprocating knitting to engage and disengage the arms extending from said thread-guide to thereby move said thread-guide during a portion of the travel of the cam-ring during its reciprocating motion and to then leave said thread-guide at rest until on the return stroke of the cam-ring when said lever is again made effective to move the thread-guide.

14. In a circular-knitting machine the following instrumentalities, viz: a needle-bed containing a series of needles, a cam-ring containing cams to reciprocate said needles; a thread-guide support; a thread-guide arranged in said support centrally over the needle-bed and provided with two arms located in different horizontal planes, a lever moving in unison with said cam-ring, and means to actuate said lever at different periods in the movement of said cam-ring during reciprocating knitting, whereby said lever in one direction of its movement will engage one of the arms of said thread-guide and move it for the desired distance and then retires from said arm leaving the thread-guide at rest, said lever in the return movement of the cam-ring meeting the other of the said arms thereby reversing the movement of the thread-guide and moving it for the desired distance, when the said lever is released from the second of said arms, again leaving the thread-guide at rest, as and for the purpose set forth.

15. In a circular-knitting machine the fol-



lowing instrumentalities, viz: a needle-bed to contain needles, a cam-ring having cams to actuate said needles, a thread-guide support; a rotatable thread-guide mounted in said support, a thread-guide-actuating lever 5 mounted on and movable with said cam-ring, means to hold said thread-guide-actuating means in position to effect the rotation of the thread-guide in unison with the cam-ring 10 during circular knitting, and means under the control of a pattern-surface to automatically partially move the thread-guide-actuating means preparatory to commencing reciprocating knitting, a pattern-surface, and 15 means under its control to thereafter automatically move said thread-guide-actuating means to effect the alternate release and engagement of said thread-guide at different periods of the reciprocating stroke of the machine in narrowing and widening, whereby 20 the thread-guide may be stopped with its thread-delivery immediately above the end-most needle to receive thread at the next reciprocating stroke of the machine in widening or narrowing, substantially as described. 25

16. In a circular-knitting machine, a cam-ring having knitting-cams provided with movable points or switches directed toward each other, said points or switches having 30 studs extended outwardly through the cam-lock of said cam-ring, a sliding plate to receive said studs, said plate also having a stud, a toe-lever having toes extended therefrom in opposite directions, said toes being set out 35 of line one with the other, said lever being mounted on a stud of said cam-lock and having an arm provided with a slot to receive the stud of said plate, means to maintain the said toe-cam in an elevated position during circular knitting, means to depress said toe-cam 40 preparatory to reciprocating knitting to thereby place its toes in operative position, two rings having cam-lugs, and means to move said rings whereby said lugs may actuate said toe-cam sooner or later during successive strokes of reciprocating knitting, substantially as described. 45

17. A needle-bed to contain a series of needles, a cam-ring provided with movable 50 points or switches and adapted to actuate said needles; a circularly-movable thread-guide; means to support said thread-guide centrally above and with relation to said needle-bed, a toe-cam carried by the cam-lock of 55 said cam-ring, a thread-guide-moving device carried also by said cam-lock, two rings, each having two lugs to actuate the toes of the toe-cam, and said rings having other lugs to operate the thread-carrier-actuating devices, 60 and means to reciprocate said rings simultaneously in opposite directions whereby said toe-cam may be actuated to move the points or switches of the knitting-cams at the proper period, as described, to insure the taking 65 from the non-knitting groove of those needles

only which are to be used at the next stroke of reciprocating knitting for narrowing or widening, and also to effect the disengagement of the thread-carrier-actuating devices from the thread-carrier to leave the 70 thread-carrier at rest with its thread immediately above and in position to be again supplied without slack to the first needle of the needles to be used at the next reciprocating course, substantially as described. 75

18. In a knitting-machine, a bed-plate, a needle-bed supported therein to contain a series of needles, a cam-ring to actuate said needles, a thread-guide, means to support it loosely centrally above said needles, a connection 80 between said cam-ring and said thread-guide to impart motion thereof, two toothed rings surrounding said needle-bed and provided with suitable actuating cam-lugs, the teeth of said rings being exposed 85 through said bed-plate, combined with a shaft having a narrow pinion engaging one of said toothed rings; a broad pinion engaging the other of said toothed rings, a shaft carrying said broad pinion, and a pinion intermediate 90 said broad pinion and on the shaft carrying said narrow pinion, whereby the broad pinion is adapted to actuate one of said rings in one direction, and through the intermediate pinion and said narrow pinion actuate the 95 other of said rings in an opposite direction, substantially as described. 95

19. In a circular-knitting machine, a thread-guide made as an open cylinder having a thread-passage from its interior to its 100 outer side, said cylinder having an attached latch-guard, combined with an arm to support said thread-guide centrally with relation to the needles, said supporting-arm being horizontally adjustable, and means to vertically 105 adjust said thread-guide to thereby adapt it to needle-beds of different sizes. 105

20. In a circular-knitting machine the following instrumentalities, viz: a thread-guide made as an open cylinder having a thread- 110 passage from its interior to its outer side, said cylinder having an attached latch-guard, combined with an arm to support said thread-guide centrally with relation to the circular series of needles being used, and means to 115 vertically adjust said thread-guide to thereby adapt it to needle-beds of different sizes, substantially as described. 115

21. In a knitting-machine, a cam-ring composed of a narrow ring having an attached 120 cam-lock provided with cams to actuate the needles, and with an attached balancing-plate, and a second ring connected to said narrow ring near the ends of said cam-lock and extended from one to the other end of 125 said cam-lock, substantially as described. 125

22. In a knitting-machine, the cam-ring having guard-cams, connected therewith and located above the delivery end of the knitting-grooves, said cam-ring having a detach- 130



able cam-lock provided with the knitting-cams and points or switches to call all or any number of needles into operation in the non-knitting groove, said cam-lock being detach-  
5 able from said ring independently of said guard-cams, substantially as described.

In testimony whereof I have signed my

name to this specification in the presence of two subscribing witnesses.

MORITZ BOAS.

Witnesses:

GEO. W. GREGORY,  
MARGARET ALICE DUNN.