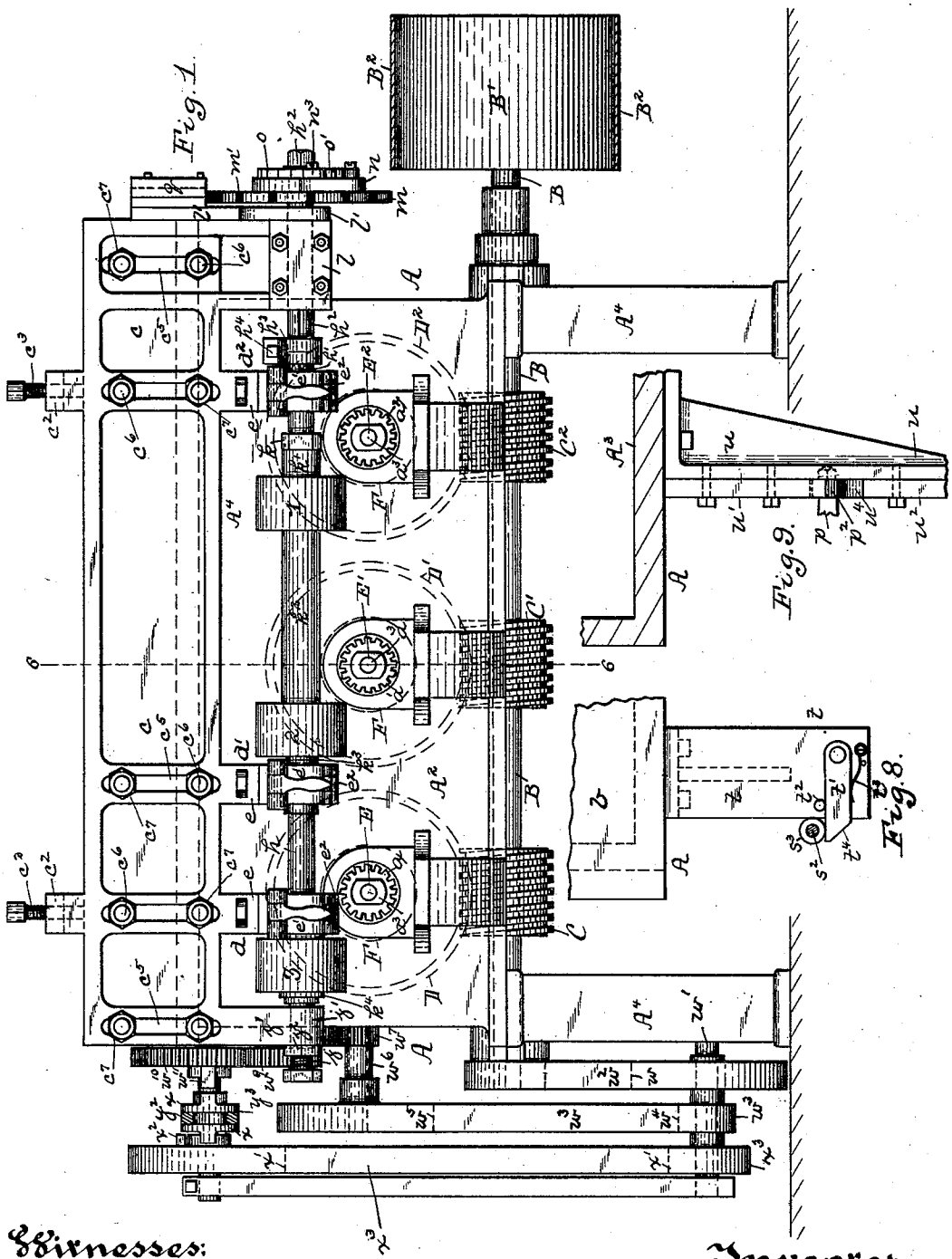
(No Model.) 4 Sheets—Sheet 1.

A. MERTES.

GEAR CUTTING MACHINE.

No. 498,720. Patented May 30, 1893.



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(No Model.) 4 Sheets—Sheet 2.

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GEAR CUTTING MACHINE.

No. 498,720. Patented May 30, 1893.

Fig. 2.

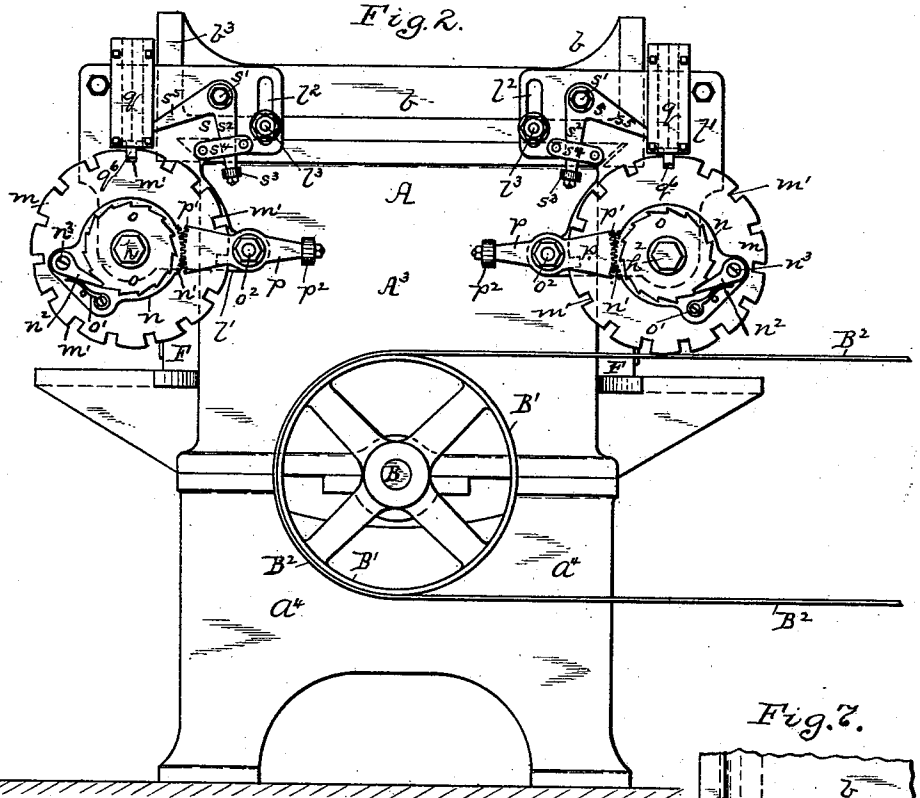
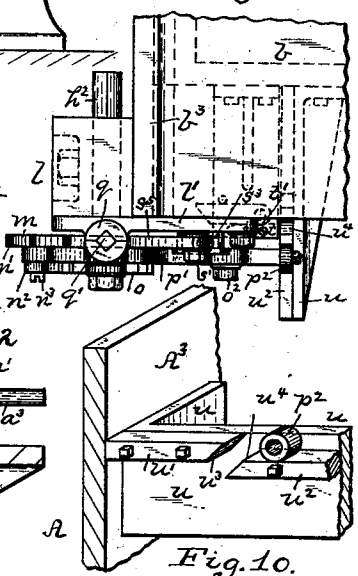


Fig. 7.



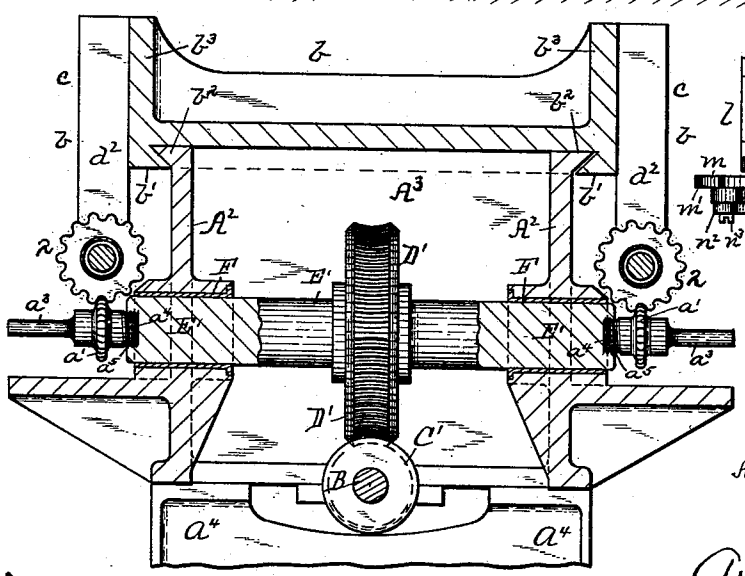


Fig. 6.

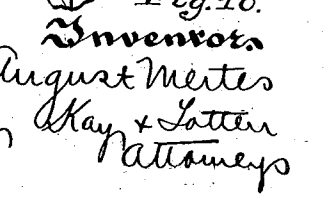


Fig. 10.

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(No Model.) 4 Sheets—Sheet 3.

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GEAR CUTTING MACHINE.

No. 498,720. Patented May 30, 1893.

Fig. 3.

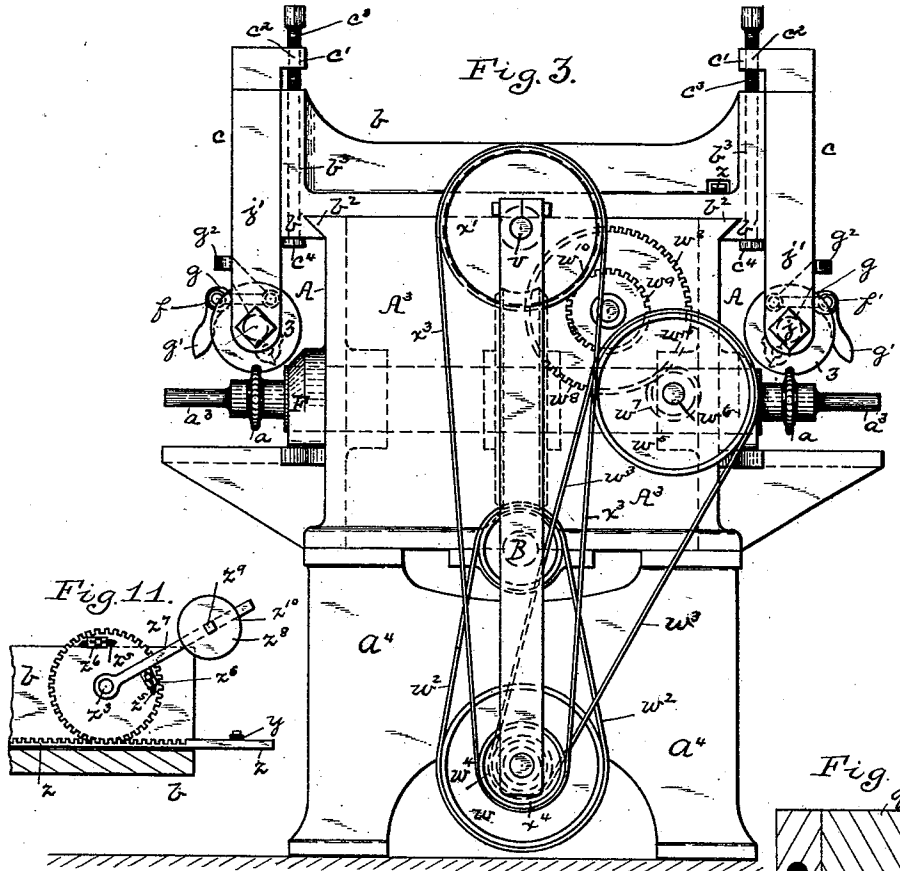
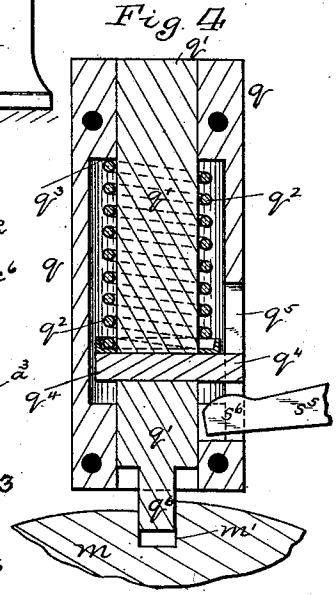


Fig. 11.

Fig. 4



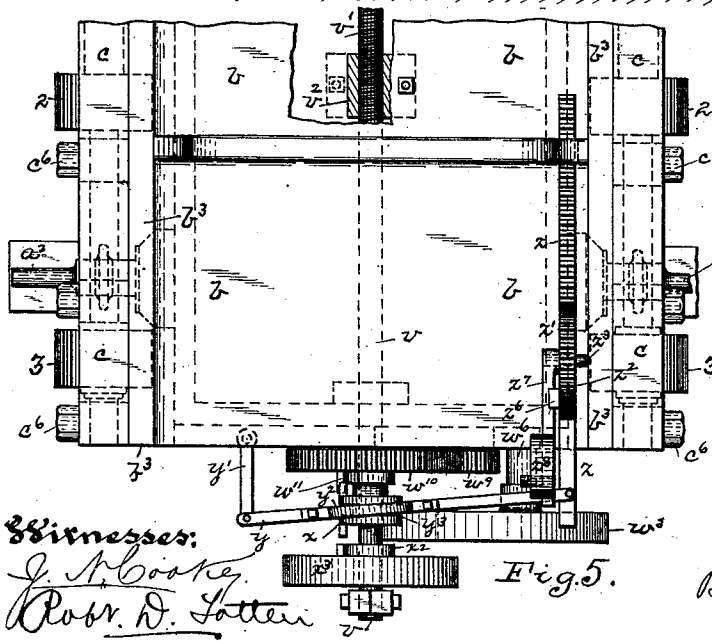


Fig. 5.

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GEAR CUTTING MACHINE.

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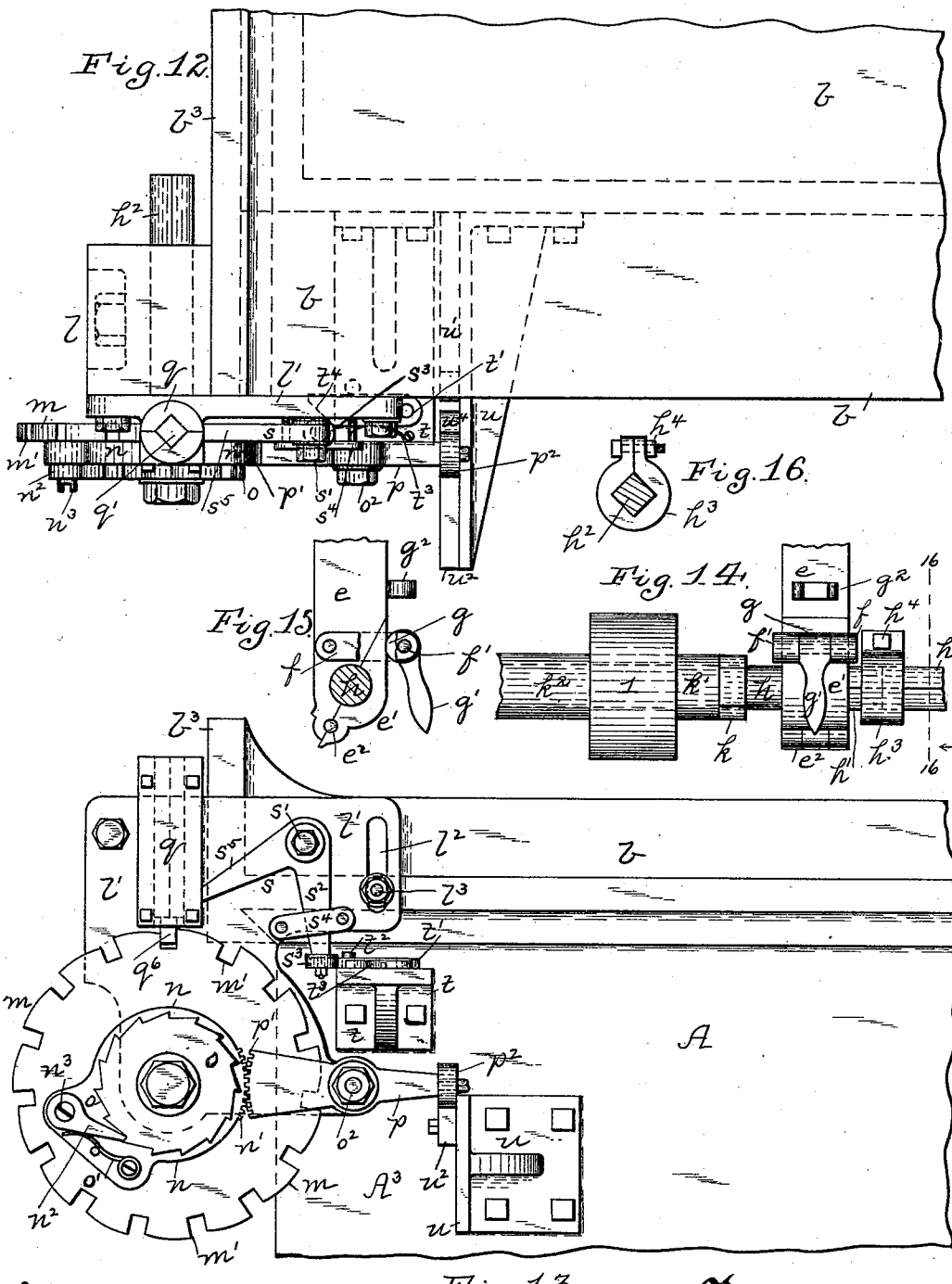

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UNITED STATES PATENT OFFICE.

AUGUST MERTES, OF ALLEGHENY, PENNSYLVANIA, ASSIGNOR TO THE A. MERTES MANUFACTURING COMPANY, OF SAME PLACE.

GEAR-CUTTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 498,720, dated May 30, 1893.

Application filed January 9, 1892. Serial No. 417,494. (No model.)

To all whom it may concern:

Be it known that I, AUGUST MERTES, a resident of Allegheny, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Gear-Cutting Machines; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to gear cutting machines, its object being to provide a form of apparatus which will have a greater capacity for work than the machines heretofore employed for this purpose, and one in which the cutting of the teeth can be done more accurately.

To these ends my invention consists in certain improvements and combinations of parts, as will be fully hereinafter set forth and claimed.

To enable others skilled in the art to make and use my invention, I will describe the same more fully, referring to the accompanying drawings, in which—

Figure 1 is a side view of my improvement in gear cutting machines. Fig. 2 is a rear end view. Fig. 3 is a front view. Fig. 4 is an enlarged view of the spring teeth which enter the several notches of the index plate. Fig. 5 is a top view of the rear end of the machine. Fig. 6 is a section in part on the line (6—6), Fig. 1. Fig. 7 is a top view of the rear end. Figs. 8 and 9 are detailed top views. Fig. 10 is a detailed perspective view. Fig. 11 is a detailed view of the mechanism for operating the clutch. Fig. 12 is an enlarged top view of the rear end showing the carriage in another position. Fig. 13 is an enlarged rear end view. Figs. 14 and 15 are enlarged detail views; and Fig. 16 is a sectional view of the shaft on the line 16—16, Fig. 14.

Like letters and figures indicate like parts in each view.

The frame A may be of any suitable construction, comprising the sides A^2, the end pieces A^3, and the standards A^4. The power shaft B is journaled in suitable bearings in the ends of the frame A, and has secured to one end thereof the driving pulley B′ adapted to be connected up to a suitable driving shaft by means of the belt B^2. The worms C, C′ and C^2 are secured to the power shaft B at regular intervals, and said worms are adapted to mesh with the worm wheels D, D′ and D^2 respectively. The said worm wheels D, D′ and D^2 are mounted on the cross shafts E, E′ and E^2, which are journaled in the journal boxes F in the sides A^2 of the frame A, said worm wheels being mounted at the mid-point of said cross shafts. The cutters a, a' and a^2 are secured to the cross shafts E, E′ and E^2.

In order to provide for the removal and the insertion of the cutters a, a' and a^2, according as it is desired to cut the gears on different sizes of wheels, the said cutters are secured to the spindles a^3. Said spindles are provided at their inner ends with the screw threads a^4 adapted to engage with the threaded seat a^5 in the cross shafts E, E′, E^2. The sliding carriage b rests upon the frame A, and is provided with the beveled flanges b' adapted to travel along corresponding beveled flanges b^2 on the sides A^2 of the frame A. Any other suitable form of sliding connection between the carriage b and the frame A may, however, be employed.

The plate c, which, for convenience of illustration, will be termed a hanger plate, is secured to the sides b^3 of the carriage b, said hanger plate being adjusted to move up and down on said sides b^3. To provide for this vertical adjustment of the hanger plate c, said hanger plate is provided with the inwardly projecting lugs c', having the screw threaded openings c^2 therein. The screw bars c^3 engage with the threaded openings c^2 of the lugs c', and pass down through the sides b^3, the collars c^4 being secured to the ends of said screw bars. The hanger plate c is formed with the vertical slots c^5, with which the pins or bolts c^6 on the sides b^3 engage, said pins or bolts c^6 having the heads or nuts c^7. It is thus apparent that by turning the threaded bars c^3 in the proper direction, the hanger plate c may be raised or lowered as desired.

Depending from the hanger plate c are the hangers or brackets d, d', d^2. These hangers d, d', d^2, are formed in two sections, the section e being formed integral with the hanger plate c, while the section e' is hinged to the section e at e^2, whereby a partible hanger or bracket is obtained.

In order to close the hangers d, d', d^2, straps

f are pivoted on both sides of the section e as at f'. Journaled in the outer ends of the straps f are the eccentrics g, provided with the handles g'. When the hangers are closed, as shown in Fig. 15, the straps f inclose the section e of said hanger, while the eccentrics g will be forced against the hinged section e', and the two sections will thus be securely locked. A spring clutch g^2 is secured to the hanger plate c above each hanger, said clutch being adapted to receive the handle g' when said handle is raised to open the hanger. The hangers d, d', d^2 form bearings for the reception of the mandrel h which carries the blank gear wheels 1, 2, 3 in which teeth are to be cut.

As the mandrel h carries the blanks, of necessity said mandrel must be capable of being readily removed to withdraw the finished gear wheels and to insert a new set of blanks to be cut. To these ends, the forward end of said mandrel h is formed square in the cross section as at h'. When said mandrel h is in position, said square section h' abuts against the shaft h^2, which is also formed square in the cross section at its inner end, and said mandrel h and shaft h^2 are adapted to be connected by any suitable coupling sleeve such as h^3, which may be tightened or released by turning the screw bolt h^4. The shaft h^2 beyond the square portion thereof is circular in form and is journaled in the bracket l depending from the hanger plate c, and said shaft carries at its forward end certain indexing mechanism, as will more fully hereinafter appear. The rear end of the mandrel h is held in place by means of the bolt j which passes through the abutment plate j' which depends from the hanger plate c. The bolt j is threaded and said thread is adapted to engage with the threaded openings in the abutment plate j'. The inner end of said bolt j is adapted to abut against the end of the mandrel h, a jam nut j^2 being interposed between the head of said bolt and the abutment plate j'. In this manner when the mandrel h is in place by tightening the bolt j, the inner end thereof is forced against the end of the shaft h^2, and acts to hold said mandrel against any longitudinal movement during the cutting operation. The mandrel h may thus be readily removed and again adjusted to place to hold the blanks in the proper alignment for the cutting of the teeth in said blanks.

In order to hold the blanks at proper intervals upon the mandrel h, said blanks are separated in the following manner: A nut k is secured on said mandrel and between said nut and the blank 1 is the tubular section k'. Between said blank 1 and blank 2 is another tubular section k^2, and beyond said blank 2 is the collar k^3 interposed between said blank and the hanger d'. The blank 3 is interposed between the collar k^5 and nut k^4. It is thus apparent that by tightening up the nut k the blanks 1 and 2 are held securely in place on said mandrel, and thus prevent any wabbling on the part of said blanks. The same result is obtained by tightening up the nut k^4 which secures the blank 3 in place.

To the front of the bracket l, which depends from the hanger plate c, is bolted or otherwise secured the face plate l'. The shaft h^2 passes through said face plate l', and beyond said plate and secured to said shaft h^2 is the index wheel m.

To provide for the vertical adjustment of the face plate l', said plate is formed with the slot l^2 through which the set screw l^3 securing said plate to the carriage b passes. By this arrangement the plate l' may be raised or lowered as may be desired.

The index wheel m is formed with notches or teeth m' in its periphery, and said notches correspond in number to the number of teeth to be cut in the blanks, so that the index wheels, varying in the number of notches, are to be adjusted on the shaft h^2, according to the number of teeth to be cut in the blanks.

Beyond the index wheel m on the shaft h^2 is the sector plate n which fits loosely on the shaft h^2. This sector plate n is provided with the teeth n' on the inner periphery thereof. A pawl n^2 is pivoted on said sector plate at one side thereof as at n^3, said pawl n^2 being adapted to engage with the teeth of the ratchet wheel o secured to the shaft h^2. The pawl n^2 is held in engagement with the teeth of said ratchet wheel o by means of the spring o'. Pivoted at o^2 to the face plate l' is the sector arm p, said sector arm having the teeth p' adapted to engage with the teeth of said sector plate n. The opposite end of the sector arm p is provided with the idle roller p^2.

Directly above the index wheel m, and secured to the sliding carriage b, is the vertical guide q within which the detent q' fits and is adapted to move up and down therein. A spring q^2 is interposed between the shoulders q^3 within said guide q and the collar q^4 on the detent q'. The slot q^5 is formed in the side of said guide q. The lower end of said detent q' is provided with the finger q^6 which extends below the guide q and is adapted to enter the several notches m' of the index plate m.

Pivoted at s' to the face plate l' is the bell crank lever s. One arm s^2 of said bell crank lever s is provided with the idle roller s^3 fitted on the end thereof. A strap s^4 secured to the face plate l' regulates the distance said arm s^2 is permitted to move. The other arm s^5 of said bell crank lever is provided with the lug s^6 which is adapted to enter the slot q^5 in the guide q, and said lug is further adapted to engage with the collar q^4 on the detent q' when said arm s^5 is raised, as will more fully appear.

In order to operate said arms s^2 and s^5 to raise the detent q', a horizontal bracket or plate t is secured to the stationary frame A, and on said plate is pivoted the arm t'. This arm t' is held against any backward movement by the stud t^2 on the plate t, while the spring t^3 holds said arm firmly in contact with the stud t^2. The arm t' is provided with

the inclined face t^4. As the sliding carriage advances, the idle roller s^3 comes in contact with the arm t', as shown in Fig. 8, when said arm yields to allow said roller to pass, but immediately springs back to place after said roller has passed. On the return of the roller, when the sliding carriage recedes, as will more fully appear, the roller s^3 travels over the inclined face t^4 of the arm t' which will operate to raise the arm s^5, and consequently the detent q'.

A bracket u is secured to the front of the frame A, and secured to that bracket u are guide strips u', u^2, the guide strips u' being slightly above the guide strips u^2. The guide strips u', u^2 are formed with the end faces inclined as in u^3 and u^4 respectively. The idle roller p^2 of the sector arm p moves in contact with the lower face of the guide strip u', and the upper face of the guide strip u^2 as the sliding carriage advances and recedes, as fully shown in Figs. 9, 10, 12 and 13, in order to operate the index wheel m, as will more fully appear in the description hereinafter set forth.

In order to feed forward the sliding carriage b, a screw shaft v is journaled in the frame A, the threaded portion v' of said screw shaft engaging with a nut v^2 on said sliding carriage b, whereby when said screw shaft is turned in said nut in the proper direction, the sliding carriage b is advanced. The power to rotate this screw shaft v for the advance of the carriage b is obtained indirectly from the main shaft B. The shaft B is connected to the pulley w on the shaft w' by means of the belt w^2. A belt w^3 connects the pulley w^4 on said shaft w' with the pulley w^5 on the stud w^6, while a pinion w^7 on said stud meshes with the gear wheel w^8. This gear wheel w^8 has secured thereto the pinion w^9 which meshes with the gear wheel w^{10} on the screw shaft v. This gear wheel w^{10} is not secured to the screw shaft v, but is fitted loosely thereon, and is provided with the clutch face w^{11}. A clutch x is provided with a groove engaging a feather on the screw shaft v and adapted to slide to and fro thereon. A pulley x' runs loosely on the outer end of said screw shaft v and said pulley x' is furnished with a suitable clutch face x^2. A belt x^3 connects said pulley x' with the pulley x^4 on the shaft w'. When the clutch x is in engagement with the clutch face w^{11}, the carriage will be advanced, and when the clutch x is in engagement with the clutch face x^2, the carriage recedes.

The clutch x is shifted from one to the other of said clutch faces w^{11} and x^2 by the following form of mechanism. A lever y is pivoted at one end thereof to an arm y' extending out from the frame A. The lever y is furnished with a collar y^2 adapted to engage with the annular groove y^3 on said clutch x. The outer end of the lever y is secured to the rack z which rests on the sliding carriage b and fits in suitable guides thereon but does not move with the sliding carriage b. The rack z is adapted to slide in the guides on the said carriage. A wheel z' provided with teeth z^2 on all or a part of its periphery is journaled on a stud z^3 on the sliding carriage b. The teeth z^2 of said wheel z' are adapted to engage with the rack z. The wheel z' is formed with the slots z^5 and within said slots are secured the stops z^6, said stops being adapted to be adjusted at different points within said slots. An arm z^7 carrying the weight z^8 is mounted loosely on the stud z^3. The weight z^8 is adjustable on the arm z^7 by means of the set screw z^9 and the slot z^{10} in said weight. As the carriage advances the clutch x will be in engagement with the clutch w^{11}, and since the toothed wheel z' is mounted loosely on the stud z^3 on the sliding carriage, it is evident that the toothed wheel z' will revolve, the rack z remaining stationary. The weighted lever z^7 being mounted loosely on the same stud as the wheel z', upon the revolution of said wheel as the carriage advances the weighted lever will be carried through the arc of the circle described by the rotation of the wheel z'. When the weighted lever z^7 has passed the center of gravity, it will fall of its own weight, striking the stop z^6. This sudden falling of the weighted lever z^7 on the stop z^6 will impart a quick turn to the wheel z'. This sudden movement imparted to the wheel z' with its teeth engaging the rack z will act to throw back said rack z a sufficient distance to throw the clutch x out of engagement with the clutch face w^{11}, and into engagement with the clutch face x^2. The carriage b will then recede to its former position with relation to the frame A. Any other suitable form of mechanism for advancing the sliding carriage or withdrawing the same may be employed.

The operation of my improved gear cutting machine is as follows: I have illustrated my invention in connection with a machine capable of cutting six blanks, three on each side, at one time. It is apparent, however, that machines embodying the same principles of construction could be constructed to have a greater or less capacity. The blanks 1, 2, 3, of the desired size, are arranged in the manner described and as shown in Fig. 1, on the shafts h, said shafts being locked in the hangers d, d', d^2 by means of the eccentrics g, while the bolt j is tightened to press against the end of said shaft h to retain said shaft against longitudinal movement. An index wheel m has been adjusted on the shaft h^2 with a number of teeth corresponding to the number of teeth to be cut in the blanks 1, 2, 3. The hanger plate c is adjusted at the proper height by means of the screw bars c^3, so that the blanks 1, 2, 3 may be held at proper height with relation to the cutters a, a', a^2, in accordance with the desired depth of the cut. The cutters a, a', a^2 are so adjusted on the spindles a^3 that the teeth of each pair of cutters break joint with each other, that is, the teeth of the cutter on one end of one of the cross shafts

will coincide with the interdental spaces on the cutter at the opposite end of said cross-shaft. By this arrangement of the cutters, as the tooth of one cutter strikes the work, the corresponding tooth of the cutter on the opposite end of the shaft is just advancing to strike the blank on that side, so that the cutters work alternately and thus produce smoother work. The blanks and cutters having been arranged in the manner described, power is applied to rotate the main shaft B, which through the worms C, C′, C² engaging with the worm wheels D, D′, D², acts to rotate the cross-shafts E, E′, E². In this manner the cutters a, a', a^2 are driven. Meanwhile, the screw shaft v is rotated by the power transmitted from the main shaft B through the connections hereinbefore decribed, the clutch x being in engagement with the clutch face w^{11} on the gear wheel w^{10}. As the carriage b advances, the blanks 1, 2, 3 are brought into contact with the cutters a, a', a^2 when the cutting operation begins. During the advance of the sliding carriage b, the idle roller a^3 at the extremity of the arm s^2 overcomes the resistance of the spring arm t' and passes said arm which springs back to its normal position. The roller p^2 of the sector arm p, as the carriage advances, moves along in contact with the lower face of the strip u' and thence up the inclined faces u^3, u^4 and along the upper face of the strip u^2. As soon as the roller p^2 travels up the inclined faces u^3, u^4 it is apparent that the end of the sector arm p carrying the roller p^2 will be raised. This movement of the sector arm p will act, through the teeth on said arm engaging with the teeth of the sector plate, n, to turn the sector plate n a sufficient distance to bring the pawl n^2 pivoted to said sector plate into engagement with the next succeeding tooth on the ratchet wheel o. In the meantime, as the sliding carriage b advances, the wheel z' has been making part of a revolution with its teeth z^2 meshing with the rack z. The several parts have been so adjusted previous to the commencement of the cutting operation that just as soon as the cutters a, a', a^2 have completed the respective teeth on the blanks brought into contact with them, the wheel z' will have turned sufficiently to carry the weighted arm z^7 beyond the center of gravity. The falling of the weight toward the forward end of the machine will throw back the rack z and with it the clutch x into engagement with the clutch face x^2. As the pulley x' rotates in the opposite direction to that of the gear wheel w^{10}, this engagement of the clutch x with the clutch face x^2 will reverse the rotation of the screw shaft v and cause the sliding carriage to recede. When the carriage b begins to recede, the rollers p^2 and s^3 on the ends of the sector arm p and arm s^2 respectively recede with it. The roller p^2 recedes along the upper face of the guide strip u^2, and when said roller begins its descent down the inclined face u^4, the roller s^2 will have traveled over the inclined face t^4. The descent of the roller p^2 down the inclined face u^4 and thence along the lower face of the guide strip u' will lower the inner end of the sector arm p and consequently raise the end in engagement with the sector plate n to its normal or horizontal position, as shown in Fig. 3. The raising of the toothed end of the sector arm p to its horizontal position will impart a contrary movement to said sector plate to that imparted when the said sector arm ascended said inclined face u^4 during the advance of the carriage. This will cause the pawl n^2 which engages with the ratchet wheel o to turn said ratchet wheel and with it the index wheel m. The descent of the roller p^2 down the inclined face u^4 occurs after the roller s^3 has traveled over the inclined face t^4 of the arm t', as stated. As the roller s^3 meets said inclined face t^4, the arm s^2 of the bell crank lever s will be thrown toward the index wheel m, and the other arm s^5 of said bell crank lever will be raised. By this action on the part of said bell crank lever the arm s^5 will raise the detent q' in the guide q and release the finger q^6 from engagement with the index wheel m. The movement imparted to the index whheel m is sufficient to bring the next tooth in position to be engaged by the finger q^6. After the roller s^3 on the arm s^2 of the bell crank lever s has traveled over the inclined face t^4 of the arm t' and has passed beyond the same, the force of the spring q^2 will act to press down the detent q' and throw out the arm s^5 of the bell crank lever s hitherto in engagement with said detent. The finger q^6 is then free to engage with the next succeeding tooth of the index wheel m, and in case said tooth has not already reached the point to be engaged by said detent q', said detent will rest upon the periphery of said index wheel, the spring q^2 always forcing down said detent to allow it to drop into the next succeeding tooth of said index wheel when it has arrived at the proper point. It is, of course, apparent that as the index wheel m turns, the shaft h carrying the blanks 1, 2, 3 will also turn a like amount. In this manner the blanks are turned a sufficient distance to provide for the distance between the several teeth to be formed in said blanks.

By having the worm wheels D D′ and D² mounted on the cross shafts E E′ E² at the mid points thereof, the power is evenly distributed and the strain on the cutters is relieved while they also receive a more positive movement.

It is apparent from the construction shown and described that the several adjustable parts may be arranged to provide for the cutting of different sized gear wheels, as well as for different depths of teeth.

By having the spindles provided with cutters at each end, the cutting is even and regular.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In gear cutting machines, the combina-

tion with a suitable frame of one or more revolving spindles carrying cutters, a reciprocating carriage, a hanger plate vertically adjustable on said carriage, and partible hangers on said hanger plate adapted to support a mandrel carrying blanks, and mechanism for turning said mandrel to bring said blanks into position for the next succeeding tooth, substantially as and for the purposes set forth.

2. In gear cutting machines, the combination with a suitable frame of one or more revolving spindles carrying cutters, a reciprocating carriage, a hanger plate vertically adjustable on said carriage, partible hangers on said hanger plate, and means for locking therein a mandrel carrying blanks, and mechanism for turning said mandrel to bring said blanks into position for the next succeeding tooth, substantially as and for the purposes set forth.

3. In gear cutting machines, the combination with a suitable frame of one or more revolving spindles carrying cutters, a reciprocating carriage, a hanger plate vertically adjustable on said carriage, hangers on said hanger plate adapted to support a mandrel carrying blanks and a shaft in line therewith connected thereto, an index wheel on said shaft, and mechanism for turning said index wheel whereby said shaft is turned to bring the blanks on said mandrel into position for the next succeeding tooth, substantially as and for the purposes set forth.

4. In gear cutting machines, the combination with a suitable frame of one or more revolving spindles carrying cutters, a reciprocating carriage supporting a mandrel carrying blanks and a shaft in line therewith connected to said mandrel, an index wheel upon said shaft, a detent engaging with said index wheel, and mechanism for raising said detent and turning said index wheel, substantially as and for the purposes set forth.

5. In gear cutting machines, the combination with a suitable frame of one or more revolving spindles carrying cutters, a reciprocating carriage supporting a mandrel carrying blanks and a shaft connected to said mandrel, an index wheel on said shaft, a sector plate beyond said index wheel, the said sector plate having a pawl adapted to engage with a ratchet wheel on said shaft, and mechanism for turning said sector plate, substantially as and for the purposes set forth.

6. In gear cutting machines, the combination with a suitable frame of one or more revolving spindles carrying cutters, a reciprocating carriage supporting a mandrel carrying blanks and a shaft connected to said mandrel, an index wheel on said shaft, a sector plate beyond said index wheel, said sector plate having a pawl adapted to engage with a ratchet wheel on said shaft, an arm on said carriage adapted to engage with said sector plate, and means for operating said arm to turn said sector plate, substantially as and for the purposes set forth.

7. In gear cutting machines, the combination with a suitable frame, of one or more revolving spindles carrying cutters, a reciprocating carriage supporting a mandrel carrying blanks and a shaft connected to said mandrel, an index wheel on said shaft, a sector plate beyond said index wheel, said sector plate having a pawl adapted to engage a ratchet wheel on said shaft, a toothed arm pivoted to said carriage and adapted to engage with teeth on said sector plate, and means for operating said arm to turn said sector plate, substantially as and for the purposes set forth.

8. In gear cutting machines, the combination with a suitable frame, of one or more revolving spindles carrying cutters, a reciprocating carriage supporting a mandrel and a shaft connected to said mandrel, an index wheel on said shaft, a sector plate beyond said index wheel, said sector plate having a pawl adapted to engage a ratchet wheel on said shaft, a toothed arm pivoted to said carriage and adapted to engage with teeth on said sector plate, the opposite end of said arm engaging with suitable guides whereby said arm is raised and lowered, substantially as and for the purposes set forth.

9. In gear cutting machines, the combination with a suitable frame, of one or more revolving spindles carrying cutters, a reciprocating carriage supporting a mandrel and a shaft connected to said mandrel, an index wheel on said shaft, a sector plate beyond said index wheel, a pawl on said sector plate adapted to engage with a ratchet wheel on said shaft, a toothed arm pivoted to said carriage and adapted to engage with teeth on said sector plate, the opposite end of said arm carrying a roller, and guide strips on the frame with which said roller engages and which act to raise and lower said arm, substantially as and for the purposes set forth.

10. In gear cutting machines, the combination with a suitable frame, of one or more revolving spindles carrying cutters, a reciprocating carriage supporting a mandrel and a shaft connected thereto, an index wheel on said shaft, a detent on said carriage adapted to engage with teeth on said index wheel, a bell crank lever pivoted to said carriage, one arm thereof adapted to engage said detent, the other arm thereof being adapted to engage with an arm on the stationary frame, whereby the first mentioned arm of said bell-crank lever is adapted to raise said detent, substantially as and for the purposes set forth.

11. In gear cutting machines, the combination with a suitable frame, of one or more revolving spindles carrying cutters, a reciprocating carriage supporting a mandrel and a shaft connected thereto, an index wheel on said shaft, a detent on said carriage adapted to engage with teeth on said index wheel, a bell crank lever pivoted to said carriage, one arm thereof adapted to engage said detent, the other arm thereof being adapted to engage with an arm on the stationary frame,

said arm having an inclined face, whereby the first mentioned arm of said bell crank lever is adapted to raise said detent, substantially as and for the purposes set forth.

12. In gear cutting machines, the combination with the frame A, of the spindles a^3, the reciprocating carriage b, the mandrel h and shaft h^2, the index wheel m, the sector plate n, the pawl n^2 adapted to engage the ratchet wheel o, the toothed arm p pivoted to said carriage and adapted to engage with said sector plate, the roller p^2, the guide strips u', u^2 on the frame A with which said roller engages, substantially as and for the purposes set forth.

13. In gear cutting machines, the combination with the frame A, of the spindles a^3, the reciprocating carriage b, the mandrel h and shaft h^2, the index wheel m, the detent q', the bell crank lever s, the arm s^5 thereof adapted to engage the detent q', the other arm s^2 adapted to engage the arm t', said arm having the inclined face t^4 and being pivoted to the frame A, the stud t^2 and the spring t^3, substantially as and for the purposes set forth.

14. In gear cutting machines, the combination with a suitable frame, of one or more spindles carrying cutters, a carriage on said frame carrying the blanks to be cut, a revolving screw shaft engaging with a nut on said carriage, a gear wheel mounted loosely on said screw shaft and a pulley adapted to rotate in the opposite direction, and a clutch on said shaft adapted to be thrown into engagement with said gear wheel and pulley to impart a reciprocating movement to said carriage, substantially as and for the purposes set forth.

15. In gear cutting machines, the combination with a suitable frame, of one or more spindles carrying cutters, a carriage on said frame carrying the blanks to be cut, a revolving screw shaft engaging with a nut on said carriage, a gear wheel mounted loosely thereon and a pulley adapted to rotate in the opposite direction, a clutch on said shaft, a lever engaging therewith, said lever being connected to a rack adapted to slide to and fro on said carriage, a pinion mounted loosely on a stud on said carriage and engaging with said rack, a weighted lever pivoted to said stud, and stops on said pinion with which said lever engages, substantially as and for the purposes set forth.

16. In gear cutting machines, the combination with the frame A, of the revolving spindles a^3, carrying the cutters a, a', a^2, the carriage b, a revolving screw shaft v engaging with the nut v^2, the gear wheel w^{10}, the pulley x', the clutch x, the clutch faces x^2, w^{11}, the lever y connected to the rack z, the pinion z' the weighted lever z^7, the stops z^6 on said pinion, substantially as and for the purposes set forth.

In testimony whereof I, the said AUGUST MERTES, have hereunto set my hand.

AUGUST MERTES.

Witnesses:

ROBT. D. TOTTEN,

J. N. COOKE.