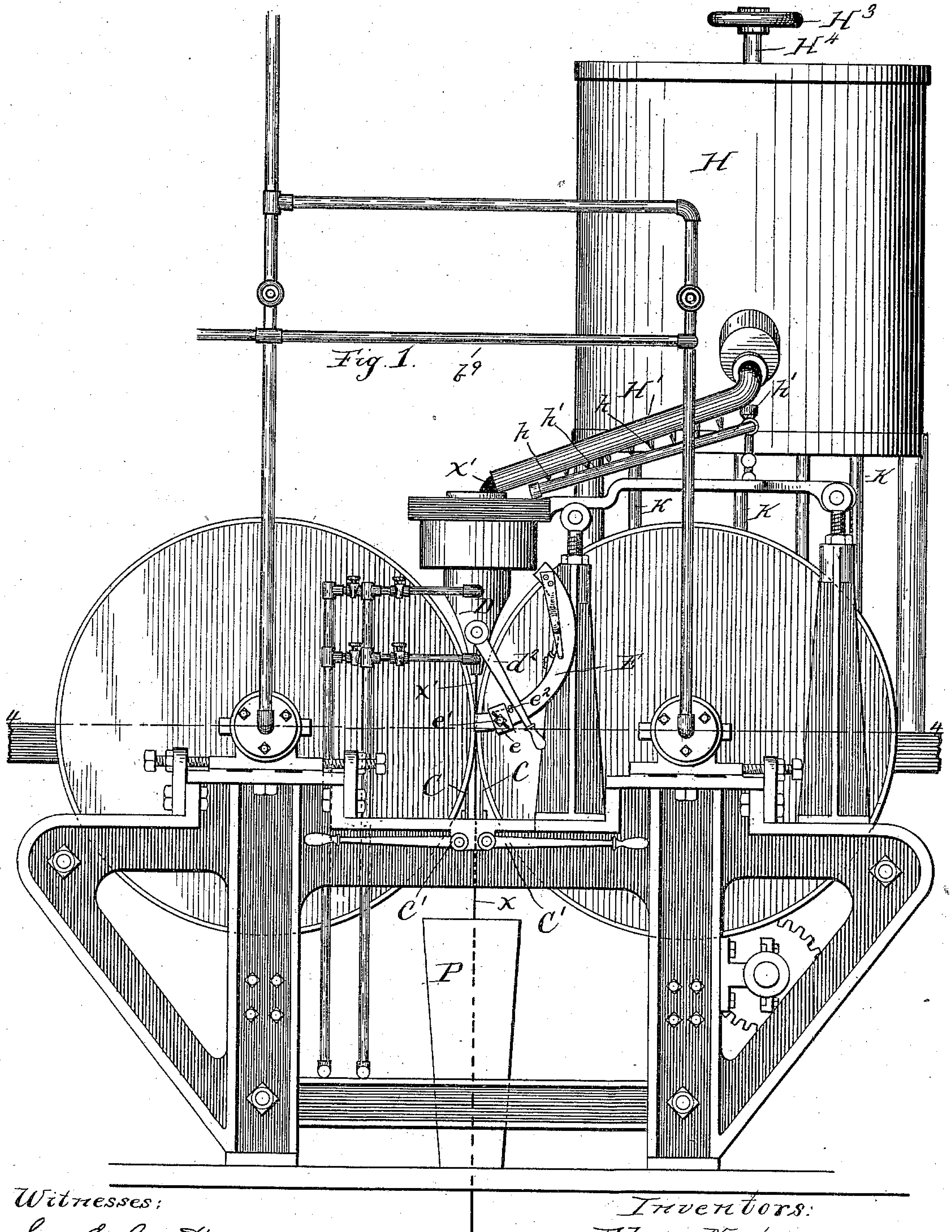
(No Model.) 4 Sheets—Sheet 1.

E. NORTON & J. G. HODGSON.

APPARATUS FOR MAKING SHEET METAL.

No. 382,319. Patented May 8, 1888.



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(No Model.) 4 Sheets—Sheet 2.

E. NORTON & J. G. HODGSON.

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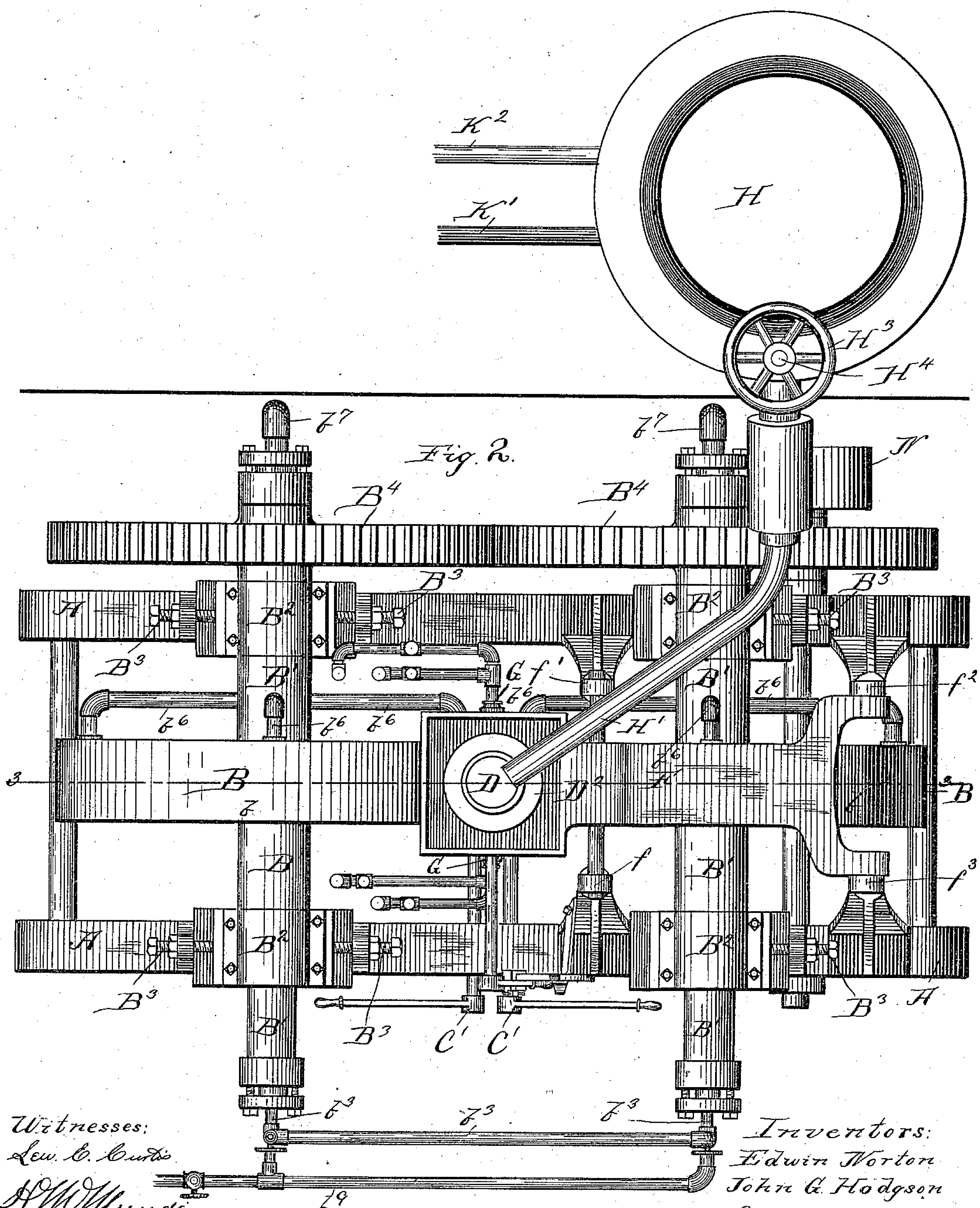
No. 382,319. Patented May 8, 1888.

Fig. 2.



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(No Model.)

4 Sheets—Sheet 3.

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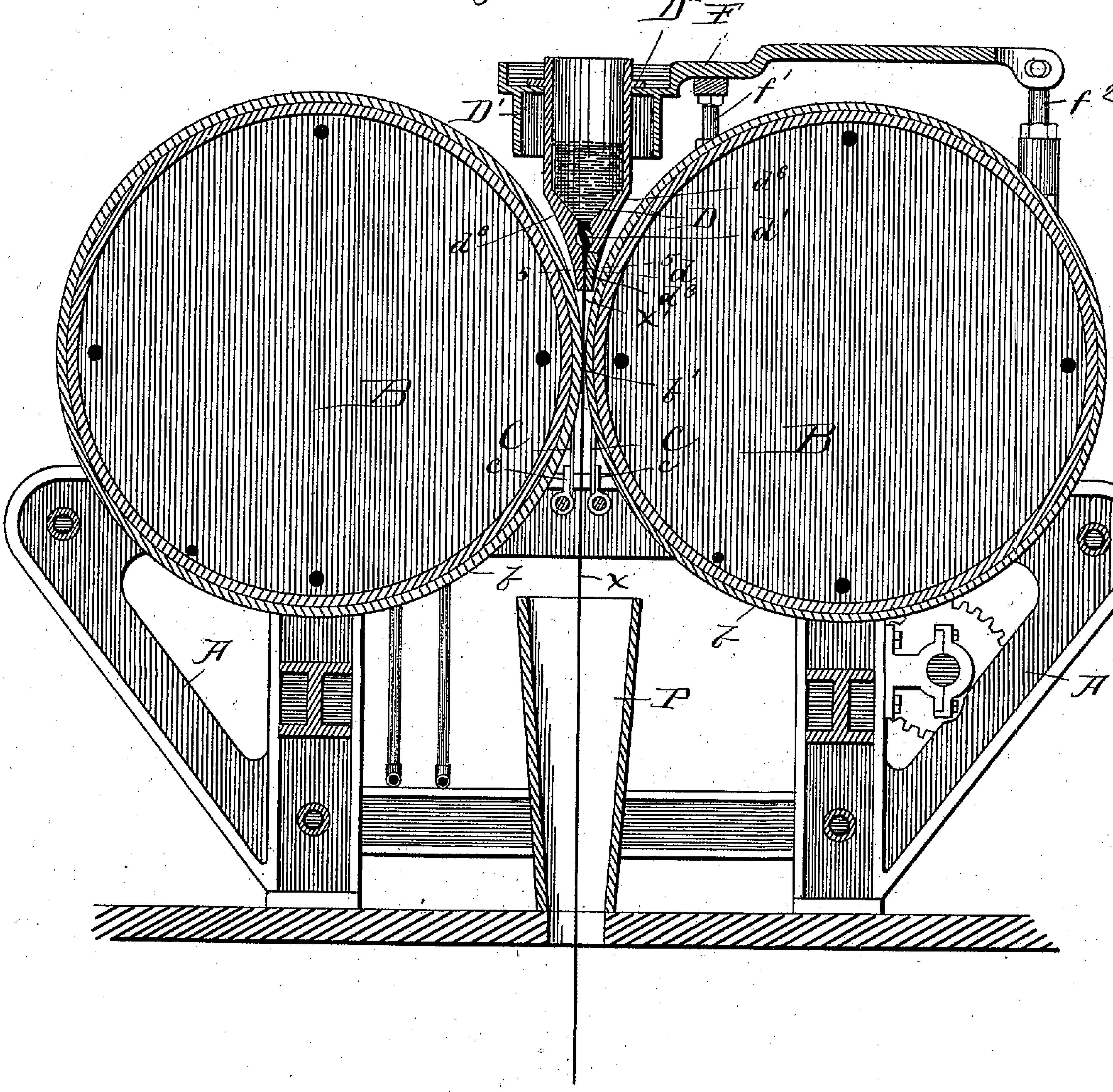
Fig. 3.



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4 Sheets—Sheet 4.

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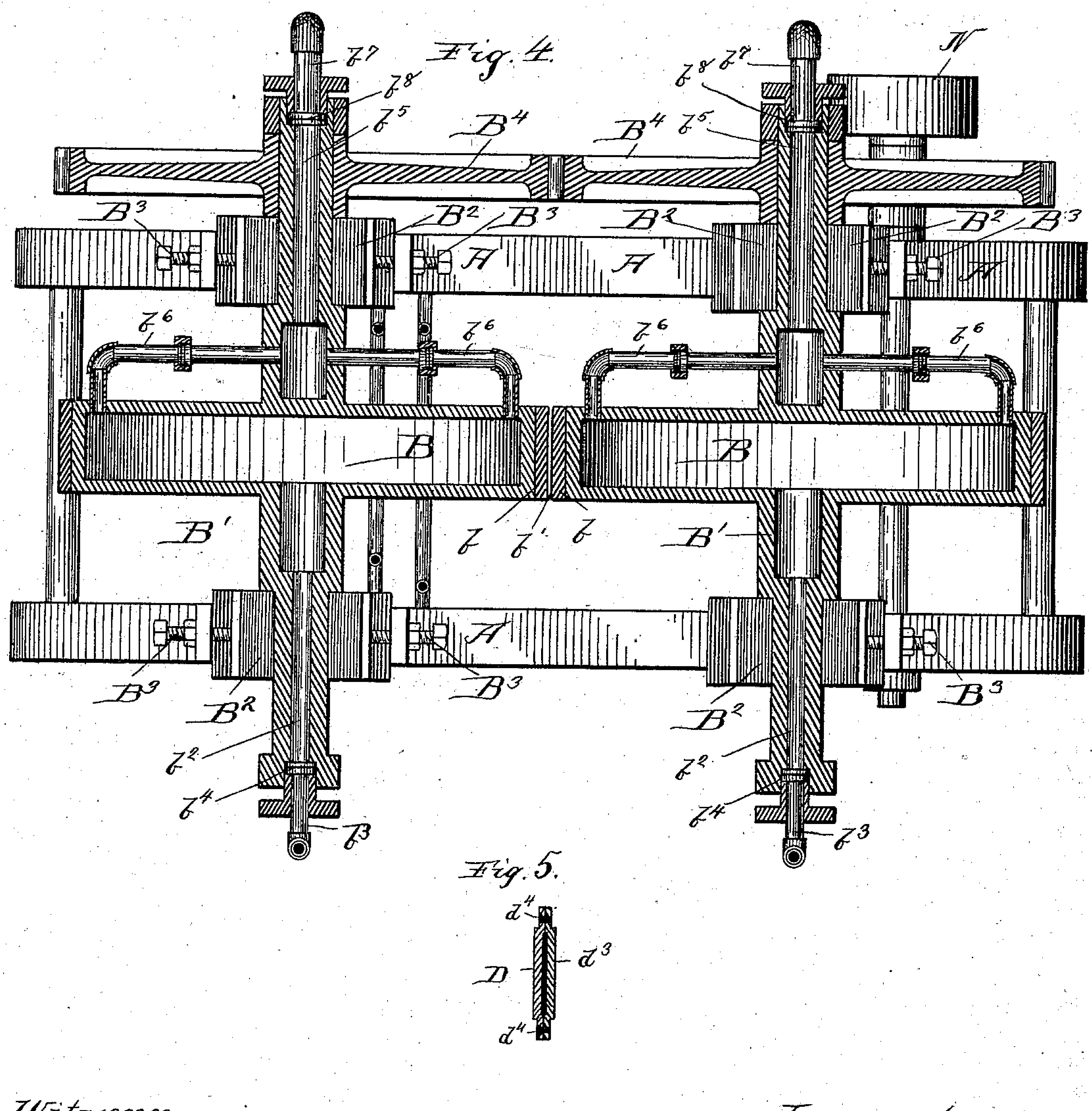

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UNITED STATES PATENT OFFICE.

EDWIN NORTON AND JOHN G. HODGSON, OF MAYWOOD, ASSIGNORS TO SAID EDWIN NORTON, AND OLIVER W. NORTON, OF CHICAGO, ILLINOIS.

APPARATUS FOR MAKING SHEET METAL.

SPECIFICATION forming part of Letters Patent No. 382,319, dated May 8, 1888.

Application filed December 27, 1887. Serial No. 258,940. (No model.)

To all whom it may concern:

Be it known that we, EDWIN NORTON and JOHN G. HODGSON, citizens of the United States, residing in Maywood, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Apparatus for Manufacturing Sheet Metal, of which the following is a specification.

Our invention relates to apparatus for manufacturing sheet metal directly from molten metal without first casting the metal into an ingot or billet and then rolling and rerolling it to reduce its thickness.

Heretofore attempts have been made to produce sheet metal by pouring the molten metal in a flat stream upon the peripheral surface of a rapidly-revolving wheel or roller the rim of which is hollow and filled with water, which circulates through the same to keep the wheel cool, so that it will solidify the stream of molten metal as it comes in contact with the surface of the wheel. In the practical operation of this method, however, we have found great difficulty in producing the same smooth and planished surface upon both sides of the sheet produced, and also in producing the sheet metal of the requisite degree of uniformity. Heretofore, also, attempts have or may have been made to produce metal bars, rails, or plates by pouring molten metal between two revolving rollers, the molten metal damming up and collecting in the space above and between the rollers, as shown and described in the patent to Bessemer, No. 49,053, of 1865. This method is objectionable, if not impracticable, by reason of the body of molten metal above the meeting-line of the rollers and in contact with the rollers either becoming chilled and solidified before passing through the rollers or else so heating the rollers as to prevent their properly chilling the issuing stream of molten metal which passes between them. By our improvement we obviate the difficulties of both these old methods and provide a successful and practical means for producing sheet metal of uniform thickness and having both sides smooth and even; and it consists in pouring the molten metal in a flat and wide stream between two wheels or rollers having smooth peripheries and revolving at an equal or greater surface speed than the velocity of the falling stream, so that the molten metal cannot dam up or collect in a body above the meeting line of the wheels or rollers at the space between them, and thus either become chilled by the rollers or rapidly heat the rollers. By this means the wide flat stream of molten metal comes in contact with the rollers only at their meeting-line, and this momentary contact we have discovered by experiment is sufficient to set the molten metal and instantly convert the wide flat liquid stream into sheet metal.

Another improvement also consists in pouring the stream of metal directly between the two wheels or rollers, the direction of the stream being tangential to both rollers or wheels, so that the stream of molten metal will be equally acted upon by both wheels, and thus produce the same smooth and polished surface on both sides of the sheet. Where the cross-section of the stream of molten metal is the same or about the same as that of the strip of sheet metal to be produced—that is to say, the same as the space between the peripheries of the two rollers at their meeting-line—the surface speed of the rollers need only equal or about equal the velocity of the issuing stream of molten metal; but where the sheet metal is to be made thinner than the issuing stream of molten metal the surface velocity of the revolving rollers is correspondingly increased, in order to prevent the molten metal collecting and damming up in the space between and above the rollers.

In practicing our invention we ordinarily drive the rollers at a uniform surface speed of from three hundred to five hundred feet per minute, and then regulate the size or thickness of the stream of molten metal to the particular thickness of sheet metal desired to be produced by varying the size of the gate or nozzle through which the stream of metal issues. As the flat stream of metal is in a liquid or molten condition at the time it passes or begins to pass between the rollers or wheels, little if any spreading strain or pressure is exerted upon the rollers to force them apart, and it is therefore comparatively easy to keep the space or opening between the rollers uniform and produce a sheet of metal of absolutely uniform thickness.

Our invention also consists in the novel devices and novel combinations of devices or parts herein shown and described, and more particularly pointed out in the claims.

In the accompanying drawings, which form a part of this specification, we have shown one form of apparatus embodying our invention, and that which we deem to be the best form for use in practicing the same. The apparatus so shown in the drawings is one which we have used and designed specially for use in the manufacture of sheet-solder, which is an alloy of tin and lead. This machine fully embodies the principle and mode of operation of our invention, and may be used without change in the manufacture of other sheet metals than sheet-solder, though with certain metals certain changes of construction obvious to those skilled in the art may be desirable, especially in the crucible and heating apparatus.

In said drawings, Figure 1 is a side elevation of the apparatus; Fig. 2, a plan view. Fig. 3 is a vertical section on line 3 3 of Fig. 2, and Fig. 4 is a horizontal section on line 4 4 of Fig. 1. Fig. 5 is a detail horizontal section on line 5 5 of Fig. 3.

In the drawings similar letters of reference indicate like parts in all the figures.

In said drawings, A represents the frame of the machine. This may be of any strong and suitable construction.

B B are a pair of hollow rollers or wheels having smooth peripheries *b*, revolving together, with a slight space, *b'*, between them at their meeting-line, or the line joining the centers. The space between these hollow wheels or rollers is equal to the thickness of the sheet metal desired to be produced. These wheels or rollers have hollow shafts or axles B' B', which are journaled in suitable bearings, B^2 B^2, on the frame of the machine. The bearings B^2 B^2 are made adjustable on the frame, so that the axes of the hollow wheels or rollers may be adjusted parallel to each other and the rollers set closer together or farther apart, according to the thickness of the sheet metal desired to be produced. The adjustment of these journals or boxes is effected by the adjusting-screws B^3. The openings b^2 b^2 at one end of the hollow shafts B' B' lead into the interior space of the hollow wheels or rollers B at the center thereof, and communicate at their outer ends with the water-supply pipes b^3 b^3 through the packed joints or couplings b^4. The holes or openings b^5 in the opposite end of the hollow shafts B' communicate through the radial branch pipes b^6 with the hollow wheels B near their peripheries, and they are connected to the water-exit pipes b^7 through the packed joints or couplings b^8. By this means the entire interior of the hollow wheels B B are or may be kept full of water and a constant circulation of water through the same maintained. The connection of the inlet and outlet water-pipes might, of course, be reversed, the inlet-pipes communicating with their wheels B B at their peripheries and the outlet at their centers; but the better way is that shown in the drawings and before described, as the centrifugal action of the revolving wheels tends to throw the water to the periphery, and thus quickly distribute the incoming cold water to the periphery of the wheel, where it is needed to cool the metallic rim, which tends to become heated by contact with the molten metal. By locating the inlet and outlet pipes one at the center and one at the periphery of the hollow revolving wheels B B a thorough circulation of the water is occasioned inside the wheel before it can escape therefrom. This circulation of the water would not be so well effected if the inlet and outlet pipes both communicated with the hollow wheels at their center or both at their periphery. The shafts of the wheels B B are geared together by gears B^4 B^4.

C C are scrapers or clearing devices, consisting, preferably, of blades of soft metal—like copper, for example—so as not to scratch the peripheral surface of the wheels B B, and located beneath the meeting-line of said wheels in position to strip the sheet metal, *x*, from the periphery of either wheel in case it should adhere or tend to adhere thereto. These stripping-blades are mounted on arms *c*, attached to the pivoted levers or handles C' C', so that they may be readily moved into or out of contact with their respective wheels B B.

D is the pouring nozzle or vessel, having a vertical slit or opening, *d*, through which a thin wide flat stream of molten metal may issue directly between the two wheels B B and in a direction tangential to both, so that said stream will equally strike the periphery of both wheels and be equally acted upon on both sides by contact therewith. The lower end, lip, or mouth of this pouring-nozzle is or should be brought down as low or near to the meeting-line of the wheels as possible, so that the stream of molten metal may have but a slight distance to fall after leaving the nozzle. The nozzle D is furnished with a valve or gate, *d'*. This valve may be of any suitable construction; but we preferably employ a cylindrical plug-valve having a slot or opening through the same. The shaft of this valve is furnished with a handle or lever, d^2, for operating the valve and for adjusting it to any desired position to regulate the size or thickness of the outlet. This valve-lever is adjusted into any desired position by means of the arc E, sliding block *e*, having set-screws *e'*, which afford an approximate adjustment, and by means of the adjusting-screw e^2, threaded on the block *e*, the head of which bears against the handle d^2, and thus affords a means for accurate adjustment of the pouring outlet or opening. The lower end of the pouring nozzle or vessel D is, for convenience as well as for nicety of construction, made in two parts, one of the parts being integral with the vessel D itself and the other part, d^3, being secured thereto by set-screws d^4. The part d^3, as well as the part upon which it fits, is provided with shoulders d^5 d^5, which fit together at the two ends or edges of the nozzle, as clearly indicated in Fig. 5, these shoulders thus forming the pouring outlet or opening in the nozzle.

The sides or walls of the pouring-vessel D should be curved or made wedging, as indicated at d^6 in the drawings, so that the pouring-vessel may fit lower down between the wheels or rollers B B.

The pouring-vessel D is mounted upon an adjustable frame or support, F, so that the pouring mouth, slit, or opening *d* of said vessel may be accurately adjusted in relation to the middle line between the wheels or rollers B B, so as to enable the molten stream of metal to be accurately directed into the space beneath the revolving wheels. The vessel D or its frame or support F may be thus adjusted by any suitable means. We prefer, however, to effect the adjustment of the vessel D by mounting its support F on four adjusting-screws or adjustable standards, f f' f^2 f^3. By turning the nuts of all four of these adjusting-screws equally the mouth of the pouring-nozzle may be adjusted up or down without affecting its position in respect to the meeting-line of the wheels B B, and without affecting the direction of the steam issuing therefrom. By turning the nuts of the two screws on one side, one corner of the pouring-nozzle may be tilted up or down or brought closer to or farther from a horizontal plane passing through the axes of the rollers. By turning the outer or the inner end pair of nuts—that is to say, the two farther from the vessel D or the two nearer thereto—the mouth of the pouring-nozzle may be moved or adjusted nearer to one wheel or the other, as may be necessary to bring the same accurately to the middle line between the two wheels. It will thus be seen that by means of these four adjusting-screws any desired adjustment may be given to the pouring-nozzle necessary to direct the issuing stream of molten metal properly between the revolving wheels B B.

The vessel D is heated and the metal therein kept in a molten condition by means of gas jets or burners G or other suitable heating devices. For heating this pouring-nozzle, however, I prefer to employ gaseous fuel, as thereby the flame may be projected directly against the nozzle and the same kept at the requisite temperature without imparting any great amount of heat to the wheels B B; and by combining gas-burning heaters with the pouring nozzle or vessel D and the revolving wheels or rollers B B we are enabled to accomplish the important result of bringing the pouring-nozzle well down between the revolving wheels. We locate, or preferably locate, one of the gas-burners G very near the lower end of the pouring-nozzle at each edge thereof. To concentrate the flame upon the vessel D, we provide said vessel with an annular hood, D′, surrounding the same. This hood also serves in part to shield and protect the wheels B B from the flame and heat. This hood D, for convenience of construction, is preferably cast integral with the frame or plate F, which supports the vessel D. We provide the vessel D with a flange or shoulder, D^2, which rests upon the plate F.

H represents a crucible or heating-vessel in which the metal to be converted into sheet metal is melted or kept in a molten condition. This crucible should be of comparatively large size, so that it may hold a considerable supply of molten metal. A pipe, H′, leads from the crucible H to the pouring-nozzle D and serves to conduct the molten metal in a continuous supply to the pouring-nozzle. This conductor-pipe is kept hot by means of a series of gas jets or burners, *h*. These burners may be simply holes in the gas-pipe *h′*. The crucible H, at the opening therein leading into this conductor-pipe, is furnished with a valve, H^2, which may be opened or closed by the valve-operating wheel H^3 and screw connecting-rod H^4. When in operation, the metal to be fused may be supplied continuously to the crucible H as fast as the molten metal flows therefrom; or, where it is desired to produce sheets or strips of sheet metal only a few thousand feet long, the crucible may be filled with metal at intervals, fused and drawn off, and then refilled, the revolution of the wheels or rollers B being stopped during the heating operation. The vessel H may be heated in any suitable manner. Where the metal being operated upon is solder or other like easily-fusible metal, the crucible may be conveniently heated by a number of gas jets or burners, K, placed under the same.

K′ represents the gas supply pipes, and K^2 air-supply pipes connected with the burners, as the gaseous fuel which we have used in the machine shown in the drawings has been that made from gasoline, in the use of which, as is well known, separate gas and air pipes are commonly employed.

N represents the driving-pulley, secured to a counter-shaft geared to the shaft of one of the revolving wheels or rollers B. By means of this driving-pulley and a suitable belt, *n*, from a pulley on a counter-shaft on an engine or other source of power, the wheels or rollers B B are revolved at an equal or greater surface speed than the velocity of the stream of molten metal, *x′*, issuing from the opening *d* of the pouring-nozzle D, so that the flow of the metal will not be obstructed by contact with the wheels or rollers B B, and be thus dammed up or collected in the space above and between said rollers, where it would tend to be chilled by them and impart its heat to them.

The surface speed of the wheels B B which we in practice have commonly employed is about four hundred feet per minute, thus producing four hundred lineal feet of sheet metal strip per minute. This surface speed may, however, be materially varied without departing from our invention. As the peripheral surfaces of the rollers B B are traveling by or away from the mouth of the nozzle at an equal or greater speed than the velocity of the flowing metal with which they come in contact, the revolving wheels tend to facilitate the flow of metal with which they come in contact and in a measure to draw the metal from the nozzle rather than to in any way obstruct the flow of the issuing stream. As the peripheries of the wheels do not come in contact with the wide thin flat stream of molten metal except at their meeting point or line, and at the very instant it is changing from a liquid to a solid state, the passing stream of metal exerts little or no spreading pressure upon the wheels to force them apart, and thus to increase or vary the distance between the rollers, and thereby cause variations in the thickness of the sheet metal produced, as would necessarily be the case if the rollers were subjected to violent and varying strains or pressures. For this reason, also, it requires very little power to run the apparatus and revolve the wheels B B at any velocity desired. Owing, also, to the very limited portion of the periphery of the wheels B B which at any instant is in contact with the molten metal and receiving heat therefrom, the temperature of the wheels B B is easily kept uniform and may be kept at any desired degree. By increasing or diminishing the capacity of the inlet and outlet pipes, or of the velocity of the water flowing through the same, the temperature of the wheels may be governed and the apparatus adapted to produce sheet metal of greater or less thickness.

The length of the wheels or rollers B B may be increased or diminished, according to the width of the metal sheet desired to be produced. The wheels B B shown in the drawings are comparatively short, as the machine illustrated is one designed for use in manufacturing narrow sheet-solder strip for a special purpose.

P represents the chute or opening below the machine through which the strip of sheet metal produced issues.

The wheels or rollers B B have smooth unflanged peripheries, so that any slight inequalities or lack of uniformity in the size of the flowing stream of molten metal will be compensated for at the edges of the strip of sheet metal produced by variations in the width. Where the stream does not flow with absolute uniformity in size or velocity in respect to the surface velocity of the wheels B B, the edges of the sheet-metal strip will be somewhat serrated, the inequalities in the flow being compensated for by such variations in the width of the strip, its thickness being maintained uniform.

The length of the slot or opening *d* in the pouring-nozzle D should preferably be equal to or about equal to the width of the strip of sheet metal designed to be produced. The nozzle or pouring vessel D should be adjusted so that it will lie or extend directly above and parallel to the space or opening *b′* between the peripheries of the wheels B B at their meeting-line.

The wheels B B have an equal surface speed, and they, of course, should preferably be of the same diameter.

As the rollers or wheels B B have smooth unflanged peripheries, strips of sheet metal from any desired width from the narrowest up to the full length of the rollers may be made upon the same machine by simply regulating the width and thickness of the stream of molten metal and the velocity of the revolving wheels. This is a great advantage in the practical use of our invention, as it obviates the necessity and expense of making separate pairs of rollers for each different width of sheet metal desired to be produced.

We claim—

1. The apparatus or machine for manufacturing sheet metal, consisting in a pair of smooth revolving chilling rollers or wheels with a space between their peripheries at their meeting-line equal to the thickness of the sheet metal to be produced and a pouring nozzle or vessel having a discharge opening or slot at its lower end or bottom directly above and extending parallel to said space between the peripheries of said rollers, so that the stream of molten metal issuing from said pouring nozzle or vessel may flow in a direction tangential to both said rollers, substantially as specified.

2. The combination of two revolving chilling-rollers, a pouring-nozzle above and between them and means for driving or revolving said rollers at a greater surface speed than the velocity of the flowing stream of molten metal, substantially as specified.

3. The combination, with a pouring nozzle or vessel having a long narrow discharge-opening, of a pair of chilling-rollers revolving with a space between them equal to the thickness of the metal sheet to be produced and at a sufficient surface speed in respect to the space between the rollers, the size of the discharge-opening, and the velocity of the flowing stream of molten metal so that the molten metal cannot collect above and between the rollers, substantially as specified.

4. The combination, with a pair of revolving rollers, of a pouring nozzle or vessel above and between them and a heater for heating said vessel, substantially as specified.

5. The combination, with a pair of revolving rollers, of a pouring nozzle or vessel above and between them, a heater for heating said vessel, and a crucible or vessel for holding molten metal, and a pipe or conductor leading therefrom to said pouring vessel or nozzle, substantially as specified.

6. The combination, with a pair of revolving rollers, of a pouring nozzle or vessel above and between them, a heater for heating said vessel, a crucible or vessel for holding molten metal, a pipe or conductor leading therefrom to said pouring vessel or nozzle, and a heater for heating said pipe or conductor, substantially as specified.

7. The combination, with a pair of revolving rollers, of a pouring nozzle or vessel above and between them and a heater for heating said vessel, said heater consisting of gas-burners, substantially as specified.

8. The combination of a pair of revolving wheels or rollers having a space between them equal to the thickness of the metal to be produced, a pouring nozzle or vessel, and a crucible connected with said pouring nozzle or vessel, substantially as specified.

9. The combination, with a pouring-nozzle having a long narrow discharge slot or opening, of a pair of hollow revolving rollers or wheels having a space between their peripheries at their meeting-line, into which the stream of molten metal issuing from said pouring-nozzle is directed, said wheels revolving at an equal or greater surface speed than the velocity of said flowing stream of molten metal, the shafts of said wheels or rollers being hollow and communicating at one end with an inlet water-pipe and at the other with an outlet water-pipe, substantially as specified.

10. The combination, with a pouring nozzle having a long narrow discharge slot or opening, of a pair of hollow revolving rollers or wheels having a space between their peripheries at their meeting-line, into which the stream of molten metal issuing from said pouring-nozzle is directed, said wheels revolving at an equal or greater surface speed than the velocity of said flowing stream of molten metal, the shafts of said wheels or rollers being hollow and communicating at one end with an inlet water-pipe and at the other with an outlet water-pipe, the inlet water-pipe communicating with the interior of the roller near its center and the outlet near its periphery, substantially as specified.

11. The combination, with a pair of revolving chilling wheels or rollers, of a pouring nozzle or vessel above and between them, one or both of said wheels or rollers being mounted on adjustable bearings to regulate the thickness of the sheet metal produced, substantially as specified.

12. The combination, with a pair of revolving rollers, of an adjustable pouring-nozzle above and between them, substantially as specified.

13. The combination of a pair of revolving wheels or rollers, B B, pouring nozzle or vessel D, having discharge-openings *d*, and support F for said vessel mounted on one or more adjusting-screws, substantially as specified.

14. The combination, with the revolving rollers B B, of pouring-nozzle D above and between them, having discharge-opening *d* at its lower end, support F, and four adjusting-screws, $f\ f'\ f^2\ f^3$, substantially as specified.

15. The combination, with revolving rollers B B, of pouring nozzle or vessel D above and between them and made of a curved or wedging shape to permit the lower end of said nozzle to project down near the meeting-line of said revolving rollers, substantially as specified.

16. The combination, with revolving rollers B B, of pouring nozzle or vessel D, located above and between them, a gas or other heater for projection of flame against said pouring nozzle or vessel, and a hood, as D′, surrounding said vessel to confine the heat, substantially as specified.

17. The combination, with revolving rollers B B, of pouring nozzle or vessel D, having discharge slot or opening *d* at its lower end, and a valve or gate, *d′*, to regulate the discharge-orifice, and an adjusting handle or lever for said valve, substantially as specified.

18. The combination, with revolving rollers B B, of pouring nozzle or vessel D, having discharge slot or opening *d* at its lower end, and a valve or gate, *d′*, to regulate the discharge-orifice, and an adjusting handle or lever for said valve, arc E, sliding block *e*, and adjusting-screw e^2, substantially as specified.

19. The combination, with a pair of revolving rollers B B, of a pouring nozzle or vessel, D, above and between the same, and a discharge-chute, N, below said rollers, substantially as specified.

20. The combination of a pair of revolving rollers having smooth unflanged peripheries, and having a space between them equal to the thickness of the sheet metal to be produced, with a pouring nozzle or vessel located above and between said rollers, whereby any inequality in the flow of the metal in respect to the velocity of the revolving wheels is compensated for by variations in the width of the strip of sheet metal produced and the sheet metal made of uniform thickness, substantially as specified.

21. The combination, with a pair of revolving wheels or rollers having smooth and unflanged peripheries, of a pouring-nozzle above and between them provided with a valve or gate for regulating the size of the issuing stream, whereby sheet-metal strips of different widths may be produced on the same machine, substantially as specified.

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