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W. SELLERS & J. S. BANCROFT.

PLANING MACHINE FOR METALS.

No. 374,908 Fig-4. Patented Dec. 13, 1887.

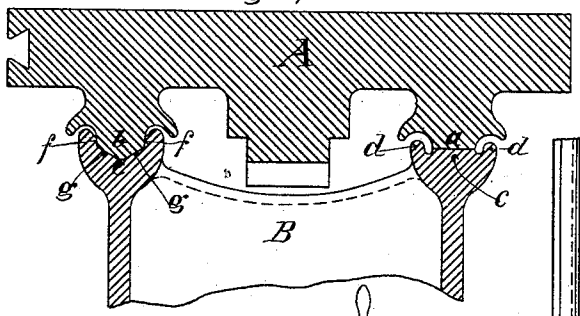
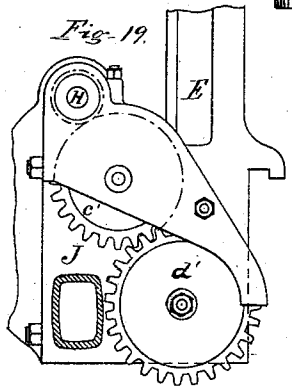


Fig-1.

Fig-19.



Witnesses.

Jas. B. Schwacke

Horace W. Sellers

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Wm. Sellers

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N. PETERS. Photo-Lithographer. Washington, D. C.

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W. SELLERS & J. S. BANCROFT.

PLANING MACHINE FOR METALS.

No. 374,908. Patented Dec. 13, 1887.

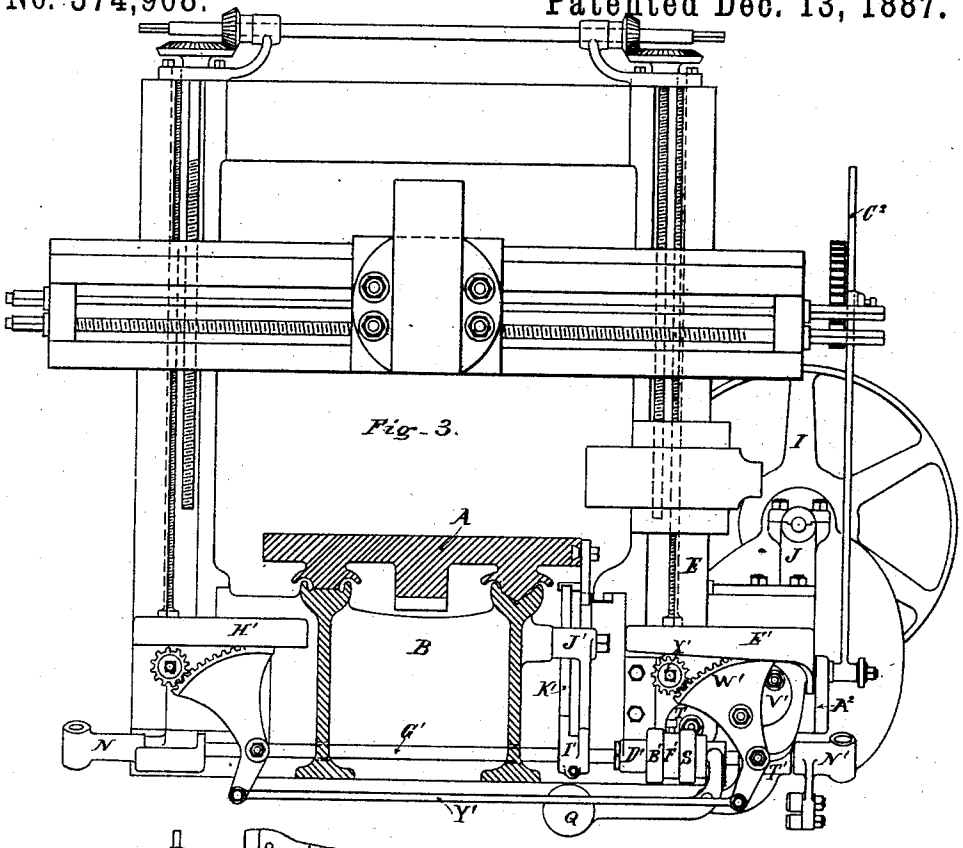


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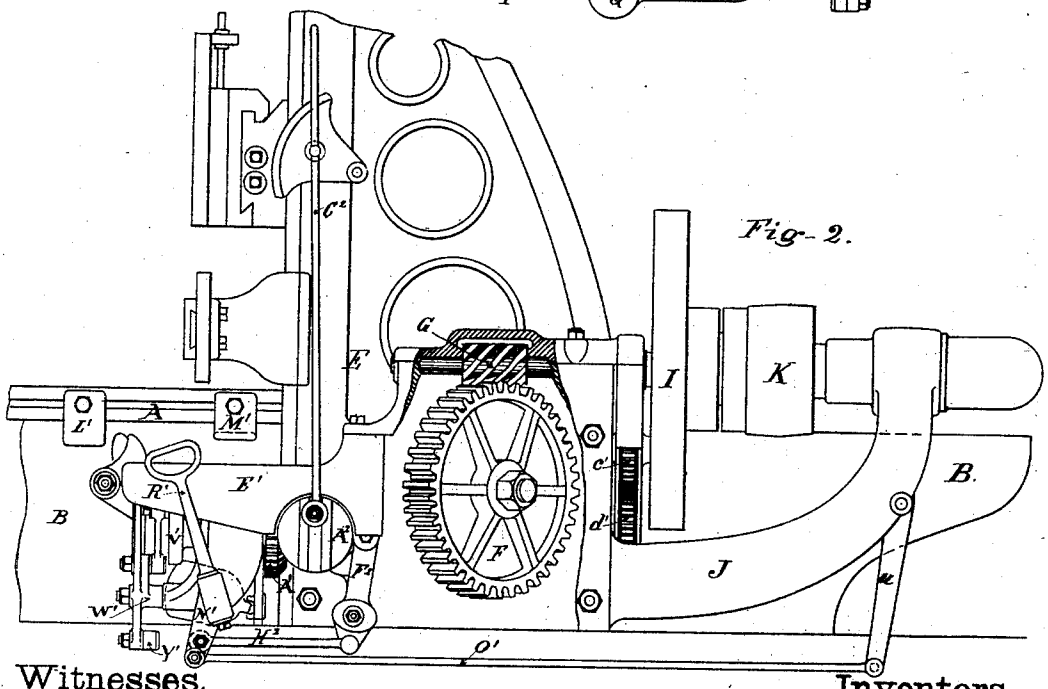


Fig. 2.

Witnesses.

Jas. D. Schnacke

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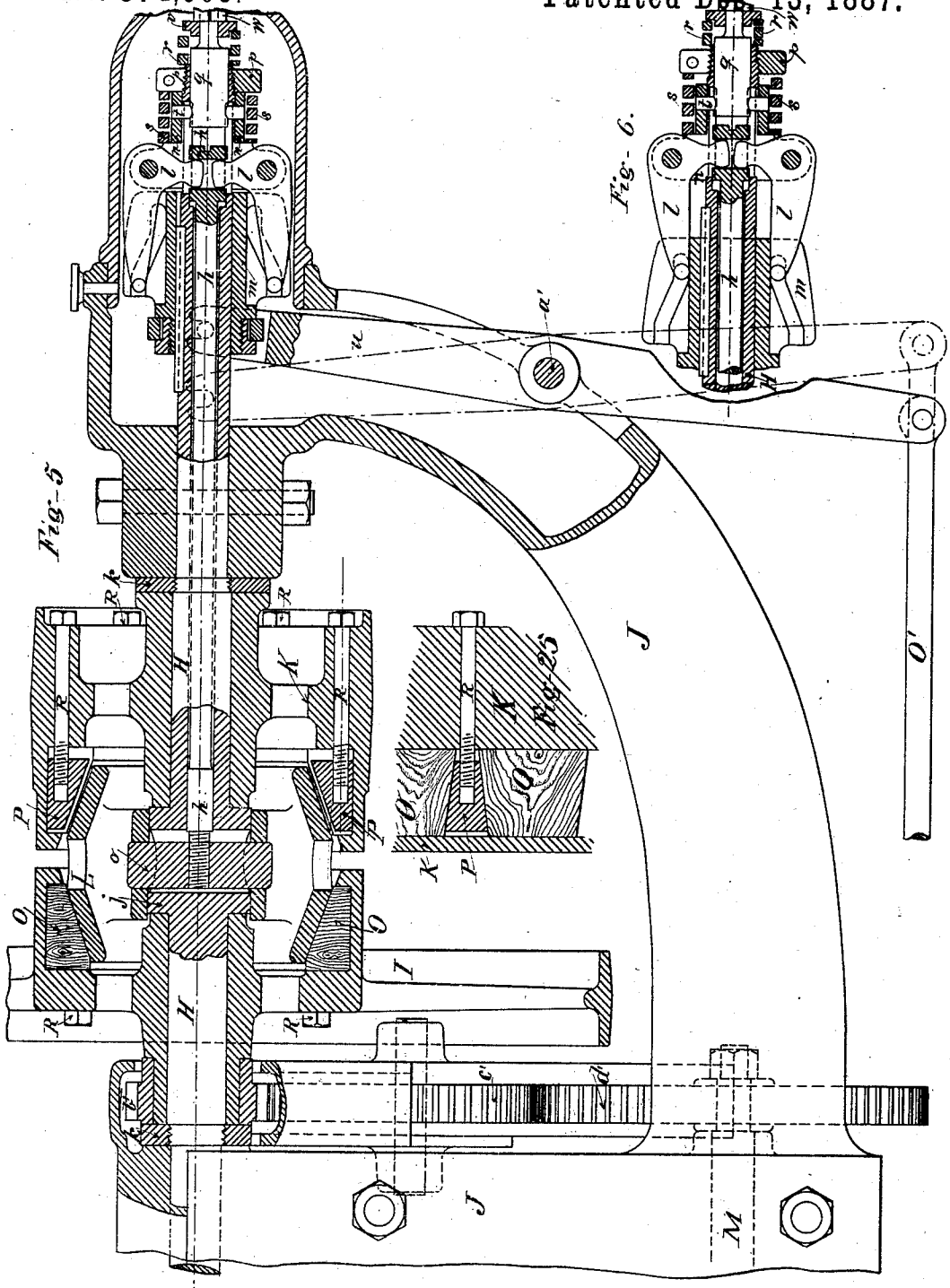
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W. SELLERS & J. S. BANCROFT.

PLANING MACHINE FOR METALS.

No. 374,908. Patented Dec. 13, 1887.



Witnesses.

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(No Model.) 7 Sheets—Sheet 4.

W. SELLERS & J. S. BANCROFT.

PLANING MACHINE FOR METALS.

No. 374,908. Patented Dec. 13, 1887.

Fig. 15

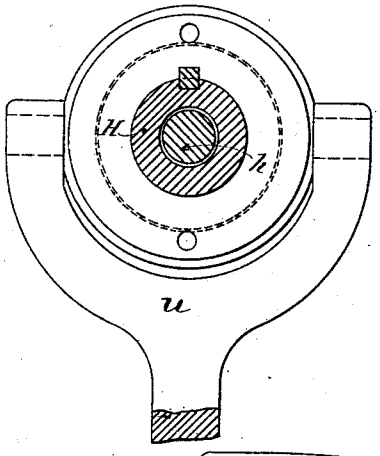


Fig. 13.

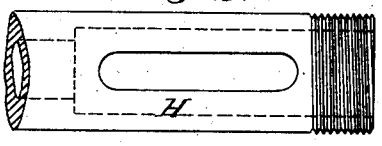


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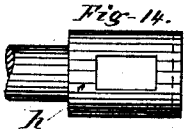


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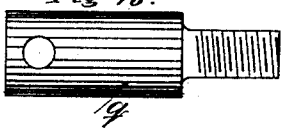


Fig. 7.

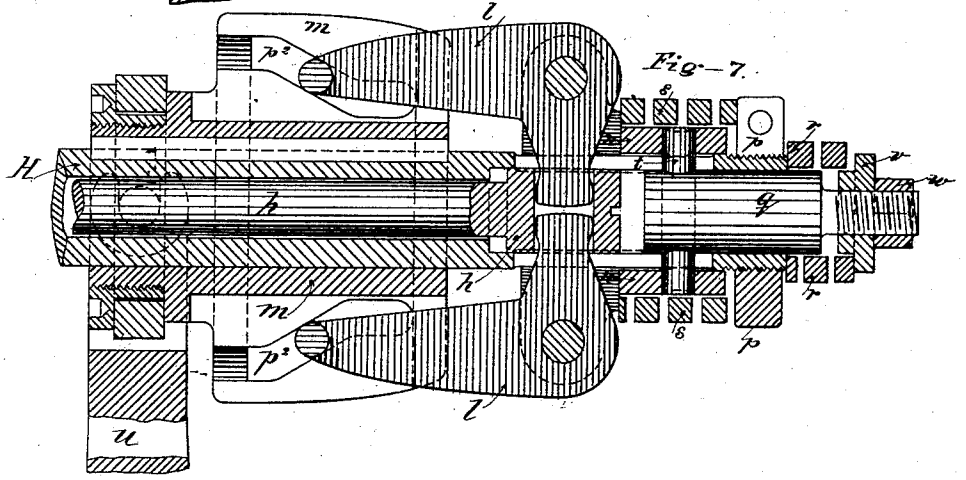
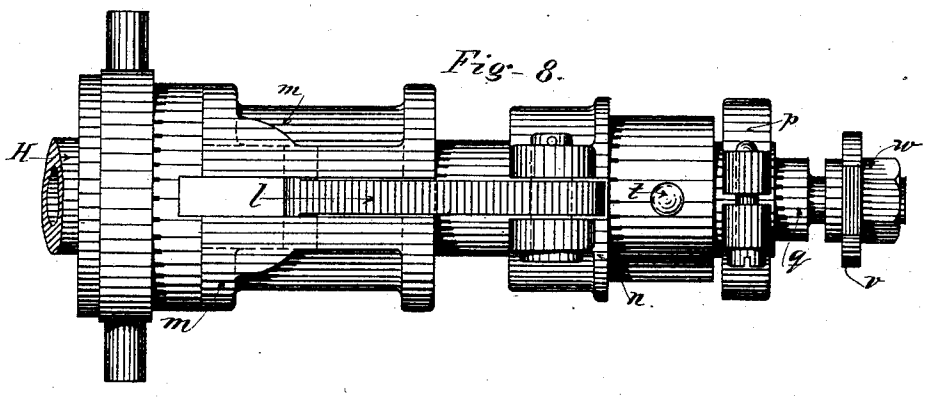


Fig. 8.



Witnesses.

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W. SELLERS & J. S. BANCROFT.

PLANING MACHINE FOR METALS.

No. 374,908. Patented Dec. 13, 1887.

Fig. 10.

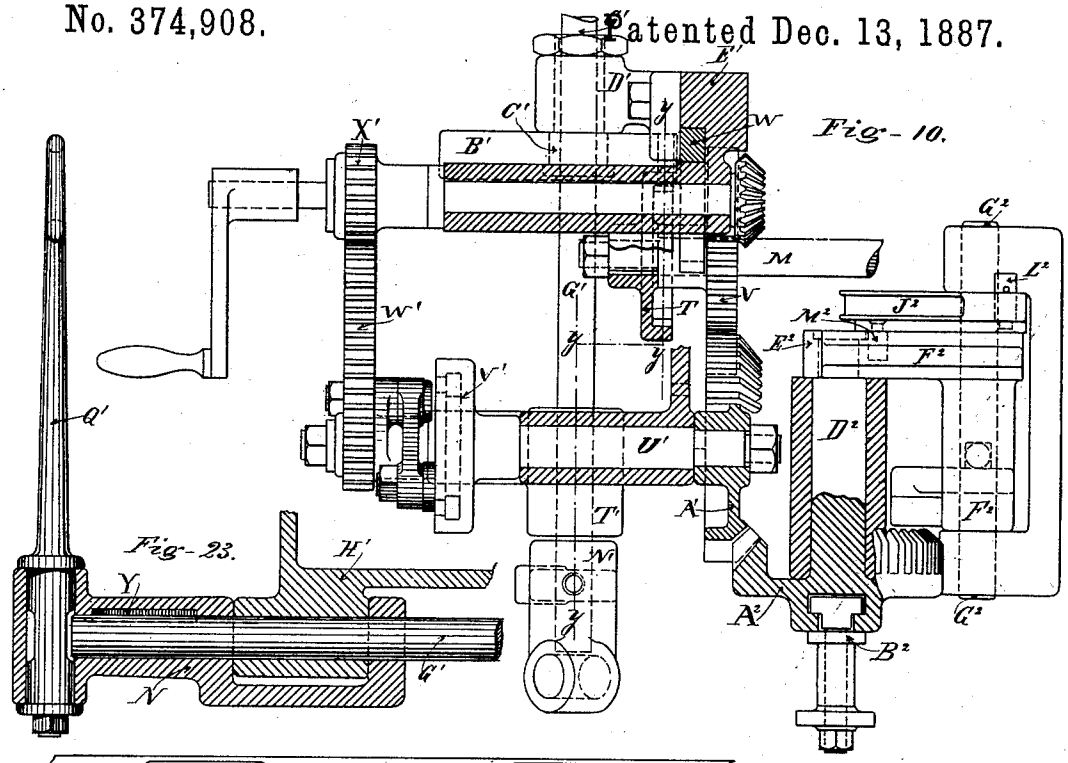


Fig. 23.

Fig. 20.

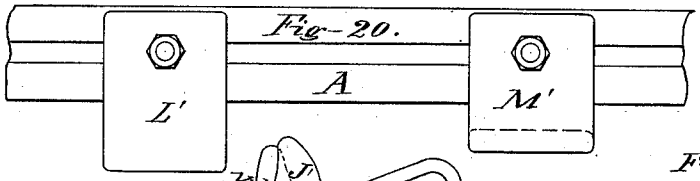


Fig. 9.

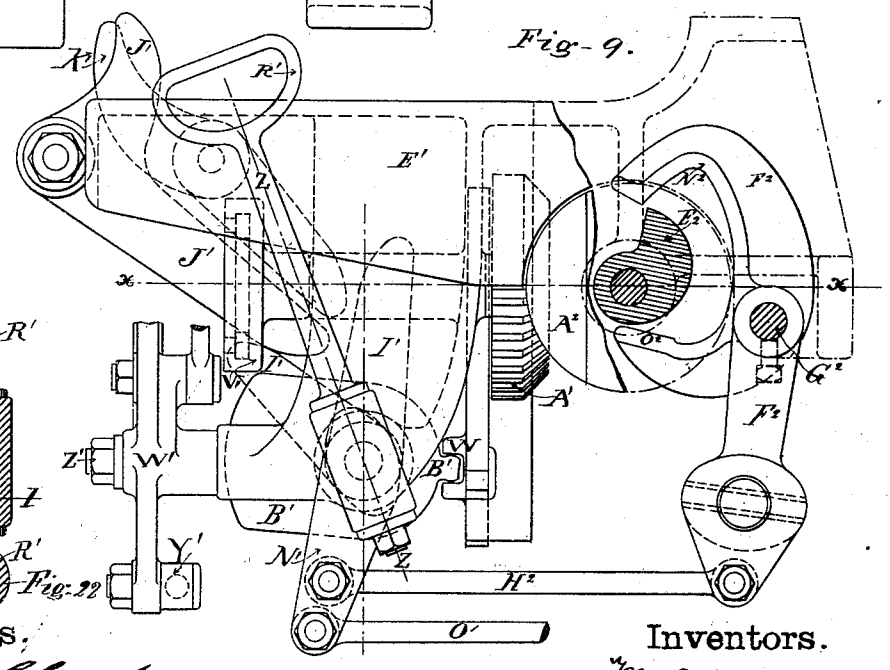


Fig. 21.

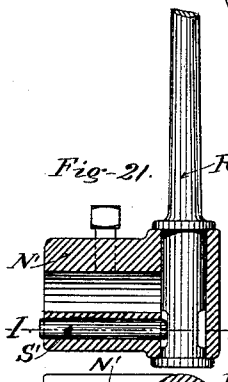


Fig. 22.

Witnesses.

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W. SELLERS & J. S. BANCROFT.

PLANING MACHINE FOR METALS.

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Fig. 11.

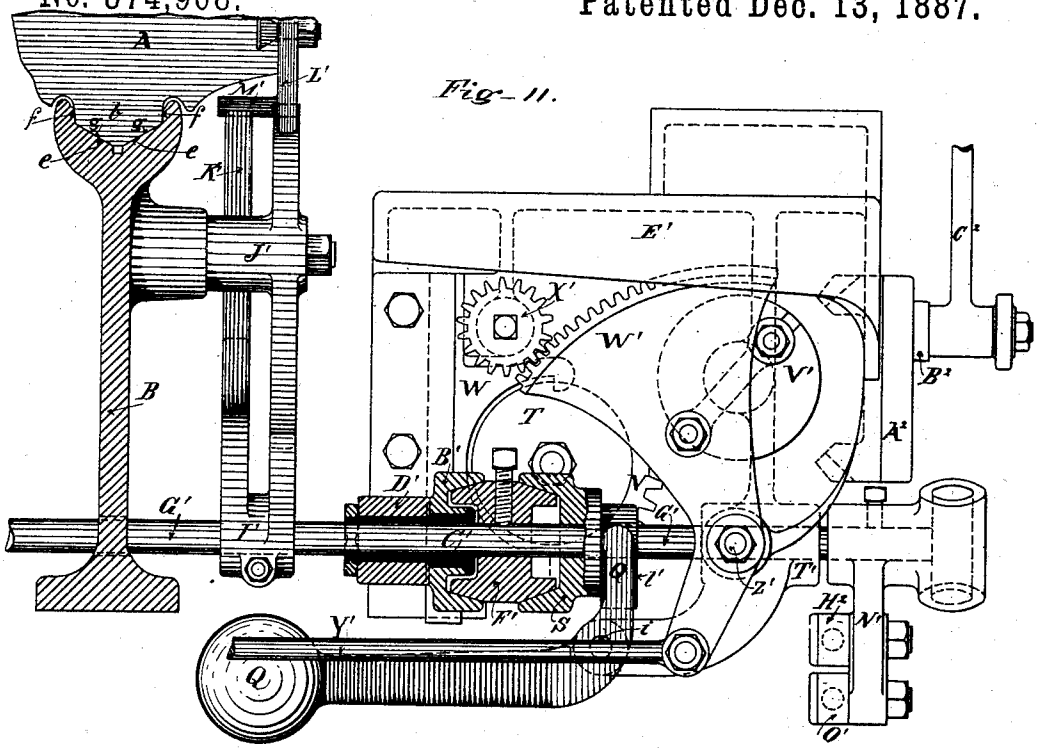
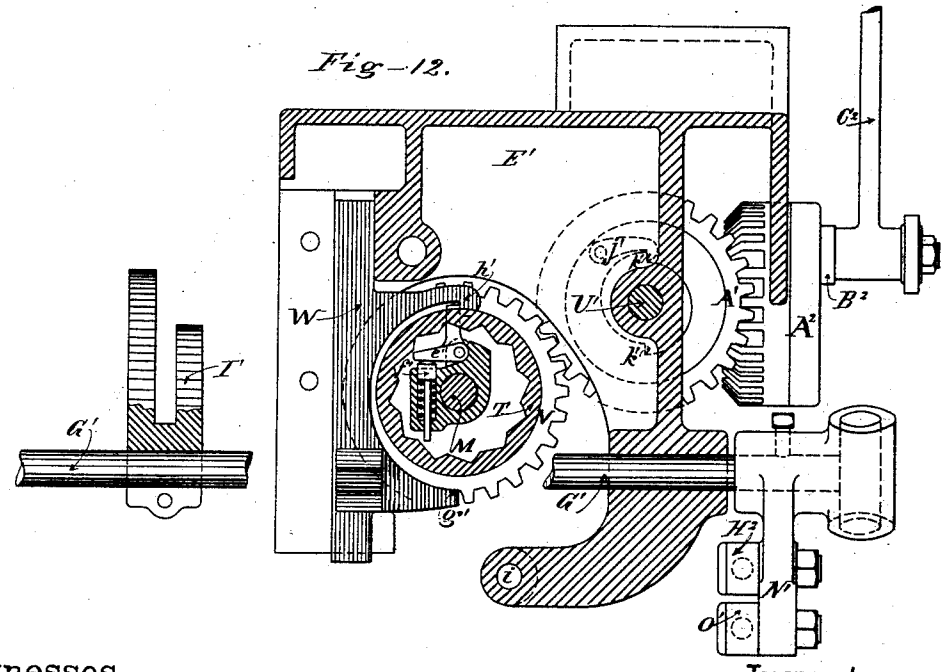


Fig. 12.



Witnesses

Inventors

Wm. Sellers

J. Sellers Bancroft

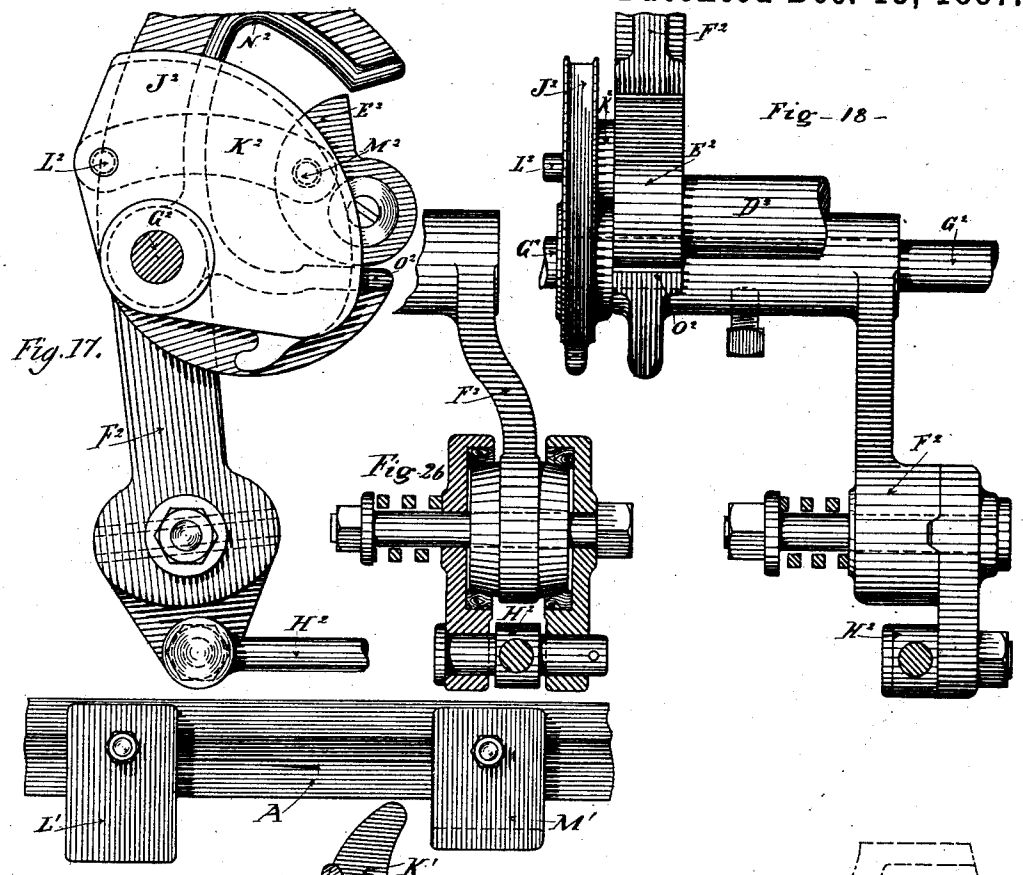
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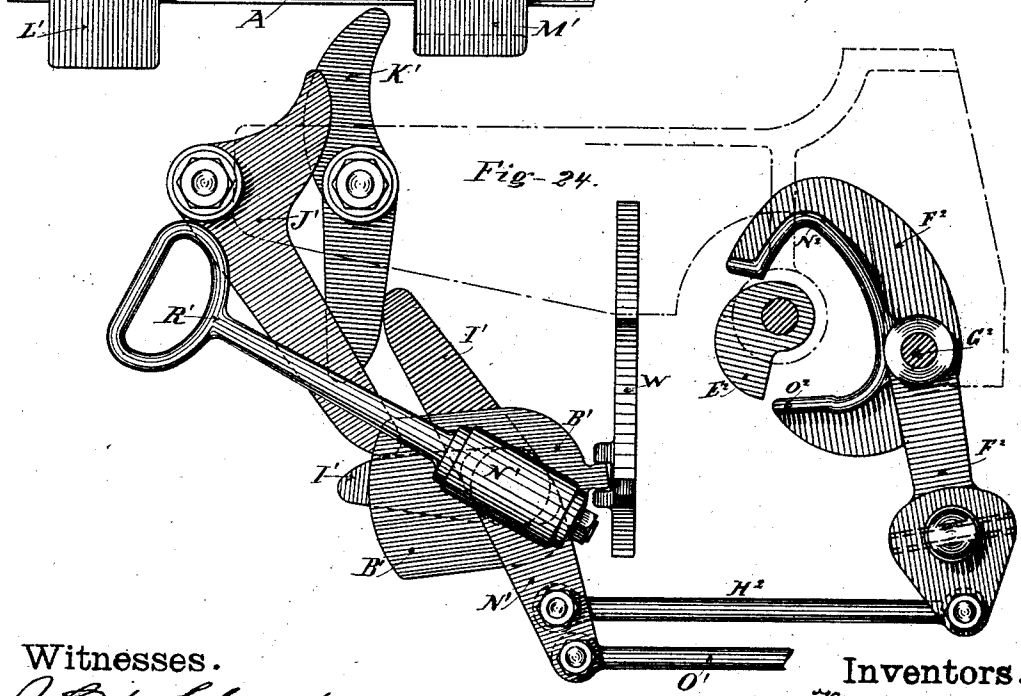
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W. SELLERS & J. S. BANCROFT.

PLANING MACHINE FOR METALS.

No. 374,908. Patented Dec. 13, 1887.





Witnesses.

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UNITED STATES PATENT OFFICE.

WILLIAM SELLERS AND JOHN SELLERS BANCROFT, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNORS TO WILLIAM SELLERS & COMPANY, INCORPORATED, OF SAME PLACE.

PLANING-MACHINE FOR METAL.

SPECIFICATION forming part of Letters Patent No. 374,908, dated December 13, 1887.

Application filed February 14, 1884. Serial No. 120,695. (No model.)

To all whom it may concern:

Be it known that we, WILLIAM SELLERS and JOHN SELLERS BANCROFT, of the city and county of Philadelphia, in the State of Pennsylvania, have jointly invented certain new and useful Improvements in Planing-Machines for Metal; and we hereby declare the following to be a full and exact description thereof, reference being had to the accompanying drawings, which form part of this specification.

Our invention relates to that class of planing-machines in which the metal to be operated upon is mounted upon a table which reciprocates back and forth under a cutting-tool which is fed over the work.

In such planing-machines as heretofore constructed the gearing which transmits the power of the driving-belt to the table produces more or less vibration in the machine, which is communicated to the cutting-tool, the effect of which is exhibited upon the work in the form of wave-lines, called "chatters," at right angles to the motion of the table and of greater or lesser intensity, dependent upon the character of the vibrations, but always visible to the naked eye, so that no planing-machine as heretofore constructed will produce a surface free from these defects, or fit for the better classes of work, without scraping and fitting. In all such planing-machines the speed of the reciprocating table under the cut must be limited by the character of metal the tool is operating upon, and in such machines as heretofore constructed, the reciprocating table being operated directly or indirectly through spur or bevel gearing, the speed of the return-stroke is limited by the capacity of this gearing to resist the shocks which a high velocity would impart, and it is also limited by the necessity of avoiding a very high velocity to the pulley-shaft on the machine, the momentum of the driving-pulleys in such case offering a greater resistance to the reversal of motion at the end of each stroke than is offered by the gearing and the reciprocating table, and it is also limited by the time in which the feed can be effected and the tool raised and lowered when this latter device is employed, these feed and tool-lifting motions having always heretofore been proportioned to the speed of the table, and it is also limited by the shock which would be produced by reversing the motion of the table at a high velocity when the gearing is constructed and operated in the manner heretofore used.

In all planing-machines heretofore constructed the movement of the table, in addition to that required for the cut, must be sufficient to reverse the driving-motion, to raise and lower the tool, and to effect the feed, excepting only when the forward movement of this latter is effected on the return-stroke of the table. If it is effected on the forward stroke of the table and the movement is not completed before the tool strikes the work, the feed-gearing is liable to be broken; but to effect feeds in two directions from one direction of table movement the gearing which actuates the feed must be reversible. This complicates it, and even if so arranged the operator would probably neglect to change it.

In all such planing-machines heretofore constructed the movement of the table reverses the driving motions to determine the length of the stroke. It is difficult, therefore, to stop the table at either extremity of its movement by manipulating the reversing apparatus, because in these positions this apparatus is more or less under the control of the table. The feed-gearing and the tool-lifting device, when this latter is employed, are connected directly to the table or to the gearing which actuates it, so that these movements can only take place while the table is in motion, and they are effected automatically either just before or just after the reversal of the table movement. If the operator desires to reverse the motion of the table while under cut, he must first throw the feed-pawl out of gear to avoid doubling the feed on the unfinished cut when automatic action is resumed, and if he throws this pawl out of gear it cannot be replaced so as to continue the original cut, and a mark upon the work is sure to occur. The belt-shifting and feeding devices in these machines have heretofore been placed upon one side, so that it is necessary for the operator to work the machine from that side in order to control these movements at will; but frequently occasions arise in which it is almost indispensable for

the operator to be upon the opposite side. This is always inconvenient and is sometimes attended with risk to the machine or to the work. The reciprocating table in these machines has heretofore been supported upon the bed in a variety of ways; but the form usually adopted is that of a V-guide in the bed and the converse of it upon the table, the angle of these V-guides being such that the weight of the table and its work will be sufficient to maintain it in position against ordinary lateral strains from the cutting-tool. Two of such guides upon the bed and two upon the table are almost universal; but some of the older machines were provided with one V-guide and one flat. Certain classes of work under cut have a tendency to lift the table and slide it sidewise in its guides. To prevent this the angle of the guides must be very sharp, which involves a great increase of friction. A compromise has heretofore been resorted to in the use of a more obtuse-angled guide, which would permit sliding under unusual side strain, but sufficient in most cases to retain the table in position, and for extreme cases a lighter cut must be resorted to. To avoid this diminution of work machines have been constructed with horizontal and vertical guides, and this involves the use of a shoe to compensate for wear upon the vertical sides, and this again to the adjustment of this shoe by the workman. If he sets up the shoe too tight at one end, unequal wear and loss of alignment must result, which destroys the value of the machine, and practically it is impossible to avoid this with this form of guide.

It is the object of our invention to operate the reciprocating table of these planing-machines by gearing which shall communicate the necessary movement without shock or jar, so that the quality of the work will be improved and no chatters will be produced, while the speed of the return-stroke may be increased, whereby a corresponding increase in quantity will result.

It is a further object of our invention to provide such machines with driving-pulleys which shall always run in opposite directions, and to connect and disconnect these pulleys and the driving-shaft at the proper times in such manner that the parts in connection with this shaft which have their motion reversed with that of the shaft shall be of the smallest possible diameter and weight, whereby the momentum of these parts will offer the least resistance to the reversal of their motion.

It is a further object of our invention to make use of the table movement for disengaging the driving motion only, and to provide other means for engaging it, so that if the engaging apparatus is thrown out of gear the table must stop at the end of its stroke.

It is a further object of our invention to effect this engaging so that the reversal of motion will take place without shock or jar.

It is a further object of our invention while operating the engaging apparatus automatically at prescribed periods to retain control of it by the operator at all times.

It is a further object of our invention to provide means for controlling the direction of the table movement and the operation of the feeds upon both sides of the machine, so that the operator may stand upon either side, as the exigencies of his work may require, and control the machine with equal facility.

It is a further object of our invention to operate the feeding and tool-lifting devices at a uniform speed, whether the table is moving in one direction or the other.

It is a further object of our invention to effect these movements while the table is at rest or changing its direction of movement.

It is a further object of our invention to provide a guide to support the reciprocating table which shall effectually prevent any side movement of this table with any character of work, and while diminishing the friction will avoid the necessity for any adjustment; and to these ends our invention consists in transmitting the power of the driving-belt to the reciprocating table through a primary system of gearing, consisting of a cogged pinion which has the contact-surfaces of its cogs arranged spirally about its axis, gearing with a cogged wheel which has the contact-surfaces of its teeth in straight lines in the direction of their width, and a corresponding secondary system, which also has a cogged pinion with the contact-surfaces of its cogs arranged spirally about its axis, gearing with the cogs of a rack upon the reciprocating table, which have their contact-surfaces in straight lines in the direction of their width, whereby the necessary movement is communicated to the table without shock or jar, the production of chatters is avoided, and the speed of the return-stroke may be increased, so as to largely increase the quantity of work produced.

It further consists in providing two driving-pulleys which revolve loosely upon the pulley-shaft in opposite directions, and in connecting and disconnecting each pulley and the shaft by means of a double friction-clutch that will not seize, that will release upon the removal of the clamping-pressure, and of the smallest possible diameter that will transmit the power of the belt, and of the lightest construction.

It further consists in providing adjustable stops upon the edge of the table to operate levers upon the side of the bed, through which the table communicates motion to a shifter-shaft connected with the double friction-clutch on the pulley-shaft, so that when the table has traversed the prescribed distance in one direction, one of the stops will come in contact with one of the levers and disengage the clutch from the pulley which is then moving the table, and when it is moving in the opposite direction the other stop will come in contact with the other lever and disengage the clutch from the pulley which is moving the table in that direction but so that motion cannot be

transmitted from the table through this mechanism for re-engaging the clutch with either driving-pulley.

It further consists in providing a shaft operated continuously, in connection with which shaft a device for transmitting and arresting motion is arranged, so that from the continuous motion of this shaft the motion transmitted will be intermittent, and but half a revolution after each intermission, and determining the times when these intermitting movements shall occur by the movement of an escapement-plate operated from the levers through which the table disengages the clutch from the driving-pulleys.

It further consists in providing a cam-shaft which is operated from the device for transmitting and arresting motion, so as to make half a revolution in the same direction whenever the escapement-plate is moved by the levers through which the clutch is disengaged from a driving-pulley, so that the half-revolution of the cam may then re-engage the clutch with the opposite driving-pulley.

It further consists in providing a clutch-connection between this cam and the double friction-clutch on the pulley shaft, so that this clutch-connection will yield upon the occurrence of any undue strain upon the cam.

It further consists in providing an elastic connection between the shifter-shaft and the friction-clutch on the pulley-shaft, so that the tension of this connection may be adjusted for either pulley, whereby the pressure with which this clutch will operate as a brake to retard the motion of the table before it has the power to reverse it and the time during which it so acts may be controlled.

It further consists in connecting this cam-shaft with the feed and the tool-lifting devices, so that the feed and the tool-lifting shall be effected while the table is at rest or changing its direction of movement.

It further consists in so arranging this cam that as it completes its half-revolution it will pass out of gear with the clutch-shifting mechanism, so as to leave this mechanism free from control by the machine.

It further consists in transmitting the motion from the levers to the escapement through a clutch on the shifter-shaft, so that when this clutch is thrown out of gear the escapement will remain at rest, the feed-motions and tool-lifting devices will not be operated, and the automatic movement of the table will cease at the end of its stroke; but the friction-clutch on the pulley-shaft may then be operated through a hand-lever on the shifter-shaft, so as to move the table back and forth, or to control its position upon the bed.

It further consists in arranging the hand-lever on the shifter-shaft so as to throw the escapement-clutch out of gear, so that the same hand-lever may suspend all of the automatic movements, while it will impart motion to the clutch which gives direction to the motion of the table.

It further consists in extending the shifter-shaft across the machine and upon each end of this shaft providing a hand-lever, either of which levers will suspend all of the automatic movements, while it will impart motion to the clutch which gives direction to the motion of the table, so that the operator may have complete control of the machine upon either side of it.

It further consists in providing the bed with a guide to support the reciprocating table, which guide has two surfaces slightly inclined to a horizontal plane to sustain the weight and two other surfaces perpendicular to the same horizontal plane or slightly divergent from this perpendicular to resist the side strains, and in providing the reciprocating table with a guide the converse of that upon the bed.

It further consists in providing the bed and the reciprocating table, respectively, with two guides, one of which has four guiding-surfaces and supports the table both vertically and horizontally, while the other has but one guiding-surface and supports the table in a vertical direction only, whereby the fitting is simplified, undue strains from variations of temperature are avoided, and the friction is reduced to a minimum.

In the accompanying drawings, which form part of this specification, Figure 1, Sheet 1, represents a plan, partly in section, of a planing-machine embodying our present improvements. Fig. 2, Sheet 2, is a side elevation, and Fig. 3 an end elevation, of Fig. 1. Fig. 4, Sheet 1, represents an enlarged section of the bed and table, showing our improved bearing and guiding surfaces. Fig. 5, Sheet 3, is an elevation, partly in section in a vertical plane passing through the center of the pulley-shaft, of the driving-pulleys and clutches and mechanism for shifting the double friction-clutch, shown in gear with the forward-motion pulley. Fig. 6 is a section on the same plane, showing the clutch-shifting levers and cam in position for the back-motion pulley. Fig. 7, Sheet 4, is an enlarged sectional view on the plane of the clutch-shifting levers, showing these levers in their middle position. Fig. 8 is a plan of the parts shown in Fig. 7, with the compensating-springs removed. Fig. 9, Sheet 5, is a side elevation of the feed-motion stand, partly broken away to show the cam for operating the double friction-clutch, the shifter-levers being in position for the forward motion. Fig. 10 is a sectional plan of Fig. 9 on the line X X. Fig. 11, Sheet 6, is an end elevation of Fig. 9. Fig. 12 is a sectional view of Fig. 11 on the line *y y y y* of Fig. 10. Fig. 13, Sheet 4, is an enlarged view of the end of the pulley-shaft, showing the slots through which the clutch-shifting levers work. Fig. 14 is an enlarged view of the end of the rod for shifting the double friction-clutch, showing the enlarged slotted end in which the ends of the clutch-levers work. Fig. 15 is an end view of Fig. 7, showing the pulley-shaft and

clutch-shifting rod in section. Fig. 16 is an enlarged view of the bolt for adjusting the compensating spring for the back-motion pulley. Fig. 17, Sheet 7, is an enlarged view of the revolving cam for operating the double friction-clutch, with the cord-segment and lever for tool-elevator, and the lever with safety-clutch for operating the driving-clutch. Fig. 18 is a side view of the same parts at right angles to Fig. 17. Fig. 19, Sheet 1, is an end elevation, partly in section, of the pulley-frame and main upright in Fig. 1, showing the train of gearing for driving the escapement-shaft. Fig. 20, Sheet 5, is an enlarged view of the stops on the side of the table for adjusting the length of travel of the table, shown in proper relation to Fig. 9. Fig. 21 is a section on the line *z z* of Fig. 9 of the hand reversing-lever on shifter-shaft. Fig. 22 is a section through Fig. 21 on the line 1 1. Fig. 23 is a section through reversing-block, showing additional hand-lever on opposite end of shifter-shaft. Fig. 24, Sheet 7, shows the shifter-levers and stops in position for the return motion of the table. Fig. 25, Sheet 3, is a section through a wedge and clamping-bolt in the clutch in the return-motion pulley. Fig. 26, Sheet 7, represents an alternate method of constructing the lever with safety-clutch for engaging the double friction-clutch.

Our driving arrangement is an improvement upon that shown in Letters Patent No. 36,113, dated August 5, 1862, granted to William Sellers, one of these applicants, in which the table was provided with a rack driven by a curved or spiral toothed gear on a diagonal shaft operated from the pulley-shaft by a primary system of gearing consisting of a bevel-wheel and pinion. With this form of construction the action of the secondary system—that is, the spiral gear driving the rack—is perfectly smooth, and the planer so constructed does work that has not hitherto been equaled. The action of the primary system of bevel-gears, however, is not so perfectly smooth, and hence that machine, even with its secondary system of gearing, has a tremor caused by the successive action of the primary gear-teeth, which tremor produces chatter-marks on the surface of the work planed. The speed of the return-stroke is also limited by the speed at which it is possible to run these primary gear-wheels safely and quietly; and to obtain the best results it is necessary that the teeth of the bevel-wheel and pinion should be very carefully cut and shaped, and this increases the expense and difficulty of constructing the machine.

C, Fig. 1, represents the spiral gear of the secondary system, as described in the above-mentioned former patent, secured to the driving-shaft D, which runs in suitable bearings in the bed B and upright E. On the outer end of the shaft D is secured the spur-gear F of the primary system, which is driven by its spiral pinion G, secured to the pulley-shaft H, which runs in bearings formed in the pulley-frame J. The spiral pinion G of the primary system is preferably placed above the spur-gear F, to provide room for the driving-pulleys above the bottom of the bed of the machine, so as thereby to avoid the necessity, which otherwise would exist, of placing these pulleys below the floor on all large machines in which the bed rests directly upon the foundation. This pulley-frame is securely bolted to the upright E. The teeth of the spiral pinion G fit in the spur-gear F, and these two gears constitute our primary system of gearing. The sides of the teeth in the spur-gear are tangential to the curved teeth of the spiral pinion G. The action is then continuous, like that of a screw, and there is absolutely no shock as the teeth enter and leave, so that by our present construction the motion of the driving-pulleys can be communicated to the planer-table without any vibration, and the work produced is entirely free from chatters, and hence requires little or no finishing afterward. The smooth and uniform action of these spiral gears renders it possible to drive them at very high speeds without shock or noise, and the return motion of the table can therefore be at a much greater speed than has hitherto been possible.

The pulley-shaft H carries two loose pulleys, I, for the forward motion of the table, and K, for the return motion. These pulleys revolve freely upon the shaft between the fast collar *j*, formed with the shaft, and the screw-collars *k k*, Sheet 3, Fig. 5. These pulleys are each provided with a taper seat, preferably of wood, adapted to receive the double friction-clutch L, which is keyed to the shaft H so as to revolve with it and at the same time slide freely along it on the raised central collar, *j*. The double friction-clutch L is shown in the drawings as constructed entirely of metal, to be as light as possible, while the diameter is the smallest that will transmit the power of the pulleys safely, the object being to reduce the momentum of the clutch to the minimum, that it may offer the least resistance to the reversal of its motion when it engages with either pulley. The interior surfaces of the clutches in each pulley are lined with wood, as two metal surfaces might cut and seize. The wood is secured in place by a groove or recess turned out in the pulley-rim, as shown in Fig. 5, and into this groove blocks O, of hard wood, are fitted so that the end of the grain will form the friction-surface. The space between these blocks O is made tapering, (see Fig. 25,) and wedges P P, drawn up by bolts R R, set the blocks O O firmly against the rim of the pulley, and so form a solid clutch, the interior being turned out to the same bevel as the outside of the double friction-clutch L. The weight of half the wooden blocks and wedges is thus added to the weight of each pulley, the motion of the pulleys being constant. Increased weight of pulley will assist in overcoming the resistance of the clutch L to the reversal of its motion without shock.

When the planer is to be used principally on short work requiring frequent reversals,

producing heating and expansion of the clutches, it will be found preferable to provide the double friction-clutch with wooden blocks secured as, for example, in the manner described in United States Patent No. 260,791, granted to William Sellers, July 11, 1882, in which case the corresponding clutch-seat in the pulleys should be entirely of metal.

The collar *j* has a slot in it, through which the pin *o* slides. This pin fits in the clutch L, and serves to couple it with the rod *h*, by which the clutch L is engaged with and disengaged from the clutches in the pulleys I and K. In Fig. 5 the clutch is shown in gear with the driving-pulley I. The pulley-shaft H has a hole drilled through its center to receive the rod *h*, which slides freely through it. The rod *h* has an enlargement on its outer end, which is slotted through to receive the short ends of the bell-crank clutch-shifting levers *l l*, which pass through slots in the pulley-shaft. These clutch-levers are pivoted, as shown, in the sliding fulcrum-piece *n*, which slides easily on the outside of the pulley-shaft H. (See Sheet 4, Fig. 7.)

The fulcrum-piece *n*, Figs. 7 and 8, is limited in its motion in one direction by the adjustable stop-collar *p*, screwed and clamped on the end of the pulley-shaft H. The long ends of the bell-crank levers *l l* are moved in and out by the diagonal grooves p^2 in the sliding cam *m* as it is moved along the pulley-shaft H, the levers *l* being provided with projections on their ends, as shown, which enter the slots p^2. The diagonal grooves p^2 are continued at each end parallel with the pulley-shaft H, so that when the cam *m* is moved along the shaft until the ends of the levers *l* enter these parallel grooves the end pressure on the shaft H, due to moving and holding the levers *l*, ceases, and the parallel grooves resist the tendency of the levers to open or close, as the case may be. The cam is always moved far enough in engaging the clutches to bring the parallel grooves to the ends of the levers, thus always moving the levers through the same angle, and hence the position of the adjustable collar *p* determines the pressure with which the clutch L is forced into the driving-pulley I when the cam *m* is in the position shown in Fig. 5, Sheet 3.

When the cam *m* is moved into the position shown in Fig. 6, the clutch L is withdrawn from the pulley I by the rod *h* and drawn into and engaged with the return-pulley K. The sliding fulcrum *n* in this case has been drawn away from the stop-collar *p*, and is now shown arrested by the compression of the spring *r*, with which it is connected by the pin *t*, bolt *q*, and adjustable nuts *v* and *w*, by which the pressure of the spring is adjusted. This spring *r* abuts against the end of the pulley-shaft H, and when compressed, as shown in Fig. 6, holds the clutch L into the pulley K with the requisite pressure. The spring *s* (see Fig. 7) fits loosely on the outside of the sliding fulcrum *n* and is compressed between the adjustable stop-collar *p* and a shoulder on *n*.

In Fig. 7 the cam *m* is shown in its middle position. The clutch L is now free from both pulleys I and K and the shaft H is at rest, the pulleys revolving freely on it without driving it in either direction. The sliding fulcrum *n* is now balanced between the two springs *r* and *s*, and it will be seen that movement of the cam *m* in either direction will first move the clutch-levers *l* and the rod *h* until the double friction-clutch L bears against the clutch in the pulley I or K. Further movement of *m* in the same direction will compress one of the springs and thus gradually increase the pressure between the clutches until the maximum pressure required for driving is obtained, when the clutch is engaged, in which position the ends of the levers *l* rest in the parallel grooves in the cam *m*, as shown in Figs. 5 and 6, thus releasing the cam *m* from all end pressure due to the action of the levers *l*, and the pulley in gear with the clutch rests against its screw-collar *k*, the pressure being all self-contained in the shaft H, thus completely freeing it from all end pressure, and when the pulley-shaft H is revolving in one direction, driven by one of the pulleys, and the clutch L is shifted to the other pulley, so as to revolve it in the other direction by mechanism to be hereinafter described, the spring presses the revolving clutch, which has just been withdrawn from one pulley, against the clutch on the opposite pulley, and its compression determines the brake-pressure which acts to bring the shaft H rapidly to rest without shock preparatory to firmly engaging with the clutch on the pulley to drive in the opposite direction, and by properly proportioning the strength and amount of compression of this elastic connection and the angle of the clutches it is easy to reverse the heavy planer-table at high speed without any shock or jar. The angle of these clutches must be such that the friction-surfaces will part the moment the pressure which holds them together is removed, as any adhesion after this will prolong the driving movement, and when the opposite clutch is thrown into gear an occasional shock will occur, caused by the varying speed at which the reversal of movement takes place. We have found by practice that when the friction-surfaces are at an angle with their axes of twenty degrees the reversal may always be effected without shock.

The lever *u*, pivoted at *a'* in the pulley-frame J, Fig. 5, Sheet 3, is coupled with the cam *m* by a collar provided with trunnions resting in a fork in the end of the lever *u*, the collar being connected with the cam *m*, which turns freely in it, without sliding, by a collared nut, as shown in Figs. 5 and 7, 8 and 15.

On the hub of the driving-pulley I, Sheet 3, Fig. 5, is secured a spur-pinion, *b'*, which, through the intermediate wheel, *c'*, drives the gear-wheel *d'*, secured to the escapement-shaft

M, which turns freely in bearings in the upright E. To the other end of the shaft M is secured the ratchet-wheel T, Figs. 10 and 12. Between the ratchet-wheel T and the bearing of the shaft M is the gear-wheel V, carrying the escapement-pawl *e'*. This gear is loosely fitted to the shaft M, so as to allow the shaft to revolve freely within it. This mechanism with the escapement-plate next mentioned constitute a device for transmitting and arresting motion, such as is shown and described in the United States Patent No. 34,217, issued January 21, 1862, to William Sellers.

The pawl *e'* is in the form of a bell-crank, and is pivoted to the hub of the gear-wheel V, (see Fig. 12,) its outer end resting against the stop *h'* on the escapement-plate W. The spring-plunger *f'* presses against the inner end of the pawl *e'*, and whenever the stop *h'* is removed will throw it into gear with the ratchet-wheel T, secured to the revolving shaft M, and thus drive the gear-wheel V. The onter end of the pawl *e'* comes alternately in contact with the stops *g'* and *h'* on the escapement-plate W, which has a motion at right angles to the axis of the shaft, as described for the stops in the above-mentioned patent, No. 34,217, when it is required to transmit rotary motion in one direction only. The forward movement of the wheel V, carrying the pawl *e'*, then throws the inner end of the pawl *e'* out of gear with the ratchet-wheel T and compresses the spring on *f'*. The reaction of this spring would tend to reverse the movement of the gear-wheel V, and so cause the pawl *e'* to engage again with the ratchet-wheel to be again thrown out by the stop. This would make considerable noise and be rapidly destructive of this part of the machine, and to avoid this difficulty we provide the retaining-pawl *j'*, which engages alternately with the two lugs *k'* on the hub of the bevel and spur gear A', driven by the gear V, and thus prevents reaction and keeps the pawl *e'* out of gear with the ratchet-wheel until the pawl *e'* is again released from the stop *g'* or *h'*. The pawl *j'* is preferably placed so as to engage with stops on the spur-wheel V, but is shown on the wheel A' for convenience in drawing.

The escapement-plate W is moved up and down to release the pawl *e'* from the stops *h'* or *g'* by means of the escapement-lever B' B', Fig. 9, one end of which engages with two lugs on the lower end of the escapement-plate W. The other end is formed as a counterweight to balance the plate W. The lever B' is carried by and turns freely on the sleeve C', Sheet 6, Fig. 11, which is secured firmly in the stand D', bolted to the feed-gear frame E'. The escapement-plate W slides in bearings formed in the feed-gear frame E', and is kept in place by the stand D', under which it slides freely.

The escapement-lever B' is provided with a friction-clutch, which engages with the friction-clutch F', secured to the shifter-shaft G', which is carried by suitable bearings in the feed-gear frame E' and feed-stand H' on opposite sides of the machine. Secured to the shaft G' is the forked lever I', which is moved back and forth by the shifter-levers J' and K', operated by the stops L' M', secured to the table A in the usual manner. (See Figs. 9 and 11.)

The retaining friction-clutch S fits loosely upon the shifter-shaft G', and is held from turning by the lug *l'*, which fits easily between the short arms of the weighted lever Q, supported at *i*. The lever Q forces the retaining-clutch S against the clutch F', secured to the shaft G', and so tends to slide the shaft through its bearings. The clutch F' is thus held in gear with the friction-clutch in the escapement-lever B' by a force due to the action of the weighted lever Q. The frictional surfaces of these clutches should not be both of metal, as indicated in the drawings, but of wood and metal, the wood being secured in the method above described for the clutches in the driving-pulleys, or in the manner described in United States Patent No. 260,791, July 11, 1882, granted to William Sellers.

The retaining-clutch S prevents any recoil of the shifter-shaft G' when it is moved in either direction by the stops L' M'. The first effect of these stops upon the shifter-shaft G' is to release the double friction-clutch L from its driving-pulley. The second is to press it against the opposite pulley, so as to retard its motion without reversing it, and the pressure required for this must be exerted against the inclined surfaces of the sliding cam *m* through the springs *s* or *r*. This pressure would cause the shifter-shaft G' to recoil after the pressure of the stops L' or M' was removed. The inertia of the shifter-levers and other parts attached or connected to the shaft G' is such that when these parts are suddenly set in motion by the stops L' or M' they continue their motion beyond the point to which the stops would positively push them, and hence leave space between the stop and the shifter-lever for the recoil just mentioned to occur. The retaining friction-clutch S, which does not turn about its axis by its friction, reduces the amount of this extra motion and will effectually prevent the recoil, so that the brake-pressure produced by the action of the stops will be maintained until the lever *u* is farther moved by the action of the revolving cam E^2 and lever F^2 to engage the clutch for driving in either direction.

The lever B' is coupled with the shifter-shaft G' by a friction-clutch, so that the escapement-pawl may be released at the earliest possible moment as the table-stops come in contact with the shifter-levers and revolve the shifter-shaft G'. When the escapement-plate W reaches the end of its stroke, it releases the pawl *e'* from the stop *g'* or *h'*, as the case may be, when the friction-clutch slips and allows the shaft G' to turn still farther in its bearings without risk of breakage, while the friction-

clutch is ready to reverse the motion of the lever B′ with the first movement of the shaft G′ in the opposite direction.

On the end of the shifter-shaft G′ is secured the reversing-lever N′, which is coupled by the connecting-rod O′ with the lever *u*, which moves the cam *m*, before described. (See Figs. 5 and 11.) When, for example, the stop L′, Fig. 20, is carried by the forward motion of the table so as to strike against the lever J′, the forked lever I′ is moved, and with it the shaft G′ and reversing-lever N′. This movement continues until the clutch L, Fig. 5, has been withdrawn from the driving-pulley I and pressed against the return-pulley K, so as to retard its motion without reversing it until the forward motion of the table ceases. If the planer-table is running back, the stop M′ will move the shifter-lever K′, and as the table, owing to its high speed, has much greater momentum, and hence requires more space to come to rest, the stop M′ and lever K′ are so proportioned that when the stop M′ runs over the end of the lever K′ the cam *m*, Fig. 5, will have been moved far enough to withdraw the clutch L from the return-pulley K and force it against the pulley I with a pressure, resulting from the compression of the spring *s*, sufficient to act as a powerful brake to retard the motion of the table without, however, reversing the motion of the pulley-shaft. The stops L′ M′ merely withdraw the clutch L from the pulleys I and K and force it against the opposite pulley, so as to form a brake to retard the motion of the table, the ends of the bell-crank levers *l* resting in the diagonal part of the grooves p^2 after the brake-pressure has accomplished its purpose. The clutch is firmly engaged with this pulley by mechanism hereinafter described.

The bevel and spur gear A′, Figs. 10 and 12, before described, is secured to the shaft U′, which runs freely in a bearing provided in the stand E′. On the outer end of the shaft U′ is fastened the slotted crank-plate V′, which, by means of an adjustable crank-pin and connecting-rod, moves the gear-segment W′, pivoted at Z′, Fig. 9, and gearing into the ratchet-box X′, through a greater or less distance, as the adjustable crank-pin is moved from or toward the center of the crank-plate V′. The lower end of the gear-segment W′ is provided with an arm which gives motion through the connecting-rod Y′ to a similar gear-segment on the stand H′ on the left-hand side of the planer, Fig. 3. These gear-segments can thus be used to impart a feed motion to slide-rests on each upright of the planer. When such feed is not required, the bevel and spur gear A′ may run loose upon a stud secured to the stand E′. The bevel-wheel A^2 is driven by the wheel A′, and has a slot extending diametrically across its face, in which is secured the crank-pin B^2, which can be adjusted to any radius on the face of the bevel-wheel A^2. A connecting-rod, C^2, Fig. 3, couples this crank-pin with the gear-segment which operates the ratchet-box on the end of the feed-screw or the feed-rod, as the case may be, on the end of the cross-head. The bevel-wheel A^2 is formed with or secured to the cam shaft D^2, which turns freely in a bearing formed in the stand E′. The inner end of the shaft D^2 has secured to it the cam E^2, which serves to give motion to the lever F^2. This lever is pivoted on the pin G^2, secured to the stand E′, and has attached to its lower end the connecting-rod H^2, which couples it with the lever N′, secured to the shifter-shaft G′. The lever F^2 is formed in two pieces, as shown on larger scale in Figs. 17 and 18, the two parts being coupled together by a tongue and groove with beveled sides clamped in contact by a stud and spiral spring, as shown. This arrangement acts as a safety-clutch for the system, and when the resistance to moving the lever F^2 is too great from any cause these beveled sides ride over each other, compressing the spiral spring, and allow the cam E^2 to complete its stroke, moving the upper part of the lever F^2, but only transmitting, through the connecting-rod H^2, the strain required to lift the beveled tongue out of its seat, thus avoiding risk of breakage of the machinery. The two parts of the lever F^2 may be coupled by friction-clutches arranged in the same manner as described for the clutches F′ and S, the friction-surfaces being clamped in contact by a nut and spring, as shown in Fig. 26, Sheet 7, with sufficient force to engage the clutch L with the pulleys I and K, but not too tight to prevent yielding under any undue strain, thus accomplishing the same purpose as the beveled tongue and seat shown and described.

The cord-segment J^2 is pivoted, also, on the pin G^2, and serves to operate the tool-lifting mechanism in the cross-head. It is moved up and down by the curved connection K^2, Sheet 7, Fig. 17, which is pivoted to the segment at L^2, and on the outer end has a pin secured to it, which moves freely in a hole in the cam E^2 at M^2, as shown, so that one half-revolution of the cam E^2 throws the segment up in the position shown and the next half-revolution draws it down, thus giving the necessary motion to the tool-lifting cord at each end of the stroke of the planer-table.

The inertia of the double friction-clutch and driving-gears is sufficient to drive the table on its bearings about twice as far as it would move of itself—as, for example, if allowed at full speed to run out of gear with the spiral pinion meshing with the rack on the table—and to avoid shock in reversing, it is essential that the bearings of the gear-teeth should be changed to the reverse side, thus taking up all backlash as soon as possible after the disengagement of the driving motion. Owing to the superior inertia of the rotating parts connected permanently with the table, it is necessary to apply brake-pressure to the revolving clutch with sufficient force to reduce its speed, so as to change the bearing of the teeth in both the primary and secondary systems of

gearing while the table is still in motion, and the change is therefore made with the difference of velocities of the table and gearing. This disengagement of the double friction-clutch and application of the brake-pressure to change the bearing of the gearing is accomplished by the table-stops before the device for transmitting and arresting motion, which is released by the action of the table-stops, reaches that point in its operation where the engaging mechanism begins to act upon the lever F^2 for the purpose of increasing the brake pressure upon the revolving clutch and of finally engaging the clutch with the reverse pulley by sliding the cam *m* until the ends of the bell-crank levers rest in the parallel part of the grooves p^2. The lever *u*, which operates the sliding cam on the pulley-shaft, moves through a portion of its arc to disengage the clutch from the driving-pulley and to apply the brake-pressure to the other pulley. After a perceptible interval it moves through the remainder of its arc to engage the other pulley with the driving-clutch, this last movement being effected by the engaging mechanism.

In all the figures, excepting Figs. 6, 7, 8, and 24, the machine is shown with the clutches and levers in position for running forward under cut, and the relative operation of the various devices will now be shown.

When the table A, Fig. 20, reaches the end of its stroke, the stop L′ strikes against the shifting-lever J′, and this presses against the forked lever I′ on the shifter-shaft G′, thus turning the shaft in its bearings. The reversing-lever N′, by means of the connecting-rod O′, moves the lever *u*, Fig. 5, which slides the cam *m* a short distance on the pulley-shaft H, and through the clutch-levers *l* and rod *h* draws the friction-clutch L away from the driving-pulley I and presses it against the return-pulley K with sufficient force to act as a brake, the clutch S serving to prevent any reaction or release of the brake-pressure, as hereinbefore described. The motion of the table is thus retarded by the friction on the driving-clutch, and by this means the teeth in the spiral driving-gears are made to bear on the opposite sides of the teeth from those just employed for driving, so that all backlash is taken up preparatory to engaging the clutch L firmly with the return-pulley K by means of the train which includes the device for transmitting and arresting motion. The rotation of the shaft G′ also moves the lever F^2 through a small angle by means of the connecting-rod H^2, the lever being cut away, as shown at N^2, to clear the point of the cam E^2, so that in either of the two positions of rest of the cam E^2 the lever F^2 is entirely free from it, and, when required, can be moved through its full stroke without striking E^2.

In the first machine constructed by us with a train having a device for transmitting and arresting motion to engage the driving-pulleys the lever F^2 was not used, and motion was communicated directly to the lever *u* by a crank and a slotted connecting-rod instead of the cam E^2 shown, the connecting-rod having at one end a slot for lost motion equal to about one-half the throw of the crank, and the crank was so placed that after having moved the lever *u* as far as was required in one direction the crank continued its revolution and stopped at a point where it just took up the lost motion in the slotted connecting-rod. This left the lever *u* entirely free from the control of the crank, so that it could be moved through its full stroke, when required, without moving the crank, while the half-revolution of the crank-shaft always moved the lever *u* to its extreme position in either direction; but we prefer the construction shown in the drawings and hereinbefore described. The rotation of the shaft G′, Figs. 11 and 12, also at the same time, through the friction-clutch F′, turns the escapement-lever B′, which lifts the escapement-plate W, thus lifting the stop *h′* clear of the pawl *e′* and raising the other stop, *g′*, to the proper height to throw the pawl *e′* out of gear on completing a half-revolution. The spring-plunger *f′* throws the pawl *e′* into gear with the ratchet-wheel T on the revolving shaft M, and the pawl then drives the train of gears V A′ A^2 through a half-revolution, the motion being arrested by the stop *g′*, above described, and the train held in position by the retaining-pawl *j′*. The stops *h′* and *g′* are fixed upon and form part of the escapement-plate W, as being the cheapest and most convenient arrangement; but they may be pivoted and connected by a link, or they may be placed upon the forked ends of a pivoted lever, or their movement may be at right angles to that shown, so as to engage alternately with the pawl *e′*, the designation "escapement-plate" being intended to refer to the device which presents the stops *h′* and *g′*, alternately, to the action of the pawl *e′*.

The half-revolution of the wheel A′ moves the gear-segments and ratchet-boxes X′ through the proper distance, determined by the position of the crank-pin on the slotted crank-plate V′. The bevel-wheel A^2, through the adjustable crank-pin B^2 and connecting-rod C^2, gives motion in one direction to the feed on the cross-head, while the half revolution of the cam E^2, secured on the shaft of the wheel A^2, presses against the arm O^2 on the lever F^2, and so moves the lever F^2, and, through the connecting-rod H^2 and O′, moves the lever *u* into the position shown by the broken lines in Fig. 5, thus moving the cam *m* still farther along the pulley-shaft H, and gradually increasing the pressure of the friction-clutch L against the return-pulley K by the compression of the spiral spring *r* until the levers *l* come to rest upon the flats in the cam *m*. The clutch L is now engaged with and driven by the return-pulley K and the motion of the planer-table is reversed, and the backlash having been taken

up, as before described, the gradually-increasing pressure on the friction-clutch reverses the planer-table without any shock whatever.

It will be seen that the clutch L is withdrawn from the driving-pulley I positively—that is, by the motion of the table itself—so that there can be no variation in the length of stroke of the table without a readjustment of the stops, and that the escapement-train is released and started by the first movement of the shifter-levers and begins to operate the feed and tool-lifting mechanism before the planer-table has ceased moving, and completes this operation at the time this train completes the engagement of the double friction-clutch with the return-pulley. The motion of the table is now in the opposite direction, and the stop M′ will, at the end of the stroke of the table, engage with the lever K′ and positively withdraw the clutch L from the return-pulley K and compress the spring *s*, which will press the clutch L against the pulley I, and so produce an effective brake to retard the motion of the table A through the driving-gearing and enable the table to be reversed without any jar. As the brake is applied on the pulley-shaft to retard the motion of the table, it will be seen that the teeth in the spiral pinions C and G, spur-wheel F, and rack under table A will have their bearings quietly changed to the opposite side, so that when the clutch L is finally pressed in contact with the pulley by the escapement-train with sufficient force to drive, as the engagement is completed, the lost motion in the teeth is entirely taken up, and there will be no blow or shock in starting up the table. The reciprocating ratchet-boxes which give direction to or suspend the operation of the feeds derive their reciprocating motion in the usual way from adjustable cranks. These adjustable cranks, however, do not reciprocate or vibrate about an axis, as usual, but revolve about an axis in one direction only, making half a revolution at the end of each stroke of the machine. They and the tool-lifting apparatus, together with the mechanism for engaging the driving-clutches, are operated by the device for transmitting and arresting motion, which makes half a revolution at each reversal of movement of the planer-table, (except when disconnected for a purpose hereinafter described,) which device derives its motion from the continuously-revolving shaft M, driven, as may be most convenient, from a pulley on the pulley-shaft or from the counter-shaft of the machine. Consequently all the feeds are made and the tool is raised or lowered in the same time and also while the clutch for reversing the motions of the table is shifting. It follows, therefore, that the feed motions and the raising and lowering of the tool take place while the table is at rest or changing its direction of movement—a condition which is not to be found in any other planing-machine—the result of which is that the movement of the table may be limited to the length of the piece to be planed without requiring any feed to be made while the tool is cutting or the loss of any time or of table movement to raise or lower the tool.

The hand-lever R′, Fig. 9, has its bearing in the reversing-lever N′, in which it turns freely. The lower end of R′ is flattened off on two sides, as shown in Figs. 21 and 22, and a plunger, S′, sliding freely in its bearings in the reversing-lever N′, just clears the flats or cams on the lever R′ when the latter is in the position shown in the drawings. The other end of the plunger S′ just clears the end of the bearing T′ in the stand E′, the reversing-lever being entirely clear of the bearing, as shown in the drawings, so that the full pressure of the weighted lever Q is taken by the friction-clutch F′ in the escapement-lever B′. As the hand-lever R′ is turned through ninety degrees in its bearings in the reversing-lever N′, one of the cams on the hand-lever R′ pushes the plunger S′ through its bearings until it abuts against the bearing T′, when the further revolution of the hand-lever R′ draws the shifter-shaft G′ through its bearings, thus bringing the friction-clutch F′ out of gear with the lever B′ without releasing it from the retaining-clutch S. The shaft G′ can now be rotated in its bearings, either by the hand-lever R′ or the shifter-levers J′ K′, as above described, without moving the escapement-lever B′. If the hand-lever R′ is again rotated through ninety degrees, a flat is again presented to the end of the plunger S′, and the lever Q slides the shifter-shaft G′ through its bearings and again couples the friction-clutch F′ with the escapement-lever B′, as shown on the drawings. The shifter-shaft G′ is supported on the opposite side of the machine in a bearing in the feed-stand H′, as shown in Fig. 23. The reversing-block N is made to fit around the bearing, so that it cannot move in the direction of the axis of the shaft, but is forced to rotate with it by means of a sliding feather, Y, the shaft G′ passing partly through the block N and supporting it. The hand-lever Q′ has its bearing in the block N, in which it turns freely, and is formed with two flats or cams like the lever R′; but these cams are opposite to and operate directly upon the end of the shifter-shaft G′ instead of acting through a plunger like that for the opposite side. When the lever Q′ is rotated through ninety degrees in the block N, which cannot move endwise, the shaft G′ is pushed endwise to release the clutch F′, so that the shifter-shaft G′ can be operated with equal facility from either side of the machine. This arrangement gives the operator complete control of the planer, as, by disengaging the friction-clutch F′ from the lever B′, the stops on the table will still draw the double friction-clutch L out of gear with the driving-pulleys, as before; but the escapement-train will not be set in motion, and the feed will not take place; nor will the clutch L be engaged with the opposite pulley, so as to reverse the motion of the table at the end of its stroke. By the movement of

the levers R′ or Q′, on either side of the machine, the motion of the planer-table can then be stopped, reversed, or adjusted to any position back or forth, as required, without producing any feed, so that when the hand-lever is rotated to engage the friction-clutch in the lever which releases the escapement-train the movement of the table will again become automatic, and the feeds will recur from the place of their suspension.

A, Fig. 4, represents a section through the table of the planing-machine.

B is the upper portion of the bed, showing our improved bearing-surfaces *a* and *b* on the bottom of the table A. *a* is flat on its face and rests upon a flat surface, *c*, on top of the bed B. The surface *c* is bounded by ribs *d d*, which serve to protect the surface *c* and to keep the lubricant from flowing off of it; but they do not guide or confine the side motion of the bearing *a*, as there is a clear space left on each side, as shown. The rib *b* has on its lower surface two angular faces, *g g*, forming with each other a very obtuse angle and fitting in a corresponding bearing, *e*, in the bed B. The angle of this bearing or guide is made sufficiently acute to resist the side motion of the table due to the pressure of any ordinary finishing cut, and as it thus may approach nearly to a flat surface the friction is very little increased over that of a perfectly-flat bearing, as at *a* and *c*. The thrust of a heavy roughing cut would, however, slide the table sidewise on the obtuse guide *e*. To resist this thrust the two walls *f f* are raised on the bed B on each side of the guide *e*. These walls *f f* have their internal surfaces nearly vertical, and the rib *b* on the table A fits easily within them without quite touching them. These guides resist the first tendency of the table to be driven up the side of the obtuse guide *e*, and act only when the planer is used for heavy side-cutting work. In this respect they differ materially from the vertical side guides heretofore used with flat bearing-surfaces, as in the latter arrangement the side surfaces have not only to resist the side thrust due to heavy cutting, but have also to guide the table accurately for finishing cuts, and hence any wear or lost motion will seriously impair the character of the work produced. In our present invention, on the contrary, the side guides, *f f*, merely resist the side thrust due to heavy cutting, and are absolutely idle during the finishing cut, the table being then guided sidewise by the obtuse guide alone. With this form of construction the guiding-surfaces of the obtuse guide will wear to fit each other, and hence there will be no lost motion to be taken up and no adjustment required by the operator.

Having thus described the nature and object of our invention, what we claim herein as new, and desire to secure by Letters Patent, is—

1. In a machine for planing metal, a primary system of gearing consisting of a cogged pinion which has the contact-surfaces of its cogs arranged spirally about its axis, gearing with a cogged wheel which has the contact-surfaces of its teeth in straight lines in the direction of their width, and a corresponding secondary system, in combination with a reciprocating table, substantially as and for the purposes set forth.

2. A pulley-shaft which carries the spiral pinion of a primary system of gearing, and a driving-shaft which carries the spur-wheel of the primary system and the spiral pinion of the secondary system, in combination with bearings for these shafts which maintain the pulley-shaft above the driving-shaft, substantially as and for the purposes set forth.

3. A primary and a secondary system of gearing, a forward-motion pulley, and a return-motion pulley, in combination with a double friction-clutch the diameter of which is less than half the sum of the diameter of the forward-motion pulley and its width of face.

4. Adjustable stops, in combination with shifter-levers, which levers are so proportioned to the stops and the speeds of travel of the table as to operate the clutch mechanism to disengage the driving-pulleys from the table without re-engaging them therewith, substantially as and for the purposes set forth.

5. Adjustable stops and shifter-levers so proportioned to the stops and the speeds of travel of the table as to operate the clutch mechanism to disengage the driving-pulleys from the table without re-engaging them therewith, in combination with an adjustable elastic connection between the shifter-levers and the clutch, substantially as and for the purposes set forth.

6. Shifter-levers which disengage the driving-pulleys from the table, in combination with a device for transmitting and arresting motion which operates the mechanism that re-engages these pulleys at times determined from the disengaging movement of the levers, substantially as and for the purposes set forth.

7. A forward-motion pulley, a return-motion pulley, a double friction-clutch, a shifter-shaft, and shifter-levers operated by stops upon the planer-table, whereby the friction-clutch is disengaged from the driving-pulley, in combination with a revolving cam or crank operated by a device for transmitting and arresting motion, which re-engages the double friction-clutch with the opposite-motion pulley, the re-engagement being effected without dependence upon the amount or the velocity of the table movement, for the purposes set forth.

8. A forward-motion pulley, a return-motion pulley, a double friction-clutch, a shifter-shaft, with shifter-levers, whereby the double friction-clutch is withdrawn from one pulley and pressed as a brake against the opposite pulley, and a re-engaging train operated by a device for transmitting and arresting motion which is started by the disengaging movement of the shifter-shaft, in combination with an ad-

justable elastic connection, whereby the pressure with which this clutch will operate as a brake to retard the motion of the table before it has the power to reverse it and the time during which it so acts may be controlled, for the purposes set forth.

9. Shifter-levers and a reversing-shaft, in combination with a retaining-clutch, substantially as and for the purposes set forth.

10. A device for transmitting and arresting motion, provided with an escapement-plate the movement of which determines the times for the transmission and the arrest of motion, in combination with a cam or crank which engages the double friction-clutch with the driving-pulleys at the times determined by the movement of the escapement-plate, substantially as and for the purposes set forth.

11. A double friction-clutch and an intermittently-revolving cam or crank which engages the clutch with the driving-pulleys, in combination with a safety-clutch connection, substantially as and for the purposes set forth.

12. A double friction-clutch and an intermittently-revolving cam or crank which engages the clutch with the driving-pulleys, in combination with an adjustable elastic connection, substantially as and for the purposes set forth.

13. A device for transmitting and arresting motion, the times for transmission in which are determined by the movement which disengages the driving-pulleys from the table, in combination with a train which communicates motion to feeding mechanism, whereby the feed will be effected during the interval between the disengagement of the driving-pulleys from and their re-engagement with the table, for the purposes set forth.

14. An intermittently-revolving shaft forming part of the train which re-engages the driving-pulleys with the table, in combination with a device for communicating motion to tool-feeding mechanism, whereby the feed will be effected during the interval between the disengagement of the driving-pulleys from and their re-engagement with the table, for the purposes set forth.

15. An intermittently-revolving shaft forming part of the train which re-engages the driving-pulleys with the table, in combination with a device for communicating motion to tool-lifting mechanism, whereby this mechanism will be operated during the interval between the disengagement of the driving-pulleys from and their re-engagement with the table, for the purposes set forth.

16. An intermittently-revolving cam or crank, in combination with clutch-shifting mechanism, so that when the cam or crank is at rest the clutch-shifting mechanism may be operated at will, substantially as and for the purposes set forth.

17. The shifter-levers and the escapement-plate, in combination with a friction-clutch through which motion is transmitted from the levers to the escapement-plate at the will of the operator, substantially as described.

18. A shifter-shaft, a friction-clutch, and a reversing-lever, in combination with the hand-lever through which the clutch may be engaged and disengaged and the shifter-shaft may be vibrated at will, substantially as and for the purposes set forth.

19. A friction-clutch, a shifter-shaft, and a reversing-block, in combination with the hand-lever through which the clutch may be engaged and disengaged and the shifter-shaft may be vibrated at will, substantially as and for the purposes set forth.

20. The guide upon the bed having four surfaces, two of which are slightly inclined to a horizontal plane to sustain the weight, while two are perpendicular to the same horizontal plane or slightly divergent from a perpendicular to resist the side strains, in combination with the guide upon the table, having surfaces the converse of those upon the bed, substantially as and for the purposes set forth.

21. A flat guide on one side of the bed, which sustains the weight of one side of the table, in combination with a guide upon the other side of the bed, which has four guiding-surfaces, two of which are slightly inclined to a horizontal plane to sustain the weight, while two are perpendicular to the same horizontal plane or slightly divergent from a perpendicular to resist the side strains, substantially as and for the purposes set forth.

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Witnesses:
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