(No Model.) 4 Sheets—Sheet 1.

F. MELBER.

ROLLING MILL.

No. 304,342. Patented Sept. 2, 1884.

Fig. I.

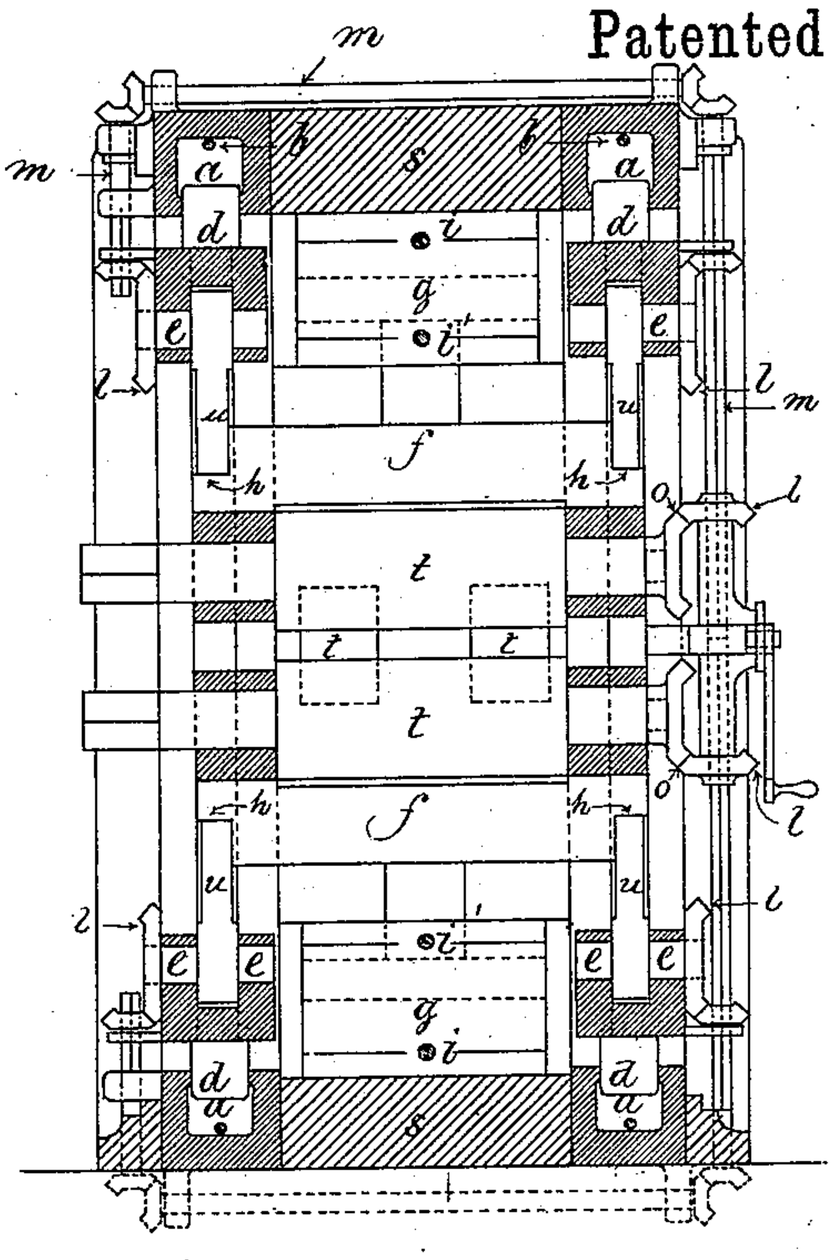
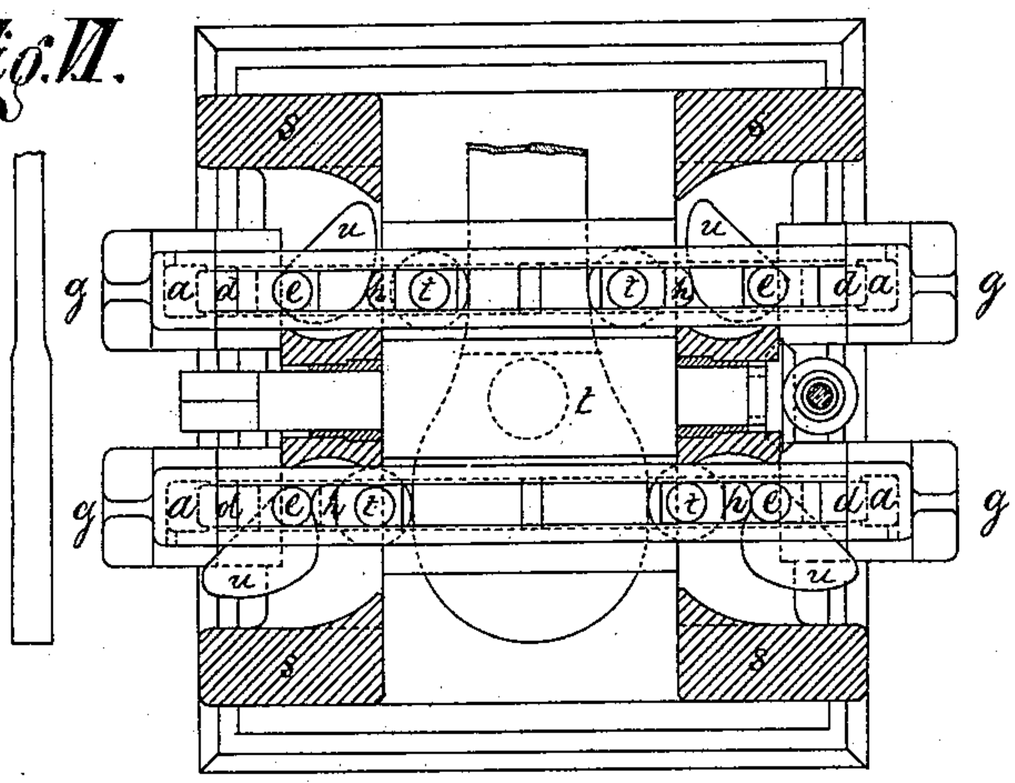


Fig. III.

Fig. II.



WITNESSES:

H. Heerlein

Oscar Paussen

INVENTOR

Frederic Melber.

(No Model.) 4 Sheets—Sheet 2.

F. MELBER.

ROLLING MILL.

No. 304,342. Patented Sept. 2, 1884.

Fig. II.

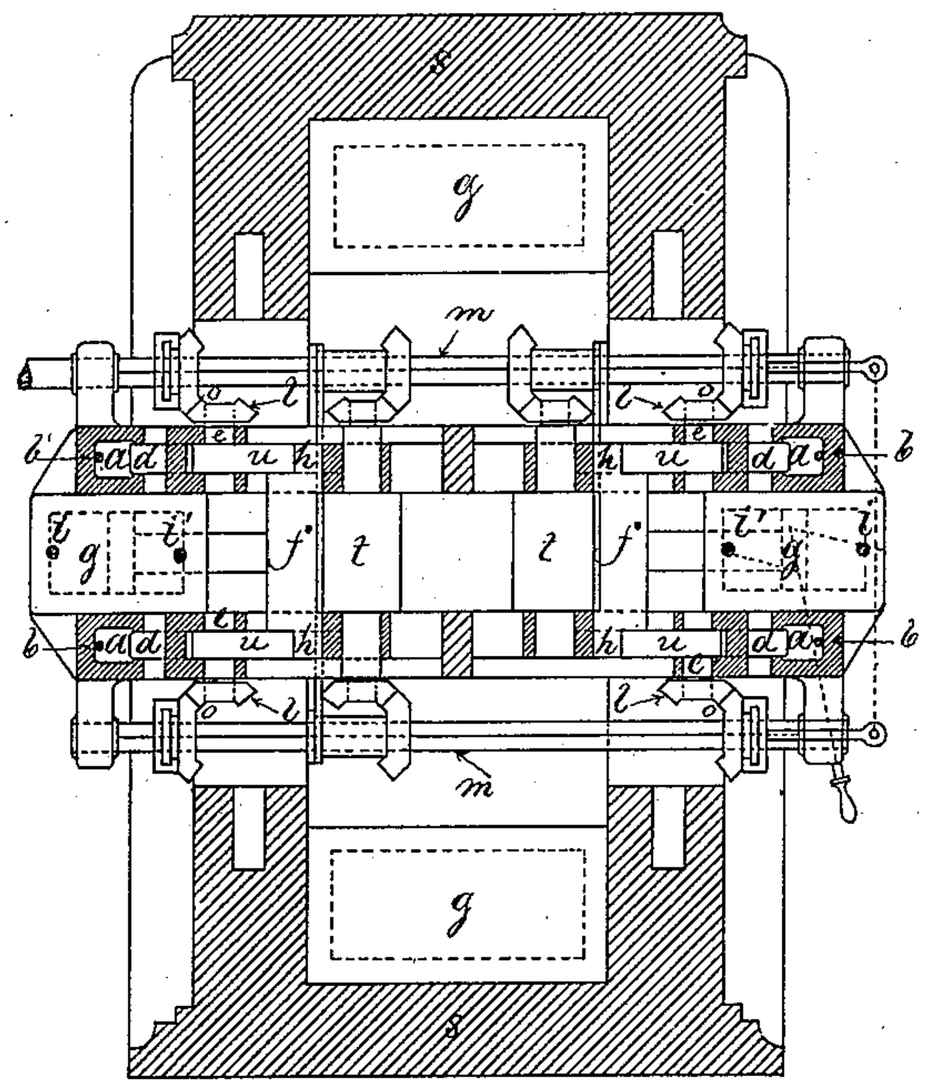
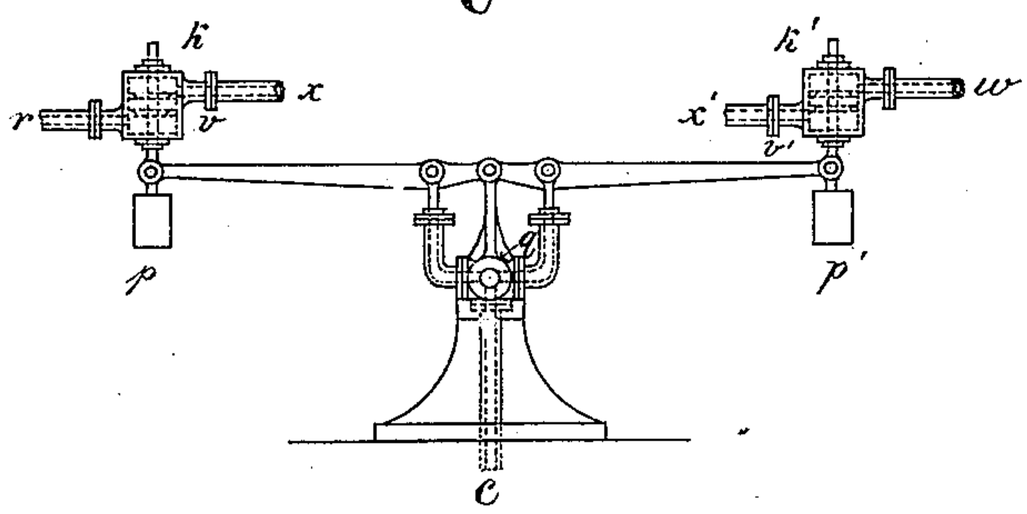


Fig. IV.



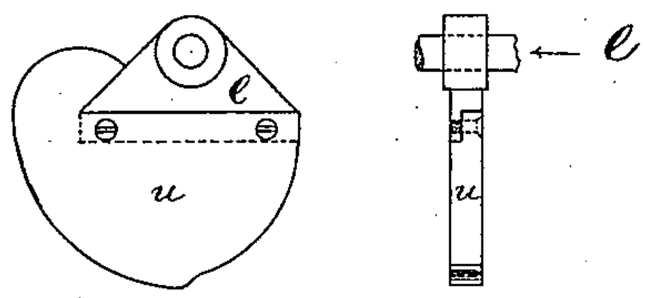


Fig. V.

WITNESSES:
D. Atterbeiu
Oscar Claussen.

INVENTOR
Frederic Melber.

(No Model.) 4 Sheets—Sheet 3.

F. MELBER.

ROLLING MILL.

No. 304,342. Patented Sept. 2, 1884.

Fig. VII.

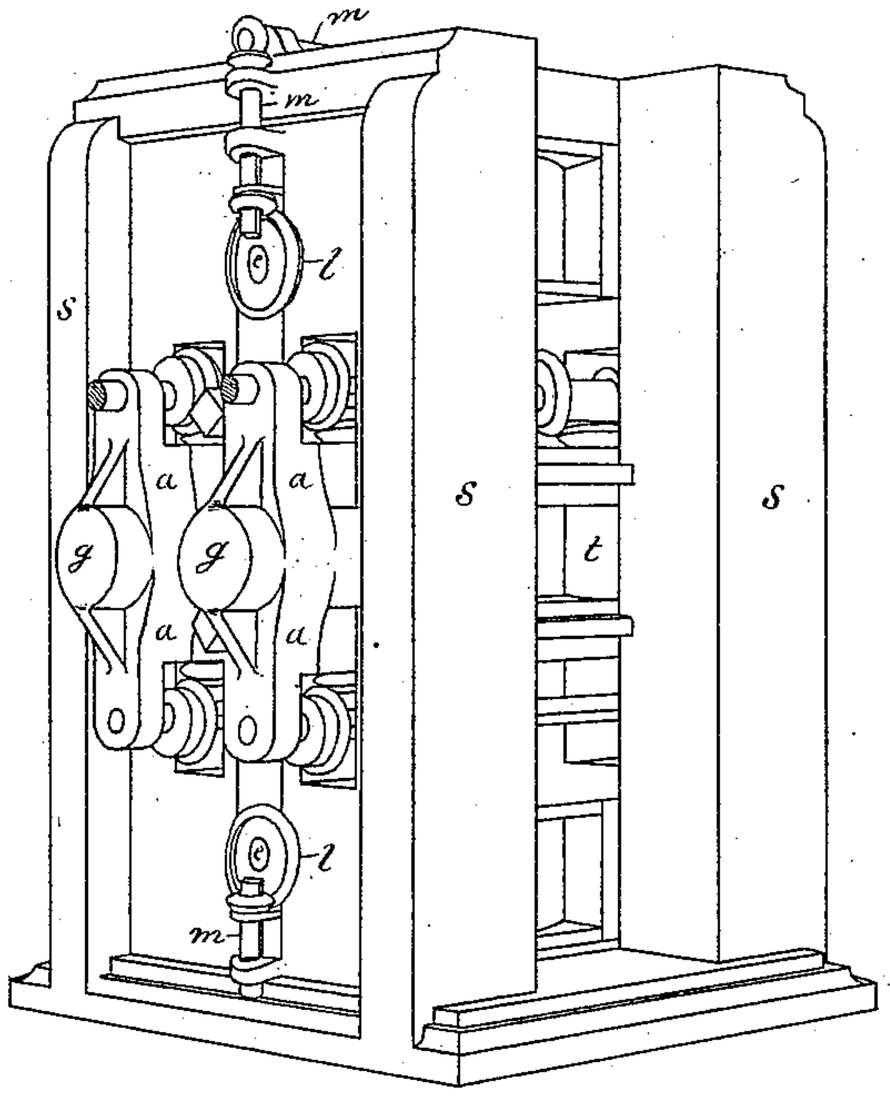
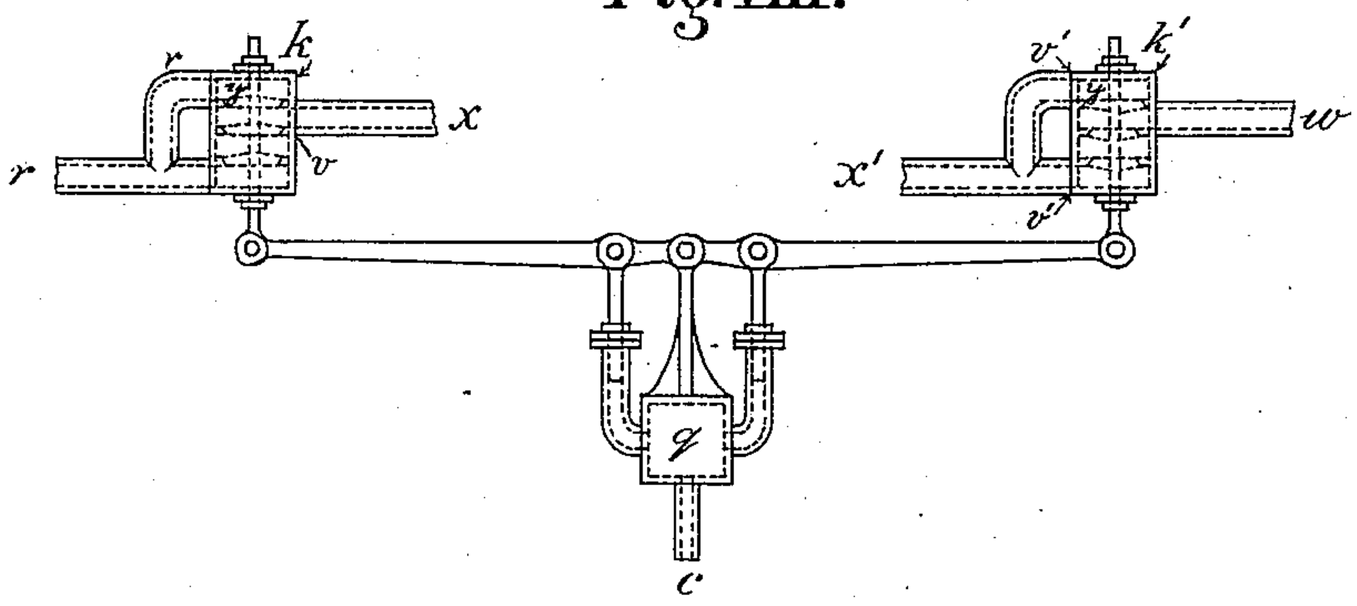


Fig. VIII.



WITNESSES:

Otto Gerdau.

Oscar Claussen.

INVENTOR

Frederic Melber.

(No Model.)

4 Sheets—Sheet 4.

F. MELBER.

ROLLING MILL.

No. 304,342. Patented Sept. 2, 1884.

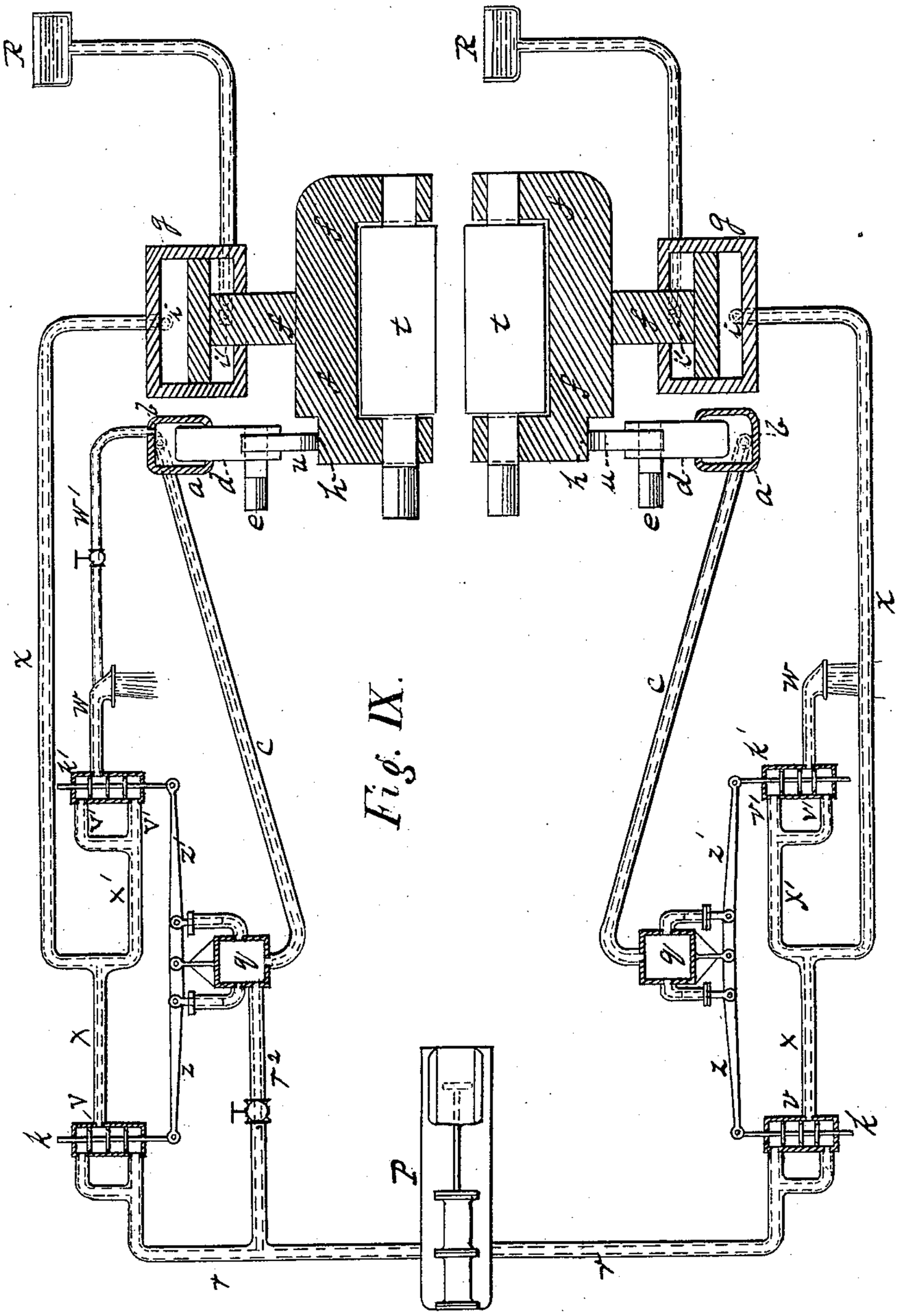


Fig. IX.

Witnesses—
H. B. Moulton
G. A. Tauberschmidt

Inventor—
Frederic Melber
by J. H. Ritter & Co

UNITED STATES PATENT OFFICE.

FREDERIC MELBER, OF SHARPSBURG, PENNSYLVANIA.

ROLLING-MILL.

SPECIFICATION forming part of Letters Patent No. 304,342, dated September 2, 1884.

Application filed February 9, 1884. (No model.)

To all whom it may concern:

Be it known that I, FREDERIC MELBER, a citizen of the United States, residing at Sharpsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Differential Rolling-Mill, of which the following is a specification.

Figure I is a partial vertical section of a universal mill having my improvements applied, the line of section being through the journal-boxes of the horizontal rolls. Fig. II is a similar section, the line of section being through the journal-boxes of one set of the vertical rolls. Fig. III is a horizontal section, the line of section being just above the vertical rolls, so as to show the operation of the guides of said rolls. Figs. IV and VIII are detached views of the pressure indicators or regulators; Fig. V, detached face and edge views of one form of guides. Fig. VI is an edge view of an eye-bar, a face view of which is seen in Fig. III. Fig. VII is a perspective view of the entire mill, so that a general idea of the relation of the parts may be obtained. Fig. IX is a diagram showing the system in one of its simplest forms applied to a single pair of rolls.

My invention relates to improvements in the rolling of metal of any kind, (in either a cold or heated state,) and to improvements of rolling-mills in which grooved or smooth surfaced horizontal and vertical rolls, or horizontal rolls only, or rolls working under different angles of inclination, are used to roll a piece of metal to a certain length, width, thickness, and to a finished shape. It has for its object to provide means whereby any or all the rolls may be caused to move at the same time, or at different times, in a prescribed manner, so as to change the form of the pass so as to produce any predetermined-shaped article, (either cold or in a single heat,) at the same time controlling and governing at any moment the forces and jars which the metal operated on exerts upon the rolls.

For the purposes of my invention I make use of rolls which are adjusted, and in which the working-pressure is obtained, by hydraulic power in any of the well-known ways; and therefore I do not wish to be understood as broadly claiming the combination with the rolls of a hydraulic cylinder and piston for operating the same.

My invention, generally stated, consists, mainly, in combining with a roll adjustable by means of a hydraulic cylinder and its piston, as aforesaid, a pressure regulator or indicator, and a controller or governor having contact with the roll-bearing, so that as the pressure between the controller or governor and bearing increases or decreases so will the pressure in the hydraulic cylinder which controls the roll be increased or decreased, causing the movement of said roll until the equilibrium in the regulator is restored.

It consists, secondarily, in the nature of the controller or governor and its combination with the roll, whereby the form of the pass may be changed at will, to produce any predetermined shape of article.

I will now proceed to describe my invention more specifically, so that others skilled in the art to which it appertains may apply the same. For this purpose I shall refer, especially, to Fig. IX, which illustrates the invention in its simplest form, and shall thereafter describe the remaining figures, which are in the main but details required in applying the invention to mills having several sets of rolls.

In the drawings, Fig. IX, *g g* indicate hydraulic cylinders having pistons *f*, to which are secured the working-rolls *t t*, the lower one of said rolls (in case of horizontal rolls) being counterbalanced in the usual manner.

At the back of each cylinder *g* is a port, *i*, from whence a pipe, *x*, leads to the pump P, by means of which the working-pressure is exerted on the rolls *t*. In this line of pipe leading to the pump are placed the two valve-chambers provided with suitable valves, one, *k*, controlling the pipe *r* leading to the pump or source of pressure, and the other, *k'*, controlling a waste port or pipe, *w*.

The valves above referred to are operated through the medium of an indicator or pressure-regulator, which I will more fully describe hereinafter.

Mounted on the housing, in line with the bearing of the roll, is a hydraulic cylinder, *a*, provided with a piston, *d*, having secured thereto a movable controller or governor, *u*,

which may be adjusted to bear on the piston *f*, near the journal of the roll, as at *h*, or at other suitable point. This controller or governor may be of any character which will permit its ready adjustment, such as a screw or a slide; but I prefer to give it the form of an eccentric, (see Fig. V,) and journal it on the piston *d* by means of shaft *e*.

Near the head of hydraulic cylinder *a* is a port, *b*, from whence a pipe, *c*, leads to the reservoir *q* of the pressure regulator or indicator.

The reservoir *q* of the pressure-regulator is provided with two pipes, in each of which is a piston, and one of said pistons is connected with a lever, *z*, fulcrumed at one end on the reservoir, and connected by its other with the valve in valve-chamber *k*, which controls the pipe leading to the force-pump P. The valve in this chamber is so arranged that, when the lever *z* is actuated by increased pressure in the reservoir *q*, the valve will open. The other of said pistons is connected with a similar lever, *z'*, fulcrumed on the reservoir and connected with the valve in chamber *k'*. The valve in *k'* is so arranged that decreased pressure in reservoir *q* will actuate lever *z'*, and open the valve which controls the waste-pipe *w*. The pump P and pipe *x*, leading to the main hydraulic cylinder *g*, supplies the power for moving the rolls *t t* toward each other and for fixing them when at work; but, in order to move the roll back when the pressure is reduced in cylinder *g*, and to maintain the contact between the controller or governor *u* and the piston *f* or journal of the roll, the cylinder *g* is provided with a port *i'*, and from thence a pipe leads to an elevated reservoir, R, at such a height as to slightly overbalance the roll *t*, and thus insure its following the controller or governor *u* when the pressure is reduced in cylinder *g*.

It will be noticed that a somewhat different construction of the pressure indicator or regulator is shown in Fig. IV from that in Figs. VIII and IX. This difference, however, is only the substitution of one mechanical equivalent for another. In Fig. IV the difference between the pressure in the pressure-regulator *q* and that in the pipe leading from the pump to the main hydraulic cylinder *g*, and in the hydraulic cylinder *g*, is compensated by weights *p* and *p'*, while in Figs. VIII and IX the valve is balanced by means of branch pipes leading to opposite sides of the valves.

I will now describe the operation of the system thus described, as by so doing the construction and operation of the mill shown in the other figures of the drawings will be more readily understood. We will suppose, first, that the lower roll, *t*, is provided with the usual counter-balance; secondly, that, by means of the hydraulic cylinders *g* the rolls *t* have been adjusted to give the desired pass or distance between the rolls *t*; third, that the pressure in reservoir *q*, pipe *c*, and cylinder *a* has been fixed at the point which circumstances require; and, fourth, that the controller or governor *u* is in contact with the piston *f* or journal of the roll, as at *h*. Now, so long as these conditions remain the same, the hydraulic cylinder *g* and its piston will receive all the force or jar caused by the passage of the metal between the rolls, the valves in chambers *k k'* will remain in equilibrium, and the pass between the rolls will remain the same; but suppose it is desired to reduce the size of the pass, the controller or governor *u* is forced down so as to increase its contact with the journal of the roll or piston *f* at *h*. This increases the pressure in cylinder *a* and augments the pressure in reservoir *q* and upon the pistons thereof. The tendency of this increased pressure on the valve in *k'* (or waste-valves) is to seat it more firmly; but its action on the valve in *k* is to open the pipe leading to the pump P, which (by way of pipe *x*) increases the pressure in main cylinder *g* and causes the rolls to move toward each other until such time as the movement of the roll has relieved the controller or governor *u* of the increased pressure. As soon as this occurs the pressure in cylinder *a* and reservoir *q* has returned to the normal point and the valve *k* closes. Next, suppose it is desired to increase the distance between the rolls *t t*, or increase the width of the pass, the controller or governor *u* is moved back so as to decrease the contact between the journal of roll *t* or the piston *f*, as at *h*. This will reduce the pressure on piston *d* and the fluid in cylinder *a* and reservoir *q*. Consequently, (while the valve in *k*, leading to pump P, will remain firmly on its seat,) the valve in *k'* will open and unclose the waste-pipe *w*, which reduces the pressure in main cylinder *g*, and the hydrostatic column, which enters cylinder *g* at *i'*, will act on the pistons *f*, forcing the rolls apart until the contact between piston *f* and controller or governor *u* augments the pressure in cylinder *a* and reservoir *q* until the equilibrium is restored, when the valve in chamber *k'* seats itself and closes the waste-pipe *w*. It is evident that this system can be applied to the vertical rolls as well as to the horizontal rolls; that the guide may be moved automatically from the rolls or by other and independent mechanism, as well as by hand; and the controllers or governors may have any desired form, according to the shape of the article to be produced, on the same well-known principle involved in the construction of lathes for producing irregular forms.

I shall finally describe the detail involving these features as applied to the well-known universal mill, shown in Figs. I, II, III, and VII, in which S S indicate the housings, in which are arranged two horizontal rolls, *t t*, and four vertical rolls, *t t t t*, each roll being provided with its main hydraulic cylinder *g* and piston *f*, as hereinbefore specified, and each roll, in this instance, is provided with two cylinders, *a*, pistons *d*, and controllers or governors *u*—one for each journal of the roll—which con-

trollers or governors bear on the piston *f* of the main hydraulic cylinder, as at *h*. The several cylinders, *g*, have their elevated reservoirs R, (not shown,) and are connected by pipes *x* and *r* (see Figs. IV and VIII) with the pump, and by pipes *x'* with the waste-pipe. The several cylinders, *a*, are also connected by means of pipes *c* with reservoirs *q* and the indicators or pressure-regulators hereinbefore described. Each roll of the series may have its independent system, as shown in Fig. IX, though a common pump may supply the power to all the main hydraulic cylinders *g*.

In order to operate the controllers or governors *u* from the rolls, the shaft *e* of each controller or governor may be provided with a bevel-pinion, *l*, and the several controllers or governors connected by cross-shafts *m*, likewise provided with bevel-pinions. The shafts *m* may be so constructed as to permit the sliding of the pinions while revolving with the shaft; or well-known clutch mechanism may be employed, so as to apply the power from the rolls to move the controllers or governors when desired, and to such controllers or governors as desired. Furthermore, the pinions may be mutilated, or equivalent and well-known gearing may be employed, so as to move the controllers or governors from the rolls at intervals or progressively. The controllers or governors *u* may be in the form of screws or of wedges having one straight edge and adapted to slide back and forth; but I prefer the eccentrics shown in Fig. V, constructed so as to be detached from the shaft *e* and replaced by others of different form when desired.

As the three following conditions exist—viz., first, the controllers or governors are or may be operated from the rolls; second, the controllers or governors, in moving, will always remain in feeling contact with the rolls (or piston *f*, which is the same thing,) and, third, the movement of the rolls through the medium of the interposed indicator or pressure-regulator, will control the pass of the rolls—it follows that, given the law of the movement of the rolls (that is to say, the movement of the driving-engine) and the movement of the shafts *e* of the controllers or governors *u*, the controllers or governors *u* may be given such shape as to produce a piece of work of any predetermined form or shape capable of being produced by rolls of any character. To illustrate this in a measure, I show in Fig. III the form and arrangement of controllers or governors adapted to roll an eye-bar.

I would further call attention to the advantageous manner in which the hydraulic adjustment of the rolls, already known in the art, may be accomplished by my devices. It is merely necessary to let a certain amount of high-pressured water enter the cylinder *a* or the reservoir *q* from the pipe *r*, (see pipe r^2, Fig. IX,) thereby increasing the regular pressure, and so opening the valve in the valve-box *k*, allowing the water to flow to the main cylinder *g*. The pistons of cylinders *a* and *g* will move on as long as there is a pressure in cylinder *a* beyond the regular amount. In a similar manner will be the reverse motion of the pistons obtained by connecting the cylinder *a* with the waste-pipe *w*, (see *w'*, Fig. IX,) thus decreasing the pressure in the reservoir *q*, and so allowing the water to flow from the cylinder *g* through pipe *x'* into the pipe *w* and so in the free air as long as the pressure in cylinder *a* is beyond its regular amount.

Having thus set forth the nature, object, and advantages of my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a rolling-mill, the combination, with a roll and a hydraulic cylinder for moving the same, of a second hydraulic cylinder having a controller or governor for contact with the roll, and an interposed indicator or pressure-regulator whereby the change of pressure in the second cylinder and the regulator will be transmitted to the main hydraulic cylinder and cause the movement of the piston thereof, substantially as and for the purposes specified.

2. In a rolling-mill, the combination, with a roll, and a hydraulic cylinder for moving the same, of a second hydraulic cylinder, an interposed pressure-regulator, and an adjustable controller or governor interposed between the piston of the second cylinder and the roll, substantially as and for the purposes specified.

3. In a rolling-mill, the combination, with a roll and a hydraulic cylinder for adjusting the roll, of a second cylinder, and interposed pressure-regulator, and a detachable controller or governor interposed between the piston of the second cylinder and the roll, and adjustable on the piston, substantially as and for the purposes specified.

4. In a rolling-mill, the combination, with the roll, of a roll controller or governor having a rotatable shaft, and a detachable eccentric-face, substantially as and for the purposes specified.

5. In a rolling-mill, the combination, with the rolls, of hydraulic cylinders, and pistons for adjusting the rolls, roll controllers or governors arranged to bear on the rolls with a guiding-touch, a pressure-regulator for transmitting any change of pressure of the controllers or governors upon the rolls to the main hydraulic cylinders, and gearing for actuating the controllers or governors from the rolls, substantially as and for the purposes specified.

6. In a rolling-mill, the combination, with a roll, of a hydraulic cylinder and its piston for adjusting the roll, a pressure-pipe leading to the pump or source of pressure, a waste-pipe, two valves, one controlling the waste-pipe and one the pressure-pipe, a second cylinder having a controller or governor which bears on the roll, and an interposed reservoir having pistons which control the valves of the pressure and waste pipes, substantially as and for the purposes specified.

7. In combination with the main hydraulic

cylinder *g* and the second hydraulic cylinder *a*, the pressure-regulator having the reservoir *q*, provided with the two pistons, the levers *z z'*, fulcrumed on the reservoir, and the valves and valve-chambers *k k'*, substantially as and for the purposes specified.

8. In a rolling-mill, the combination, with a roll, of a hydraulic cylinder and piston for moving the roll, a governor which bears on the roll, valves for controlling the entrance and exit of water to and from the cylinder, and a column of water interposed between the governor and the hydraulic cylinder, whereby change of pressure on the column of water will actuate the valves controlling the cylinder supply and waste, substantially as and for the purposes specified.

Witnesses: FREDERIC MELBER.

FR. NEERLEIN,

OSCAR CLAUSSEN.