No. 611,661. Patented Oct. 4, 1898.

B. W. TUCKER.

FURNACE FOR STEAM BOILERS.

(Application filed Nov. 5, 1897.)

(No Model.) 7 Sheets—Sheet 1.

Fig. 1.

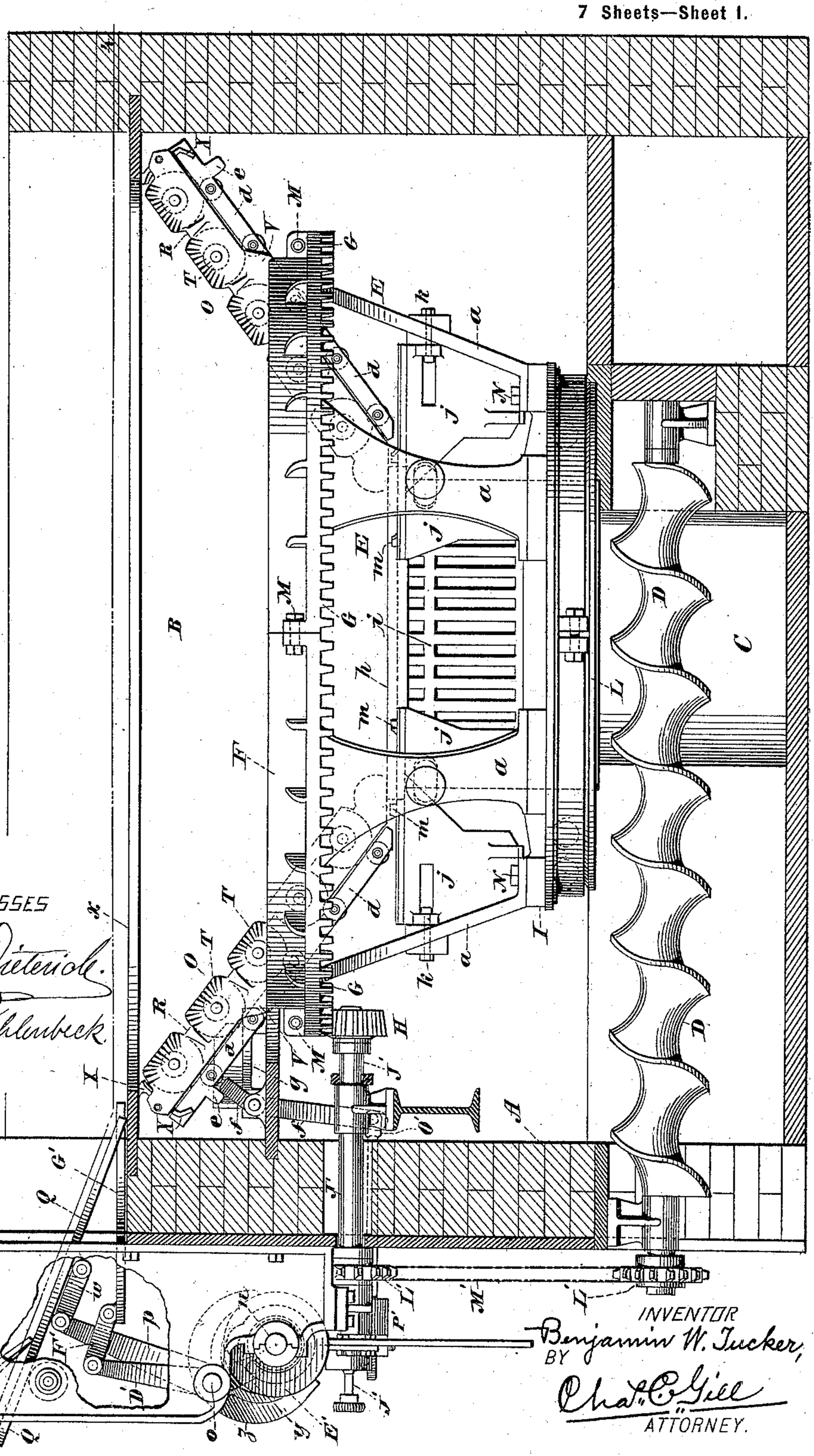
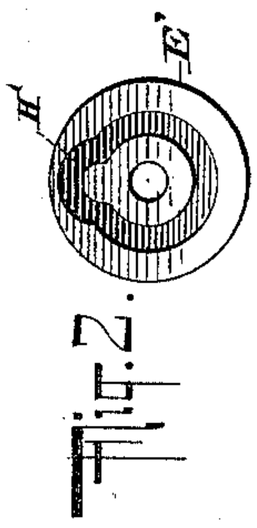


Fig. 2.



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No. 611,661. Patented Oct. 4, 1898.

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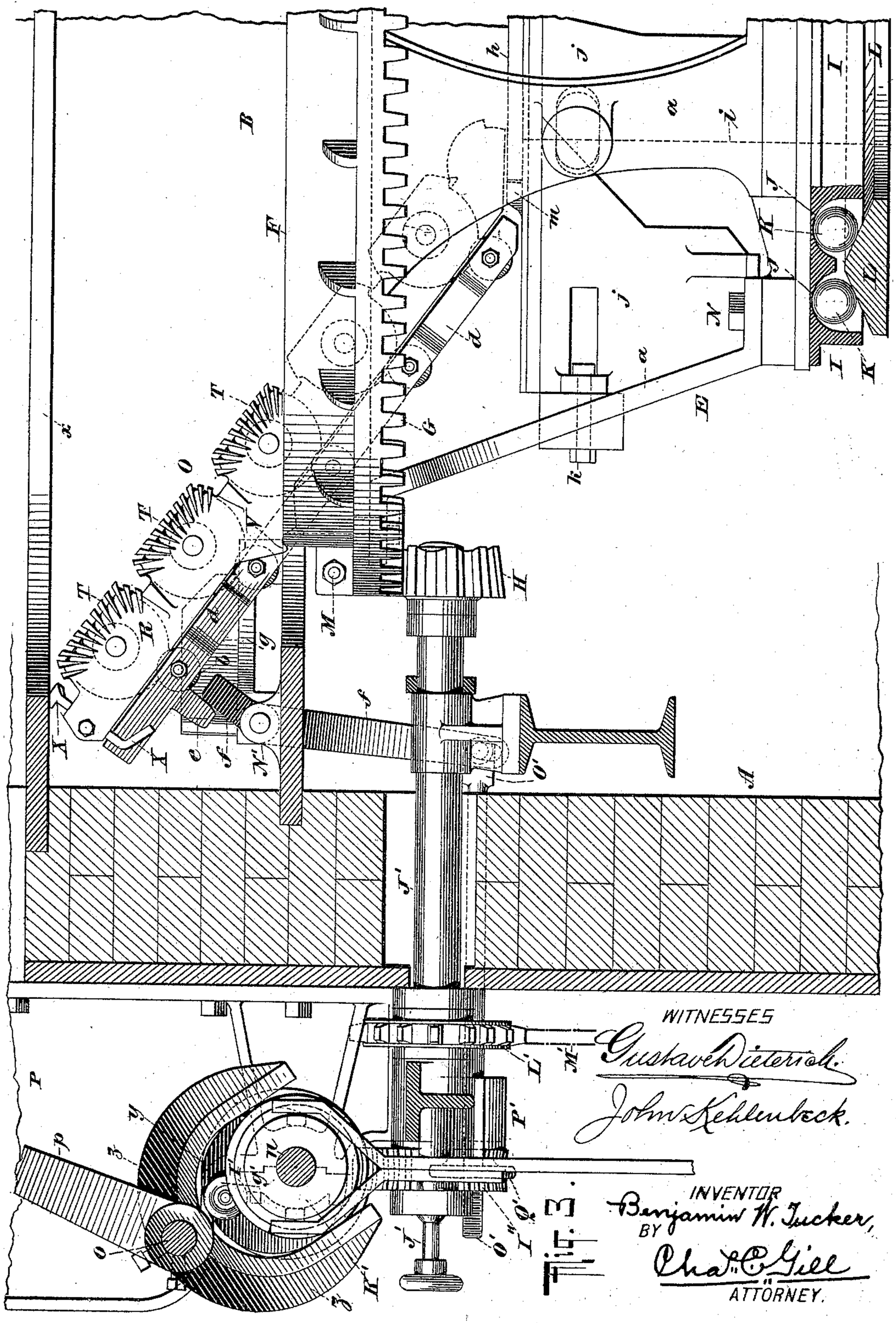
(No Model.) 7 Sheets—Sheet 2.



No. 611,661. Patented Oct. 4, 1898.

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(No Model.) 7 Sheets—Sheet 3.

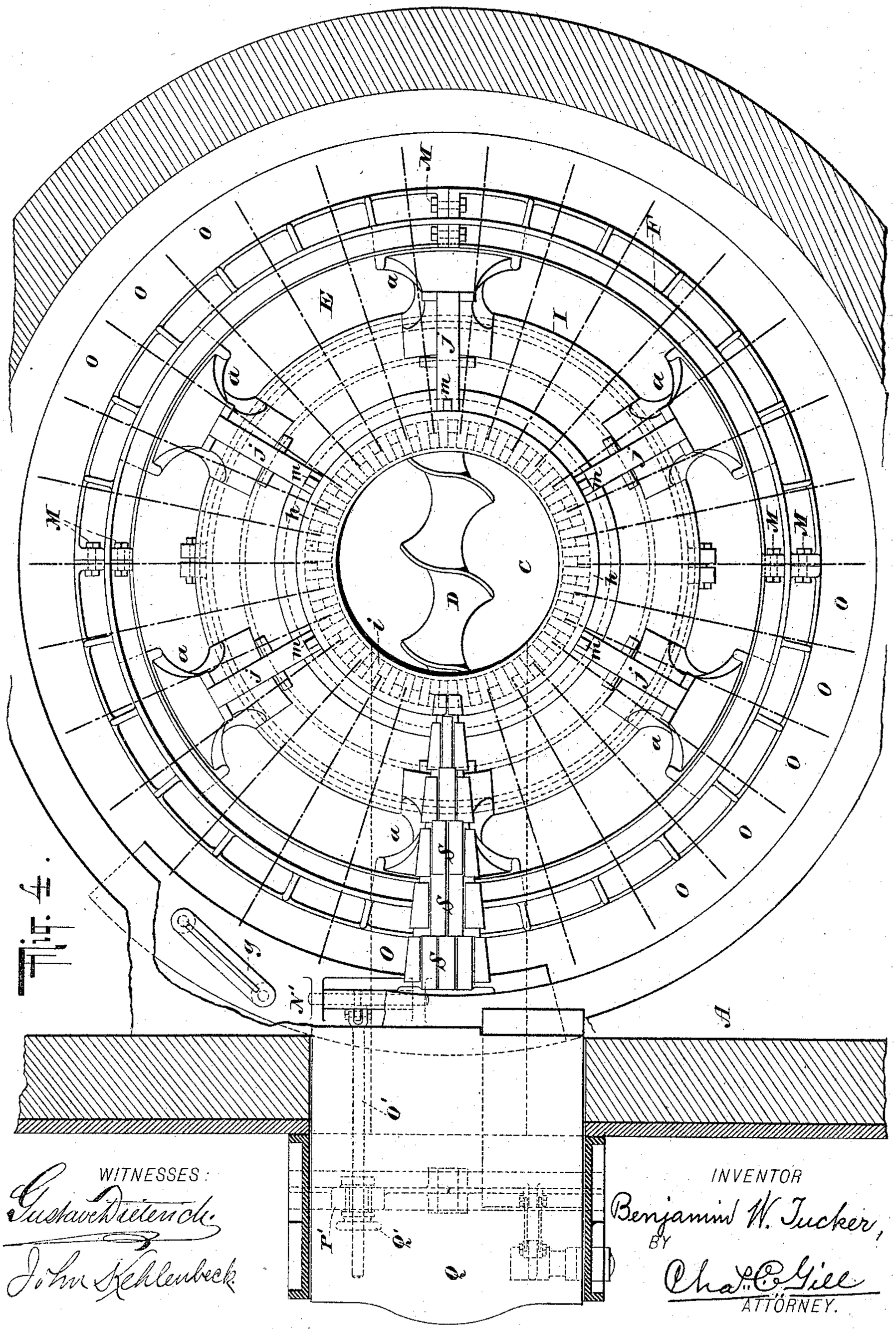

Fig. 4.

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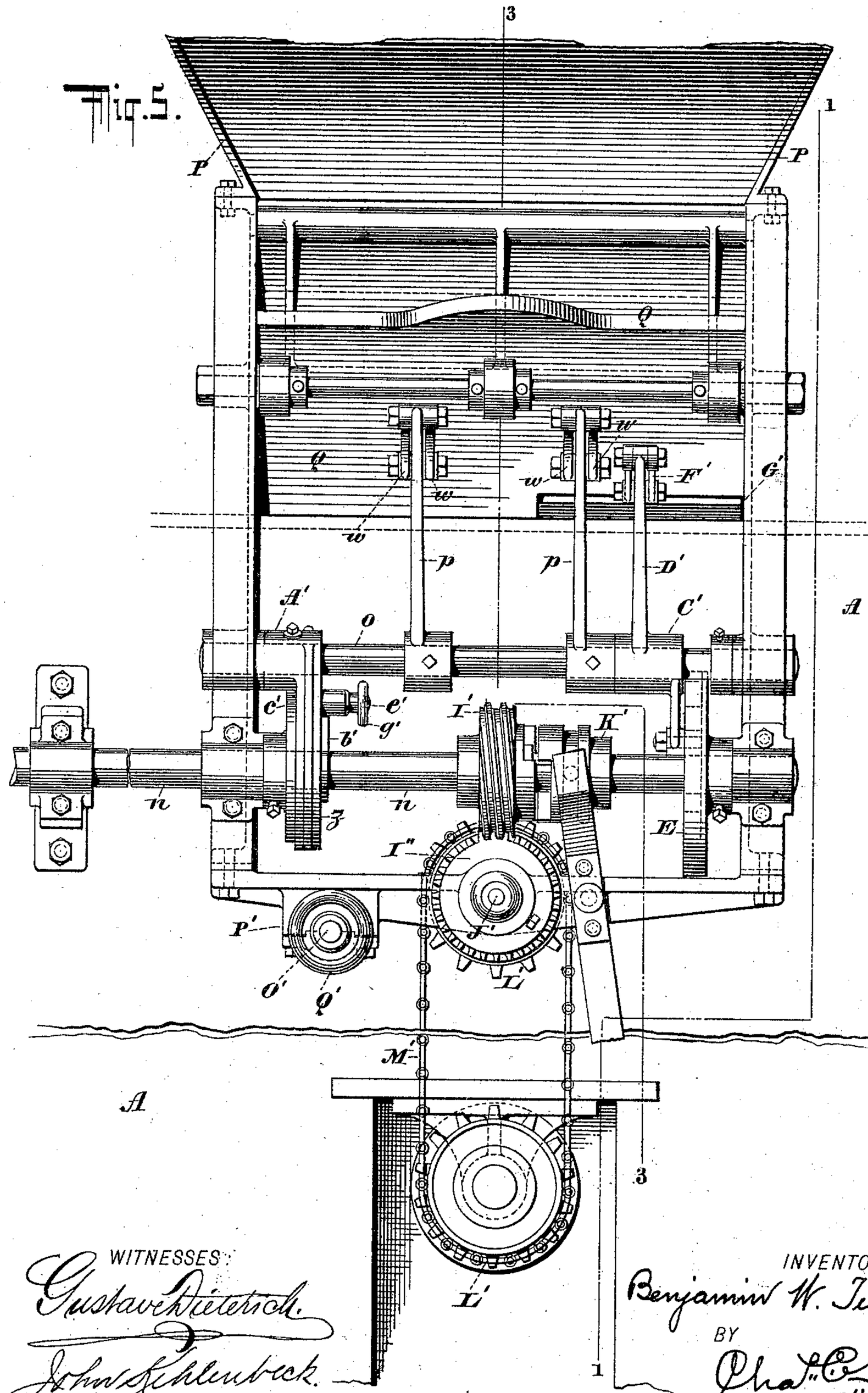
Fig. 5.



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(No Model.) 7 Sheets—Sheet 5.

Fig. 16.

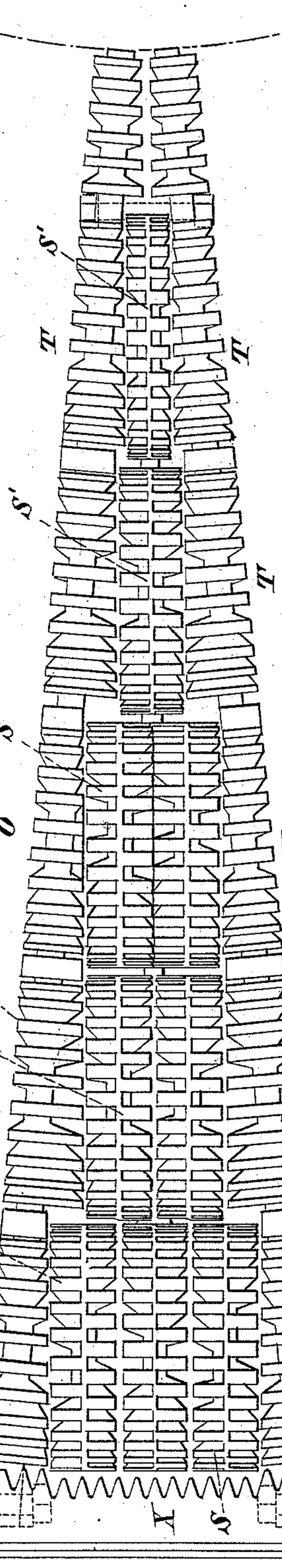

Fig. 17.

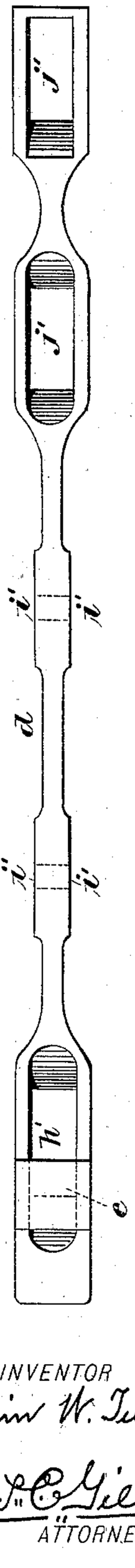

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Fig. 7.

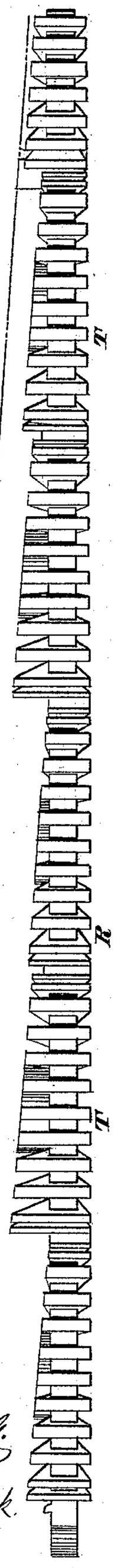

Fig. 8.

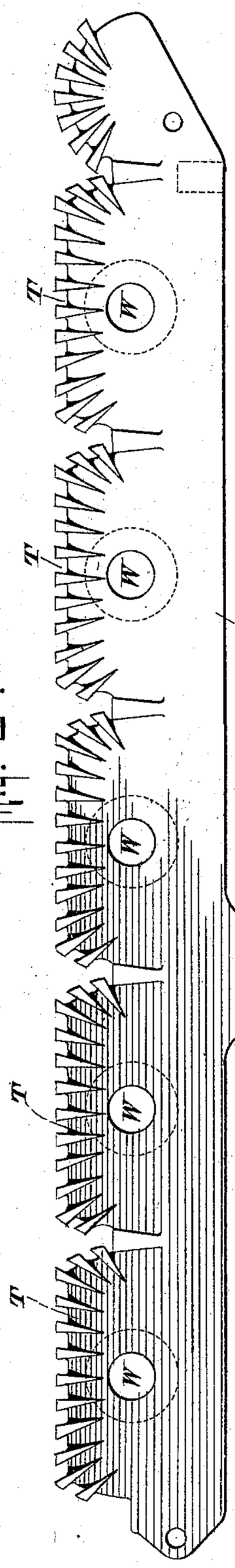

Fig. 9.

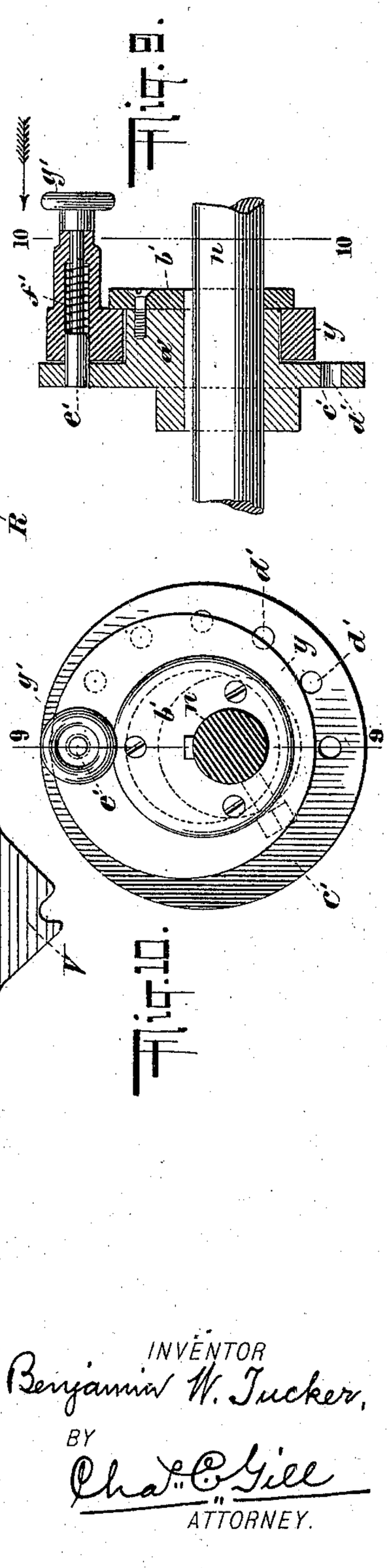

Fig. 10.

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FURNACE FOR STEAM BOILERS.

(Application filed Nov. 5, 1897.)

(No Model.)

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Fig. 15.

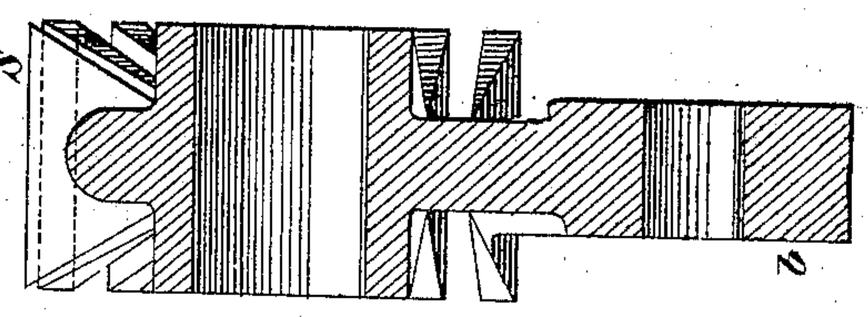


Fig. 15.

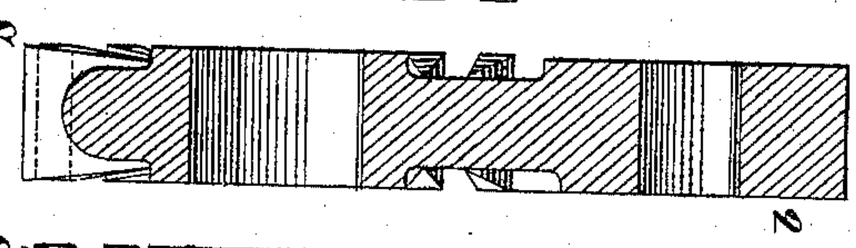


Fig. 14.

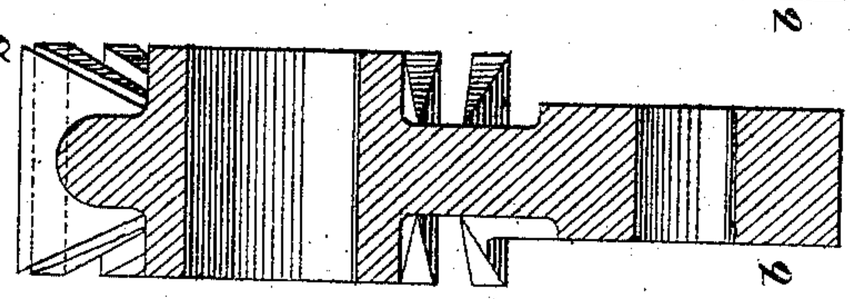


Fig. 13.

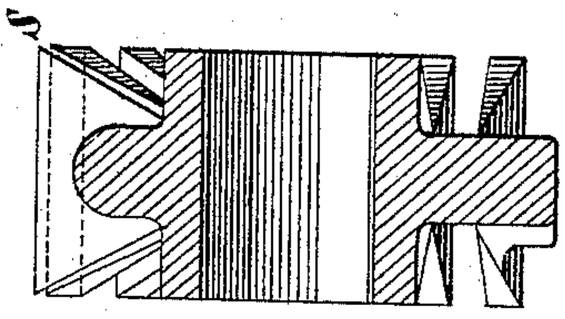


Fig. 12.

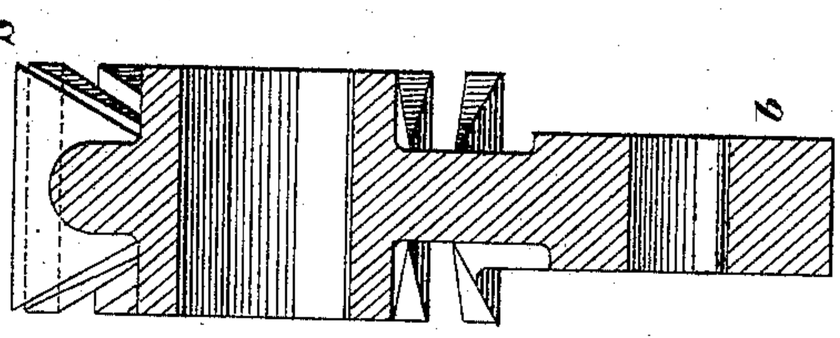
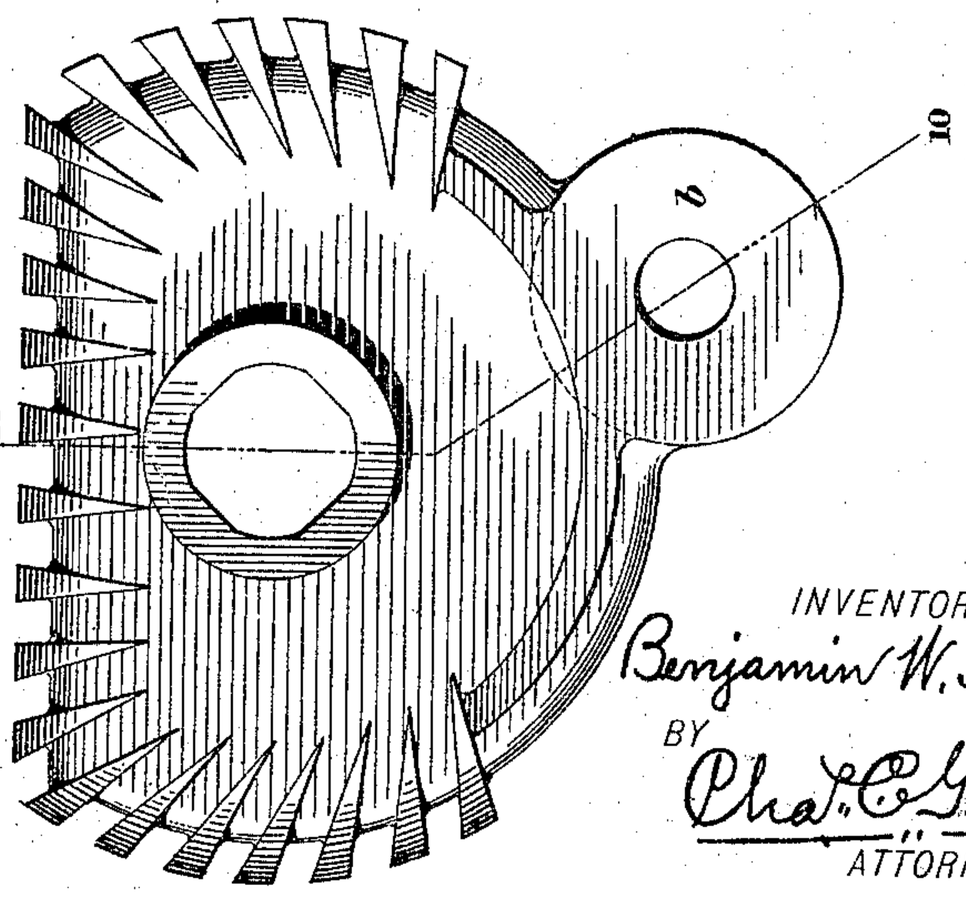


Fig. 11.



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UNITED STATES PATENT OFFICE.

BENJAMIN W. TUCKER, OF NEWARK, NEW JERSEY, ASSIGNOR TO THE AUTOMATIC ROTARY STOKING GRATE COMPANY, OF SAME PLACE.

FURNACE FOR STEAM-BOILERS.

SPECIFICATION forming part of Letters Patent No. 611,661, dated October 4, 1898.

Application filed November 5, 1897. Serial No. 657,479. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN W. TUCKER, a citizen of the United States, and a resident of Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Furnaces for Steam-Boilers, of which the following is a specification.

The invention relates to improvements in furnaces for steam-boilers; and it consists in the novel features of construction and combinations of parts hereinafter described, and particularly pointed out in the claims.

In the accompanying drawings I illustrate a furnace embodying the various features and combinations of my invention, and said furnace comprises a revoluble grate-frame with means for imparting motion to the same; ball-bearings upon which said grate-frame is mounted and has its axial revoluble motion; a series of radiating sectors mounted in an inclined position upon the upper annular edges of said grate-frame and forming the grate-bars, said sectors being composed in part of movable portions whereby the coal thereon may be agitated during the revoluble motion of the grate; means for actuating the movable portions of the aforesaid sectors; means for moving inward the ridge of coals which have a tendency to accumulate upon the upper outer portion of said sectors, and means for automatically stoking the furnace.

The features of the furnace are new as to their construction and operation, and the various combinations of said features hereinafter claimed are new; and it is desired to be understood that the claims of this application are not limited to details of form except in such instances as said claims are by their terms purposely so limited.

The invention will be fully understood from the detailed description hereinafter presented, reference being had to the accompanying drawings, in which—

Figure 1 is a central vertical longitudinal section, partly broken away, through a furnace constructed in accordance with and embodying the invention, the revoluble grate-frame being shown in side elevation. Fig. 2 is a face view of a cam forming one of the details of the operative mechanism and hereinafter referred to. Fig. 3 is an enlarged central vertical section, partly broken away, of the front portion of the furnace embodying the invention. Fig. 4 is a horizontal section, partly broken away, of the furnace on the dotted line 4 4 of Fig. 1, the various sectors constituting the grate-bars proper being indicated by the dotted radial lines. Fig. 5 is a front elevation, partly broken away, of a furnace embodying the invention. Fig. 6 is an enlarged top view of one of the sectors constituting the grate-bars proper of the furnace. Fig. 7 is an enlarged detached top view of one side bar of one of the said sectors. Fig. 8 is a side elevation of same. Fig. 9 is an enlarged detached vertical section through an adjustable eccentric mechanism on the driving-shaft for operating and regulating the throw of the stoking-shovel. Fig. 10 is a side elevation of same, the shaft being in section on the dotted line 10 10 of Fig. 9. Fig. 11 is an enlarged detached side elevation of one of the movable or rocking portions of said sectors, said rocking portions substantially corresponding with one another, but, as indicated in Fig. 6, being in rows and varying somewhat in size. Figs. 12, 13, 14, 15, and 16 are detached sectional views, on the dotted line 10 10 of Fig. 9, of the several movable or rocking portions of each of said sectors; and Fig. 17 is a detached elevation of the connecting-bar, to which the groups of segments of each of the sectors are secured.

In the drawings, A designates the masonry for the furnace, B the combustion-chamber, and C the ash-pit, the latter being furnished with the spiral conveyer D for the automatic removal of the ashes.

Within the combustion-chamber B is mounted a revoluble frame E, having open sides and provided at its upper edge with the annular frame F, upon which is formed the series of teeth G for engagement with the pinion-wheel H, by which said frame E has imparted to it an axial revoluble motion, as hereinafter described. The frame E has at its lower annular edges the ring I, formed with the inverted annular grooves or sockets J J to receive the balls K, which are freely arranged within said annular inverted grooves or sockets J and bear upon the downwardly-

diverging upper faces of the ring L, the latter forming a tramway for and supporting the frame E. The frame E, having the ring I of the nature shown and described and combined with the ring L, having the downwardly-diverging upper surfaces and forming a tramway and support for the frame E, constitutes one of the combinations sought to be protected herein. The downwardly-diverging upper surfaces of the ring or tramway L and the form of the ring E constitute desirable surfaces for the balls K and are of a construction which prevents the clogging up of the ball-bearings by ashes or dust.

The annular frame F is composed of sections which are secured together by the bolts M, and the open sides of the frame E are formed of sections *a*, secured at their lower ends to the ring I by means of the bolts N and at their upper ends to the frame F to support the latter and also the series of sectors, each lettered O, which constitute the grate-bars proper and are arranged on radial lines and converge downward and inward, as clearly indicated in Figs. 1 and 4. The sectors O travel with the frames E F and receive the fuel from the hopper P, said fuel being automatically delivered to the sectors O by means of a blade or shovel Q, which is adapted to have a reciprocating motion imparted to it by the means hereinafter described. The sectors O all correspond with one another, and each is of the construction more clearly illustrated in Figs. 6, 7, 8, and 11 to 16, inclusive, in which it will be seen that each sector comprises the rigid side bars R R and the series or groups of rocking segments S, the latter being keyed upon or secured to short shafts which are mounted in the side bars R R, said shafts being capable of axial motion within the apertures (see Fig. 8) of said side bars R R, but incapable of axial motion within said segment S, whose substantially central apertures receive said shafts and are polygonal in outline, as illustrated in Figs. 11 to 16, inclusive. The groups of segments S, located between the side bars R of each sector O, vary in dimensions in accordance with their position, and hence in Figs. 11 to 16, inclusive, I illustrate one segment S of each of the several groups of segments. The side bars R R of each sector O are probably more clearly illustrated in Figs. 7 and 8, in which it will be seen that said side bars substantially correspond with one another, and each is formed with the series of toothed segmental sections T, the bearing-lug V, and the apertures W, the latter being substantially centrally arranged within said sections T and adapted to receive the short shafts upon which the segments S are secured. The teeth of the sections T of the side bars R and also the teeth of the segments S not only cross the upper transverse surfaces of said sections T and segments S, but extend downward for a definite distance along the sides of said sections T and segments S, whereby vertical spaces between said teeth are formed for the upward passage of the air necessary for the proper combustion of the fuel upon the sectors O.

It is desired that the spaces between the bars R R of the sectors O shall be as nearly as proper completely filled with the supporting-surfaces for the fuel, and hence, as shown in Figs. 6 and 7, the teeth of the sections T of said side bars extend inward varying distances to approach as nearly as may be proper the sides of the rocking segments S. The series of sectors O form, as denoted in Fig. 4, a complete annular grate-bar surface to receive the fuel and support the same during combustion. The sectors O are in their relation to one another indicated more clearly by the dotted radial lines in Fig. 4, which lines are used to prevent confusing the figure and for the reason that said sectors all correspond with one another and are shown in full in Figs. 6, 7, 8, and 11 to 16, inclusive. The side bars R R of each sector O are secured together and are substantially rigid with, though detachable from, the revoluble frame E, supporting them. The upper outer ends of the side bars R R of each sector O are connected together, as clearly shown in Fig. 6, by means of the plate X, and said side bars at the lugs V engage the upper edges of the annular frame F, constituting the upper portion of the revoluble frame E. The groups of segments S located between the side bars R R are not, however, rigid on, although they travel with, the frame E. The segments S (with the exception of the two side segments of the upper group of segments) are formed with the lugs *b*, (shown more clearly in Figs. 11, 12, 14, 15, and 16,) which lugs are apertured and are by means of pins secured to the bars *d*, (shown in Figs. 1, 3, and 17,) which extend lengthwise of and below the said sectors O and connect the said segments S from one end to the other of the sectors O, and in the operation of the furnace the said bars *d* are given a reciprocating motion, so as to rock the segments S for the purpose of agitating the fuel resting upon the said segments. The connecting-bar *d* is shown on a large scale in Fig. 17. The lug *b* of the middle one (shown in Fig. 11) of the uppermost row of segments S is inserted into the bearing-slot *h'* of the bar *d* and is there secured on its pin, which passes through said lug and the sides of said bar, while the two side segments S of said uppermost row of segments have no lugs *b*, (see Fig. 13,) but are rigid on the shaft holding said row of segments between the bars R R. All of the segments S below the upper row or group of segments have lugs *b*, and the lugs *b* of the two pairs of segments S, forming the second and third groups or rows from the top, are placed at opposite sides of the hubs *i'*, Fig. 17, and the lugs *b* of the two lower segments S are placed in the slots *j'* of the said connecting-bar *d*. The bars *d* are each

provided with the lug *e*, the latter being adjacent to the upper ends of said bars *d* and in position to be acted upon first by the upper end of the arm *f* to move said bars *d* in one direction and then by the plate or flange *g* to move said bars *d* in the opposite direction, whereby the arm *f* upon moving the bars *d* upward is enabled to rock all of the segments S inward and downward toward the center of the furnace, and thereafter the said plate or flange *g* by moving said bars *d* downward is enabled to rock all of said segments upward and outward, and thereby restore them to their normal position. The middle portions of the upper surfaces of the segments S are preferably substantially flat, corresponding with the segmental sections T of the side bars R, and hence upon the rocking of the said segments S said segments are enabled to thoroughly break up the bed of fuel resting upon them and prevent clinkering and other objectionable conditions. The arm *f* and flange *g* for acting upon the bars *d*, connected with the segments S, and the mechanism for adjusting said arm *f* will be fully described hereinafter. The segments S are carried wholly by the said bars R of the sectors O. The greater length of the sectors O is preferably within the outline of the frame F, and the inner portions of the side bars R of said sectors, as more clearly indicated in Figs. 1 and 2, rest upon a suitable ring *h*, which affords support for the inner ends of all of the sectors O. The sectors O constitute the grate-bars proper and they constitute a novel feature of the invention sought to be protected hereby. Centrally within the frame E and below the lower ends of the sectors O is the stationary vertical cylindrical grate or cage *i*, which is preferably composed of sections for convenience, and is rigidly seated within the central portion of the furnace and above the ash-pit, and has its upper edges below the ring *h*, which supports the lower ends of the sectors O. The vertical cylindrical cage or grate *i* may be of any convenient form and construction and may be secured in place in any suitable manner. The edges of the ring *h* have an overhanging flange, and said ring *h* is supported upon the cast brackets *j*, which are secured by bolts or screws *k* to the several sections *a* composing the frame E, and said brackets *j* extend radially inward along their upper portions through recesses formed in the outer flange or depending edges of said ring *h* and are provided with the lugs *m*, which press against the outer edges of said ring *h* and serve to retain the same in place. The brackets *j* all correspond with one another and radiate inward from the sections *a* of the frame E.

The mechanism for stoking the furnace, operating the segments S of the sectors O, breaking down the bridge of fuel which has a tendency to accumulate upon the sectors O, revolving the grate-frame E, and operating the conveyer D are more clearly illustrated in Figs. 1, 3, 4, and 5, and said parts receive their motion from a power-shaft *n*, (shown in Fig. 5,) and which may be actuated by any suitable means. The shaft *n* may be continuous along the front of several furnaces, and thus be made to supply the power necessary for the care of a battery of furnaces, or said shaft may be confined to one furnace. The front of the furnace is also provided with the auxiliary shaft *o*, which receives its rocking motion from the main driving-shaft *n* and is connected by lever-arms *p p* and links *w* with the reciprocating blade or shovel Q, by which the furnace is automatically stoked with fuel descending through the hopper P. The inner end of the shovel Q rests upon the ring or plate *x*, located above the sectors O, and said shovel Q is from the shaft *o* given a reciprocating motion for the purpose of moving the fuel inward into a position in which it may fall upon the sectors O, as said sectors are revolved toward the front of the furnace by the means hereinafter described. The shaft *o* has no other operative function in the present instance than that of actuating the shovel Q, and said shaft *o* receives its power from the shaft *n* through the medium of an eccentric *y*, secured upon the shaft *n* and engaging the fork or frame *z*, straddling the said eccentric *y* and secured by a sleeve A′ upon the shaft *o*. The movement of the fork or frame *z* is created wholly by the eccentric *y*, and said fork or frame *z* is given a rocking motion and imparts such motion to the shaft *o*, which in turn, through the lever-arms *p* and links *w*, effects the sliding movement of the shovel Q. The fork or frame *z* may be varied in position with relation to the eccentric *y* by the adjustment of said eccentric on its hub *a′*, and hence the degree of motion the eccentric *y* shall impart to the fork or strap *z* and through said fork to the shaft *o* may be regulated at will in order that the feeding of the fuel by means of the plate or shovel Q may be regulated to meet all conditions. The adjustment of the relation between the fork or frame *z* and the eccentric *y* may be such that the shaft *n* will impart no motion whatever to the shaft *o* and may also be such that any degree of motion, from the minimum to the maximum, may be imparted from the shaft *n* to the shaft *o*, and thus the motion of the shovel Q may be absolutely controlled.

The means by which the eccentric *y* may be adjusted to alter the throw of the fork or frame *z*, and consequently the action of the shovel Q, is more clearly illustrated in Figs. 9 and 10, in which it will be observed that the eccentric *y* is in the nature of a band or strap arranged upon the eccentric-hub *a′*, being thereon retained by means of a plate *b′* and the flange *c′*, which is integral with said hub *a′*. The hub *a′* is keyed upon the driving-shaft *n*, and the fork or frame *z* straddles the eccentric *y*. The flange *c′* of said hub *a′* is provided with the series of apertures *d′*,

adapted to receive the end of the pin e', carried by said eccentric y, and has an outward tension imparted to it by the spring f'. The pin e' is provided with a suitable head g', by which it may be conveniently operated. The purpose of the pin e' and apertures d' is to permit of the adjustment of the eccentric y around the hub a' in order that the action of the eccentric y upon the fork or frame z may be regulated at will, whereby the throw of said fork or frame z is brought under the absolute control of the attendant, and the action of the shovel Q may be regulated in accordance with the condition of the fire in the furnace, the character of the fuel employed, and any other circumstance that may arise. By moving the eccentric y on the hub a' to one extreme of its movement the shovel Q may be brought to a standstill, and thus the shaft n may continue to revolve and operate the grate-frame E while the shovel Q remains at rest. The point of the pin e' is adapted to enter any of the apertures d' of the flange c' and serves to lock the eccentric y in any of its adjusted positions. The spring f' retains the point of the pin within the proper aperture d', and said pin may when desired be conveniently withdrawn from said aperture d' by means of the head g'. Upon the shaft o is loosely mounted, by means of the sleeve C', the lever D', whose lower end is engaged by the cam E' and whose upper end is by means of the links F' connected with the plate or blade G', as clearly illustrated in Figs. 1 and 5. The cam E' is shown in detail in Fig. 2 and, as illustrated in Fig. 5, is mounted upon and revolves with the driving-shaft n, and said cam E' operates through the lever D' to reciprocate the plate or blade G', the latter, owing to the form of the cam E', having a quick thrust inward and outward while the projecting portion H', Fig. 2, of said cam is engaging the roller carried on the lower end of the lever D'. The purpose of the blade G' is to break down the bridge of fuel which has a tendency to accumulate upon the outer portions of the sectors O, and this result is accomplished merely by driving said plate or blade G' inward against the said bridge of fuel and causing the latter to descend downward upon the sectors O. The shovel Q is of substantial width, as indicated in Fig. 5, and at one corner is cut away sufficiently to permit of the motion of the plate or blade G^3 along the upper surface of the ring x, as indicated in Fig. 5. The shaft o operates simply as a fulcrum for the lever D', which receives all of its motion from the cam E' on the shaft n.

The shaft n through the intermediate gearing I' I'' communicates its motion to the shaft J', upon whose inner end, as shown in Figs. 1 and 3, is secured the pinion-wheel H, which meshes with the teeth G of the revoluble frame E, and hence said shaft n through the medium of the shaft J' operates the revoluble frame E, the latter having a constant revoluble axial motion during all of the time that the shaft J' is in motion. A suitable clutch K' is provided by which the power of the shaft n may be cut off from the gear I' and shaft J' whenever desired, and hence when deemed proper the shaft J' may be allowed to remain stationary and the revoluble frame E and the parts carried thereby caused to cease their motion. The shaft J' is utilized, through the medium of the sprocket-wheels L' and sprocket-chain M', to actuate the conveyer D for removing the ashes and other foreign matter from the ash-pit C. Thus the power-shaft n actuates the shaft o to effect the reciprocation of the shovel Q for stoking the furnace, and the shaft n through the cam E' operates the plate G' for the purpose of breaking down the bridge of fuel likely to form upon the upper outer portions of the sectors O. The said shaft n, also through the medium of the gearing I' I'', is adapted to effect the revolving motion of the grate-frame E and the parts carried thereby, as well as the revolving motion of the conveyer D.

The means for setting the arm f for the purpose of regulating the extent of throw the bars d shall impart to the segments S of the sectors O is illustrated in Figs. 3, 4, and 5, in which it will be seen that the arm f is mounted in the bearings N' and has its downwardly-extending portion connected to the inner end of the rod O', which has upon its outer threaded end the internally-threaded adjusting-sleeve Q', which is held within the bearing P', and by which the rod O' may be drawn outward from the furnace or moved inward toward the furnace for the purpose of adjusting the position of the arm f with relation to the lug e on the bars d of the sectors O. The arm f when adjusted remains rigid and has no movement imparted to it. The lugs e on the bars d of the sectors O are brought against the upper inclined end of the arm f by the revoluble action of the frame E, and said lugs e upon meeting the upper end of the arm f are by said arm forced outward toward the front of the furnace, as by the action of a cam, and said bars d remain in this outward position until the lugs e thereof during the continued revolution of the frame E have their outer edges brought into contact with the plate or flange g, (shown in Figs. 1 and 4,) which plate or flange is in an inclined position and operates as a cam to drive the lugs e and bars d inward as said lugs are moved against the same by the revoluble action of the frame E. Thus during the revoluble motion of the frame E the inner edges of the lugs e of the sector-bars d first ride against the upper inclined end of the arm f and, with the said bars d, are forced outward, thereby rocking the segments S downward and inward, and immediately thereafter the continued revolving of the frame E carries the outer edges of the lugs e on the sector-bars d against the inner edges of the flange or plate g, which effects the movement of the

sector-bars *d* downward and inward, and thereby causes the segments S to rock upward and outward to their former normal position in line with the side bars R R of the sectors O. The rocking motion of the segments S is thus automatically effected by the arm *f* and flange or plate *g* and is in no way dependent upon the driving-shaft *n*.

The operation of the various parts and combinations of the furnace have been sufficiently described hereinbefore in connection with the explanation of the construction of said parts.

This application is not limited to the special revoluble frame E described and shown, since said frame constitutes simply a convenient means for supporting the sectors O and facilitating their axial revolution in a body, nor is the invention confined to the ring *h* or brackets *j* shown, nor is the invention confined to any special cage or grate *i* over the ash-pit, nor is the invention in all its parts confined to the rocking segments S. The cage or grate *i* is allowed to remain substantially full during the use of the furnace, so as to prevent the coals on the sectors O from passing too freely to the ash-pit. In the use of the furnace the body of burning fuel extends over the sectors O and cage *i*.

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

1. In a furnace, the central grate-frame, and the series of radiating inclined sectors extending downward and inward to said grate-frame and constituting the grate-bars proper, said sectors each comprising the sides and movable segments, combined with power mechanism for imparting to said sectors as a body an axial revoluble motion, and means for automatically rocking said movable segments as said sectors pass a given point; substantially as set forth.

2. In a furnace, the central grate-frame, and the series of radiating inclined sectors extending downward and inward to said grate-frame and constituting the grate-bars proper, said sectors each comprising the sides and movable segments, combined with power mechanism for imparting to said sectors as a body an axial revoluble motion, means for automatically rocking said movable segments as said sectors pass a given point, and means for adjusting the throw of said segments; substantially as set forth.

3. In a furnace, the series of radial inclined sectors constituting the grate-bars and comprising the groups of rocking segments, combined with means for imparting to said segments a rocking motion, power mechanism for imparting to said sectors as a whole an axial revoluble motion, means for automatically stoking the furnace from a given point, and means for automatically breaking down the bridge of fuel tending to form at the upper outer portion of said sectors; substantially as set forth.

4. In a furnace, the series of radial inclined sectors constituting the grate-bars and comprising the groups of rocking segments, combined with means for imparting to said segments a rocking motion, power mechanism for imparting to said sectors as a whole an axial revoluble motion, the hopper for fuel, the stoking-shovel at the discharge end of said hopper, and power mechanism for operating said shovel to automatically stoke the furnace; substantially as set forth.

5. In a furnace, the series of radial inclined sectors constituting the grate-bars and comprising the groups of rocking segments, combined with means for imparting to said segments a rocking motion, power mechanism for imparting to said sectors as a whole an axial revoluble motion, the hopper for fuel, the stoking-shovel at the discharge end of said hopper, power mechanism for operating said shovel to automatically stoke the furnace and means for varying the throw of said shovel; substantially as set forth.

6. In a furnace, the central grate-frame having the grooves along its lower edge, power mechanism for imparting to said frame an axial revoluble motion, and the sectional grate-bars supported on said frame, combined with the tramway below the edges of said frame and having the downwardly-diverging surfaces below said grooves, and the balls confined within said grooves and bearing on said surfaces; substantially as set forth.

7. In a furnace, the central grate-frame, grate-bars radiating upward and outward from said frame, and the power-shaft, combined with means intermediate said frame and shaft for revolving the former from the latter, the hopper for fuel, the shovel at the discharge end of said hopper, the auxiliary or rock shaft, means connecting said shovel and shaft for reciprocating the former from the latter, the forked frame connected with said auxiliary shaft, and the eccentric on said driving-shaft and engaging said forked frame for actuating said auxiliary shaft and said shovel; substantially as set forth.

8. In a furnace, the central grate-frame, grate-bars radiating upward and outward from said frame, and the power-shaft, combined with means intermediate said frame and shaft for revolving the former from the latter, the hopper for fuel, the shovel at the discharge end of said hopper, the auxiliary or rock shaft, means connecting said shovel and shaft for reciprocating the former from the latter, the forked frame connected with said auxiliary shaft, the hub on said driving-shaft, and the eccentric-strap encompassing and adjustable on said hub and engaging said forked frame for actuating said auxiliary shaft and said shovel; substantially as set forth.

9. In a furnace, the central grate-frame, grate-bars radiating upward and outward from said frame, and the power-shaft, combined with means intermediate said frame and shaft for revolving the former from the

latter, the hopper for fuel, the shovel at the discharge end of said hopper, the auxiliary or rock shaft, means connecting said shovel and shaft for reciprocating the former from the latter, the forked frame connected with said auxiliary shaft, the hub on said driving-shaft, the eccentric-strap on said hub and engaging said forked frame for actuating said auxiliary shaft and said shovel, the apertured plate at the side of said hub, and the pin carried by said eccentric-strap for engaging the apertures of said plate and securing said strap in its adjustments; substantially as set forth.

10. In a furnace, the central grate-frame, grate-bars radiating upward and outward from said frame, and the power-shaft, combined with means intermediate said frame and shaft for revolving the former from the latter, the hopper for fuel, the shovel at the discharge end of said hopper, means intermediate said shovel and said shaft for operating the former from the latter, the independent blade or plate for breaking down the bridge of fuel tending to form on the upper outer portions of said grate-bars, and means intermediate said independent blade or plate and said shaft for operating the former from the latter; substantially as set forth.

11. In a furnace, the central grate-frame, grate-bars radiating upward and outward from said frame, and the power-shaft, combined with means intermediate said frame and shaft for revolving the former from the latter, the hopper for fuel, the shovel at the discharge end of said hopper, means intermediate said shovel and said shaft for operating the former from the latter, means for stopping said shovel without stopping said shaft or said grate-frame, and means for stopping said grate-frame without stopping said shaft or said shovel; substantially as set forth.

12. In a furnace, the central frame, and the radial sectors converging downward and inward to said frame and constituting the grate-bars, said sectors comprising the side bars and the series of groups of rocking segments intermediate said side bars, the segments of each group being connected to rock together, combined with the connecting-bar uniting the groups of segments of each sector, means for reciprocating said connecting-bar to rock said segments, and means for imparting to said grate-bars as a whole, an axial revoluble motion; substantially as set forth.

13. In a furnace, the central frame, the series of radiating grate-bar sectors converging downward and inward to said frame and each comprising the sides and rocking segments, and a connecting-bar secured to said segments to rock the same in unison, combined with a projecting surface in the path of said connecting-bar to move the same and said segments in one direction, and a further projecting surface in the path of said connecting-bar to move the same and said segments in the opposite direction; substantially as set forth.

14. In a furnace, the central frame, the series of radiating grate-bar sectors converging downward and inward to said frame and each comprising the sides and rocking segments, and a connecting-bar secured to said segments to rock the same in unison, combined with the arm in the path of said connecting-bar to move the same and said segments in one direction, means for adjusting the position of said arm to regulate the movement of said bar and segments, and the inclined plate also in the path of said bar to move the same and said segments in the opposite direction; substantially as set forth.

15. In a self-stoking furnace, the revoluble frame E comprising the base-ring, the side sections *a*, and the upper annular sectional frame F having the teeth G, combined with gearing for revolving said frame, the series of radial downwardly-converging sector grate-bars mounted upon said frame, and the cage or grate located within said frame and below the inner edges of said sector grate-bars; substantially as set forth.

16. In a self-stoking furnace, the revoluble frame E comprising the base-ring, the side sections *a*, and the upper annular sectional frame F having the teeth G, combined with the radial brackets *j* secured to said sections *a*, the ring *h* supported upon the converging ends of said brackets, gearing for revolving said frame E, brackets *j* and ring *h*, the series of radial downwardly-converging sector grate-bars mounted upon said frame, and the cage or grate located within said frame and below the inner ends of said sector grate-bars; substantially as set forth.

Signed at New York, in the county of New York and State of New York, this 3d day of November, A. D. 1897.

BENJAMIN W. TUCKER.

Witnesses:

CHAS. C. GILL,

E. JOS. BELKNAP.