No. 867,948. PATENTED OCT. 15, 1907.

I. W. COLBURN & E. WASHBURN.

APPARATUS FOR DRAWING SHEET GLASS.

APPLICATION FILED MAR. 6, 1906.

12 SHEETS—SHEET 1.

Fig. 1.

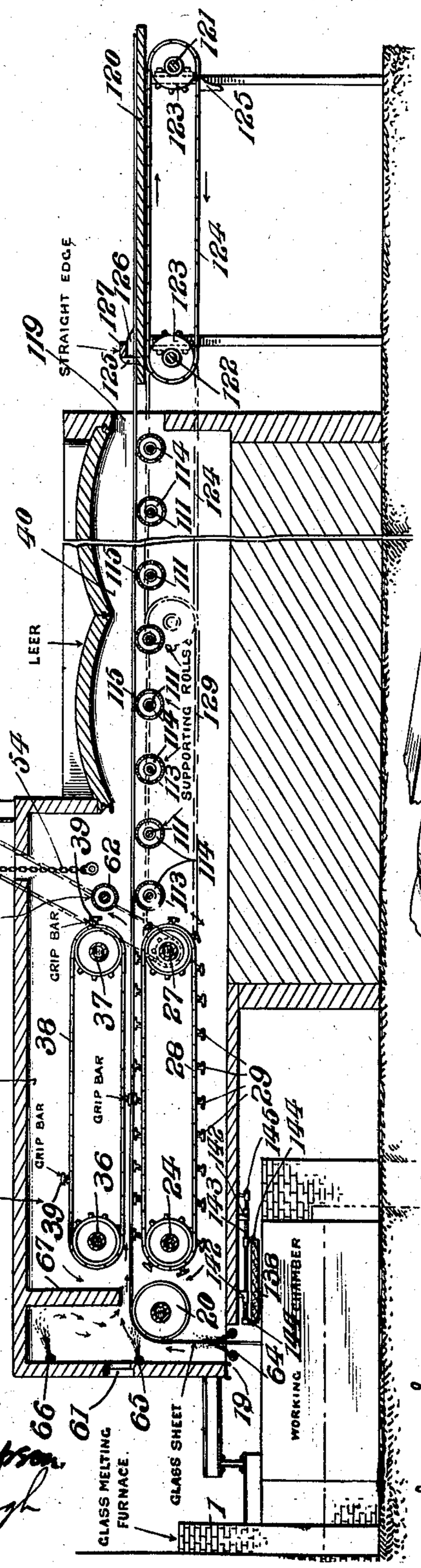
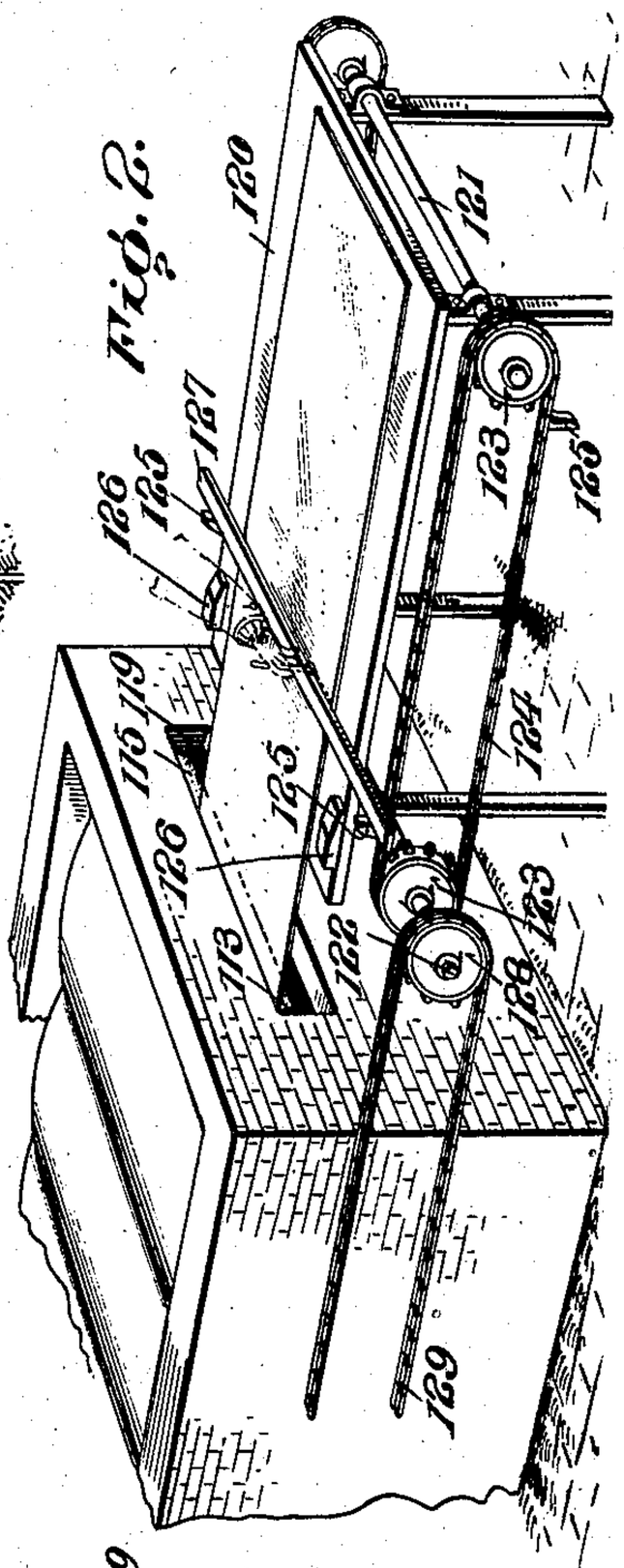


Fig. 2.



Witnesses
Hubert R. Thompson
Ruth C. Fitzhugh

Inventors
Irving W. Colburn
Edgar Washburn
by
Mauro, Cameron,
Lewis & Massie
Attorneys

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12 SHEETS—SHEET 2.

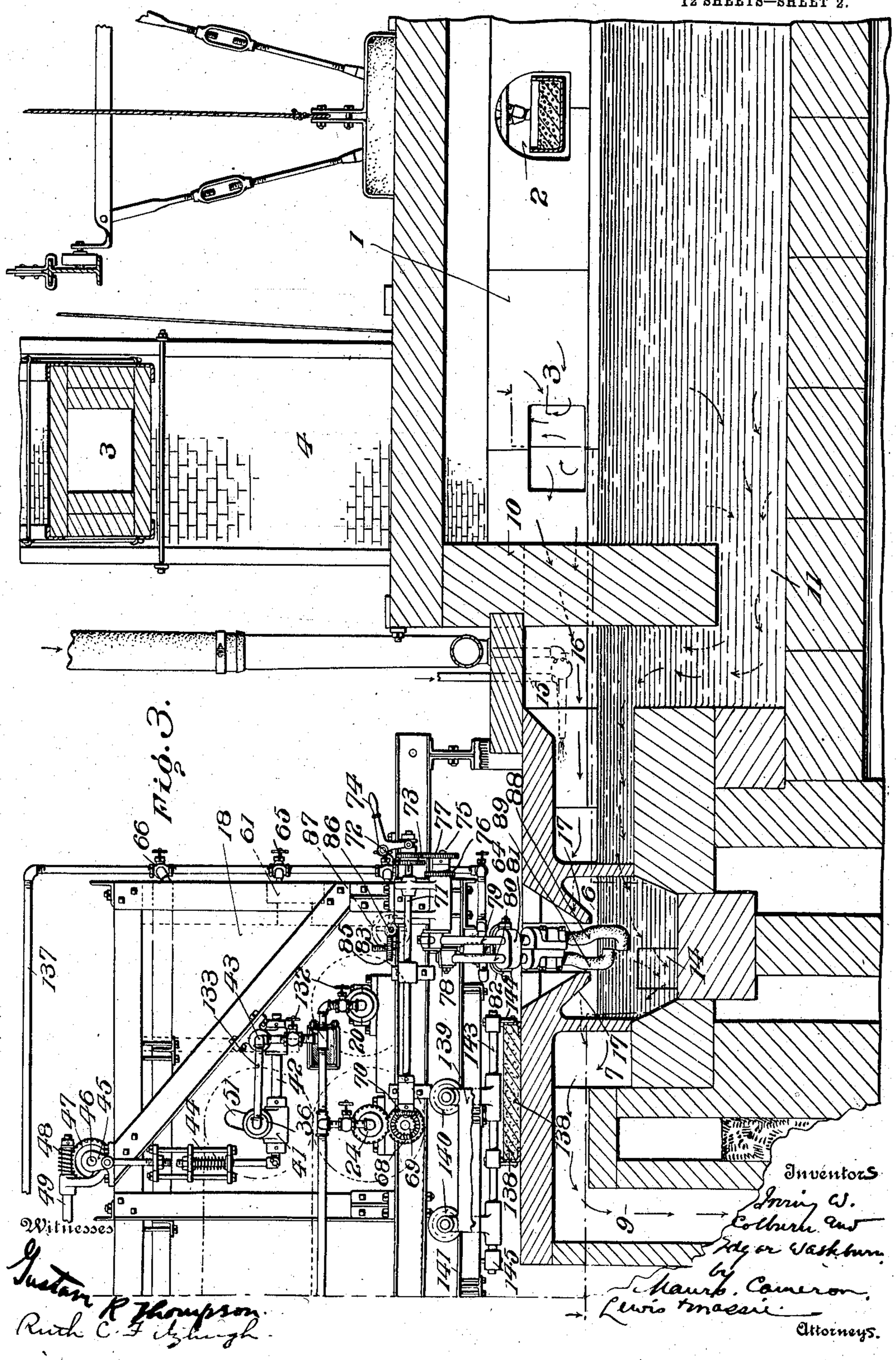

Fig. 3.

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12 SHEETS—SHEET 3.

Fig. 4.

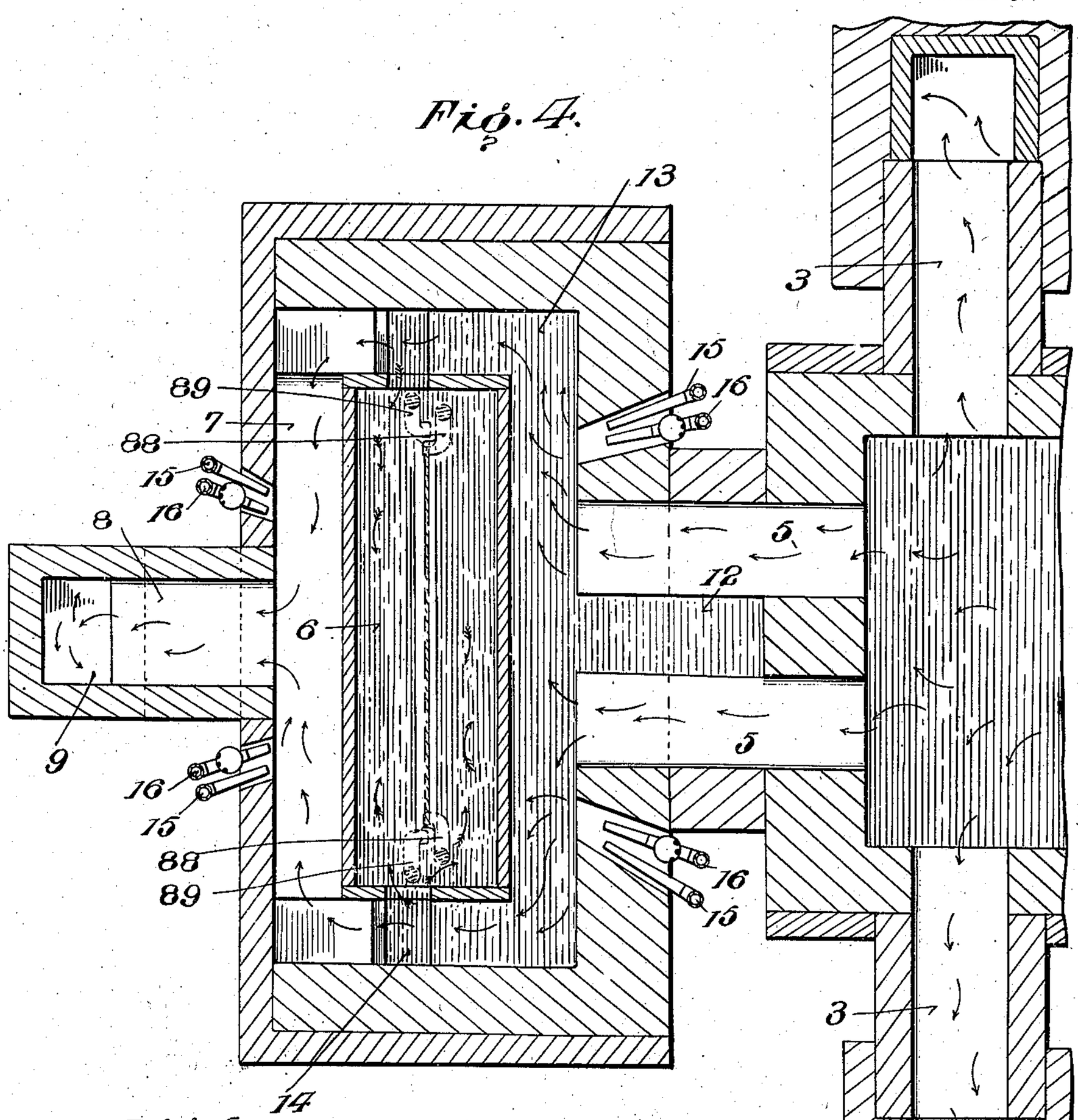
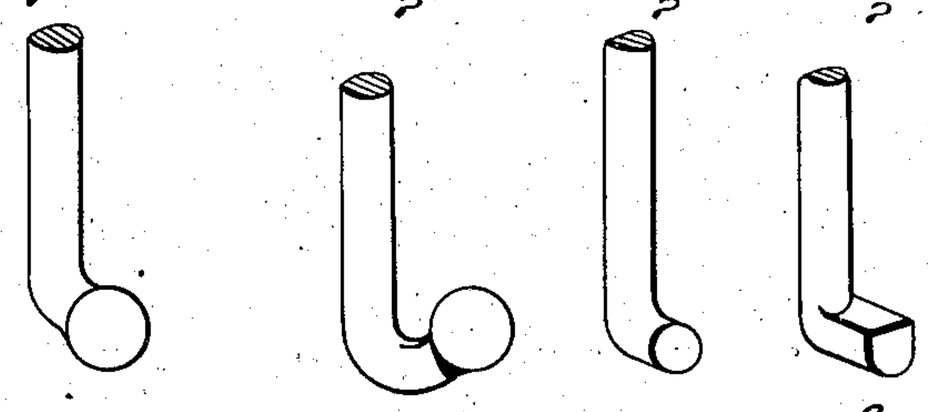


Fig. 5. Fig. 6. Fig. 7. Fig. 8.



Witnesses
Gustave R. Thompson
Ruth C. Fitzhugh

Inventors
Irving W. Colburn and
Edgar Washburn
By Cameron, Kerr & Mauro.
Attorneys.

No. 867,948. PATENTED OCT. 15, 1907.

I. W. COLBURN & E. WASHBURN.

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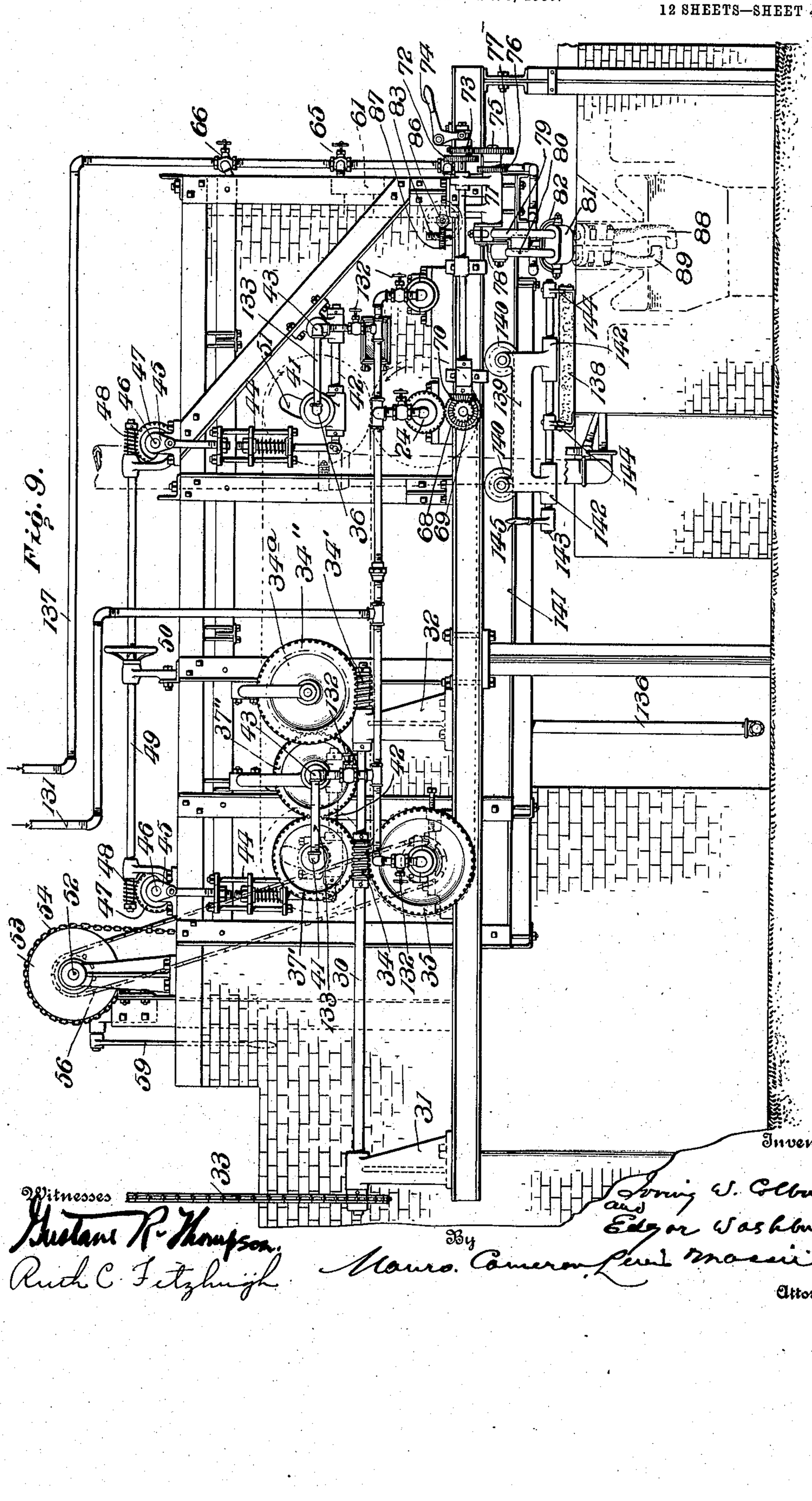
12 SHEETS—SHEET 4.

Fig. 9.



Witnesses

Gustave R. Thompson.

Ruth C. Fitzhugh.

Inventors

Irving W. Colburn

and

Edgar Washburn

By Mauro, Cameron, Lewis & Macrae

Attorneys

No. 867,948. PATENTED OCT. 15, 1907.

I. W. COLBURN & E. WASHBURN.

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12 SHEETS—SHEET 5.

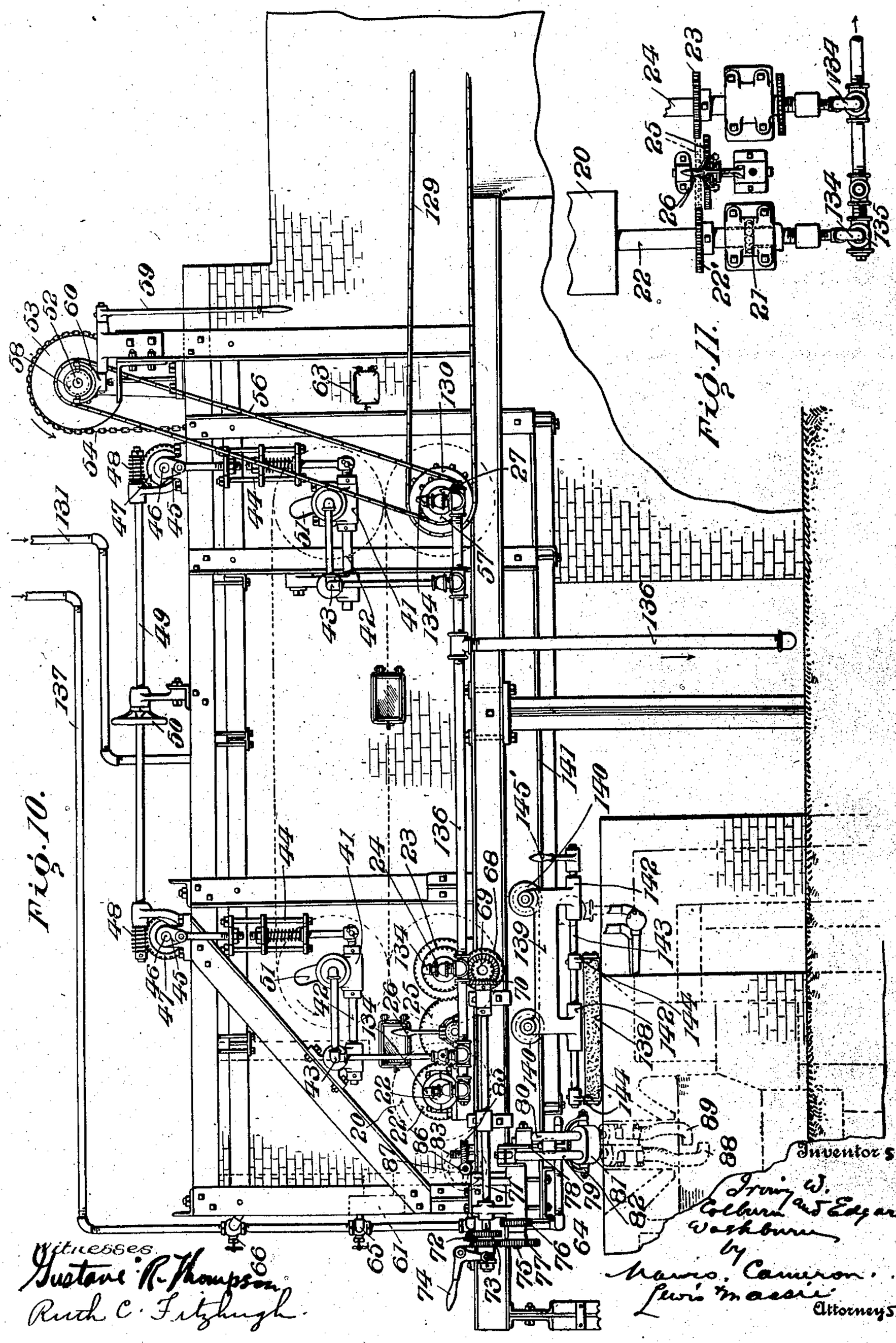

Fig. 10.

Fig. 11.

Witnesses
Gustave R. Thompson
Ruth C. Fitzhugh.

Inventors
Irving W. Colburn and Edgar Washburn
by Munn, Cameron, Lewis & Massie
Attorneys.

No. 867,948. PATENTED OCT. 15, 1907.

I. W. COLBURN & E. WASHBURN.

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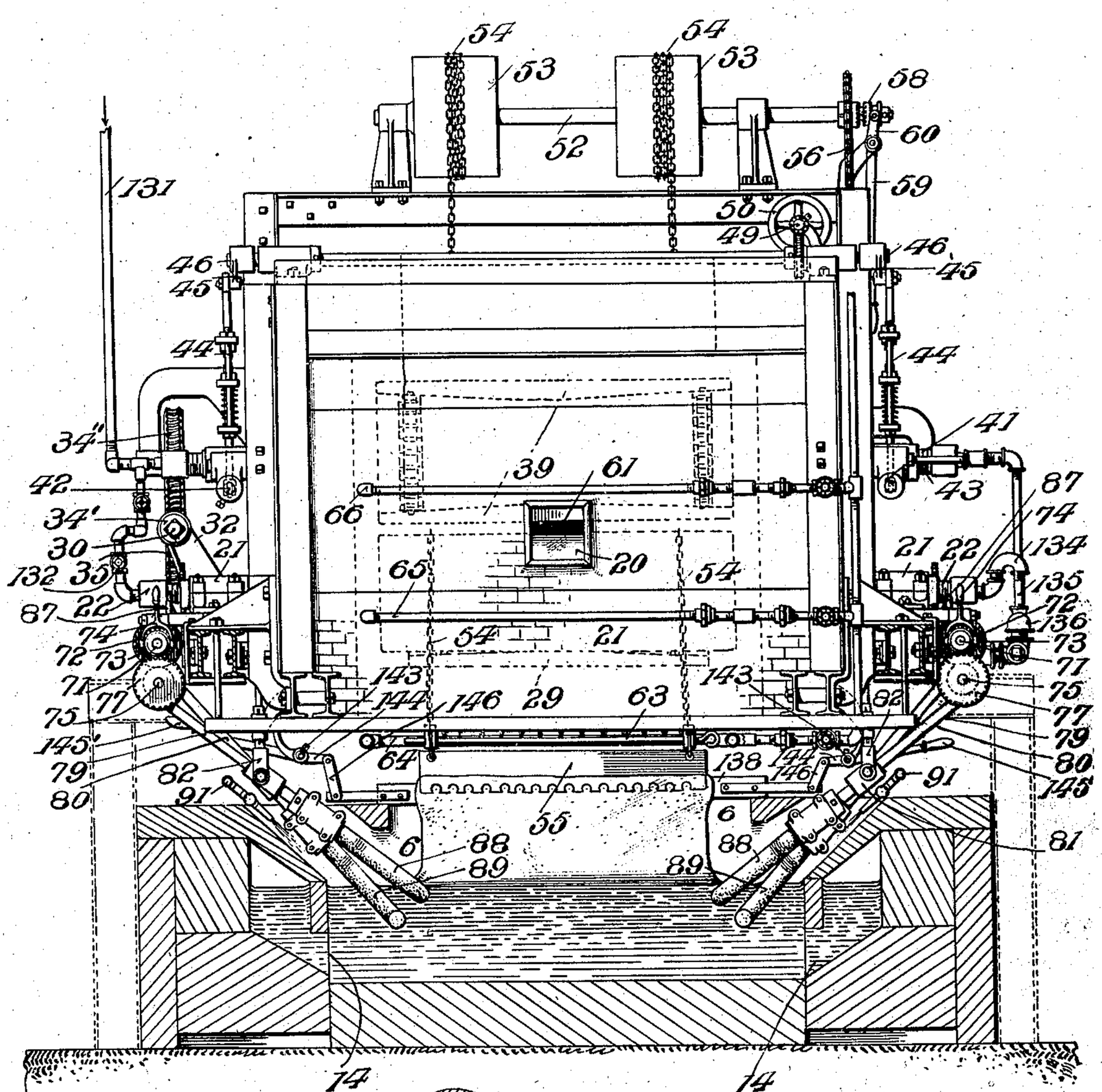
12 SHEETS—SHEET 6.

Fig. 12.



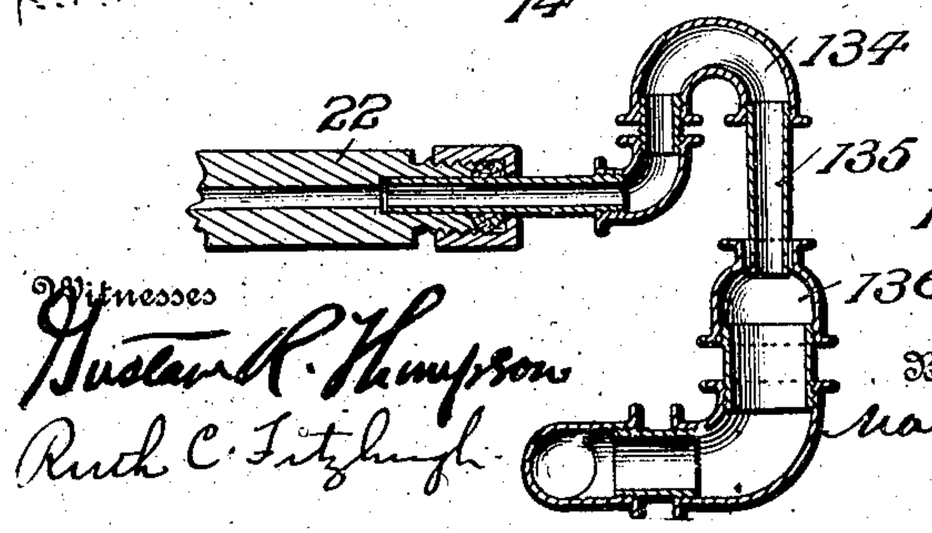


Fig. 13.

Witnesses

Gustave R. Thompson

Ruth C. Fitzhugh

Inventors

Jonig W. Colburn

Edgar Washburn.

By Mauro. Cameron Lewis Massie

Attorneys

No. 867,948. PATENTED OCT. 15, 1907.

I. W. COLBURN & E. WASHBURN.

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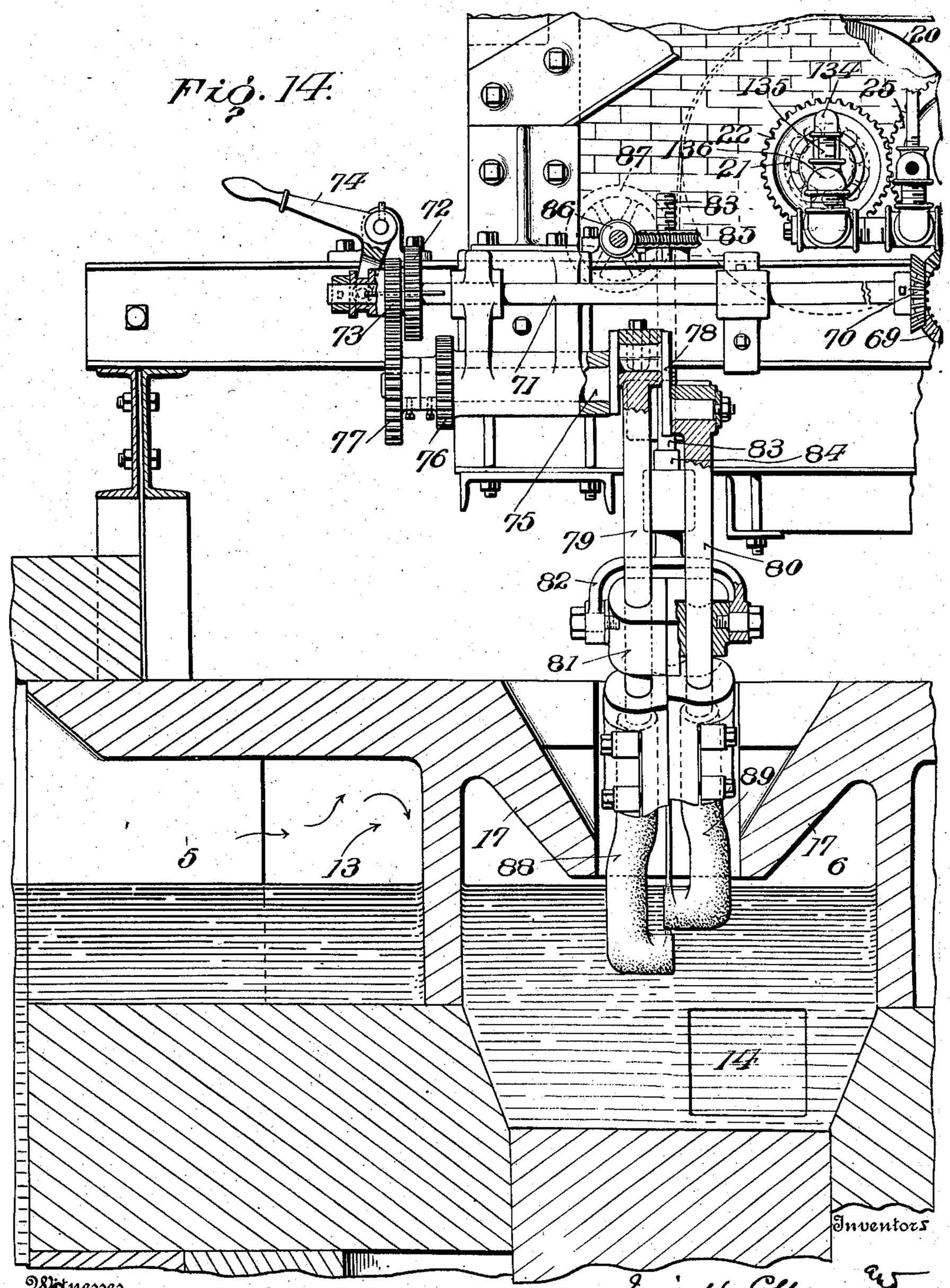
12 SHEETS—SHEET 7.

Fig. 14.



Witnesses

Gustave R. Thompson.

Ruth C. Fitzhugh.

Inventors

Irving W. Colburn

Edgar Washburn

By Mairo, Cameron, Lewis & Mosser

Attorneys

No. 867,948. PATENTED OCT. 15, 1907.

I. W. COLBURN & E. WASHBURN.

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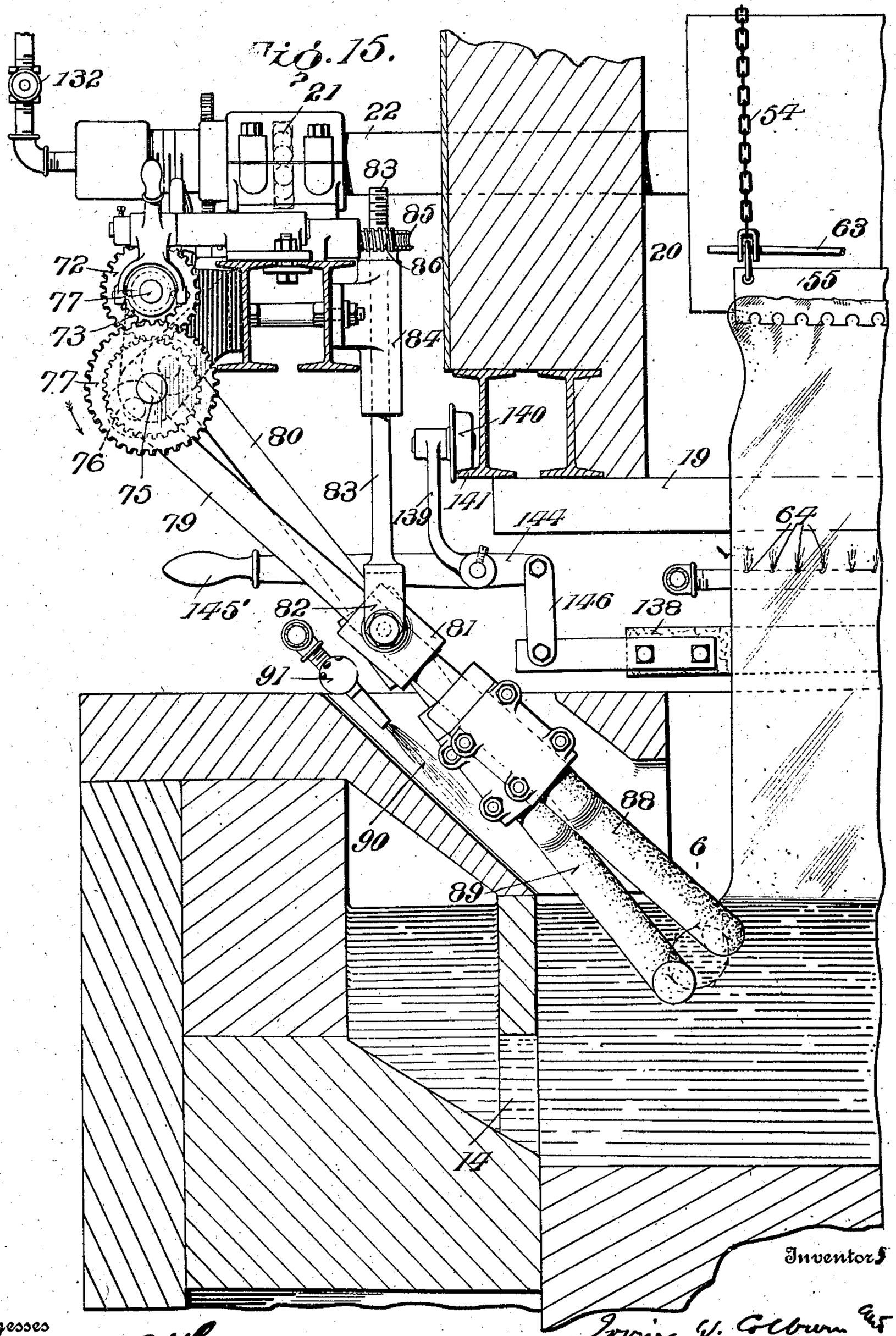
12 SHEETS—SHEET 8.

Fig. 15.



Witnesses
Gustave R. Thompson.
Ruth C. Fitzhugh

Inventors
Irving W. Colburn and
Edgar Washburn
By Mauro, Cameron & Lewis Macrae
Attorneys

No. 867,948. PATENTED OCT. 15, 1907.

I. W. COLBURN & E. WASHBURN.

APPARATUS FOR DRAWING SHEET GLASS.

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12 SHEETS—SHEET 9.

Fig. 16.

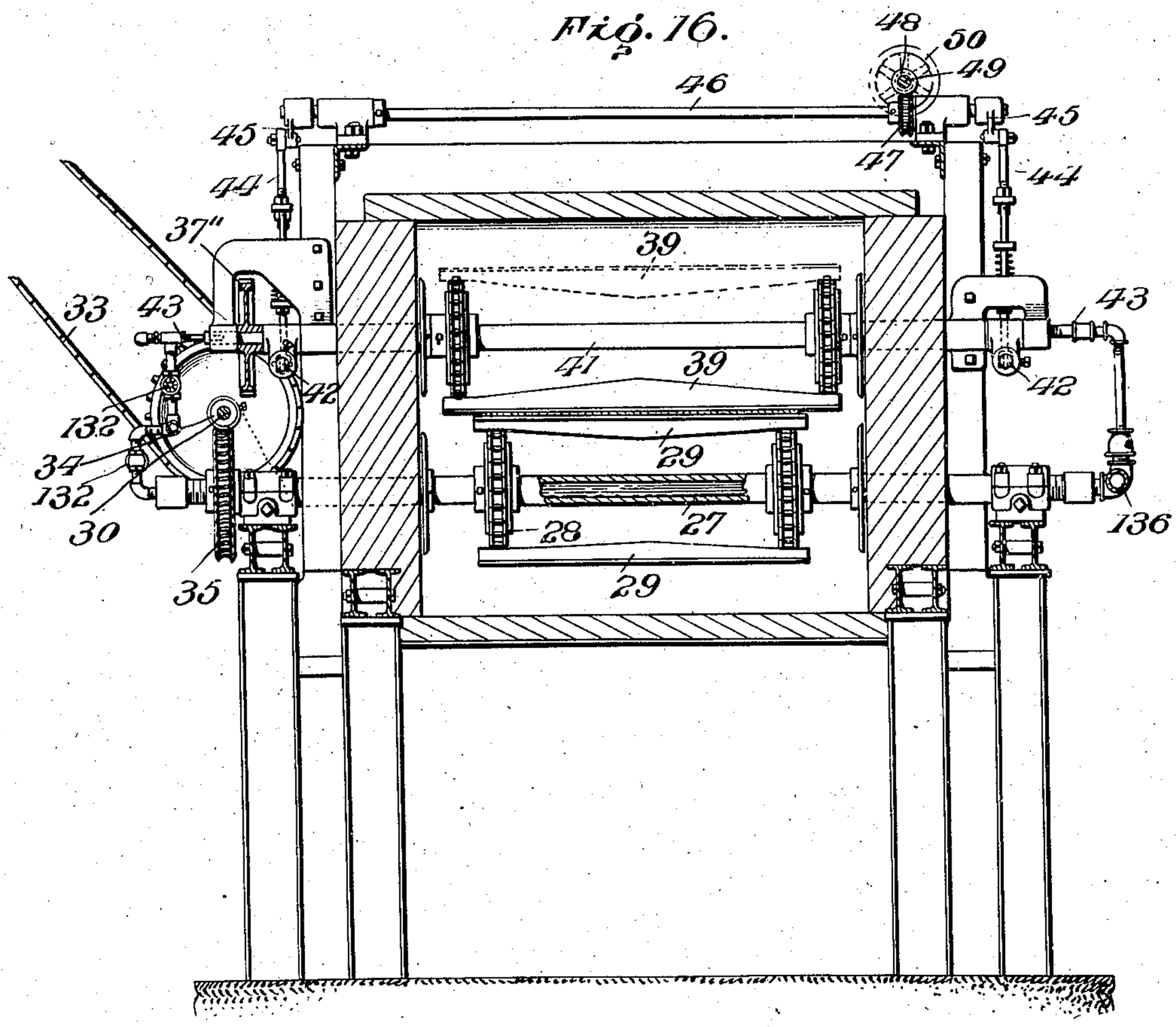


Fig. 17.

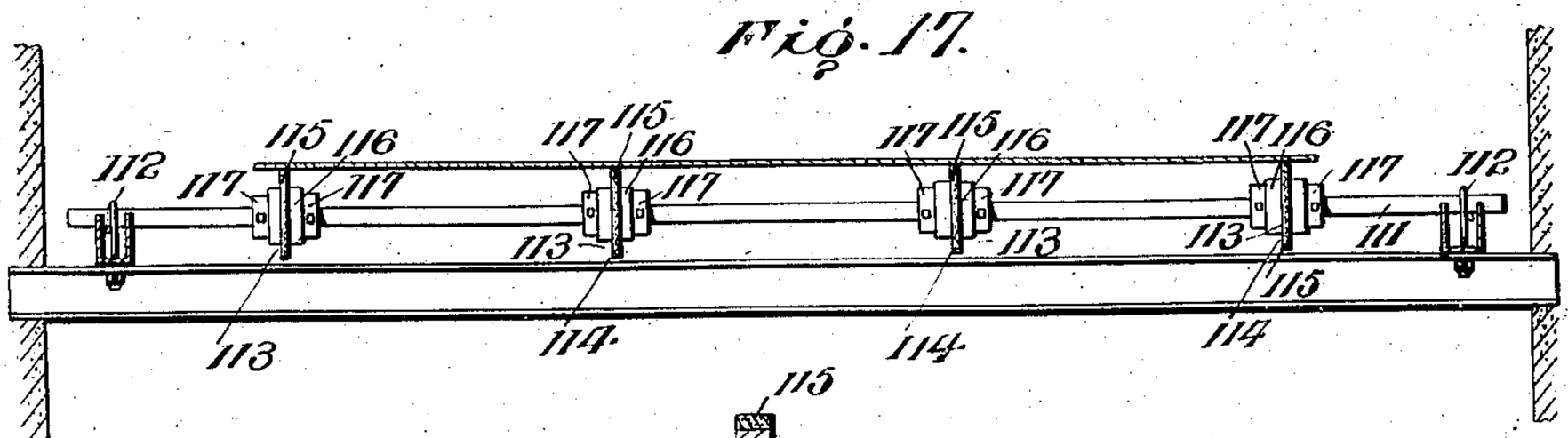
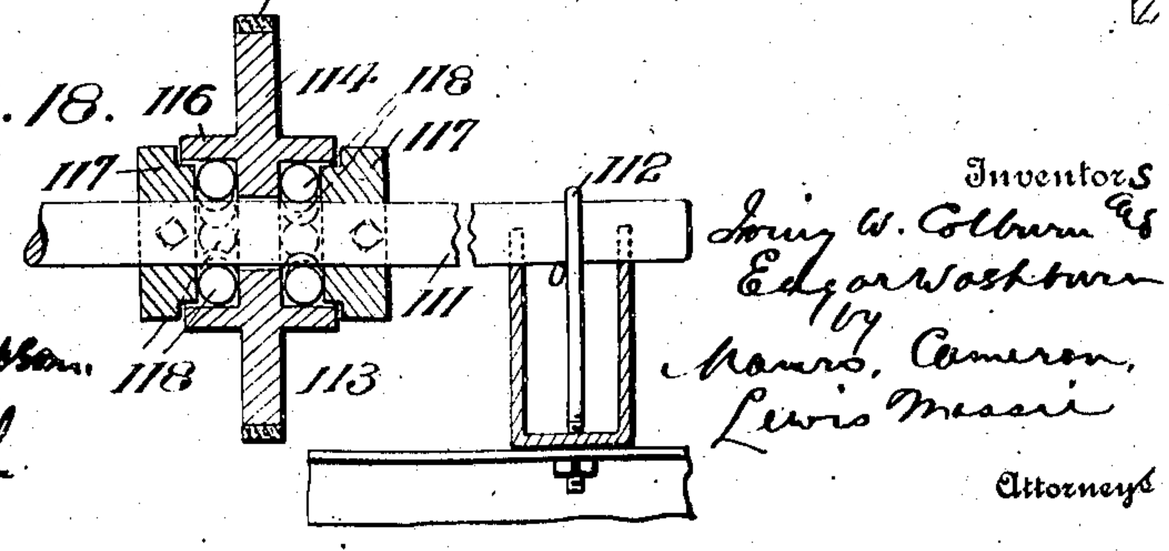


Fig. 18.



Witnesses
Gaston R. Thompson.
Ruth C. Fitzhugh.

Inventors
Irving W. Colburn &
Edgar Washburn
by
Howard, Cameron,
Lewis & Massie
Attorneys

No. 867,948. PATENTED OCT. 15, 1907.

I. W. COLBURN & E. WASHBURN.

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12 SHEETS—SHEET 10.

Fig. 20.

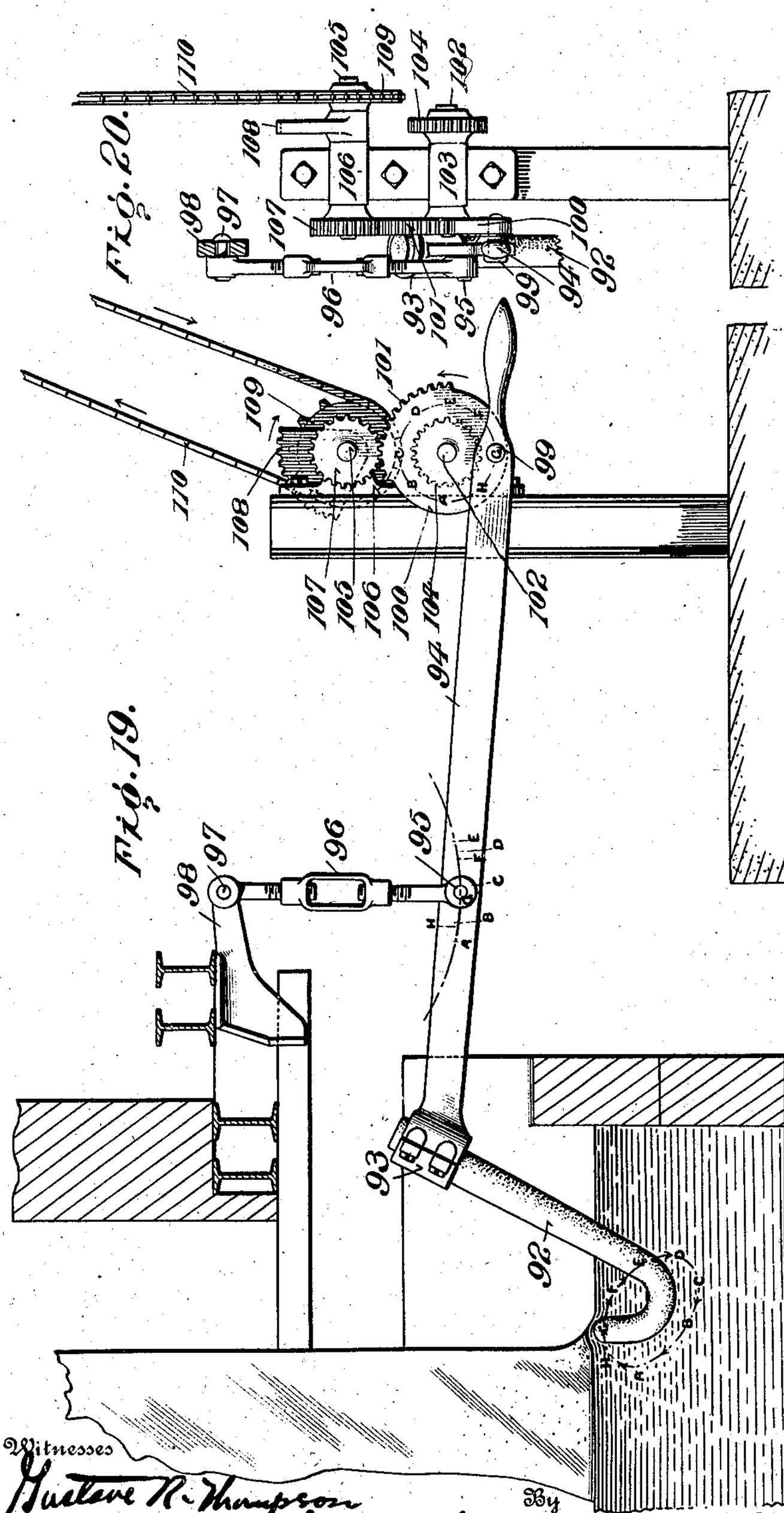

Fig. 19.

Witnesses

Gustave R. Thompson

Ruth C. Fitzhugh

Inventors

Irving W. Colburn

and

Edgar Washburn

By Munn, Cameron, Lewis & Massie

Attorneys

No. 867,948. PATENTED OCT. 15, 1907.

I. W. COLBURN & E. WASHBURN.

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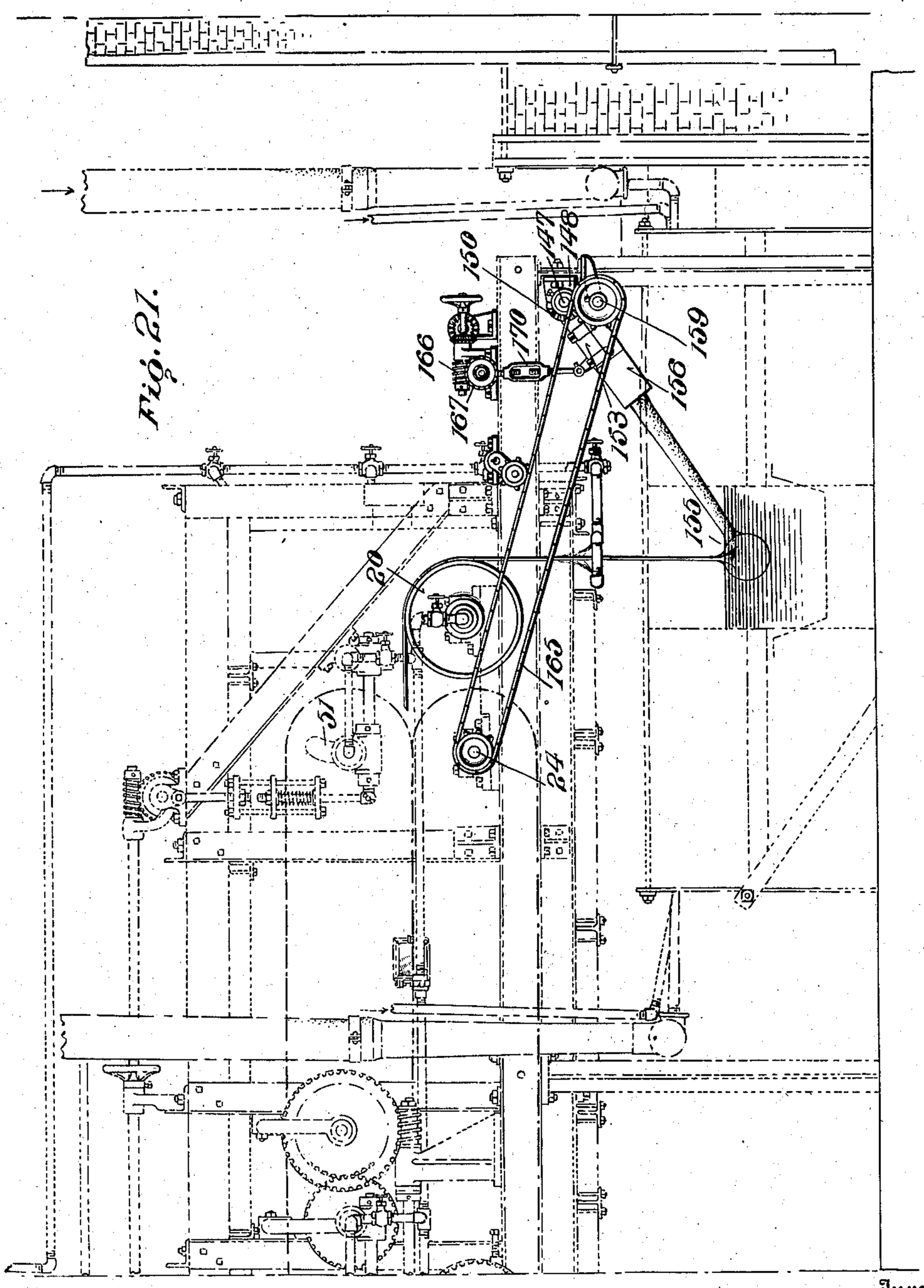
12 SHEETS—SHEET 11.

Fig. 21.



Witnesses
Gustave R. Thompson
Ruth C. Fitzhugh

Inventors
Irving W. Colburn
Edgar Washburn

By Mauro, Cameron, Lewis & Mauro
Attorneys

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I. W. COLBURN & E. WASHBURN.

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12 SHEETS—SHEET 12.

Fig. 22.

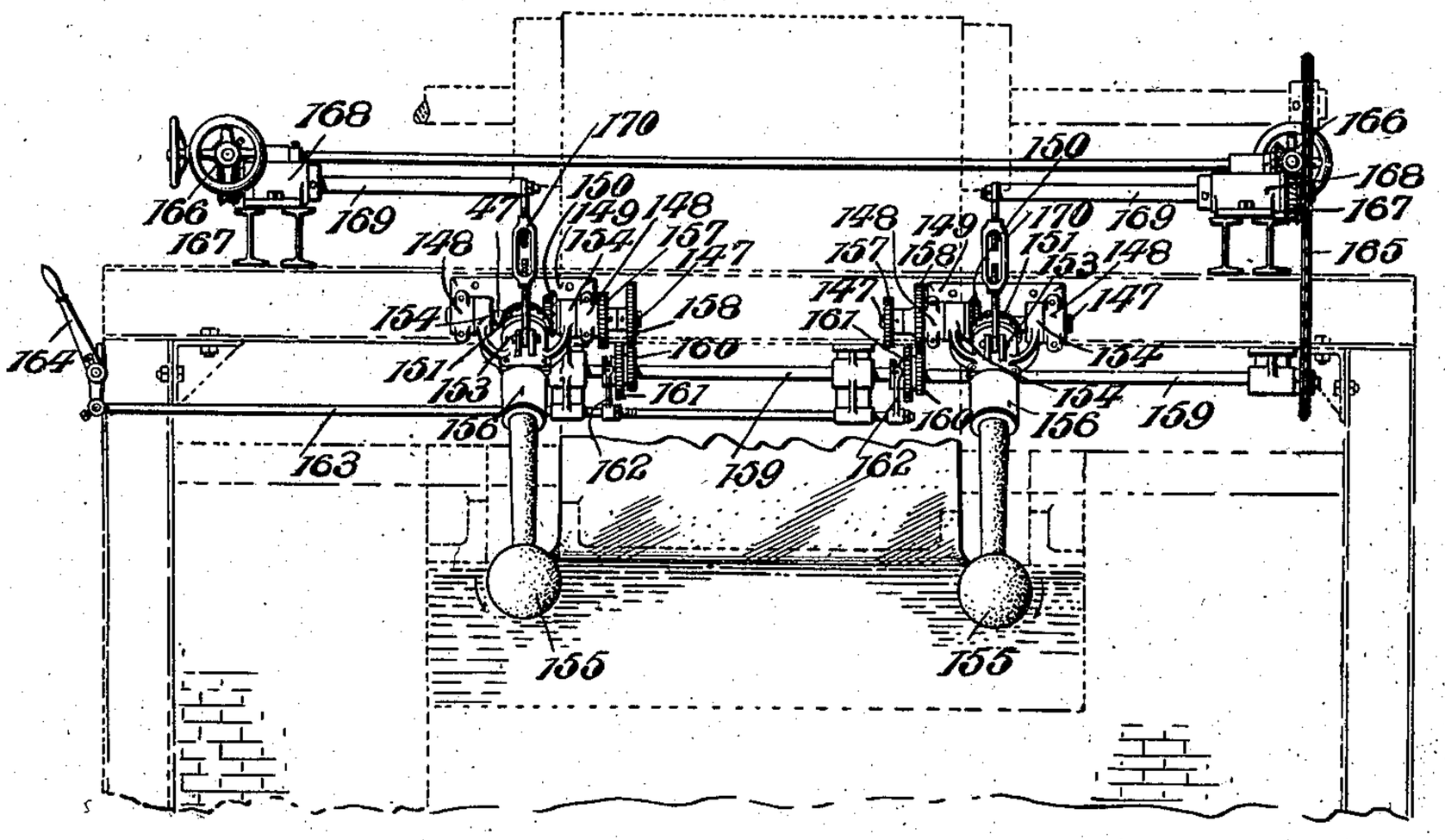
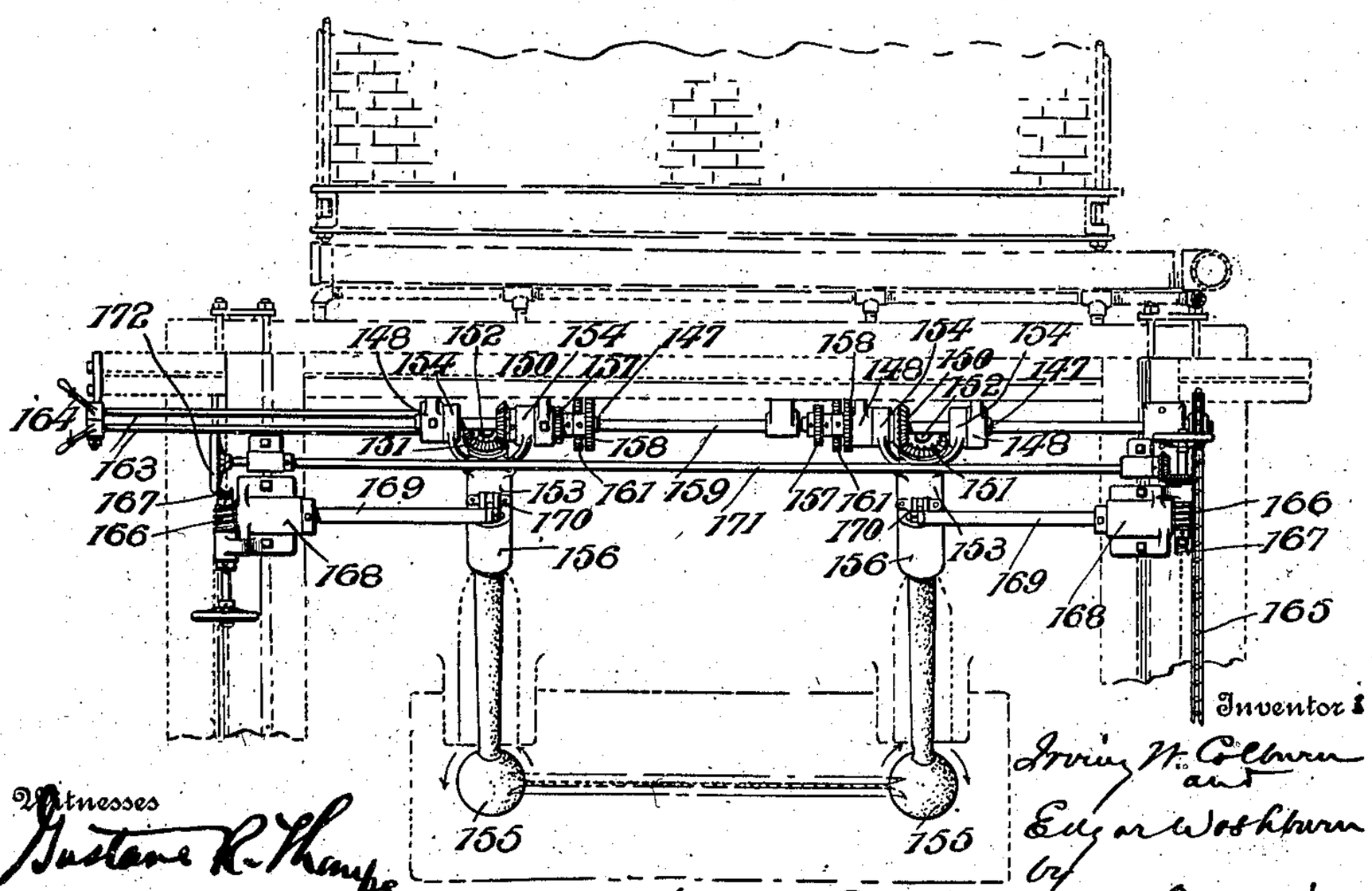


Fig. 23.



Witnesses
Gustave R. Thompson
Ruth C. Fitzhugh

Inventors
Irving W. Colburn
and
Edgar Washburn
by
Mauro, Cameron, Lewis & Massie
Attorneys

UNITED STATES PATENT OFFICE.

IRVING W. COLBURN AND EDGAR WASHBURN, OF FRANKLIN, PENNSYLVANIA, ASSIGNORS, BY DIRECT AND MESNE ASSIGNMENTS, TO COLBURN MACHINE GLASS COMPANY, OF FRANKLIN, PENNSYLVANIA, A CORPORATION OF NEW JERSEY.

APPARATUS FOR DRAWING SHEET-GLASS.

No. 867,948. Specification of Letters Patent. Patented Oct. 15, 1907.

Application filed March 6, 1906. Serial No. 304,555.

To all whom it may concern:

Be it known that we, IRVING W. COLBURN and EDGAR WASHBURN, of Franklin, Pennsylvania, have invented a new and useful Improvement in Apparatus for Drawing Sheet-Glass, which invention is fully set forth in the following specification.

This invention relates to the art of glass working, and more particularly to the art of drawing sheet glass. In some of its broader features it relates to the drawing of sheet glass whether the operation be a continuous or intermittent one, while in certain other of its most specific features it relates particularly to the continuous production of sheet glass.

The object of the invention is to draw sheets of glass of uniform width and, within certain limits, of any desired thickness.

As is well known in this art, whenever efforts are made to draw a sheet of glass from a mass of molten glass, the tendency of the sheet is to rapidly narrow down to a rope or thread. Moreover in the continuous production of sheet glass, (by which is meant the drawing of a sheet of glass continuously from a molten mass and severing the continuous sheet into suitable sections, the work proceeding for an indefinite length of time) it is necessary to provide means for carrying away the glass as it is produced and the division of the sheet into sections; and preferably there should also be provided means for annealing the glass.

In certain previously filed applications by ourselves, as joint inventors, as well as by Irving W. Colburn as sole inventor, there have been described and claimed certain methods and apparatus for performing these several operations, and the object of the present invention is to provide simplified mechanism and apparatus which in some respects may be regarded simply as improvements over structures disclosed in said previous applications.

Generally stated, the invention consists in a machine for drawing sheet glass, having a receptacle containing a mass of molten glass obtained from any suitable source, but preferably from a melting tank, in continuous and open connection with said receptacle, combined with means for drawing the sheet of glass from said receptacle, which means coöperate with devices for holding the sheet to uniform width, the sheet being drawn in a vertical direction and then turned from a vertical to a substantially horizontal direction, and passed through a suitable leer, where it is annealed, after which, as it emerges from the leer, it is divided into suitable sections preferably sections of uniform length.

In bending the glass from the vertical to the horizontal direction during the drawing operation, it is turned or bent over a suitable drum or roller, the glass at this point being softened by heat sufficiently to enable it to be thus bent without injury. As specifically pointed out in some of our previous applications, the glass is bent over a roller of this kind which is positively driven by power obtained from any suitable source, preferably in synchronism with the other elements of the apparatus. It has been found that while this operation can be very successfully performed, nevertheless in practice it sometimes occurs that, no matter how nicely revolutions of the drum may be timed with relation to the advancement of the sheet being drawn, there will take place an occasional slipping or relative movement between the surface of the drum and that portion of the sheet of glass in contact with said surface, which slipping or relative movement has a tendency to, and in many cases does, slightly mar the fine fire finish of the sheet. For the purpose of obviating this difficulty, the roller in the present invention is mounted upon any suitable frictional bearings and during the operation of drawing the sheet of glass the roller is caused to revolve slowly by the frictional contact of the sheet of glass with the surface of the roller, no power for positively driving the roller being applied thereto. This has been found to afford a perfect remedy for the marring of the sheet due to the relative movement between the surface thereof and that of the roller.

In the practical operation of mechanism of this kind, the entire machine and apparatus is always preliminarily heated or warmed up before the drawing of the sheet of glass is commenced, to the end that all the parts may be at the proper temperature. This preliminary heating would unevenly heat the drum or roller if it were permitted to remain stationary during the time (some hours) in which the preliminary heating occurs, and in the present invention means are therefore provided for causing the bending roll to turn during this preliminary heating operation, and after the preliminary heating has been completed and at the time when the drawing of the sheet is about to begin, the power applied to drive the roll is disconnected, and thenceforth, as above stated, it is moved slowly by the frictional contact of the sheet of glass therewith. Any suitable means for applying power to revolve the roller during the preliminary heating may be employed, such, for example, as a slip pinion, by means of which the shaft of the drum is geared or connected temporarily to any other moving part of the machine.

In our application Sr. No. 248,288, filed March 3, 1905, we have disclosed a method and apparatus for holding the width of the sheet uniform during the drawing operation, which consists broadly in imparting movement to the surface portion of the molten mass in the working chamber or pot away from the medial line of the sheet during the drawing operation, and in suitable apparatus for performing this step. Several forms of

apparatus for this purpose are disclosed in said application, one of which is in the form of revolving spheres, which revolve within the molten mass of glass and in opposite directions at points immediately adjacent to where the edges of the sheet are lifted from the surface of the molten mass. The present invention provides an improved means for thus imparting lateral movement to the surface of the mass of molten glass, said means consisting in a hook or hooks, which, without turning upon an axis, do, nevertheless, rotate or revolve in a given orbit within the mass of glass in such a manner as to have the hooks first dip into the glass a considerable distance below the surface and then move upward until they approach the surface of the molten mass at about the point where the edge of the sheet of glass being drawn leaves the molten mass, whereupon the hook then moves outward and downward to again repeat the operation. There may be, if desired, a single hook in the mass of molten glass adjacent to each edge of the sheet being drawn; or under certain conditions it is found desirable to employ two pairs of hooks in the mass of molten glass, each pair of hooks being immersed in the mass of molten glass at points adjacent to the edges of the sheet being drawn, the two hooks of each pair preferably moving in such manner that one of the hooks is at the upper portion of its orbit while the other hook is at the lower portion.

The sheet of glass being drawn and held to uniform width is, by the present invention, advanced from the bending roll to a suitable carrier by which it is moved into an annealing leer of any suitable construction, preferably one in which the carrier consists of a series of parallel rollers mounted on anti-frictional bearings and along which the sheet is advanced to the exit end of the leer, where a cutting table is located to receive the sheet as it emerges from the leer. An operator stands at this table and places a suitable ruler across the sheet, and with a diamond or other suitable cutting device, cuts the sheet as it progresses, (without interrupting its forward movement,) into suitable sections.

For the purpose of enabling the operator to hold the straight edge or other guide for the diamond in the position in which it was originally placed upon the sheet, means are provided moving synchronously with the sheet of glass, which pick up the straight edge or ruler and cause it to advance at the same rate as the sheet. Preferably these means are in the form of abutments placed immediately opposite each other near the edges of the table and advanced by any suitable means, preferably geared with the mechanism by which the sheet is drawn or advanced so that the whole will move together. As here shown, these abutments are in the form of two oppositely placed lugs carried by sprocket-chains on opposite sides of the cutting table, which sprocket-chains are driven by the same mechanism which draws the sheet of glass.

Other detailed features of the invention will be hereinafter specifically described and then pointed out in the claims.

The inventive idea involved is capable of expression in a variety of mechanical forms, one of which for the purpose of illustration is shown in the accompanying drawings, but it is to be understood that said drawings are for the purpose of illustration only, and not for the purpose of defining the limits of the invention, reference being had to the claims for this purpose.

In said drawings Figure 1 is a longitudinal, vertical, diagrammatic section of our glass drawing apparatus; Fig. 2 is a perspective view of the rear end of the leer and the cutting table, showing the straight edge or ruler in operative position; Fig. 3 is a longitudinal, vertical section through a portion of the melting furnace, and the connections between the same and the working chamber or pot, with the left-hand forward portion of the machine or apparatus for drawing a sheet of glass shown in elevation; Fig. 4 is a horizontal, sectional plan of the working chamber or pot, and the connections from the melting furnace with said chamber showing the course taken by the molten glass in moving from the furnace to the working chamber or pot, and also the paths taken by the heated products of combustion; Figs. 5, 6, 7 and 8 illustrate some of the forms which the hooks for retaining the glass to uniform width during the drawing operation may assume; Fig. 9 is a side elevation of the left-hand side of the external mechanism showing the gearing and connections for applying the power to draw and advance the sheet; and Fig. 10 is a like view of the right-hand side thereof; Fig. 11 is a plan showing the gearing by means of which the bending roll is connected to and disconnected from power driven mechanism; Fig. 12 is a front elevation of the machine with the working chamber or pot shown in vertical section; Fig. 13 is a broken sectional detail illustrating the exit end of the water conduit passing through the axes of the various shafts within the drawing chamber; Fig. 14 is an enlarged detail view of the right-hand side of the mechanism showing the means for simultaneously revolving or rotating in a desired orbit, a pair of hooks within the mass of molten glass; Fig. 15 is a front elevation of said hooks, the working chamber or pot being shown in transverse vertical section; Fig. 16 is a vertical section taken on the line 16—16, Fig. 9; Fig. 17 is a part sectional and part elevational detail illustrating the construction of the carrier rollers in the leer; and Fig. 18 is an enlarged sectional detail of the same; Fig. 19 is a side elevational detail illustrating one form of imparting the rotations or revolutions to the holding hook in its desired orbit; Fig. 20 is a side elevation of Fig. 19 looking from the right; Fig. 21 is a side elevation of a different means of holding the sheet of glass to the desired width, portions of the apparatus being shown in dotted outline. Fig. 22 is a rear elevation of the apparatus shown in full lines in Fig. 21; and Fig. 23 is a plan of the apparatus shown in Fig. 22.

Referring to the drawings in which like reference numerals indicate like parts, 1 is a melting furnace of any suitable description in which the raw materials for making glass are introduced, as for example, through door 2 (Fig. 3), and to which heat is supplied in any suitable manner, as for example, by means of suitable burners, certain portions of the products of combustion being conducted off through flues 3, leading to a stack 4, which flues are preferably controlled by any suitable damper, not shown. The other portions of the products of combustion are conducted through suitable flues 5, 5, over the surface of the glass as it advances to the working chamber or pot, this as plainly indicated in

Figs. 3 and 4. After passing over the surface of the glass on its way to the working chamber or pot, the waste products of combustion are conducted into a flue 7 to the rear of the chamber or pot and thence by a flue 8 to a downwardly leading flue 9, which connects preferably by an underground tunnel to stack 4 or any other suitable stack. The rear end of the melting chamber or pot has a depending partition wall 10 (Fig. 4) which has an opening 11 preferably at the bottom thereof, which opening communicates in an upward direction with a central conduit 12, and this conduit conducts the glass into a chamber 13 immediately surrounding the working chamber or pot 6. This chamber 13 divides where it leaves the conduit 12 and extends to the right and to the left around the working chamber or pot 6 and conducts the glass to the ends of said pot, where it enters the pot through two end openings 14, 14, situated in the bottom portion of the end walls of the pot 6. By this means, the hot glass flowing from the melting furnace passes around or comes in contact with three of the walls of the working chamber or pot and this hot glass is thus of service in maintaining the glass within the working chamber or pot in proper working condition.

For the purpose of assisting in maintaining the glass in the working chamber or pot at the desired temperature, there are provided suitable burners 15, 16, clearly shown in Fig. 4, which burners are preferably so positioned as to direct their flame directly against the side walls of the working chamber. As here shown these burners are of two kinds, the burners 15 being blast burners using gas and air under pressure; these burners 15 are employed when a high degree of heat is desired, and are generally used at the time when the cover is removed from the working chamber or pot during the operations of the machine. The burners 16 are of the Bunsen type and are designed to supply the heat necessary to hold the glass in the desired molten condition when the machine is out of operation. Manifestly, either of the burners may be used at any time as may be desired.

The working chamber or pot is much longer than it is wide, and is provided at its upper portion with an oblong opening somewhat greater in length than the width of the widest sheet to be drawn, all of the upper surface of the pot except this oblong opening being closed by overhanging walls, preferably in the form of downwardly extending lips or brackets 17, 17 (Fig. 3), which protect the greater portion of the surface of the molten mass of glass in the working chamber or pot from the cooling influences of the atmosphere.

Mounted on a suitable frame-work whose end extends out from the working chamber or pot is an inclosed drawing chamber having a transverse opening or slot in its bottom immediately above the oblong opening in the top of the working chamber. This drawing chamber is indicated by the reference numeral 18, and the bottom opening therein through which the sheet of glass is drawn is indicated by the reference numeral 19 (see Figs. 1 and 15).

Within the drawing chamber 18 is located a roller or drum 20 (Fig. 1), which is mounted upon anti-frictional bearings, as for example, ball bearings, such as shown at 21 in Fig. 14. These bearings are on the exterior portion of the drawing chamber, and the shaft of the drum is made hollow for the circulation of cold water or other cooling fluid therethrough, in order to obviate the injurious effects of the heat employed. This shaft is shown at 22 (Fig. 13). As hereinbefore stated, the drum with its shaft is in the form of an idle drum or roller, and during the operations of the machine is driven solely by the friction of the sheet of glass passing thereover in the manner shown in Figs. 1 and 14. During the preliminary stages however, when the mechanism is being heated up to the proper degree for the operation of drawing the glass, it is desirable to have the drum and all of the other parts of the mechanism moving substantially as they would during the drawing operation in order that all of the parts may be evenly and uniformly heated, and means are therefore provided for gearing the drum 20 with one of the moving parts of the machine. The gearing for this purpose is shown in Fig. 11, where 22′ is a gear keyed to the shaft of the drum 20, and 23 is a gear keyed to a driven shaft 24 forming a part of the carrier, as will be hereinafter described. Intermediate the gears 22′ and 23 is a slip gear or pinion 25, provided with a lever 26 by which it may be thrown into operative relation with the gears 22′ and 23, as shown in dotted lines in Fig. 11, or may be thrown out of operative relation with said gears 22′, 23, as shown in full lines in said figure.

Referring to Fig. 1, 27 is a shaft within the drawing chamber and parallel with shaft 24, each of said shafts extending through the chamber, and with their ends projecting through the walls thereof. Within the chamber each of said shafts is provided with a pair of sprocket wheels over which pass two sprocket chains 28, bearing bars 29, which together unite to form an endless carrier or table for receiving the glass immediately after it leaves bending roller 20. Motion is imparted to the carrier table by a worm shaft 30 mounted in suitable bearings 31, 32, supported on the frame-work of the machine and driven by a sprocket chain 33 extending from any suitable power shaft. The worm 34 on shaft 30 engages a worm gear 35 on the projecting end of the shaft 27, and thereby serves to revolve said shaft, the shaft 24 being in turn driven by the sprocket chains 28, extending over the shaft 27 to said shaft 24.

Mounted immediately above and parallel to shafts 24 and 27 are two shafts 36 and 37, whose ends likewise project through the walls of the drawing chamber 18. On the interior of the said chamber these shafts 36 and 37 are provided with sprocket wheels over which pass a pair of sprocket chains 38, and carried on said sprocket chains 38 are a plurality of grip bars 39. As here shown, there are three of such grip bars. When in normal operative position, these grip bars act to grip the sheet of glass against one of the bars of the endless carrier supported on the chain 28 and impart the necessary pull to continue the drawing operation, and at the same time advance or push the sheet which has been already drawn through the leer 40.

Power is transmitted to drive the grip bar carrying chains 38 through the shaft 37. Referring to Fig. 9, 37′ is a gear wheel keyed to the end of the shaft 37, which gear wheel is in mesh with an idler gear 37″, turning on a stub shaft projecting from the side of the machine. Worm 34′ gears with worm wheel 34″, which is integral with or has secured thereto a gear wheel 34ª in mesh with the idler gear 37″. By this means the lower por-

tions of the sprocket chains 38 are driven in the same direction as the upper portions of the sprocket chains 28, and at the same rate of speed as the latter sprocket chains.

The shafts 36 and 37, carrying chains which support the grip bars are mounted upon bearings 41, 41 on the exterior of the machine, which bearings are supported upon bars 42 pivoted to turn about axes 43, 43. The outer ends of the bearing bars 42, 42, are supported by adjustable spring links 44, 44, which in turn are pivotally connected to cranks 45, 45, attached to shafts 46, 46. On each of the shafts 46 there is keyed a worm gear 47 in mesh with a worm 48 on a shaft 49 turning in suitable bearings upon the top of the frame-work of the machine, having a hand wheel 50 secured thereto. It will be understood that the shafts 46 extend entirely across the machine and have cranks 45 and links 44 connected thereto at each end, as clearly shown in Fig. 16. By turning shaft 49 through the medium of wheel 50, the shafts 36 and 37 may be elevated, the side walls of the drawing chamber being provided with slots 51, through which said shafts may move during said elevating operation. By this means the grip bars may be elevated out of contact with the carrier table within the drawing chamber. This is a very important manipulation in connection with the start of the drawing operation, as will be hereinafter more fully described.

Mounted to turn in suitable bearings upon the top of the machine near the rear end of the drawing chamber is a shaft 52, bearing a drum or drums 53 around which are wound chains or cables 54 to the ends of which is attached any suitable form of bait as a bar of metal 55. The outer projecting end of the shaft 52 is provided with a sprocket over which extends a sprocket chain 56 which chain also extends to and around a sprocket wheel 57 on the outer end of the carrier shaft 27, as is clearly shown in Figs. 1 and 10. The sprocket on the shaft 52 is loose thereon, but is capable of engagement by a clutch 58 keyed to the shaft and manipulated by means of a clutch lever 59 and clutch fork 60, as will be readily understood from inspection of Figs. 10 and 12.

In starting the drawing operation, the operator inserts a long iron bar in front opening 61 (Fig. 1) of the drawing chamber, and the shafts 36 and 37 being elevated so as to raise the grip bars, said rod is advanced to the rear of the drawing chamber where by means of a hook on the end of the rod, it engages the bait on the chains 54 and draws the same forward, the chains passing under guide roll 62 (Fig. 1) and the chain drum or drums being permitted to run loose or free as the bait is pulled forward. After it is pulled over the roller 20, it is permitted to drop down through the bottom opening 19 in the drawing chamber and into the molten glass in the working chamber or pot, as will be clearly understood from inspection of Figs. 1 and 12. After the bait has been dropped into the molten glass, it is permitted to remain till the glass sticks or adheres thereto when the clutch 58 is thrown so as to revolve the shaft 52, and the bait chains are wound upon the drum or drums 53, thereby slowly elevating the bait with the glass adhering thereto in sheet form and drawing it over the roll 20 along over the top of the carrier table and out from under the guide roll 62. At this point a bar or rod 63 which serves to connect the chains 54 to the bait 55, is withdrawn through a suitable opening 63 (Fig. 10) in the side walls of the drawing chamber and the shafts 36 and 37 are simultaneously lowered so as to bring the grip bars 39 down upon the sheet of glass, and thereafter the pulling or drawing of the sheet of glass is accomplished by the grip on the sheet between the said grip bars and the carrier table. During this drawing operation, in order to maintain the sheet of glass in a sufficiently heated condition to enable it to be bent readily over the drum 20, burners 64 (Fig. 1) play upon each side of the sheet of glass before it reaches the roller, and burners 65 direct their flame upon the sheet of glass at the point where it makes it bend over the roller. In addition to these burners, there are preferably employed burners 66 entering the front end of the chamber at its upper portion, and these burners direct their flame into the front portion of the chamber, preferably against a depending partition wall 67 which acts to direct the heat from the burners 66 downward upon the sheet of glass, and at the same time prevent the heat from becoming too intense in that portion of the drawing chamber in which is located the carrier table and the grip bars and other mechanism.

For the purpose of overcoming the tendency of the sheet to narrow or draw to a rope during the drawing operation, we provide, on either side of the front end of the machine, bodies of refractory material preferably in the form of hooks, which extend down into the ends of the working chamber or pot at an angle of about 45°, and provide means for revolving or rotating said hooks in orbits which lie beneath the surface of the molten glass in the working chamber or pot. The orbits of these hooks are located immediately opposite each other, and have their nearest points at a distance apart substantially equal to the width of the sheet to be drawn. If desired, a pair of such refractory hooks may be located on each side of the machine. For purposes of illustration, the construction is so shown, the two members of each pair of hooks moving in their particular orbit in such a manner that one of the hooks is at the top portion of the orbit nearest to the surface of the molten glass at the time when the other hook is at the lowest portion of their orbit of movement.

Referring to Figs. 9, 10, 14 and 15, 68 is a spur gear on the projecting end of the continuously driven shaft 24, which spur gear is keyed to or integral with a bevel gear 69, meshing with spur gear 70, secured to shaft 71, turning in suitable bearings supported on part of the frame-work of the machine. On the other end of the shaft 71 from the bevel gear 69 are splined two spur gears 72 and 73, the former of which is considerably larger in diameter than the latter, which gears are arranged to be slid or adjusted upon the shaft 71 by means of bell-crank forked lever 74, in a way that will be readily understood from inspection of the drawings. Immediately below the shaft 71 is a crank shaft 75 having keyed to its end adjacent to the spur gears 72 and 73, spur gears 76 and 77, the former of which is of less diameter than the latter. These two spur gears are so spaced and of such diameter that when the spur gear 73 is adjusted into alinement with the spur gear 71, it engages and operates the same, and when the spur gear 72 is adjusted into alinement with spur gear

76, it engages and operates said spur gear, the gear 73 being at that time out of engagement with the gear 77. By adjusting the spur gears 72 and 73 into a position between the spur gears 76 and 77, the shaft 71 will be entirely disconnected from the shaft 75. This shaft 75 has on its end opposite the spur gears 76 and 77, a double crank 78 upon which are loosely hung crank arms 79 and 80, which crank arms are arranged to slide loosely through a bearing block 81, hung on trunnions in fork 82, supported by a rod 83, passing up through a guide bracket 84, bolted to a part of the frame-work of the machine. This rod 83 is screw-threaded at its upper end and has a nut 85 threaded thereon, which nut has its cylindrical exterior surface cut with worm gear threads which are engaged by a worm 86 on a shaft turning in suitable bearings, and having a hand-wheel 87 secured thereto. The crank rods 79 and 80 have clamped thereto refractory hooks 88 and 89, the whole being arranged so that the shanks of these hooks stand at an angle of approximately 45°, and with the lower or hooked ends immersed beneath the surface of the molten mass in the working chamber or pot, which pot has its end walls cut away or formed with an inclined channel 90 to permit of the insertion of the hooks as shown.

By revolving the hand-wheel 87, the worm gear 85 may be revolved upon the screw-threaded end of the rod 83, and said rod is thereby raised or lowered as the case may be, thus determining the extent of the immersion of the hooks 88 and 89 in the molten glass. The power from the shaft 24 continuously drives the shaft 71, and through the medium of the gear 72 or 73, and the gear 76 or 77, as the case may be, revolves the crank shaft 75, thereby causing the crank arms 79 and 80, and with them the hooks 88 and 89, to oscillate the supporting block 81, and at the same time slide up and down therethrough, thereby causing the lower or hooked end of each of the hooks to move in an orbit, substantially such as indicated by the dotted lines and arrows in Fig. 15. If it is desired that the hooks move at a fairly rapid rate, the lever 74 is thrown so as to bring gear 72 into mesh with the gear 87; and on the other hand, if a slower movement is desired, the lever is thrown to bring the gear 73 to mesh with the gear 77, as shown in Fig. 14. By connecting the mechanism for operating the hooks directly with the mechanism for drawing a sheet of glass, it will be seen that the operation of the hooks may be synchronous with the drawing of the sheet.

Manifestly, instead of employing a double crank on the shaft 75 and two crank rods and two hooks, one of the cranks together with one of the rods and hooks might be omitted and in certain classes of work this is done, while in other classes of work, the use of two hooks is preferred.

For the purpose of preventing the molten glass from hardening and piling up upon the shanks of the hooks 88 and 89, and thereby clogging the working of the apparatus, a suitable burner or burners 91 are so positioned as to direct their flame downward into inclined channel or way 90, and melt down the glass which would otherwise collect upon the shanks of the hooks.

In some instances it is found desirable to have the refractory hook as it moves in its orbit, make a rapid downward movement, and then as it approaches the surface and begins to move outward again, have the movement slowed up, to the end that the hook may quickly descend into position to get hold of hot glass well beneath the surface, and as quickly rise into operative position near the surface of the molten glass, and then slowly move outward. By this operation the hooks consume a very small amount of time in getting hold of the hot glass, and the greater portion of the time is consumed in the positive operation of holding the sheet to its full width. In this particular operation, the means for causing the hooks to move in the particular orbit indicated, differ somewhat from those shown in Figs. 9 and 10, and may be of the character illustrated in Figs. 19 and 20, in which 92 is a hook of refractory material, clamped at 93 to a lever 94, pivoted at 95 to a swinging link 96, suspended by pivot 97, to any suitable support, as a bracket 98, connected to the frame-work of the machine. The outer end of the lever 94 is connected as by a crank pin 99 to a disk 100, having gear teeth 101 throughout a portion only of its periphery. This disk is keyed to a shaft 102, supported in bearings 103, having on its other end a continuous gear 104. Immediately above the shaft 102 is shaft 105, turning in bearings 106, and has keyed thereto, in the same vertical plane with the disk 100, a continuous gear 107, and in the same vertical plane as the gear 104 is a segmental gear 108. The shaft 105 has also secured thereto a sprocket wheel 109, engaged by a driving sprocket chain 110.

The proportions of the several gears and segmental gears are such that the small gear 107 engages the segmental gear 101, and the instant that the gear 105 passes off of or becomes disconnected from the segmental gear 101, the segmental gear 108 picks up the continuous gear 104. The gear 105 moves the crank disk 100 at a comparatively slow rate of speed, while the segmental gear 108 through its engagement with the small gear 104 revolves disk 100 at a comparatively rapid rate of speed, thereby imparting to the right-hand or handle hand of the lever 94 a movement in a generally horizontal direction, as well as an up and down movement, the point at which it is connected to the disk, that is, the crank pin 99, moving in a circle, indicated by the reference letters A, B, C, D, E, F, G and H. This movement of the lever causes the same to swing in an arc on the link 96 at the same time that the ends of the lever are elevated and depressed, this arc being indicated by the letters from A to H. This combined swinging and oscillating movement of the lever 94 causes the hooked end of the hook 92 to travel in the orbit indicated by the letters A to H, and in the direction indicated by the arrow-heads on said orbit. The relative positions of the three points, viz., the crank pin 99, the pivot pin 94, and the point of the hook 92, at any given time will be indicated by the corresponding letters. It will be seen that while the crank pin 99 on the disk 100 is moving from the position G to the position E, the point of the hook in the molten glass will be moving from the point G to the point E in the orbit, and the pivot pin 95 will be swung from the position G to the position E in the arc of its movement. Referring to Fig. 19, the gear 107 will engage the segmental gear 101 at about the time when the crank pin 99 is in the position H, at which time the point of the refractory hook 92 will occupy about the position H in

its orbit. The disk will then be slowly revolved by the small gear 107 and the crank pin 99 will move from position H to the position G, and then position F, and then the position E, and during that time the point of the hook 92 will have reached its highest point G, and then begin to descend to the point F and then to the point E, this portion of its movement being comparatively slow. At this instant however, the segmental gear 108 picks up the pinion 104, and the disk is quickly revolved so as to move the crank pin 99 rapidly from the position E around to the position H, thereby occupying in turn positions D, C, B and A. This will cause the point of the hook 92 to be quickly depressed, moving from position E to positions D, C, B and A; that is, it will be caused to quickly dip to the lowest point of its orbit, and quickly rise therefrom to a point near H, when it will begin to move slowly in an outward direction, first rising very slightly, and then lowering very slightly. In this way, the hook is caused to quickly pick up the hot glass well below the surface and bring it up to near the surface, and then moves slowly outward, thereby consuming the greater portion of its time in moving outward.

As hereinbefore mentioned, the power used for moving the sheet of glass through the leer is the push of the sheet secured by a gripping of the same between the grip bars 39 and the carrier table 28, and in order that the friction of the sheet moving through the leer may be reduced to the lowest amount, the sheet moves on rollers placed in the leer. These rollers are of a peculiar construction, clearly shown in Figs. 17 and 18. Loosely mounted on a series of parallel shafts 111, which are fixed in bearings 112, are a series of rollers 113. These rollers are in the form of disks 114, faced preferably with asbestos 115, and provided on each side with hub-like flanges 116, which form, together with adjustable sleeves 117, raceways for ball-bearings 118, the whole constituting a ball-bearing and raceway therefor of an ordinary and well-known construction, which permit the rollers 113 to turn around the shaft with a minimum of friction. It will be understood that there are a large number of these shafts 111 arranged parallel to each other and in a horizontal plane, as shown in Fig. 1, the same being suitably spaced throughout the length of the leer.

When the sheet of glass reaches the end of the leer, it emerges from a long horizontal slit or opening 119 (Figs. 1 and 2) onto a table 120. Supported on the frame-work of this table are two transverse shafts 121 and 122, bearing on each of their projecting ends sprocket wheels 123, and sprocket chains 124 pass over each of the sprocket wheels on each side of the table. Secured to these sprocket chains at suitable intervals are projecting lugs 125, the distance between any two lugs upon the chains being preferably the same as the distance between any two of the grip bars 39 on the sprocket chains 38. The sprocket chains 124 and the lugs 125 are so arranged with reference to the table that the lugs 125 project upward above the surface of the table, as clearly shown in Figs. 1 and 2. Arranged on each side of the table, and at the end adjacent to the leer are two blocks 126, upon which is laid a straight edge or rule 127, and as the lugs 125 advance they strike or pick up the straight edge or rule 127, and push it off of the blocks 126, carrying the straight edge across the face of the table. The parts are so timed that the lugs 125 will pick up the straight edge 127 at just the instant when that portion of the sheet of glass which has been marred by the grip bars 39, is under the straight edge 127, so that the sheet of glass can be cut along the marred line due to the gripping of the bars 39. As the sheet of glass, and with it the straight edge, continues to move, the operator with a diamond cuts the glass along the line of the straight edge.

In order that the lugs 127 may move in synchronism with the other parts of the machine, they are connected by means of sprocket wheel 128 on shaft 122, and sprocket chain 129 on shaft 27 (see Fig. 10) which is provided with a driving sprocket 130, for this purpose.

All of the shafts which extend through a highly heated part of the drawing chamber, for example shafts 24 and 36 and the shaft bearing the bending roller 20, are hollow, and if desired shafts 27 and 37 are also hollow, and cold water or other cooling liquid is circulated through these shafts for the purpose of preventing the intense heat from softening the shafts and causing them to bend out of alinement. For the purpose of introducing water through these shafts, a water conduit 131 (Fig. 9) has branches leading to all of the shafts above named on the left-hand side of the machine, and connected thereto by suitable stuffing boxes. The flow of water is controlled by suitable valves 132. In the case of the shafts 36 and 37, the main water conduit 131 is connected to the hollow shaft by branch pipes 133, which turn upon the same center as the rods 42, which support the bearings for said shafts so that when the shafts are elevated and move through the arc-shaped slots 51, the water pipe connections yield to permit this movement without any disturbance of the water connections. The exit of the water from the hollow shafts is on the right-hand side of the machine, and the construction is substantially the same for all of the shafts. This construction is shown in Fig. 13 in connection with shaft 22, in which there is an inverted U-shaped connection 134, which empties freely, and by gravity, by means of a nozzle, into the pipe connection 136, which leads to the sewer. By placing in this inverted U-shaped connection the exit of the water passage through the shafts, the possibility of all the water flowing directly out of the shafts and being emptied at a time when heat is applied, is avoided, since the water will remain within the shafts at all times, and when pressure is applied by opening the valves 132, this pressure will act to force the water upward over the inverted U 134, and into the sewer.

The gaseous fuel for the burners 64, 65 and 66 is supplied by gas main 137 (Fig. 9), which by suitable branch pipes, conducts the gas to the front of the machine and to the several burners, as will be readily understood from inspection of said Fig. 9.

For the purpose of covering the working chamber or pot at the time when the same is out of use, and thereby shielding the glass in said pot from cooling influences of the external atmosphere, a cover 138 (Figs. 3, 9, 10 and 15) is provided, which cover is preferably a slab of refractory material, of sufficient length and width to close the opening in upper portion of said pot; and

for the purpose of facilitating the handling of this cover in placing it in, and removing it from, its position, the same is inclosed in a metal frame-work, which frame is connected by suitable means at each end to a pair of trucks running upon tracks, furnished by the flanges of the angle irons forming a part of the frame-work of the machine. Each of these trucks consists of a frame-work 139 (Figs. 9 and 10) provided with wheels 140, running upon the flange or rail 141, the frame-work depending from the wheels in the manner shown in said figures, and forming bearings 142 for a crank rod 143, to which are attached crank arms 144, whose depending ends are pivotally secured to the frame of the cover 138. The crank shaft 143 has an operating lever 145 keyed thereto, and by turning the crank rod through the medium of said lever, the cover may be lifted, and the truck, while the cover is held lifted, run backward or forward upon the track 141. It will be understood that there are two of these trucks, one at each end of the cover, and that two operators are engaged in moving the cover, one manipulating each truck.

A slightly modified construction is shown in Fig. 15, in which the operating lever 145′ is fulcrumed on the frame 139 of the truck, and has its load end connected by a link 146 to a portion of the frame of the cover, and by depressing the handle end of the lever 145′, the cover may be lifted and while held lifted, the truck may be run along the rail.

It will of course be understood that various forms of hooks for holding the glass to its proper width may be employed. Thus for example, these hooks may be shaped as shown in Figs. 3 and 14, or in Fig. 19, or they may assume any one of the forms shown in Figs. 5, 6, 7 and 8, or any other form suitable for the purpose.

In some cases, instead of employing the hooks moving in an orbit, as shown in Figs. 15 and 19, revolving bodies which turn about a fixed axis may be employed, as shown in Figs. 21, 22 and 23. In this case, the shafts for the revolving bodies (which bodies are preferably made of refractory material) extend out through the sides of the working chamber or pot, as shown in our previous application, Serial No. 238,592. In this construction, the mechanism for operating each one of the revolving bodies is substantially the same, and a description of the mechanism connected with one will therefore be sufficient for both. Referring to said Figs. 21, 22 and 23, 147 is a shaft turning in bearings 148, supported by a bracket 149 suitably secured to the frame-work of the machine. Keyed to the shaft 147 is a bevel gear 150 which meshes with a gear 151 on a shaft 152, which shaft turns in a bearing 153, swinging by means of supporting arms 154 around the shaft 152. Shaft 152 extends through the bearing 153, and the refractory bodies have their shanks clamped to said shaft by means of a clamp 156 so that the bodies 155 turn with the shaft 152. Shaft 147 has keyed on the end opposite the bevel pinion 150, small spur gear 157 and large spur gear 158. Power shaft 159 has small gear 160 and larger gear 161 splined thereon, so that they may slide together upon the shaft 159. The relative arrangement of the parts is such that gear 160 on shaft 159 can engage gear 158 on shaft 147, as shown in Fig. 22; or the two gears 160 and 161 may be shifted to the left so as to throw gears 160 and 158 out of engagement, and gears 157 and 161 into engagement. Or the two gears 160 and 161 may be thrown into a position so that neither one of them will engage either of the gears upon shaft 147. By this means, the power may be wholly disconnected from the revolving spheres 155 or they may be connected so as to give a slow revolution to said spheres, or a more rapid revolution, as may be desired.

For the purpose of effecting the adjustment of the gears 160 and 161 along the shaft 159, arm 162 is keyed to a sliding rod 163, supported in suitable bearings, and said rod has connected thereto an angle lever 164, by which the rod 163 may be caused to slide in its bearings, and thereby effect the movement of the arm 162, and with it the gears 160 and 161, with whose common hub arm 162 is in loose engagement.

Power is imparted to shaft 159 through a sprocket chain 165 engaging a sprocket wheel on the end of said shaft, and extending to a continuously moving part of the machine, as for example, the shaft 24 (see Fig. 21).

For the purpose of elevating and depressing the revolving spheres 155, and thereby determining the extent of the immersion of said spheres within the mass of molten glass, means are provided for elevating or lowering the bearings 153. These means as here shown consist of a worm shaft 166 (Fig. 22) engaging a worm 167 (Fig. 21) secured to a shaft turning in bearings 168, and having on its opposite end an eccentrically placed crank pin 169 connected by link 170 to the bearing 153. As shown in Figs. 22 and 23, the worm 166 on the right-hand side of the figures, instead of being turned by the hand-wheel attached to the worm shaft, may be revolved by intermeshing bevel gears, one of which is on said shaft, and the other of which is on a shaft 171, turning in bearings on the frame and extending to the opposite side of the machine, where it is provided with a hand-wheel 172. By this means, both of the spheres can be adjusted from the same side of the machine.

In some instances it is desirable to manipulate by hand at the beginning of the operation the hooks for holding the sheet to its full width. For example, in the construction shown in Figs. 19 and 20, the lever 94 may be disconnected from the disk 100, and the operator by grasping the handle-end of the lever can swing the same upon link 26, and also effect such immersion of the hook in the mass of molten glass as may be effective for securing the control of the sheet and holding it to its proper width. This operation might be continued indefinitely with an operator at each side of the sheet of glass, but preferably when the operation is carried to the point where the sheet is being drawn at uniform width the lever 94 is again connected to the disk 100 and the operation proceeds automatically.

By the use of the mechanisms hereinbefore described, it will be perceived that a sheet of glass can be drawn and held to uniform width by very simple mechanism, capable of fine adjustment, and that the sheet of glass being drawn may be readily and at once advanced through an annealing leer, and cut into sheets of desired length with a minimum waste of glass. Moreover, it will be perceived that the mechanism for drawing the sheet, for holding it to its width, for annealing, and for cutting, are of extremely simple construction, and all of them operate synchronously.

What we claim is:

1. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass,

means for drawing a sheet of glass of uniform width from said mass, and an idler roller over which said sheet is bent to change its direction of movement.

2. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means for vertically drawing a sheet of glass of uniform width from said mass, and an idler roller over which said sheet is bent to change its direction of movement.

3. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet of glass from said mass, means moving in said molten mass to maintain the uniform width of the sheet, and an idler drum or roller over which the sheet is bent to change its direction of movement.

4. In a continuous sheet glass making machine, the combination of a receptacle containing a mass of molten glass, means for continuously drawing a sheet of glass of uniform width therefrom, and means moving in unison with said drawing means and determining a line of cut, whereby said continuously moving sheet may be severed into sections along predetermined lines without interrupting the drawing operation.

5. In a continuous sheet glass making machine, the combination of a receptacle containing a mass of molten glass, means for continuously drawing a sheet of glass of uniform width therefrom, a leer into which the sheet is passed as drawn, and means at the exit end of the leer moving in unison with the drawing means and determining a line of cut, whereby the annealed sheet may be cut into regular sections along predetermined lines.

6. In a continuous sheet glass making machine, the combination of a receptacle containing a mass of molten glass, means continuously drawing a sheet of uniform width therefrom, and ruler-controlling means moving at the same rate as the drawn sheet, whereby a straight line for the cutter may be had without interrupting the advancing movement of the sheet.

7. In a continuous sheet glass making machine, the combination of a receptacle containing a mass of molten glass, a leer, with means continuously drawing a sheet of uniform width and advancing it through said leer, and ruler-controlling devices moving in unison with said drawing means, whereby a ruler may be placed on the moving sheet and be moved with it during the cutting operation.

8. In a continuous sheet glass making machine, the combination of a receptacle containing a mass of molten glass, means continuously drawing a sheet of uniform width therefrom, and a pair of ruler-controlling abutments one adjacent to each edge of said sheet, and means moving said abutments synchronously with said sheet.

9. In a continuous sheet glass making machine, the combination of a receptacle containing a mass of molten glass, means continuously drawing a sheet of uniform width therefrom, a leer through which the sheet is advanced as drawn, a pair of ruler-controlling abutments one adjacent to each edge of said sheet near the exit end of the leer, and means moving said abutments synchronously with said sheet.

10. In a continuous sheet glass making machine, the combination of a receptacle containing a mass of molten glass, means for continuously drawing a sheet of uniform width therefrom including grip bars which seize the sheet at uniform intervals, and ruler-controlling means moving synchronously with said sheet adjacent to the points where the sheet has been engaged by said grip bars, whereby the sheet may be cut at the points where the grip bars mar the same.

11. In a continuous sheet glass making machine, the combination of a receptacle containing a mass of molten glass, means for continuously drawing a sheet of uniform width therefrom including grip bars which seize the sheet along transverse lines at uniform intervals, and ruler-controlling abutments one adjacent to each edge of the sheet opposite the ends of said transverse lines, and means moving said abutments synchronously with said sheet, whereby said sheet may be cut along the lines where the grip bars have marred the sheet.

12. In a continuous sheet glass making machine, the combination of a receptacle containing a mass of molten glass, means for drawing a continuous sheet of uniform width therefrom, a leer through which the sheet is advanced, a table along which the sheet is advanced as it emerges from the leer, and a pair of oppositely disposed ruler-controlling abutments moving along the edges of the table synchronously with the sheet.

13. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet of glass therefrom, a pair of oppositely disposed hooks one adjacent to each edge of the sheet being drawn, and means moving said hooks in the mass of molten glass and in a plane of the sheet being drawn.

14. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet of glass therefrom, a pair of oppositely disposed hooks one adjacent to each edge of the sheet being drawn, and means moving said hooks in curved paths within the molten mass and in the plane of the sheet being drawn.

15. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet therefrom, a pair of oppositely disposed hooks one adjacent to each edge of the sheet being drawn, and means moving said hooks in the mass of molten glass in proportion to the rate of movement of the sheet being drawn and in the plane of said sheet.

16. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet of glass therefrom, means for maintaining the width of the sheet uniform consisting of a pair of oppositely disposed hooks one adjacent to each edge of the sheet being drawn but within the mass of molten glass, and means moving each of said hooks in an elliptical path within the molten mass and in the plane of the sheet being drawn.

17. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means drawing a sheet of glass therefrom, means for maintaining the width of the sheet uniform consisting of two pairs of hooks one pair adjacent to each edge of the sheet being drawn, and means moving each pair in the mass of molten glass and in the plane of the sheet being drawn.

18. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means drawing a sheet of glass vertically therefrom, an idling roller over which said sheet is bent as drawn, a pair of oppositely disposed hooks one adjacent to each edge of the sheet being drawn, and means moving said hooks within the mass of molten glass and in the plane of the sheet being drawn.

19. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means drawing a sheet of glass vertically therefrom, an idling roller over which said sheet is bent as drawn, a pair of oppositely disposed hooks one adjacent to each edge of the sheet being drawn, and means moving said hooks in elliptical paths within the mass of molten glass and in the plane of the sheet being drawn.

20. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet of glass therefrom, refractory bodies moving in said mass to hold the sheet to uniform width, shanks or supports for said bodies projecting out of the molten mass, and means directing a melting heat against said shanks or supports.

21. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet of glass therefrom, bodies moving in said mass to hold the sheet to uniform width, supports for said bodies projecting out of the molten mass, and burners directing a melting heat around said supports.

22. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet of glass therefrom, channels or ways formed in the walls of said receptacle, bodies moving in said mass to hold the sheet of uniform width and having supporting members extending outward through said channels or ways, and means directing a melting heat along said channels or ways around said supporting members.

23. In a sheet-glass drawing machine, the combination

of a receptacle containing a mass of molten glass, means for drawing a sheet of glass therefrom, a chamber into which the sheet passes as drawn, means for heating said chamber, operative parts of the mechanism mounted on hollow revolving shafts passing through said chamber, and means directing a cooling medium through said hollow shafts.

24. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, a heated drawing chamber, drawing means in said chamber, including grip devices and hollow shafts for revolving the same, means for moving said shafts bodily in adjusting them into and out of operative position, and flexible connections directing a cooling medium through said hollow shafts.

25. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, a heated drawing chamber, drawing devices in said chamber and including a continuous carrier and continuously moving grip bars co-acting therewith, hollow shafts for supporting and driving said carrier and grip bars, and means directing a cooling medium through said hollow shafts.

26. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, a drawing chamber, a continuous carrier in said chamber, continuously moving grip bars co-acting with said carrier to grip the sheet and impart the drawing pull thereto, and means moving said grip bars out of coöperative relation with said carrier.

27. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, a heated drawing chamber, a continuous carrier in said chamber, a pair of shafts located above said carrier and bearing sprocket chains, a plurality of grip bars on said chains and normally coöperating with the carrier to grip and draw the sheet, openings in the walls of said chamber through which the ends of said shafts project, bars pivoted at one end to the walls of said chamber and having bearings for said shafts at the other end, and means supporting the free ends of said pivoted bars.

28. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, a heated drawing chamber, a carrier and grip devices acting to draw a sheet of glass into said chamber, an idler roller in said chamber and over which the sheet is bent as drawn, and a partition wall across the upper portion of the chamber and in advance of the carrier and grip devices.

29. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, a drawing chamber, a continuous carrier and grip devices in said chamber operating to draw a sheet of glass from said receptacle into said chamber, an idler roller in the chamber and over which the sheet is bent as drawn, a partition across said chamber above said roller, and a burner entering the upper forward part of the chamber formed by said partition.

30. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, a drawing chamber, a continuous carrier and grip devices in said chamber operating to draw a sheet of glass from said receptacle into said chamber, an idler roller in said chamber over which the sheet is bent as drawn, a partition across said chamber above said roller, and a burner directing flame upon the sheet of glass at or near the point where it is bent over the idler roller.

31. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass and means for drawing the sheet of glass therefrom, with a cover for said receptacle, a pair of trucks at each end of said cover, means on said trucks for lifting said cover, and ways along which said trucks may be moved.

32. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, and means for drawing a sheet of glass therefrom, hooks located in the molten glass one adjacent to each edge of the sheet, bearings in which the projecting shanks of said hooks reciprocate, means for reciprocating the hooks, and means for vertically adjusting said bearings to determine the amount of immersion of said hooks in the molten mass.

33. In a sheet-glass drawing machine, the combination of a glass-melting furnace, a working chamber or pot from which the glass is drawn, a conduit leading from beneath the surface of the molten glass in the melting furnace to the exterior of one side wall of the working chamber, conduits leading along said side wall to the ends of said working chamber, and ducts or ports at the ends of said chamber and conducting the molten glass from the said conduits to the interior of the chamber.

34. In a sheet-glass drawing machine, the combination of a glass-melting furnace, a working chamber or pot from which the glass is drawn, a conduit leading from beneath the surface of the molten glass in the melting furnace to the exterior of one side wall of the working chamber, conduits leading along said side wall to the ends of said working chamber, a passage for the hot gases of combustion over the surface of the glass in said melting furnace and said conduits, and flues and dampers in said furnace and in connection with said conduits for controlling the exit of the products of combustion.

35. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet of glass therefrom, bodies located in the mass of molten glass adjacent to each edge of said sheet, means for imparting movement to said bodies to hold the width of said sheet uniform, and means to vary the speed of movement of said bodies.

36. In a sheet-glass drawing machine, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet of glass therefrom, bodies located in the mass of molten glass adjacent to each edge of the said sheet, means for imparting movement to said bodies to hold the width of the sheet uniform, and power connections between said last means and the drawing means.

37. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet of glass therefrom, and a pair of oppositely disposed hooks one adjacent to each edge of the sheet being drawn and movable in the mass of molten glass and in the plane of the sheet being drawn.

38. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means for drawing a sheet of glass of uniform width therefrom, and a roller over which said sheet is bent as drawn and receiving driving power from the sheet.

In testimony whereof we have signed this specification in the presence of two subscribing witnesses.

IRVING W. COLBURN.
EDGAR WASHBURN.

Witnesses:
F. B. BLACK,
EARL MACVAY.