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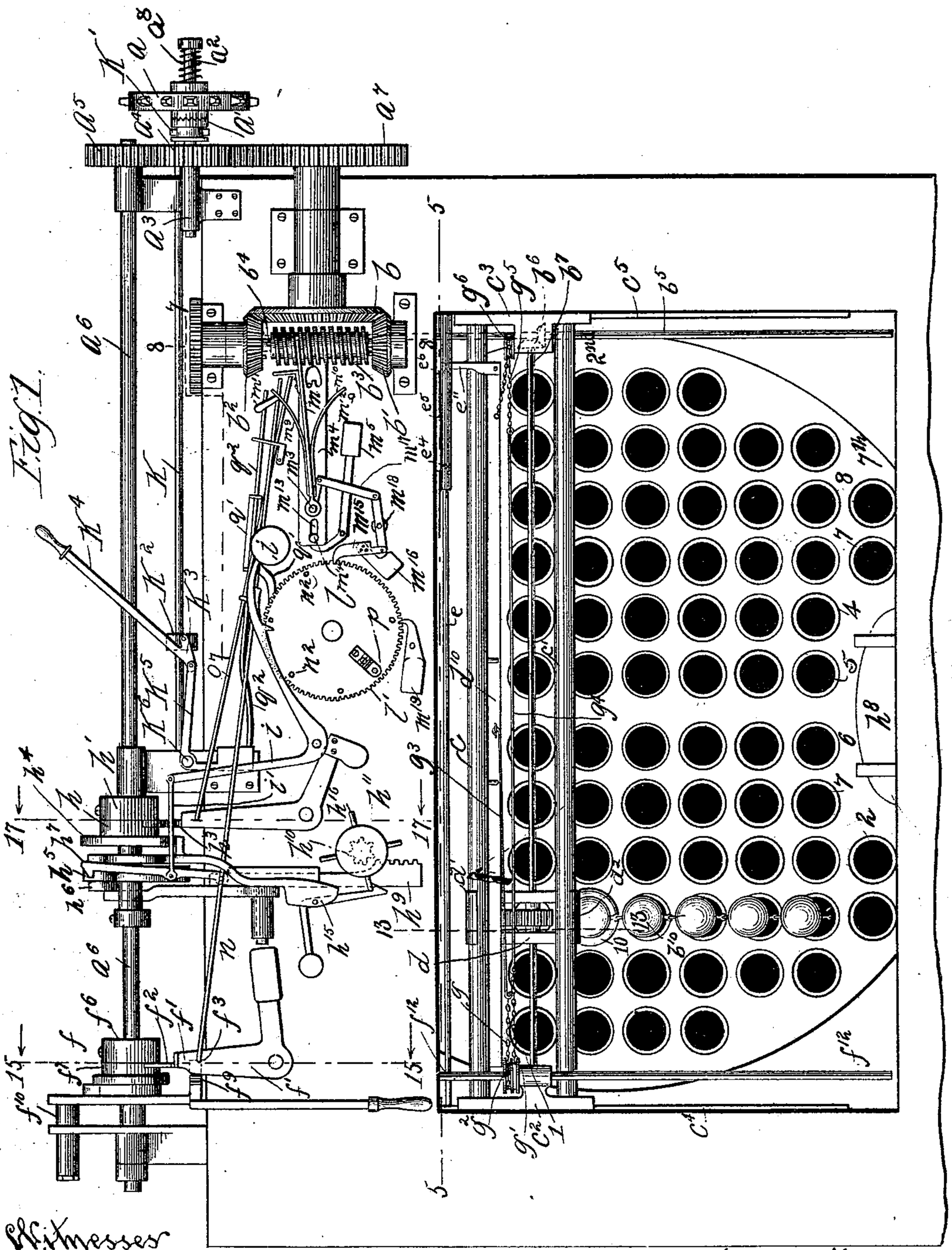
P. S. KINGSLAND & C. C. HILL.

AUTOMATIC BOILER FLUE SCRAPER.

No. 514,195. Patented Feb. 6, 1894.

Fig. 1.



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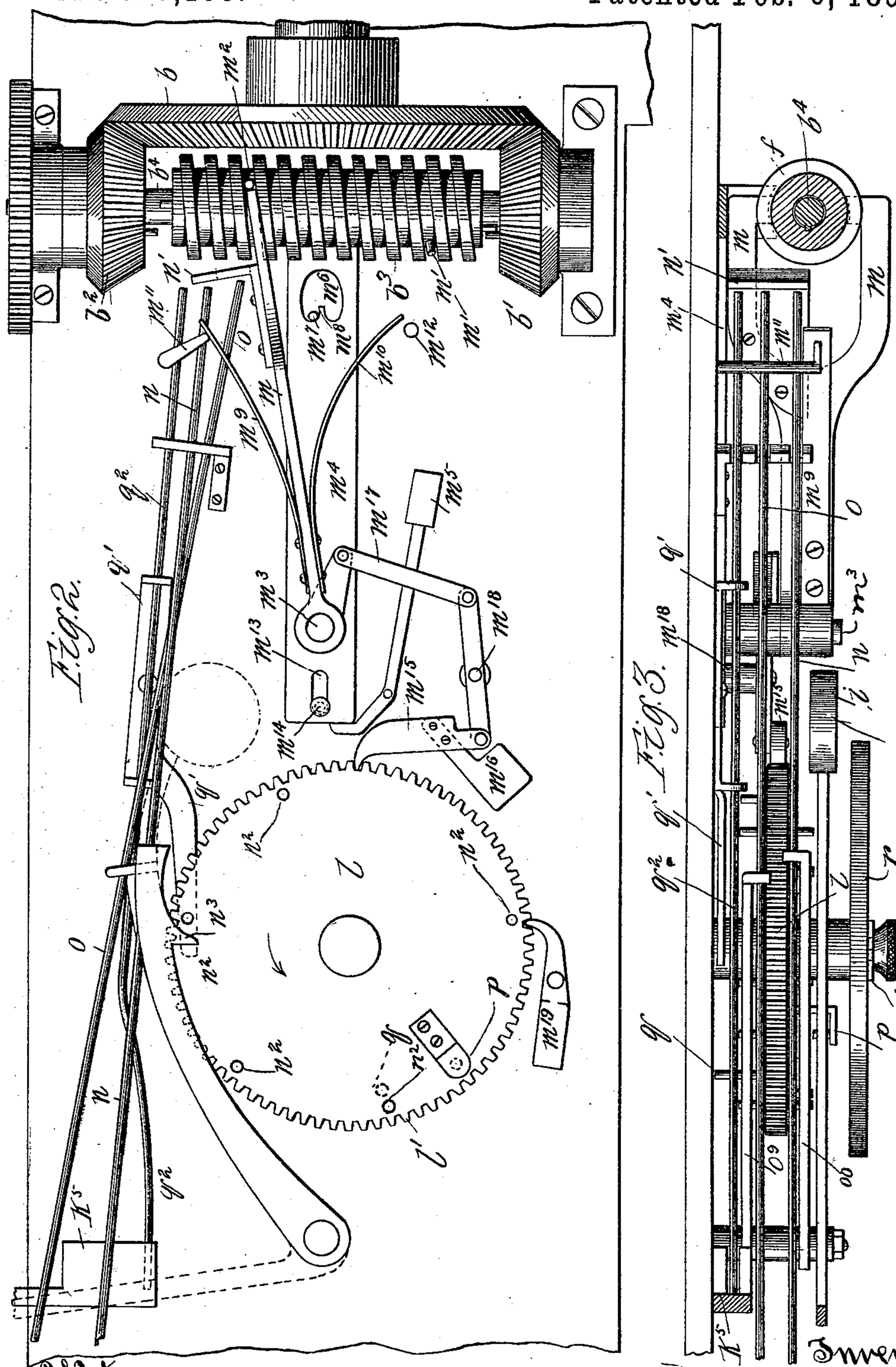

Fig. 2.

Fig. 3.

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AUTOMATIC BOILER FLUE SCRAPER.

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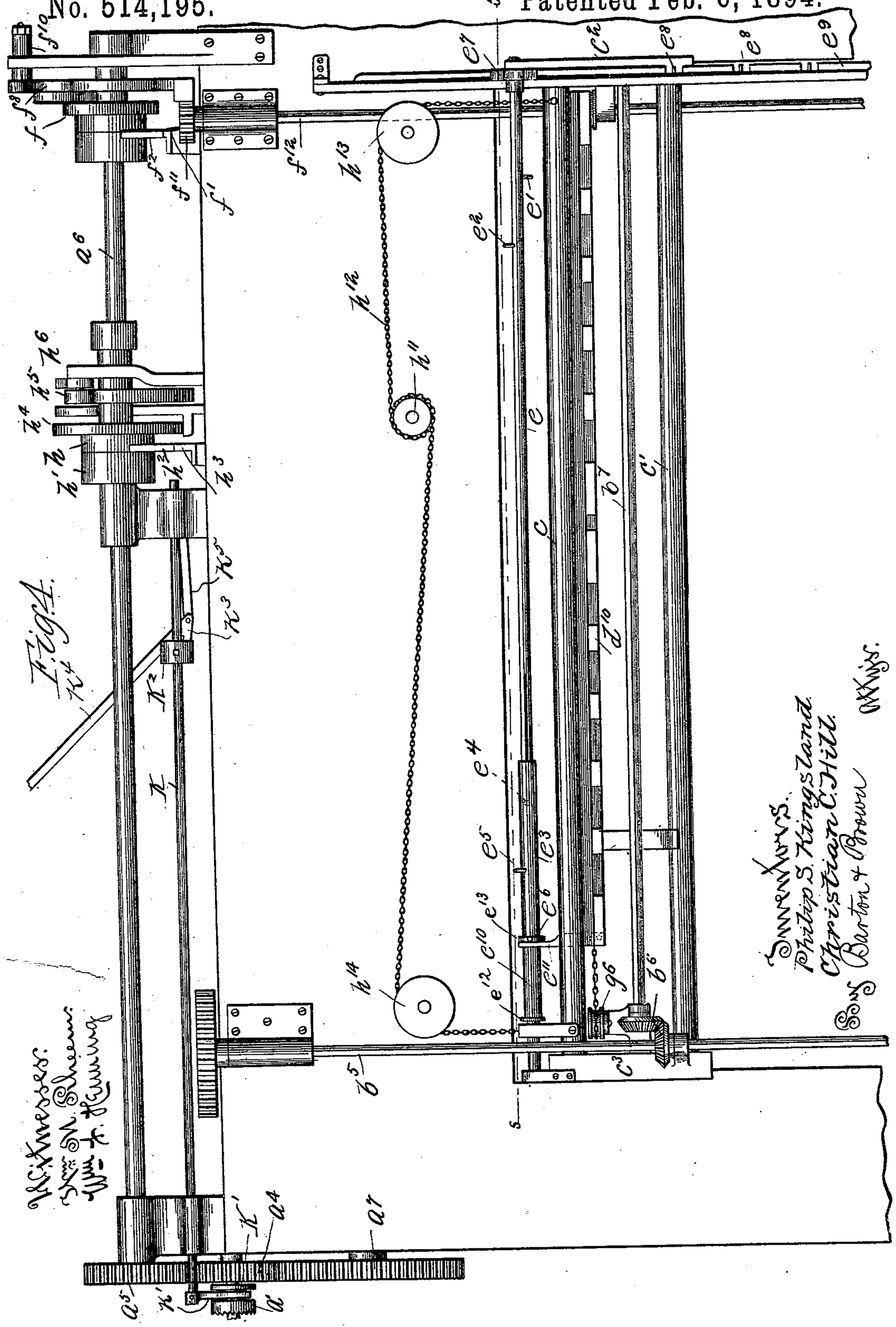

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AUTOMATIC BOILER FLUE SCRAPER.

No. 514,195. Patented Feb. 6, 1894.

Fig. 5.

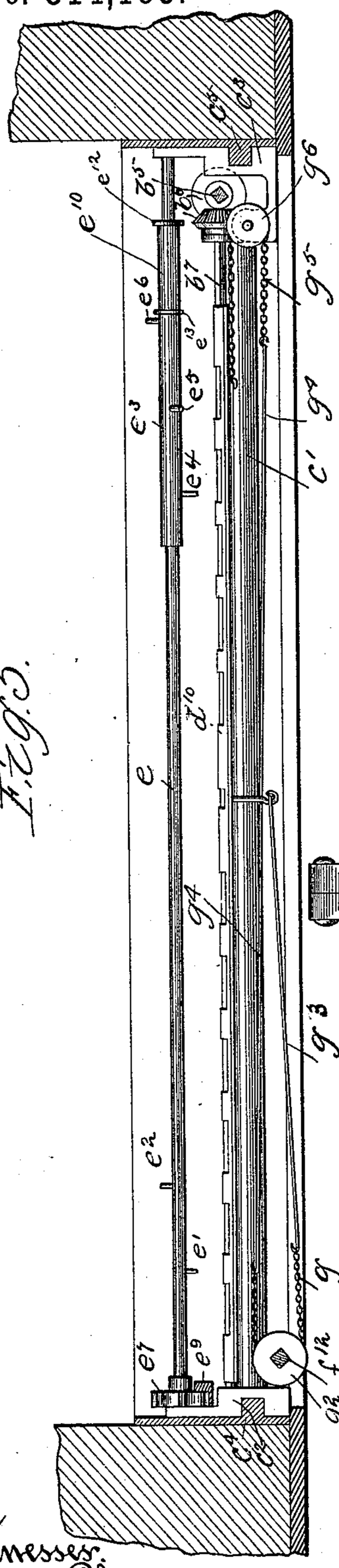
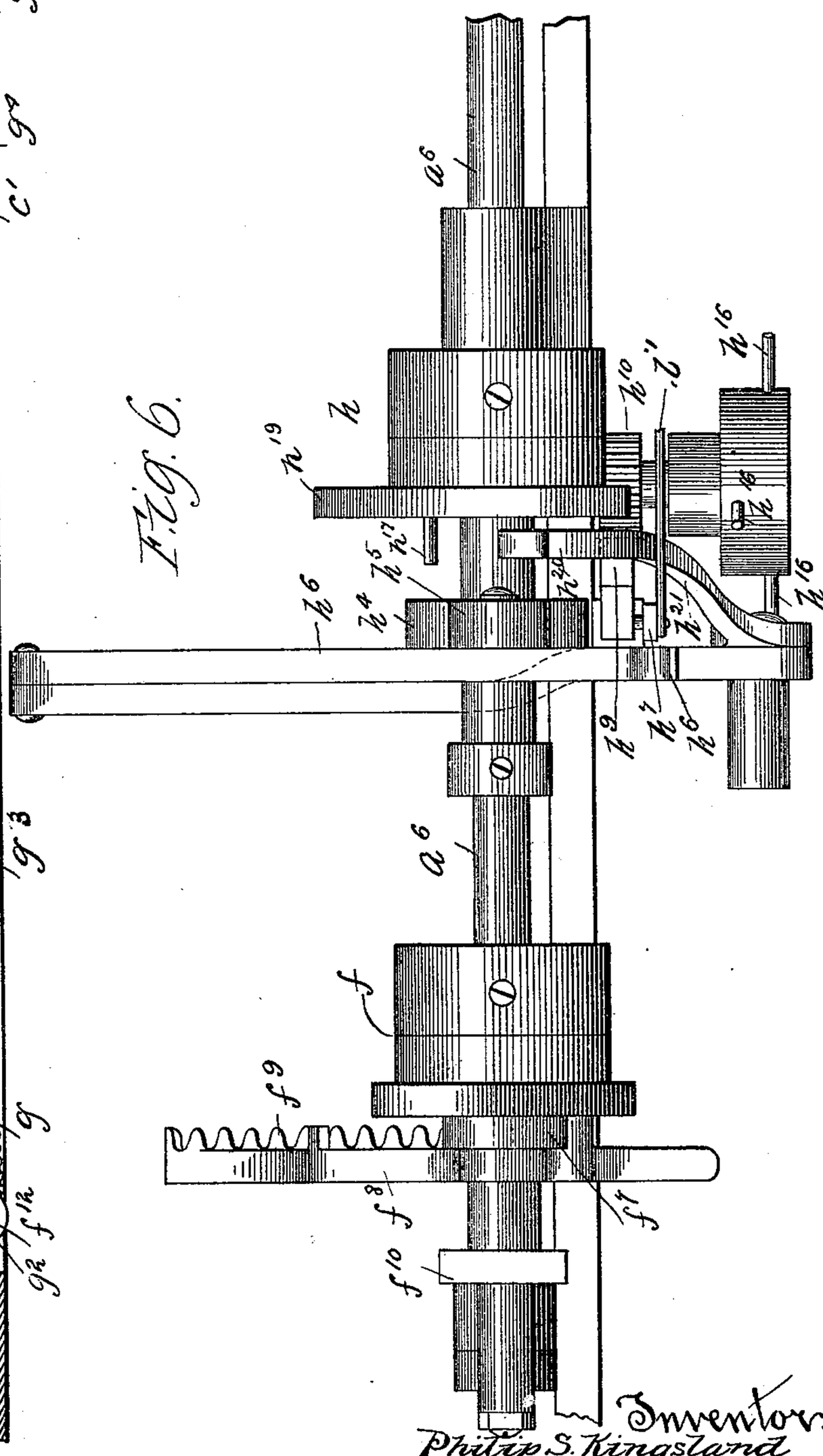


Fig. 6.



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AUTOMATIC BOILER FLUE SCRAPER.

No. 514,195. Patented Feb. 6, 1894.

Fig. 8.

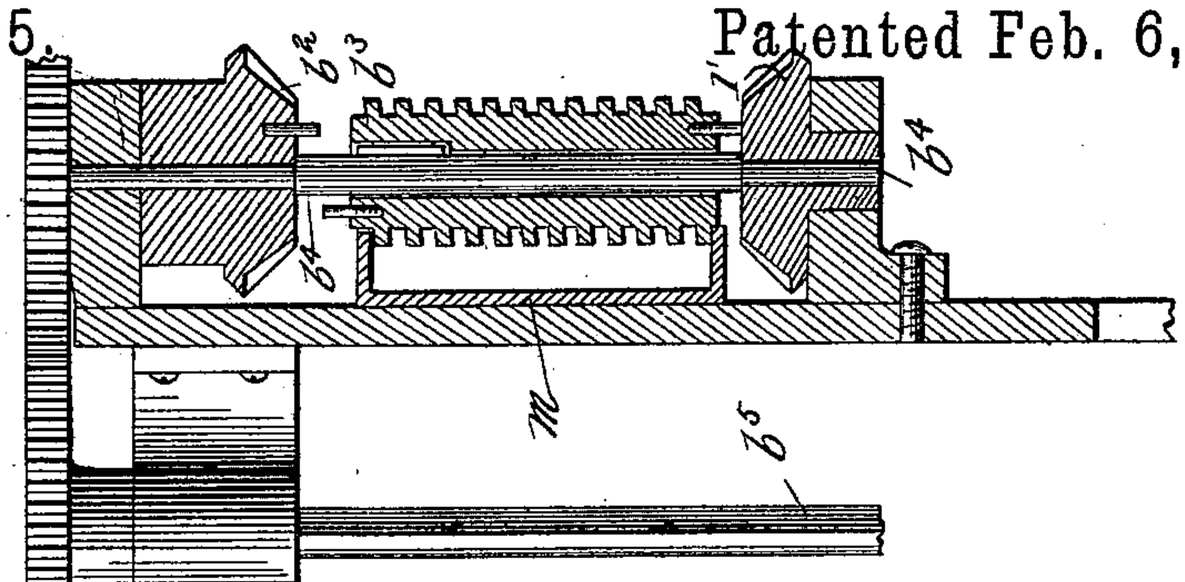

Fig. 1.

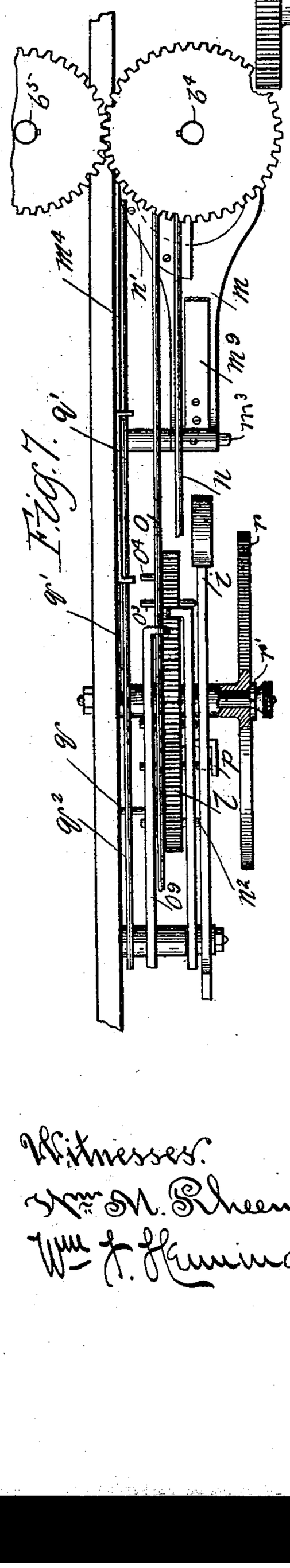

Fig. 11.

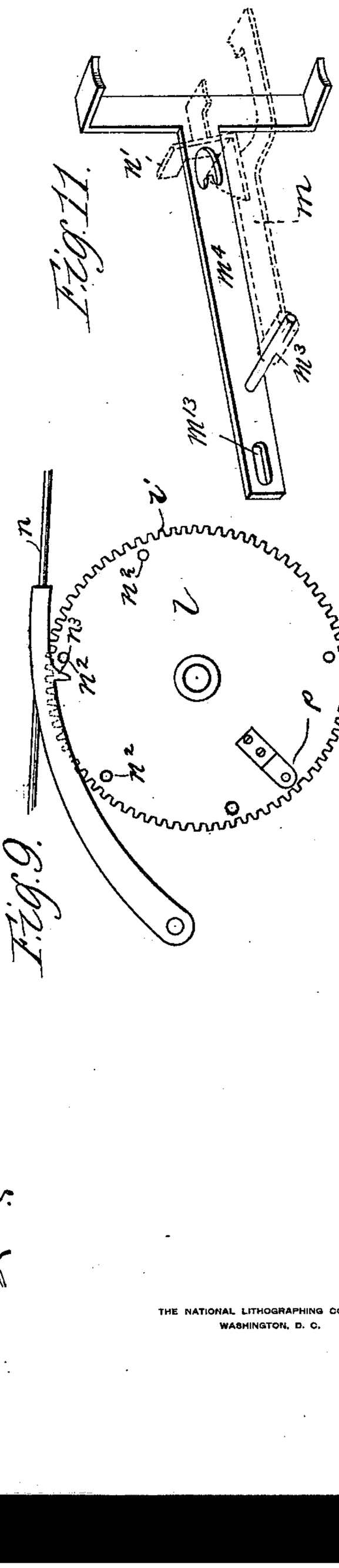

Fig. 12.

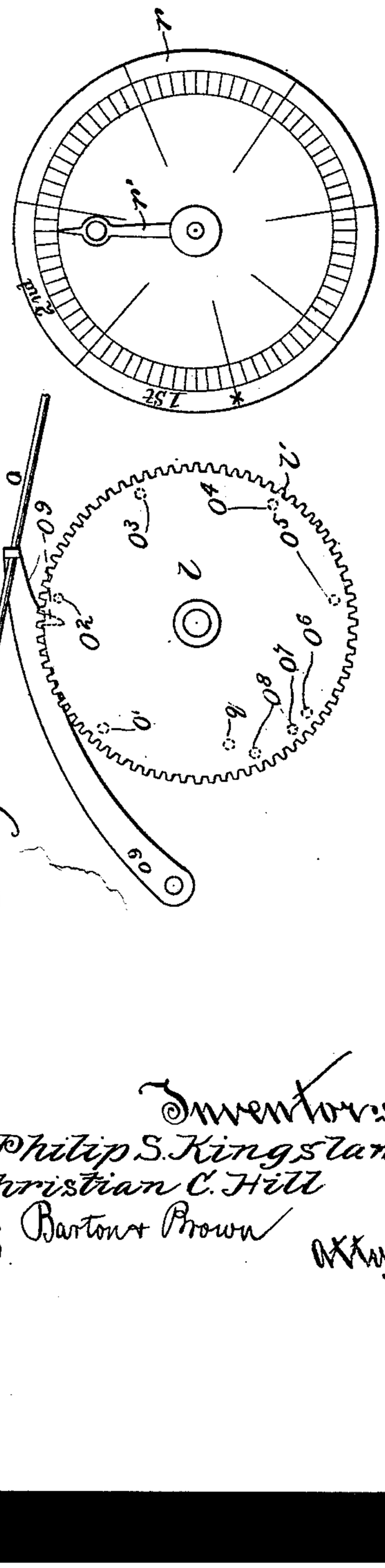

Fig. 9.

Fig. 10.

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AUTOMATIC BOILER FLUE SCRAPER.

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Fig. 13.

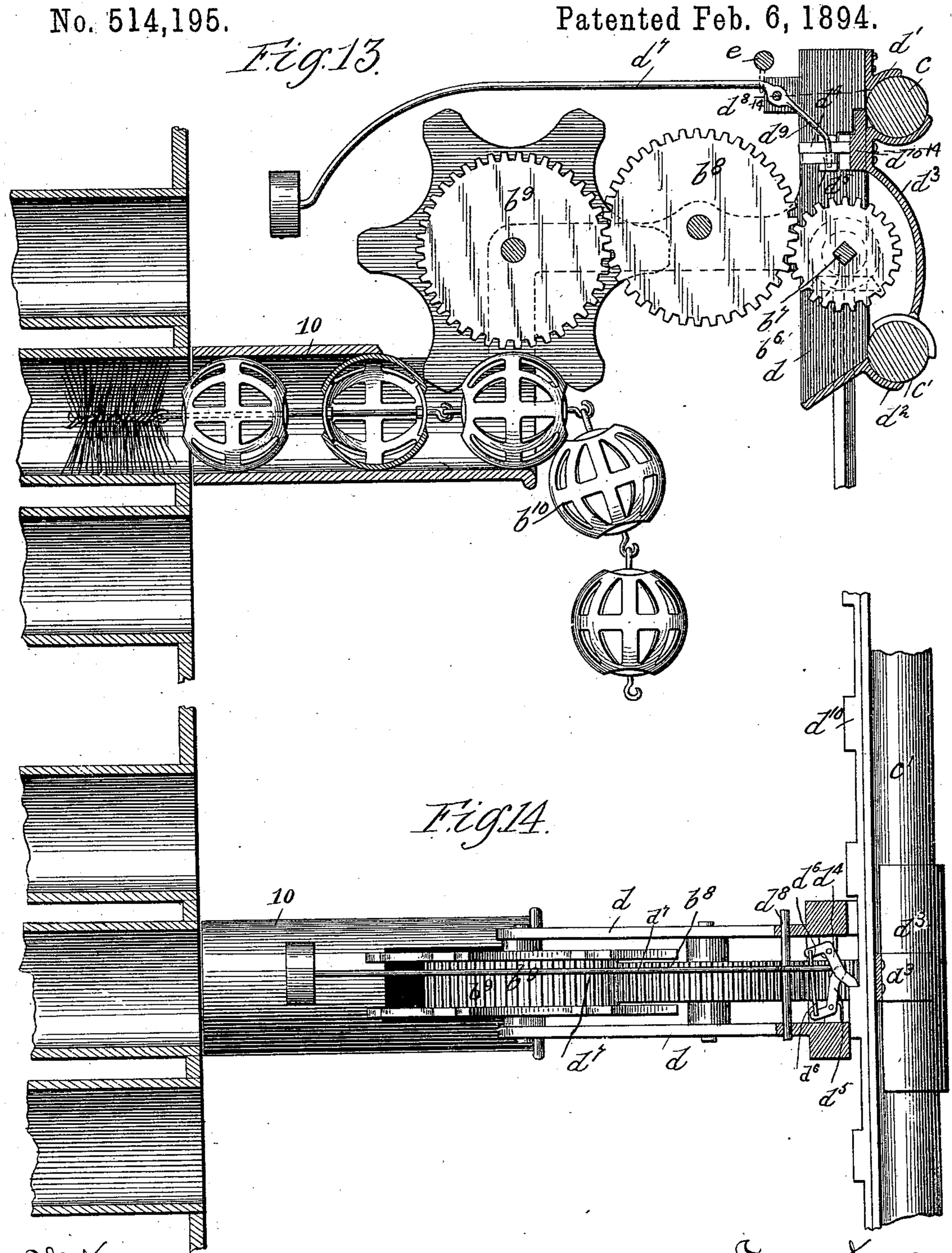

Fig. 14.

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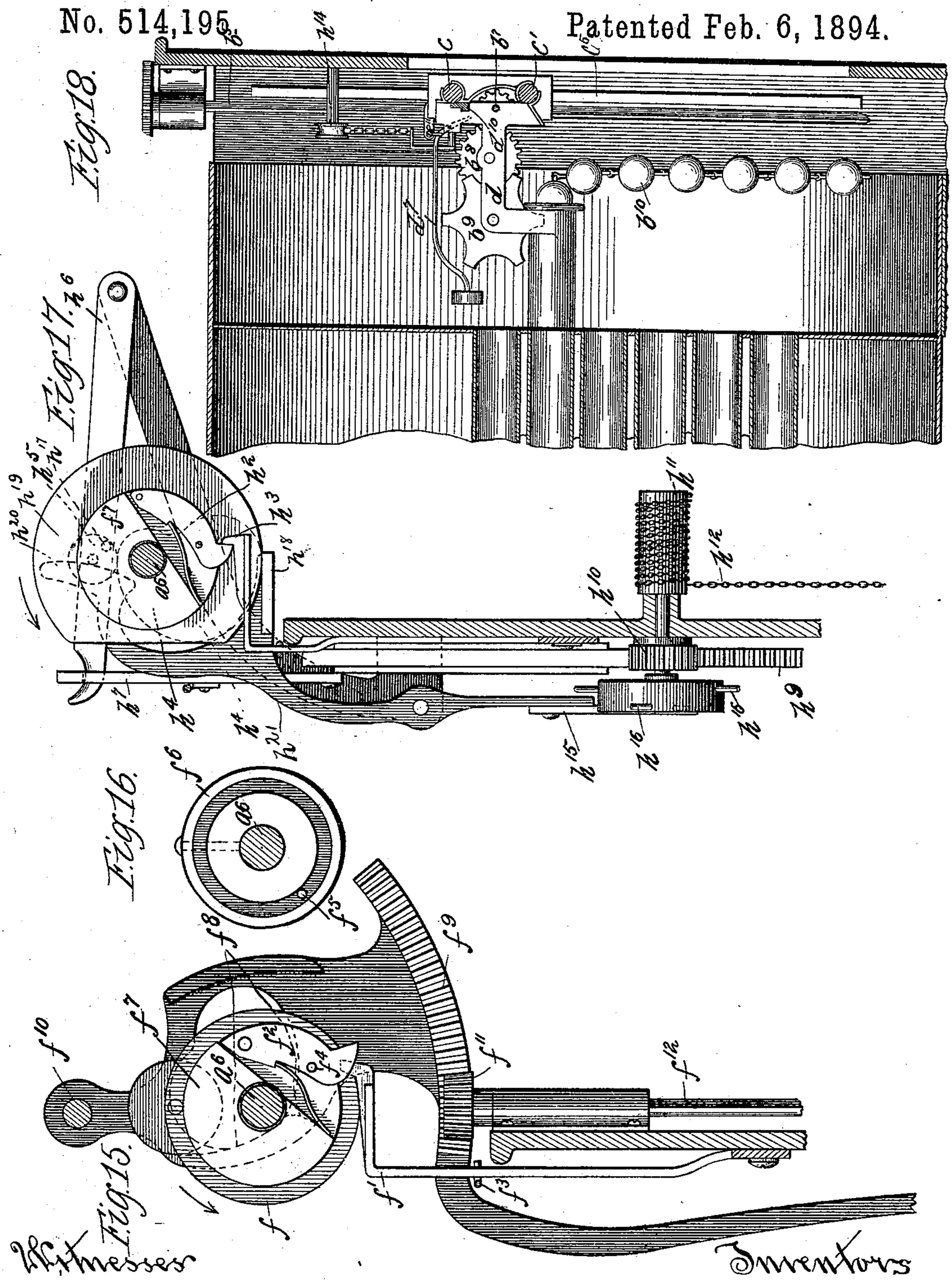

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UNITED STATES PATENT OFFICE.

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AUTOMATIC BOILER-FLUE SCRAPER.

SPECIFICATION forming part of Letters Patent No. 514,195, dated February 6, 1894.

Application filed May 9, 1892. Serial No. 432,312. (No model.)

To all whom it may concern:

Be it known that we, PHILIP S. KINGSLAND and CHRISTIAN C. HILL, citizens of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Automatic Boiler-Flue Scrapers, (Case No. 4,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

Our invention relates to cleaning steam boiler flues, and the machine embodying our invention is adapted to be placed at the front of a tubular steam boiler, and is so constructed and arranged that, when once started, the scraper will be positively forced through and positively withdrawn from each of the flues, one after the other in successive order until all are scraped out. We preferably use a chain composed of skeleton hollow balls connected by jointed links and driven by a sprocket wheel, whereby the chain is caused to operate the scraper, positively pushing it through a flue and then positively withdrawing it again through the same flue. A tubular guide is provided for the chain which serves to direct the scraper to the proper flue as the carriage, upon which the chain and guide are mounted, is brought into position. The carriage must be moved horizontally back and forth in front of the rows of flues, and must be lowered at the end of each row and the direction of its horizontal movement reversed. Where the row below the row that has been cleaned contains less flues, a diagonal downward movement must be imparted to the carriage in order that it may come to rest opposite the first flue of the row having the lesser number. Usually the cover of the hand hold comes between the flues of the last row, as illustrated herein. In such case, after the flues on one side of the cover have been cleaned, it is necessary to pass up around the cover; therefore, means must be provided for hoisting the carriage. These movements of the carriage must be made in proper relation, with respect to time, to the operation of the chain so that the chain may be forced into and withdrawn from the different flues, the carriage remaining at rest in front of each flue while the action of the chain in reciprocating the scraper is taking place.

We will now refer in a somewhat general way to certain of the more important features of our apparatus as embodied in our machine. First:—A pair of pinions driven in opposite directions are loosely mounted upon a shaft, upon which a worm clutch is splined; lever mechanism for shifting this clutch to engage first with one pinion and then with the other is provided. The shaft is thus driven in one direction or the other, according to the engagement of the clutch with one or the other of the loose pinions. This shaft is connected by suitable gearing with the sprocket wheel which carries the chain, and thus, change of the engagement of the clutch between the driven pinions, changes the direction of the movement of the sprocket wheel carrying the chain and scraper. Second:—After the scraper has thus been inserted in and withdrawn from a flue, the carriage must be advanced a step to the next flue. This horizontal step or movement is imparted to the carriage by a rack bar, which being reciprocated engages with one or the other of a pair of pawls provided upon the frame of the carriage. Third. The pawls are separately pivoted, and their free ends or arms linked together, and so arranged with respect to the rack that when one pawl is in position to be taken by a notch of the rack, the other pawl will be drawn back so as not to be engaged; thus the rack on being reciprocated will take a pawl and so carry the carriage in one direction during one-half of its stroke, but will not take the other pawl during the other half of its stroke. A weighted lever in connection with a rotatable bar provided with pins for shifting said lever when the direction of the carriage is to be reversed, is adapted to bear against the free end of one of the pawls or that of the other as it is shifted to one side or to the other of the carriage by coming against the pins upon the rotatable bar. Fourth.—By means of a reciprocating sleeve carrying pins, provided upon one end of the rotatable bar, the rack bar is prevented from simply exchanging pawls to move the car

riage back by the return stroke of the rack bar, and the carriage is allowed to remain at its extreme position, in this instance to the right until the rack is again reciprocated. Fifth.—A clutch connected with the vertically movable frame on which the carriage is mounted is so arranged that the frame is lowered and raised as required. Sixth.—A clutch splined to the main shaft is adapted to engage with the hub of the main driving wheel when the machine is brought into operation, and to be automatically disengaged therefrom when the last flue has been cleaned, thus throwing the machine out of action at the proper time. Seventh.—A ratchet wheel provided with notches about its periphery, and with pins upon the sides thereof, is combined with pawls, detents and levers in such manner as to cause the different parts of the machine to operate in proper sequence with respect to one another.

Our invention will be more readily understood by reference to the accompanying drawings, in which—

Figure 1 is a front elevation of our automatic boiler flue scraper applied to the front of a boiler, the doors of the smoke chamber being removed to expose the front ends of the flues. Fig. 2 is a detailed front view of the worm clutch, the ratchet wheel and levers and rods combined therewith. Fig. 3 is a plan view thereof. Fig. 4 is a rear view of the machine, the carriage being removed. Fig. 5 is a plan view of the rack bar with the attachment for reciprocating the same together with the rotatable bar for changing the position of the pawls of the carriage, as seen from line 5—5 of Fig. 4. Fig. 6 is a plan of the clutch which acts to reciprocate the rack bar, and of the clutch which acts to lower and raise the frame on which the carriage is mounted. Fig. 7 is a sectional plan upon line 7—7 of Fig. 1, with certain parts broken away and removed. Fig. 8 is a sectional view upon line 8—8 of Fig. 1, showing the worm clutch and the pinions between which the clutch is placed, and the shaft geared to shaft upon which the carriage is mounted. Fig. 9 is a front view of the main ratchet wheel showing the pins upon the front side thereof. Fig. 10 is a front view of the same ratchet wheel, the pins upon the front side thereof being omitted, and the pins upon the rear side being indicated in dotted lines. Fig. 11 is a detailed view of the shifting lever provided with the yoke, which lever acts to shift the worm clutch to cause it to engage with the different loose pinions. Fig. 12 is a front view of the graduated indicator. Fig. 13 is a detailed sectional view upon line 13—13 of Fig. 1, showing the carriage carrying the sprocket wheel which drives the chain, and the weighted lever in connection with the bar provided with pins for shifting the said weighted lever to cause one or the other of the dogs of the carriage to engage with the rack bar. Fig. 14 is a plan view of the same on line 14—14 of Fig. 13. Fig. 15 is a sectional view showing the clutch, the segment gear operated by an eccentric provided thereon, and the bar provided with a pinion meshing with the segment gear which is brought into action to shift the direction of the carriage. Fig. 16 is a view of the portion of the clutch which is rigid upon the driving shaft. Fig. 17 is a detailed sectional view showing the lowering and hoisting mechanism on line 17—17 of Fig. 1. Fig. 18 is a side view of the carriage in connection with the tubular guide.

The main driving wheel a in Fig. 1 is shown in engagement with the clutch a' which is splined to the shaft a^2. This shaft a^2 is provided with journal bearing a^3 and the gear wheel a^4 meshing with the pinion a^5 upon the shaft a^6 and also meshing with the teeth upon the wheel a^7. The teeth of the clutch a' and of the hub of the driving wheel are V-shaped, and a spring a^8 tends to hold the wheel a toward the clutch. If, however, the shaft a^2 should be prevented from turning under moderate power from the driving wheel, the V-shaped teeth will cause the sprocket wheel to be moved slightly on the shaft against the resistance of spring a^8, and the teeth passing over one another will make a noise to warn the attendant of the obstruction. The bevel gear b engages with the pinions b' b^2 between which is placed the worm clutch b^3. This clutch is splined to the shaft b^4 upon which the pinions b' b^2 are loosely mounted, and thus the direction of the revolution of the shaft b^4 will be reversed as the engagement of the worm is shifted between the clutches by moving the same longitudinally upon the shaft, as will be more fully explained later. The shaft b^4 is geared to the shaft b^5, which by suitable bevel gears b^6 is connected with the shaft b^7 which, as shown most clearly in Figs. 13 and 14, is connected through the idler b^8 with the sprocket wheel b^9 which drives the chain b^{10}. The linkage between the shaft b^4 and the sprocket wheel b^9 of the form shown and described, we have found very satisfactory.

By the term "linkage" we mean to designate any system of kinematic links by means of which constrained motion may be transmitted from one element of a combination to another; such links being levers, gear wheels, or the like. We however fully understand that this linkage whereby the movement of the shaft b^4, as it is controlled and driven first in one direction and then in the other, is transmitted and imparted to the sprocket wheel b^9 and thence to the chain and scraper, might be varied according to circumstances and the judgment of the mechanic without departing from our invention. We have thus shown how the chain by power transmitted from the shaft b^4 is inserted in and withdrawn from a flue.

We will now describe the carriage which carries the chain longitudinally and the ver-

tically movable frame on which the carriage is mounted. This frame consists essentially of the bars c c' secured to the end pieces c^2 c^3, which are provided with grooves corresponding to the upright guides c^4 c^5. The carriage d is mounted upon the bars c c', the bars serving as guides for the concave surfaces of the pieces d' d^2, which are adapted to slide thereon, as shown most clearly in Fig. 13. The piece d^3 is attached to the rack and moves therewith and is curved to make room for the gear wheel upon the shaft b^7. This curved piece d^3 slides upon the bars c c', as shown in Fig. 13. Mounted upon this carriage are the pawls d^4 d^5 separately pivoted, and having their arms connected together by the link d^6. The weighted pivoted shifting lever d^7 is mounted upon the bar d^8 at the rear of the lugs and so arranged that its shorter arm d^9 will press against the pawls d^4 d^5 to cause one or the other of the same to project so as to be in the path of the rack d^{10}, accordingly as the weighted lever d^7 is in one position, or is moved upon said bar d^8 to one side or the other of the carriage. As shown in Fig. 14, the weighted lever d^7 is moved to the right of the carriage so as to be opposite and press against the pawl d^4 so as to bring the working end of said pawl d^4 into the path of the rack d^{10}, while by means of the link d^6 the pawl d^5 is drawn back so as to bring the working end of said pawl d^5 back out of the path of the notches of the rack d^{10}. The rack d^{10} is reciprocated to move the carriage step by step from one flue to another, and the direction in which the carriage is moved is determined by the position of the pawls d^4 d^5. When the weighted lever d^7 is at the right of the carriage, pawl d^4 will be in position to be taken by the notches, and hence the carriage will be moved to the right a step each time the rack d^{10} is reciprocated. When the weighted lever d^7 is shifted to the left side of the carriage, the other pawl d^5 will be brought in position to be taken by the notches of the rack when reciprocated, and thus the carriage will be moved to the left. As illustrated in Fig. 1, the carriage is in position to direct the scraper through the tenth flue of the second row; that is, the carriage may be considered as having started at the flue 1 of the upper row to travel across the upper row and back to the left so as to be in the position shown to clean flue 10, counting from the right of the second row of the flues. The rotatable bar e is provided with pins e' e^2 at one end, and at the other end, said bar is provided with a sleeve e^3 having pins e^4 e^5 e^6. A star wheel e^7 is provided upon one end of this bar e, and so arranged with relation to notches e^8 e^8 in the vertical bar e^9 that, as the vertically movable frame is raised and lowered, the wheel will take the appropriate notches so as to turn the bar e to bring the appropriate pins e' e^2 e^4 e^5 e^6 into the path of the pivoted weighted lever d^7 to shift the same so as to reverse the direction of the movement of the carriage as the carriage passes from one row to another

The sleeve e^3 is splined to the bar e at the right end or portion thereof, as shown in Figs. 1 and 5. This sleeve is provided with a bearing e^{10}, as shown in Figs. 4 and 5, to which arm e^{11}, connected with the rack bar d^{10}, is fitted so that as the rack d^{10} is reciprocated, said arm e^{11}, which is fitted to said bearing e^{10}, may slide back and forth upon said bearing e^{10} between the shoulders e^{12}, e^{13} thereof. The shoulders of this sleeve or bearing e^{10} are a less distance apart than is the length of the stroke of the rack bar, and so the sleeve e^3 will be moved the amount of the difference between the length of said stroke and the distance the collars are from one another each time the rack is reciprocated. By means of the reciprocating sleeve e^3, the pin upon said sleeve which is to do the shifting is kept out of the way of the weighted arm d^7 during the forward stroke of the rack, but on the return the pin will be carried against the said weighted lever to shift the same. This shifting taking place after the notch, which will on the next reciprocation carry the carriage to the left, has gone entirely past the pawl d^5, and thus the carriage is allowed to remain at its extreme position to the right until the rack is again reciprocated, whereupon the said notch of the rack engages with said pawl d^5, which is now in position, and the carriage is carried a step to the left on the return stroke of the rack.

We will now describe the manner in which power is transmitted from the shaft a^6 to the rack d^{10} to reciprocate the same immediately after the scraper has been withdrawn from a flue. As shown in Figs. 1, 4, 6 and 15, a clutch f is provided upon shaft a^6. This clutch f is held out of engagement by a latch f', which is normally in the path of the spring catch f^2 until at the proper time the said latch f' is pushed aside by the rod or bar connected with the latch at f^3, which is brought into position to be thrust longitudinally, as will be explained more in detail later at the time the scraper is withdrawn from the flue. The spring catch f^2 is thus left free to move outwardly, so that the pin f^4 provided thereon will engage with the pin f^5 provided upon the collar f^6, as shown in Fig. 16, which collar is secured rigidly to the shaft a^6 so as to move therewith. The cam roller f^7 mounted upon the clutch, when the clutch is thus brought into engagement with the collar f^6 and shaft a^6, will be carried in the direction indicated by the arrow in Fig. 15 about the cam roller guide f^8 provided in the swinging segment gear f^9, and thus the said segment gear will be swung upon its pivot f^{10}. The segment gear f^9 is in engagement with the pinion f^{11} provided upon the upright shaft f^{12}. Thus it will be seen that whenever the latch f' is thrown out of the path of the spring catch f^2, the pivoted segment gear f^9 will be reciprocated, and thus the shaft f^{12} will be turned back and forth. It is by means of this reciprocal movement of the shaft f^{12} that

the reciprocating motion required is imparted to the rack d^{10}. Any suitable mechanical connection may be made between the shaft f^{12}, and the rack d^{10}. The connecting mechanism we preferably employ consists of the chains g g' each fastened respectively on different sides of the wheel g^2 carried upon said shaft f^{12}. The chain g is connected with the rack d^{10} by means of a link g^3. The other chain g' is connected by the link g^4 with the chain g^5, which after passing over the loose sleeve g^6 is attached to the rack d^{10}. When the shaft f^{12} is reciprocated the chains or cords g g' will be wound upon and unwound from their grooves respectively upon the wheel g^2; that is, during the first movement of the segment gear, the chain g' will be wound upon its groove, thus drawing the link g^4 to the left, and hence through the medium of the chain g^5 and sleeve g^6 the rack d^{10} will be moved a stroke to the right. When the segment gear f^9 returns, the shaft f^{12} will be moved in a direction to wind up the chain g, and thus through the link g^3 connected directly with the rack d^{10}, the rack will be moved to the left. The rack thus reciprocated engages with the pawls of the carriage, as before described, to move the carriage a step in one direction or the other. It is the releasing of the spring catch f^2 by moving the latch f' which determines the time of the movement of the carriage, and as before stated this movement must take place immediately after the scraper is withdrawn from a flue.

We will now describe the lowering and hoisting mechanism, whereby the vertically movable frame upon which the carriage is mounted, is lowered and raised by power communicated from the shaft a^6. The clutch h upon the shaft a^6, by means of which the lowering and hoisting movements are transmitted from the shaft is, generally speaking, similar in construction to the clutch f previously described. In fact, the fixed collar h' may be the precise counterpart of the collar f^6 of said clutch f. The clutch h is best illustrated in Figs. 1, 6 and 17. When the spring catch h^2 is in engagement with the latch h^3 the shaft does not move the clutch, and the clutch remains in the position shown in Fig. 1. The cam h^4 carried on the sleeve on the loose portion of the clutch, acts upon the cam roller h^5, which is mounted upon the lever h^6, when the said lever h^6 is locked by the latch or detent h^7, as shown in Fig. 17. It is only at one time during the operation of the machine we have illustrated, that the lever is thus locked, and that is when the flue 2 of row 7 having been cleaned, it is necessary to raise the carriage to pass around the handle h^8 of the man hole. The mechanism connected with the ratchet disk for causing the latch or detent h^7 to lock the lever h^6 to cause the same to act as a bell crank to lift the rack h^9, meshing with the pinion h^{10} of the windlass h^{11}, will be explained after we have described the releasing or lowering mechanism connected with said clutch h. The chain or cord h^{12} passes over the sleeves h^{13} h^{14} and down to the bar c, or rather to studs projecting from said bar c. The weight of the frame acts upon the chain or cord h^{12}, but the chain is kept from unwinding by the escapement which consists of the detent h^{15} and the pins h^{16}. When the lever of the detent h^{15} is moved out of engagement with that one of the pins h^{16} with which it happens to be in engagement, the frame will be lowered by gravity, the windlass simply turning to permit the chain h^{12} to unwind. In our machine, as illustrated, the windlass will turn half way around each time the escapement lever is operated.

The escapement lever is operated in the following manner. Referring to Figs. 6 and 17, when the latch h^3, is moved out of engagement with the spring catch h^2 the pin carried upon the spring catch h^2 comes in contact with the pin upon the clutch collar h', thus causing the disk h^{19} to revolve with the shaft a^6. A pin h^{17}, carried upon the disk h^{19}, comes in contact with the guide h^{20} provided upon the detent arm h^{21}, causing the said detent arm h^{21} to move to the left, thus causing the detent lever h^{15} to move to the right out of the path of the pin h^{16} with which it was engaged and into the path of the next pin, thus permitting the windlass to turn one-fourth way around. Then the windlass is brought to rest for an instant by the engagement of the detent lever h^{15} with the next pin h^{16} upon the periphery of the drum. As the disk h^{19} continues to revolve the pin h^{17} slides from the guide h^{20}, and the detent arm h^{21} falls to the right and is held to the right by the sliding of the periphery of the disk h^{19} upon the lug h^{18} provided upon the detent arm h^{21}. A portion of the disk h^{19} is cut away so that it will not slide upon lug h^{18} while the pin h^{17} is in contact with the guide h^{20}. This movement of the detent arm h^{21} to the right causes the detent lever h^{15} to move to the left again, into its former position, thus disengaging the pin with which it was for the instant in contact and permitting the windlass to make another quarter revolution, when it is again arrested by the detent lever coming in contact with the pin diametrically opposite the pin which was in engagement with the detent lever, before the clutch h caused the disk h^{19} to revolve. Thus the windlass is permitted to turn half way around at each engagement of the clutch h, but this semi-revolution is made up of two quarter revolutions caused by the detent lever moving into the path of the second pin for an instant. The weighted bell crank lever i is connected by means of link i' with the hook h^7; this hook h^7 is connected with the rack bar h^9, which meshes with the pinion h^{10} of the windlass. When this weighted bell crank lever i is lifted the link i' will be thrust in a direction to cause the catch h^7 to go over the lever h^6 to engage therewith. The ratchet wheel, which will be presently explained in detail, is combined in such manner with this

bell crank lever i as to cause the hook or latch h^7 to engage with the lever h^6 just before the latch h^3 is disengaged from the catch h^2. The clutch h is thus brought into engagement with the shaft a^6 and the cam h^4 carried by the clutch, is forced against the cam roller h^5 carried upon lever h^6, and thus the lever h^6 is raised, drawing up with it at the same time the hook h^7 and the rack h^9, which meshing with the pinion h^{10} of the windlass, turns the windlass to wind up the chain connected with the vertically movable frame, and thus the frame and the carriage mounted thereon, are raised. As before stated, it is only necessary to raise the carriage once during the operation of cleaning the flues of a boiler like that illustrated, this being when the carriage is to pass from flue 2 of the seventh or last row, to flue 7 of the sixth row to pass around the cover of the man hole. If the arrangement of the flues in any case should be such that it would be necessary to hoist the carriage more than once during one operation of cleaning, it would only be necessary to arrange for lifting the weighted lever i as many times and at the moments required. The driving shaft a may be driven by any suitable power and the clutch a' remains in engagement with the driving wheel until the work is completed, whereupon the clutch a' is automatically moved slightly upon the shaft a^2, away from the hub of the driving wheel. The clutch is moved longitudinally upon the shaft a^2 by means of the rod k, which is provided with the yoke k', which yoke rests in the groove provided in said clutch a'. Upon the rod k is the collar k^2 rigid therewith. To this collar is pivoted the link k^3, provided with a handle k^4. This link k^3 is attached to the bell crank lever k^5. When the machine is started, the handle k^4 is thrown to the position shown in Fig. 1. The movement of the clutch a' away from the hub of the wheel a is caused by vibrating the bell crank lever k^5 on its pivot k^6, after the last flue is cleaned, a pusher being thrust against said bell crank lever k^5 as will be explained more in detail in connection with the ratchet wheel.

We have thus described the actions of the various mechanisms by which the scraper is thrust in and withdrawn from a flue, and carried along step by step from one flue to another and lowered and raised as required by the position of the flues. We have also described how the machine is thrown out of employment automatically after all the flues have been cleaned. We have, however, only briefly referred to the means whereby these various movements are brought into operation and in proper sequence, and controlled as to time and action with respect to one another. The ratchet wheel l shown in Figs. 1, 2, 3, 7, 9, and 10 should be provided with as many teeth l' in its periphery as there are flues to be cleaned; that is, the mechanism between the ratchet wheel and the carriage is so arranged that when the ratchet wheel is rotated one notch, the carriage will be moved one step, that is to the next flue. There being seventy-two flues, and four, that is 7, 6, 5 and 4 of the sixth row, being cleaned twice each time, the ratchet wheel is provided with seventy-six teeth l'. The lever m is provided with prongs which ride back and forth in the thread or spiral groove of the worm clutch between the limiting stops m' m^2 therein. This lever m is pivoted at m^3 to a stud carried on the shifting lever m^4. This shifting lever m^4 is provided with a yoke or stirrup, as shown in Figs. 3 and 11, which is adapted to embrace the worm clutch, and when shifted acts to change the engagement thereof between the different pinions b' b^2. The weighted lever m^5 tends to hold the shifting lever m^4 forward or to the right so that the lock m^6 may be pressed against the pin m^7, either on one side or the other of the tongue m^8. The lever m is provided with springs m^9 and m^{10} on opposite sides thereof, which springs are compressed against stops m^{11} m^{12} respectively as the lever m is carried back and forth by the worm. The shifting lever m^4 is provided with a slot m^{13} at the stud m^{14}, which permits the lever m^4 to move longitudinally so that the tongue m^8 may pass over the pin m^7 as the lever, when moved longitudinally by the stops m', m^2, is thrown by the springs m^9 m^{10}. The worm clutch b^3 in Fig. 2 is shown just engaging with the pinion b', and the stop m^2 in the thread of the worm just starting to turn or move away from the prong or lever m. The bifurcated end of lever m will then be carried down until the stop m' comes against the under or back prong of lever m. While the lever m is being carried down from the position shown in Fig. 2 until its downward motion is arrested by the stop m', the pawl m^{15} will be carried up to slowly rotate the ratchet wheel l. It will be observed that the pawl m^{15} is normally held by the weight m^{16} toward the ratchet wheel l. Motion of the lever m is imparted to the pawl m^{15} through the link m^{17}, the lever being pivoted at m^{18}. Any other suitable lever mechanism might be used with the lever m. The ratchet wheel l when advanced by the pawl m^{15} is held in place by the click m^{19}; thus each time the lever m makes a complete excursion from stop m^2 down to stop m' and back again, the ratchet wheel l is rotated a single notch. When the lever m is forced longitudinally by the stop m^2, the pushing rod n is in position to be forced longitudinally by the plate n' carried on said lever m, and thus force the latch f' out of engagement with the spring catch f^2 of the clutch f so that the clutch f is brought into action and reciprocates the bar f^{12}, and thus moves the carriage, as before described. The rod n is thus pushed each time the ratchet wheel moves a notch, except when one of the pins n^2 coming under the guide n^3 raises said guide n^3 and hence the rod n, so that the plate n' passes under said rod n, in which case the clutch f is not operated. As shown in the

drawings Fig. 1, there are five times when the machine is performing an operation when the carriage must not be moved longitudinally, but simply directly down, and the pins n^2, n^2, &c., are placed in position accordingly upon the ratchet wheel l. That is the carriage is not moved longitudinally in passing from the first row to the second, from the second to the third, from the third to the fourth, and from the fifth row to the sixth; thus there are four times when the plate n' must pass the rod n, and hence four pins n^2 are provided. The pushing rod o is connected with the latch h^3 of the spring catch h^2 of clutch h. The under or inner edge of plate n' is cut away, as shown in Fig. 11, so that the plate n' does not come against the rod o to push the same longitudinally, except when the rod o is slightly raised. The vertically movable frame on which the carriage is mounted must be lowered seven times and raised once during the process of cleaning a set of flues arranged as shown; therefore eight pins o' o^2 o^3 o^4 o^5 o^6 o^7 o^8 are provided upon the rear side of the ratchet wheel, as shown in Fig. 10, and so arranged as to come against the guide o^9, thus slightly raising the rod o^9, and hence the rod o whenever the said frame is to be lowered or raised by the windlass. Thus pin o' raises guide o^9 at the end of the first row, and the clutch h is brought into action to operate the escapement. The pins o^2 o^3 o^4 o^5 and o^6 are brought into action to lower the carriage at the ends of the second, third, fourth, fifth, and sixth rows. The pin o^7 is brought against the guide o^9 to raise the rod o and bring the clutch h into action when the carriage is to pass from flue 2 of the seventh row to flue 7 of the sixth row, and the pin o^8 is brought into action to lower the frame when the carriage is to pass from flue 4 of the sixth row to flue 7 of the seventh row. The pin p upon the face of the ratchet wheel acts in conjunction with the weighted bell crank lever i to bring the catch h^7 into engagement with the lever h^6, as before described, while at the same time, the pin o^7 acts to raise the rod o to bring the clutch h into action. Thus the frame and with it the carriage is raised at the right moment. When the last flue, that is flue 8 of seventh row, is cleaned, the clutch a' is thrown out of engagement with the driving wheel a automatically by means of the pin q upon the disk l, which is brought up under the guide q', thereby changing the position of the push lever q^2, so as to be in the path of the plate n' of lever m. The push lever q^2 is thus forced longitudinally against the bell crank k^5, and this longitudinal movement is imparted to the rod k to move said rod, and hence the clutch a' away from the sprocket wheel a. We preferably place the pin q upon the disk in such position that the machine will not be thrown out of gear until the carriage has been moved the distance of one step to the right of the last flue of the series.

As shown most clearly in Figs. 3, 7, and 12, a graduated disk r is provided in connection with the ratchet wheel l, the spaces on the indicator corresponding to the notches in the periphery of the ratchet wheel. As the ratchet wheel is turned the indicating disk turns with it, and the pointer r' remaining at rest will indicate the position of the ratchet wheel and consequently that of the carriage in its course over the flues, the division x on the dial or indicator when opposite the pointer indicates that the carriage is in its highest position at the left, ready to begin cleaning flue 1 of the first row. The pointer, as illustrated, being at the tenth division of space second of the dial indicates that the carriage is in the position shown in Fig. 1, that is opposite flue 10 of the second row of flues.

It will be seen that we have practically dispensed with springs for retaining the various levers, pawls and rods in their normal position, weights being used in place of springs. We prefer the weights, yet it is evident that springs might be used to perform the functions of the weights.

It is obvious that the mechanical details of our machine might be varied indefinitely by those skilled in the art, without departing from our invention.

Having now particularly described and ascertained the nature of our invention and in what manner the same is to be performed, we declare that what we claim is—

1. In a flue cleaner, the combination with a scraper and means for positively forcing the same into and withdrawing the same from the flue, of a carriage adapted to support said scraper, and intermittently acting mechanism adapted to move said carriage from flue to flue, substantially as described.

2. The combination with the shells forming the chain, of the flue scraper carried thereby, a carriage adapted to support and guide said chain, a driving wheel adapted to engage with said shells to positively force said scraper into and withdraw the same from the flue, and intermittently acting mechanism adapted to move said carriage from flue to flue, substantially as described.

3. The combination with the pinions driven in opposite directions, of a worm clutch, means for changing the engagement of the worm clutch from one pinion to the other, and the chain of a flue scraper, with a system of kinematic links between the shaft of the worm clutch and said chain; whereby the movement of the chain is reversed in direction when the engagement of the worm is shifted from one pinion to the other, substantially as described.

4. The combination with the carriage provided with the guide for the chain, of the clutch f, the worm clutch, and mechanism actuated by the worm clutch and adapted to bring the clutch f into action to move the carriage step by step as required, substantially as described.

5. The combination with the clutch h

mounted on a driven shaft, of the worm clutch adapted to reciprocate the chain carrying the scraper, mechanism controlled thereby and adapted to bring the clutch h into action to lower the frame on which the carriage is mounted, substantially as described.

6. The combination with the clutch h, of the latch h^7 and the lever h^6 and mechanism adapted to cause said latch to engage with said lever, the rack adapted to engage with the pinion upon the windlass, said windlass, and the vertically movable frame connected with the windlass; whereby the windlass is turned to raise said frame, substantially as described.

7. The shifting lever m^4 operated by springs m^9 m^{10} in combination with the bifurcated lever m provided with the plate n', and the worm clutch; whereby the worm clutch is shifted longitudinally upon its shaft to change the engagement thereof between oppositely driven pinions, substantially as described.

8. The carriage provided with pawls and the weighted lever d^7, in combination with a rotatable bar e provided with pins, and with a reciprocating sleeve e^3 provided with pins, said pins adapted to engage with said lever d^7 for shifting the position of the pawls to change the direction of the movement of the carriage, substantially as described.

9. The rack bar d^{10} combined with means for reciprocating the same, the rotatable bar e and the sleeve e^3, each provided with pins, and a carriage provided with pawls d^4 d^5 linked together, and the shifting device d^7 for changing the position of the pawls, substantially as described.

10. In a machine for cleaning boiler flues, a ratchet wheel adapted to be rotated notch by notch as the flues are cleaned, said ratchet wheel being provided with pins adapted to engage with and alter the positions of the ends of levers, said levers controlling clutch devices, and a moving plate n' adapted to engage with the ends of said levers, according to the position of the ratchet wheel, substantially as described.

11. The combination with the carriage, the cleaner and guide thereof, of the main shaft and intermittently acting mechanism between the shaft and the carriage for giving the same longitudinal step-by-step movement, substantially as described.

12. In a machine for cleaning steam boiler flues, the combination with the worm, of two pinions mounted loosely on the same shaft and driven in opposite directions, between which the worm, splined to the same shaft, is adapted to alternately engage to drive the worm alternately in opposite directions, and a flue scraper connected with said worm and adapted to be inserted into or witdrawn from the flue, according to the direction of rotation of said worm substantially as described.

13. In a machine for cleaning steam boiler flues, the worm between the pinions, the pinions being loose upon the shaft to which the worm is splined, said pinions being driven from opposite edges or sides of the same wheel or gear, in combination with the spring lever shifting mechanism, said mechanism being brought into action to shift the worm on the shaft to engage first with one pinion and then with the other, substantially as described.

14. The tubular guide of the chain, the chain consisting of balls linked together, and of practically the diameter of the opening in the tubular guide, said guide reaching nearly to the boiler flues, a driving wheel adapted to engage with said balls to positively force said chain into and positively withdraw the same from the flues, and intermitently acting mechanism adapted to move said guide from flue to flue, substantially as described.

15. The combination with the boiler flues, of a carriage carrying a cleaner adapted to be inserted in and withdrawn from the flues in order, driving mechanism provided with clutches, a ratchet wheel provided with teeth corresponding in number to the number of flues to be cleaned, pins on the ratchet wheel, and levers brought into action by said pins to control the action of the clutches, mechanism controlled by one of said clutches to move the carriage longitudinally, and an escapement controlled by the other clutch for lowering the carriage, substantially as described.

16. The combination with the driving shaft, of a clutch brought into action from time to time to operate a rock shaft, said rock shaft being connected with a rack bar, a carriage provided with pawls with which said rack bar engages, when reciprocated, and a weighted shifting lever adapted to bear against one or the other of said pawls to hold the same in position to be engaged by the rack bar, substantially as described.

17. The windlass and the beam suspended therefrom, said windlass being provided with an escapement and a pin in combination with a clutch upon the main shaft, and mechanism adapted to throw said clutch into and out of employment at definite periods, lever mechanism operated by the clutch to move the pallet of the escapement to permit the beam to descend, and the lever provided with the segment gear which engages with said pinion, said lever having the segment gear being adapted to be brought into action at a definite period to raise the beam, substantially as described.

18. The combination with the windlass, of the escapement consisting of the radial arms and the pallet mounted upon the bell crank lever, mechanism controlled from the main shaft to operate the bell crank lever, and the beam suspended from the windlass, which beam may be lowered, substantially as described.

19. The combination with the clutch h, of a lever actuated thereby, a second lever provided with gear teeth, a windlass provided with a pinion meshing with said teeth, and a latch adapted to connect said levers, whereby

the motion of the clutch actuated lever is imparted to the lever provided with the teeth to rotate the pinion upon the windlass, substantially as described.

20. The combination with the worm adapted to be driven regularly in opposite directions, of a spring lever pivoted to a shifting lever, said shifting lever being yieldingly held against longitudinal motion, a ratchet wheel, a pawl adapted to successively take the teeth of said ratchet wheel to drive the same, said pawl adapted to be actuated by the movement of said spring lever as the same is moved back and forth upon its pivot by the action of the worm clutch, substantially as described.

21. The combination with the rack bar and the rock shaft, of pawls with which said rack bar engages, a shifting lever for changing the pawls, and a pin carried upon a sleeve, which sleeve is reciprocated by the motion derived from said rock shaft, whereby the pin is carried out of the way of the shifting lever on the forward stroke and brought against the lever to shift the same upon the return stroke, substantially as described.

22. The combination with the spring lever, of the worm, with the thread of which said spring lever is in engagement, push rods actuated by said spring lever, a shifting lever provided with a stirrup, said shifting lever being provided with a pivot upon which the spring lever is mounted, said shifting lever being adapted to hold the worm clutch in engagement alternately with the oppositely driven pinions, guiding mechanism for said pushers controlled by the ratchet wheel, clutches upon the main shaft normally held out of employment by latches controlled by said pushers, said guiding mechanism acting to cause said pushers to actuate said latches, as required, to bring one or both of said clutches into action, substantially as described.

23. In a machine for cleaning the flues of steam boilers, a shaft on which two pinions are loosely mounted and driven in opposite directions, the worm clutch splined to said shaft and provided with stops at each end of the thread thereof, a pivoted bifurcated lever engaging with the thread of said worm clutch and provided with springs on opposite sides thereof for shifting said clutch into alternate engagement with said pinions, in combination with a shifting lever provided with a stirrup engaging with each end of said clutch, a lock, and means for holding the shifting lever in either of two positions, and a slot to permit longitudinal movement thereof, said shifting lever being pivoted to said first named lever, said longitudinal movement in one direction being caused by the engagement of the said bifurcated lever with the stops on the clutch, and in the other by a yielding pressure, substantially as described.

24. The combination with a chain consisting of hollow balls linked together and carrying a flue cleaner, of a guide for the same, and a sprocket wheel with means for driving the sprocket chain back and forth through the guide, and automatically actuated mechanism adapted to present the guide in succession to different flues of a steam boiler; whereby the scraper is positively forced through and positively withdrawn from the different flues in successive order, substantially as described.

25. In a machine for cleaning boiler flues, the combination with a flue cleaner adapted to be inserted into and withdrawn from the flues, of a carriage supporting said flue cleaner and adapted to be moved back and forth horizontally, and a frame supporting said carriage and adapted to be moved back and forth vertically; whereby the flues are successively cleaned, substantially as described.

26. In a machine for cleaning boiler flues, the combination with a continuously revolving shaft carrying a bevel gear *b*, of loosely mounted pinions engaging therewith and adapted to rotate in opposite directions, a rotatable shaft and a system of kinematic links between said rotatable shaft and the flue cleaner, and means for causing said pinions to alternately engage with said rotatable shaft to revolve the same alternately in opposite directions, substantially as described.

27. In a machine for cleaning boiler flues, the combination with a normally locked windlass, of a vertically movable frame connected therewith and adapted to carry the carriage supporting the flue cleaner, an escapement mechanism for unlocking said windlass to permit said frame to descend, a rack bar engaging with a pinion carried upon said windlass, and means adapted to rotate said windlass to raise said frame, substantially as described.

28. In a machine for cleaning boiler flues, the combination with the carriage supporting the flue cleaner, of a continuously revolving shaft, clutches carried thereon, and automatically actuated mechanism for throwing said clutches into action; whereby the carriage supporting the flue cleaner is moved from flue to flue, substantially as described.

29. In a machine for cleaning boiler flues, an indicator and a dial whose relative motions are adapted to indicate the position of the flue cleaner, substantially as described.

30. In a flue cleaner, the combination with a chain composed of balls linked together, of a flue scraper secured to the end of said chain, and a driving mechanism adapted to engage said balls successively to positively force said scraper into and positively withdraw the same from the flue, substantially as described.

31. In a machine for cleaning boiler flues, the combination with a flue cleaner adapted to be inserted into and withdrawn from the flues, of a carriage supporting said flue cleaner and adapted to be moved back and forth, and a frame supporting said carriage and adapted to be moved back and forth in a direction at

right angles to the direction in which said carriage is moved, substantially as described.

32. In a machine for cleaning boiler flues, the combination with a flue cleaner adapted to be inserted into and withdrawn from the flues, of a carriage supporting said flue cleaner, said carriage being adapted to be moved back and forth in horizontal and vertical directions, substantially as described.

33. In a flue cleaner, the combination with a scraper adapted to be inserted into and withdrawn from the flues, of a carriage supporting said scraper, and intermittently acting mechanism for automatically moving said carriage horizontally from flue to flue, substantially as described.

34. In a flue cleaner, the combination with a scraper adapted to be inserted into and withdrawn from the flues, of a carriage supporting said scraper, and intermittently acting mechanism for automatically moving said carriage vertically from row to row, substantially as described.

35. In a machine for cleaning boiler flues, the combination with a reciprocating rack bar, of a carriage carrying a pair of pawls, and a lever adapted to occupy alternate positions to maintain one or the other of said pawls in position to be engaged by said rack bar, whereby said carriage may be moved back and forth, substantially as described.

36. In a machine for cleaning boiler flues, the combination with a vertically movable frame, of a windlass connected therewith, said windlass being provided with radially extending arms lying alternately in different parallel planes, a pallet adapted to engage with said arms, said pallet being pivoted to move parallel to the axis of said windlass, and means for actuating said pallet to permit said windlass to unwind step by step, substantially as described.

37. In a machine for cleaning boiler flues, the combination with a vertically movable frame, of a windlass connected therewith, said windlass being provided with radially extending arms lying alternately in different parallel planes, a pallet adapted to engage with said arms, said pallet being pivoted to move back and forth parallel to the axis of said windlass to permit said windlass to unwind and the frame thereby to descend, said pallet being pivoted to yield to the pressure of said arms when said windlass is moved in a direction to raise said carriage, substantially as described.

38. In a machine for cleaning boiler flues, the combination with a clutch between the driving shaft and the driven shaft, of a system of levers in connection with said clutch and adapted to be engaged by a moving part of said machine after the last flue is cleaned; whereby said clutch is operated and said machine is thrown out of action, substantially as described.

39. In a machine for cleaning boiler flues, the combination with the carriage supporting the flue cleaner, of a continuously revolving shaft, a clutch carried thereon and connected by linkage with said carriage, and automatically actuated mechanism for throwing said clutch into action to move said carriage back and forth horizontally, substantially as described.

40. In a machine for cleaning boiler flues, the combination with the carriage supporting the flue cleaner, of a vertically movable frame supporting said carriage, a continuously revolving shaft, a clutch carried thereon and connected by linkage with said movable frame, and automatically actuated mechanism for throwing said clutch into action to move said frame back and forth vertically, substantially as described.

41. The combination with a boiler flue, of a flue cleaner comprising a chain composed of links of such diameter relatively to the diameter of the boiler flue that the chain cannot double upon itself, a flue scraper secured to the end of said chain, and a driving mechanism adapted to engage with the links of said chain to positively force said scraper into and positively withdraw the same from the flue, substantially as described.

In witness whereof we hereunto subscribe our names this 20th day of April, A. D. 1892.

PHILIP S. KINGSLAND.
CHRISTIAN C. HILL.

Witnesses:
M. JEANE TALLETT,
GEORGE P. BARTON.