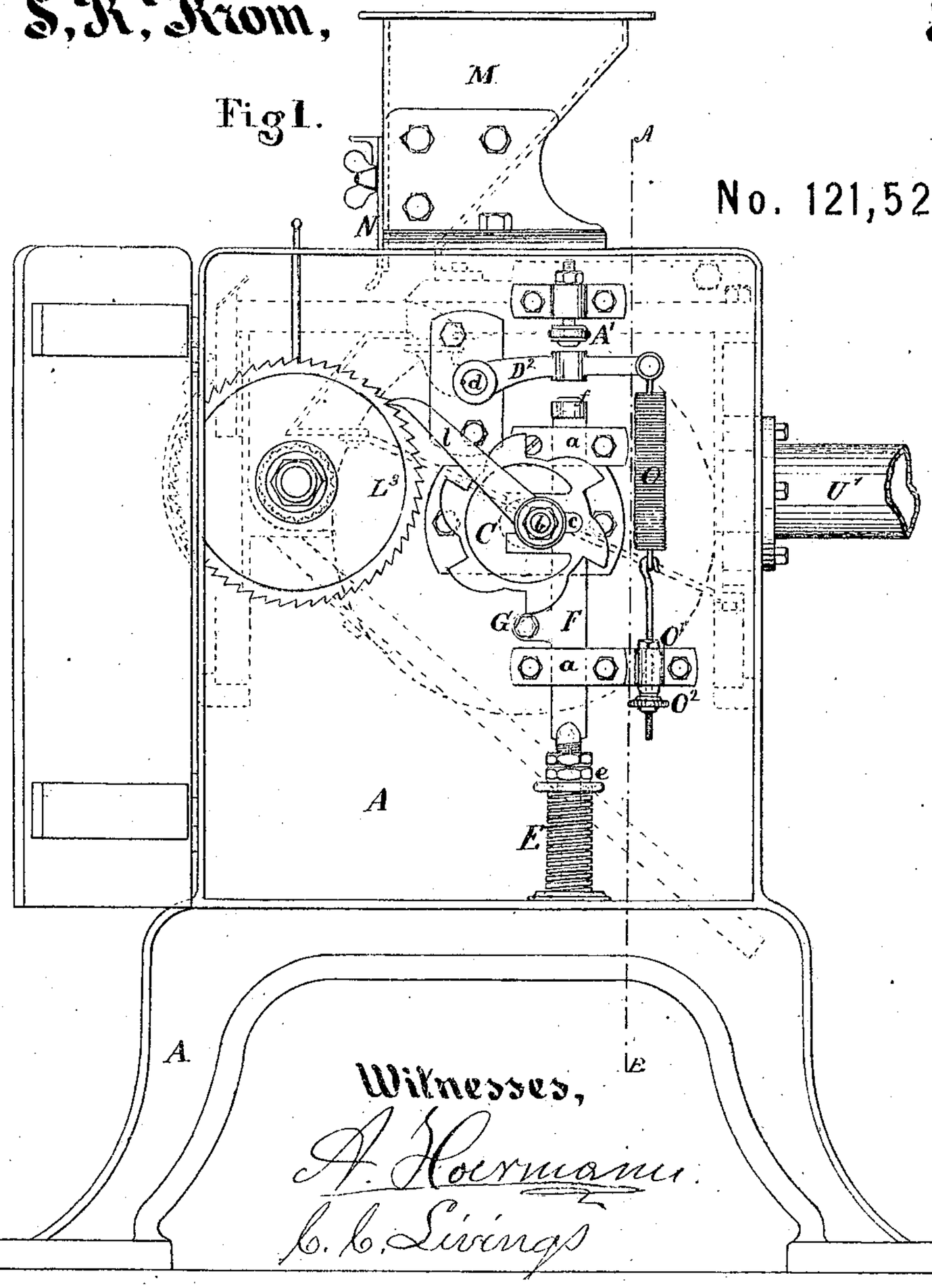
4 Sheets--Sheet 1.

S. R. Krom, Separating Machine,

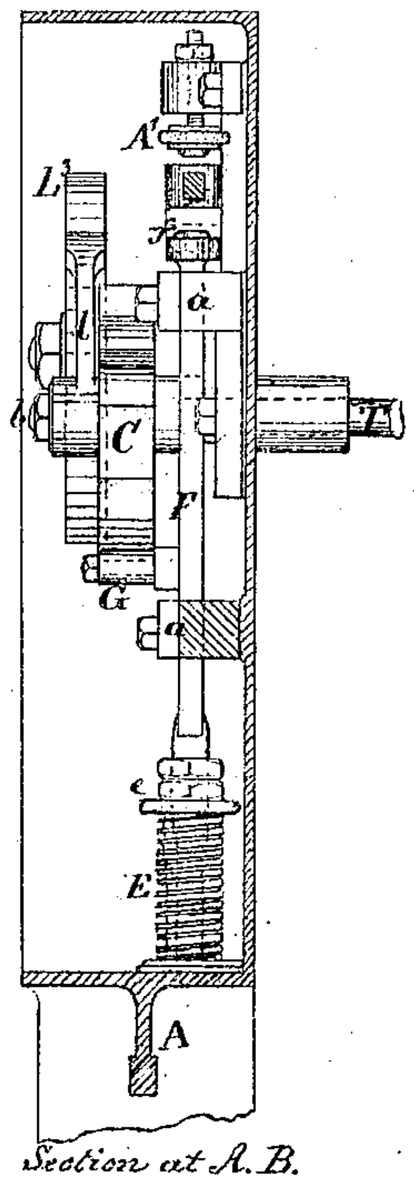
No. 121,526. Patented Dec. 5, 1871.

Fig 1.



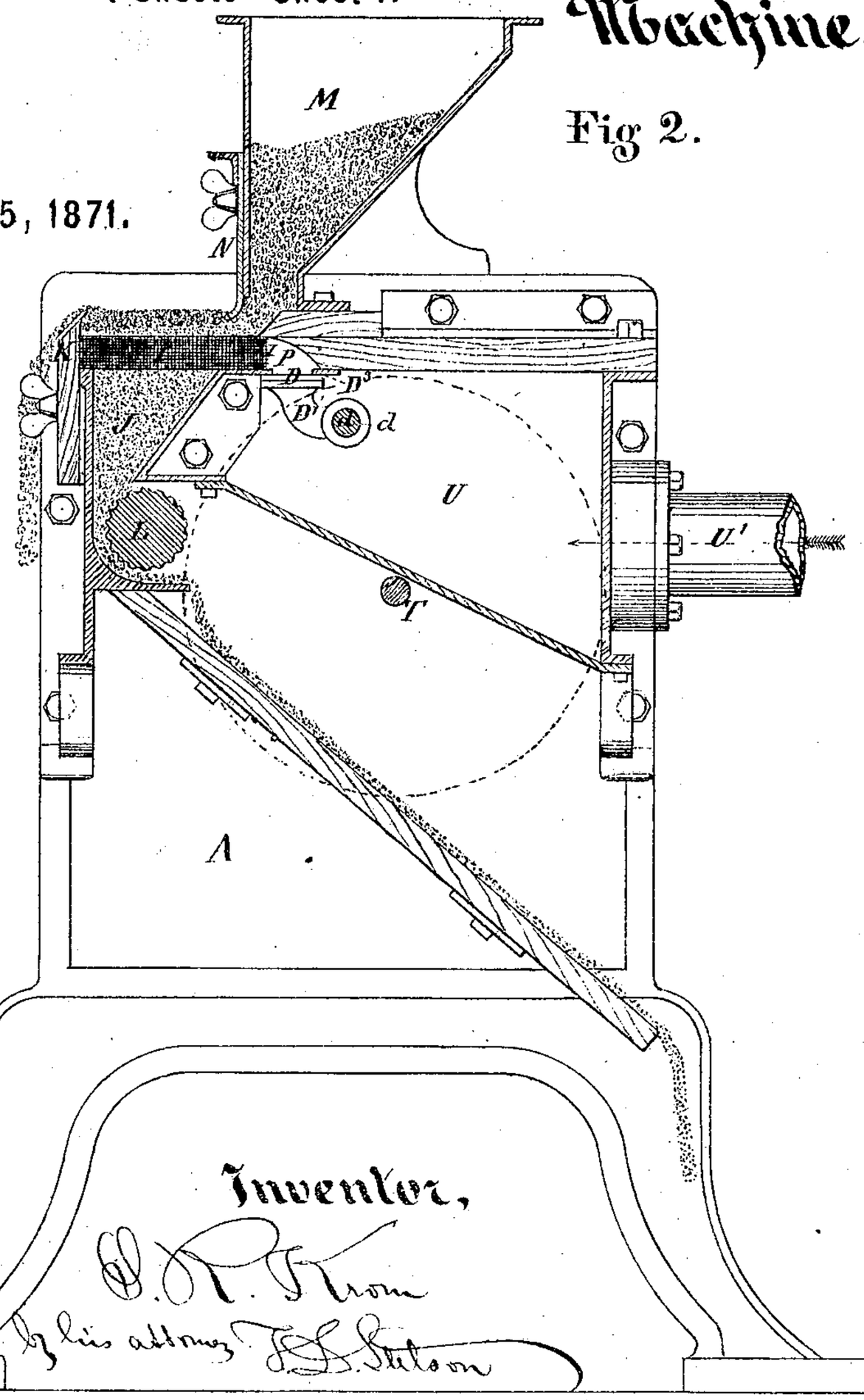
Witnesses,
A. Hoermann.
C. C. Livings

Fig 3.



Section at A. B.

Fig 2.

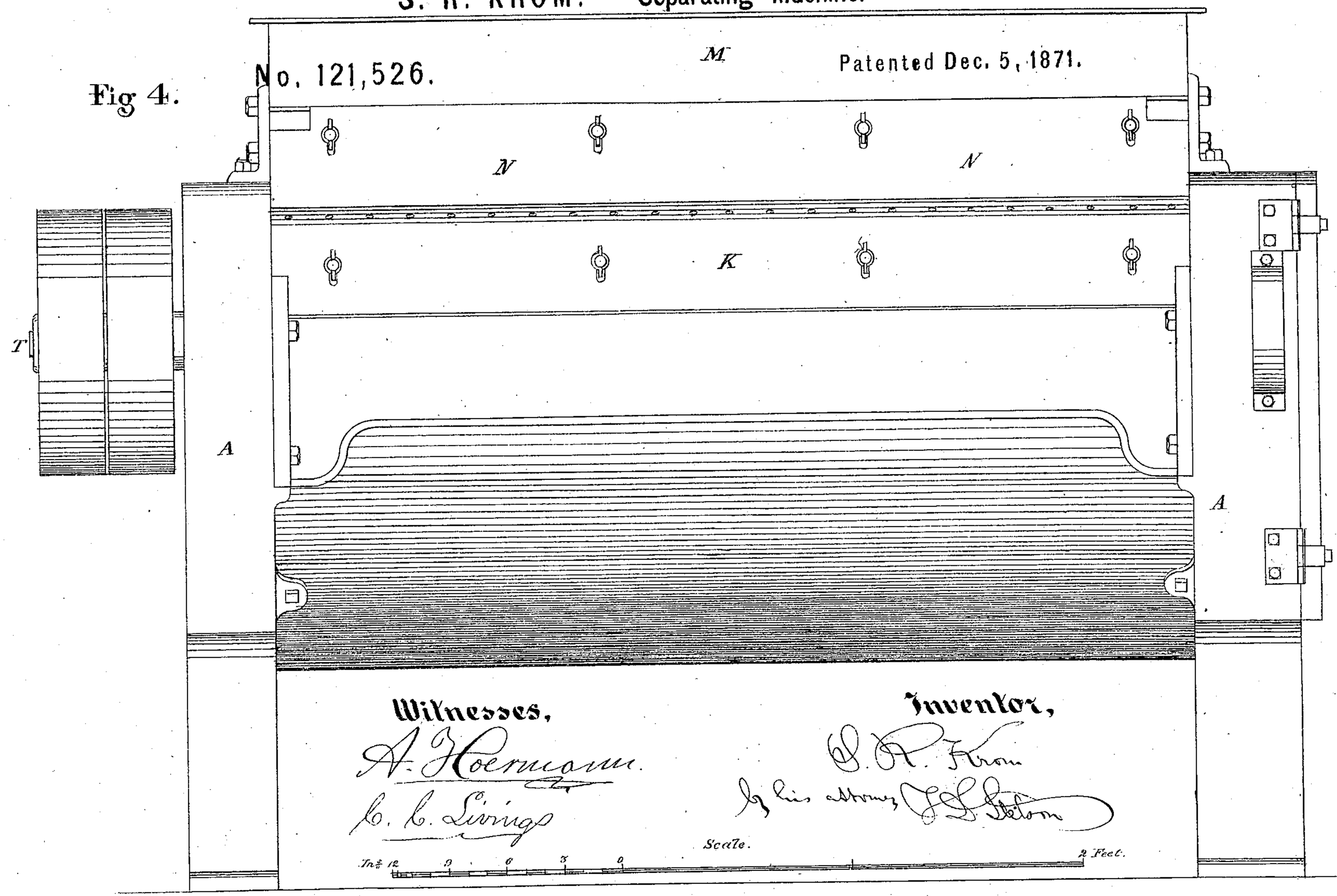


Inventor,
S. R. Krom
by his attorneys T. S. & S. Stetson

S. R. KROM. Separating Machine. 4 Sheets--Sheet 2.

No. 121,526. Patented Dec. 5, 1871.

Fig 4.



Wilnesses,

A. Hoemann.

C. C. Livings

Inventor,

S. R. Krom

by his attorney D. L. Stetson

Scale.

In. 12 9 6 3 0 2 Feet.

S. R. KROM. Separating Machine. 4 Sheets--Sheet 3.

Patented Dec. 5, 1871.

No. 121,526.

Fig 6.

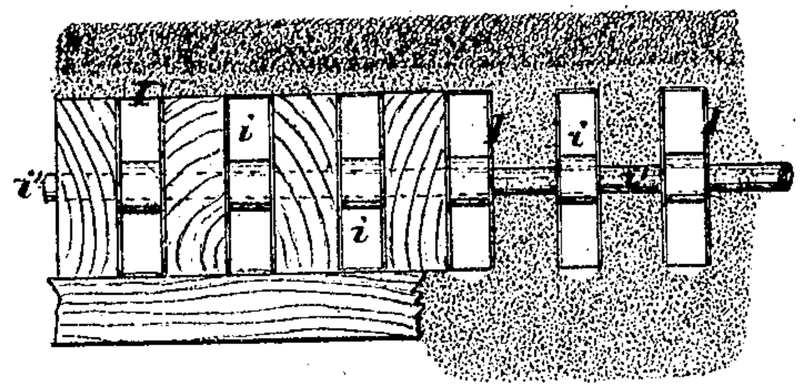


Fig 9.

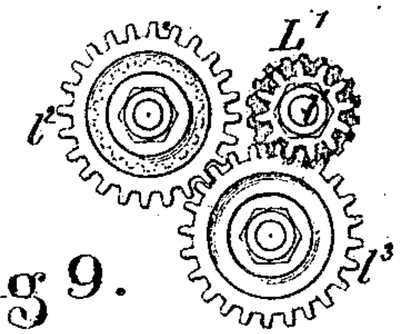


Fig 5.

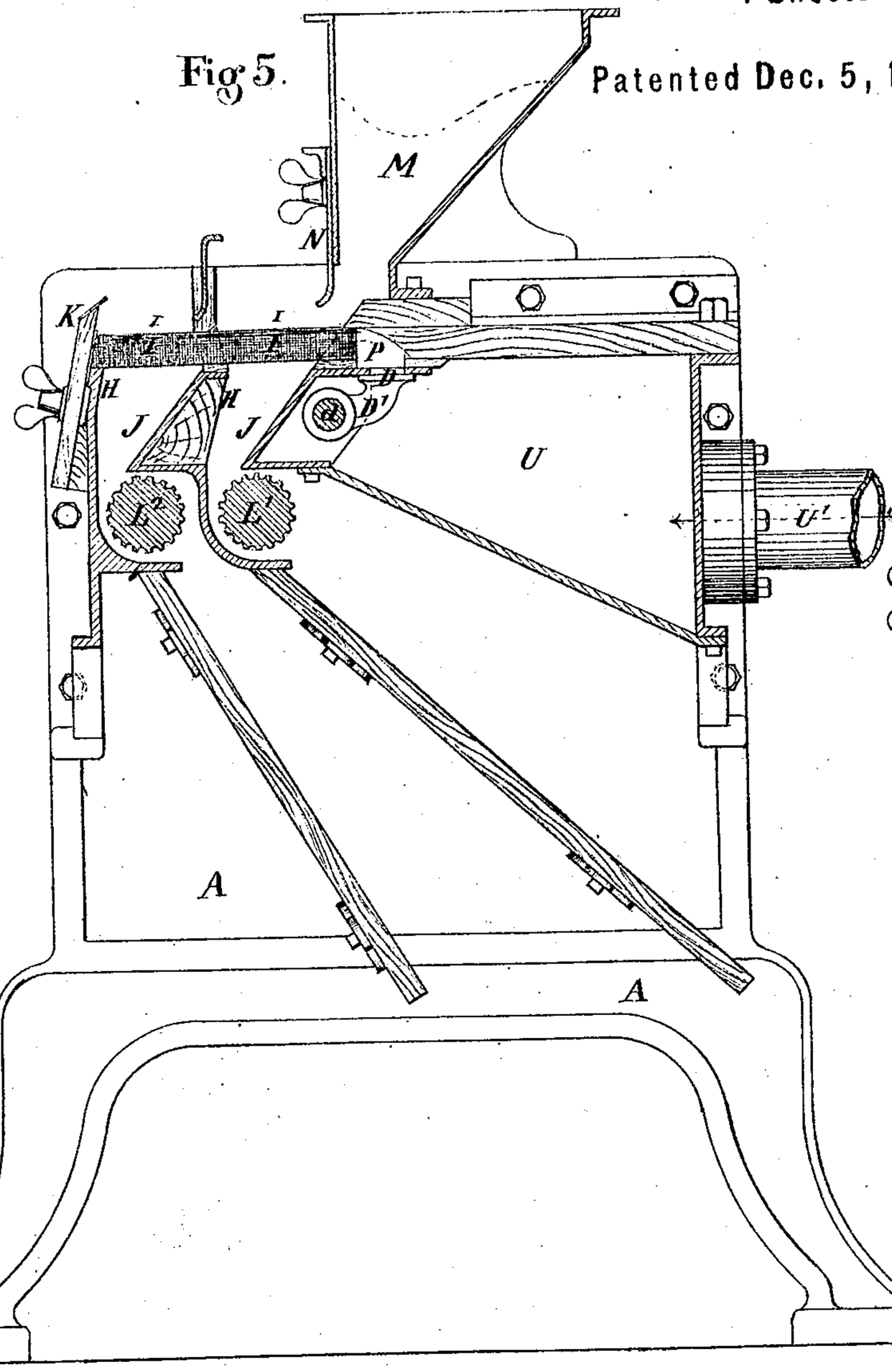


Fig 10.

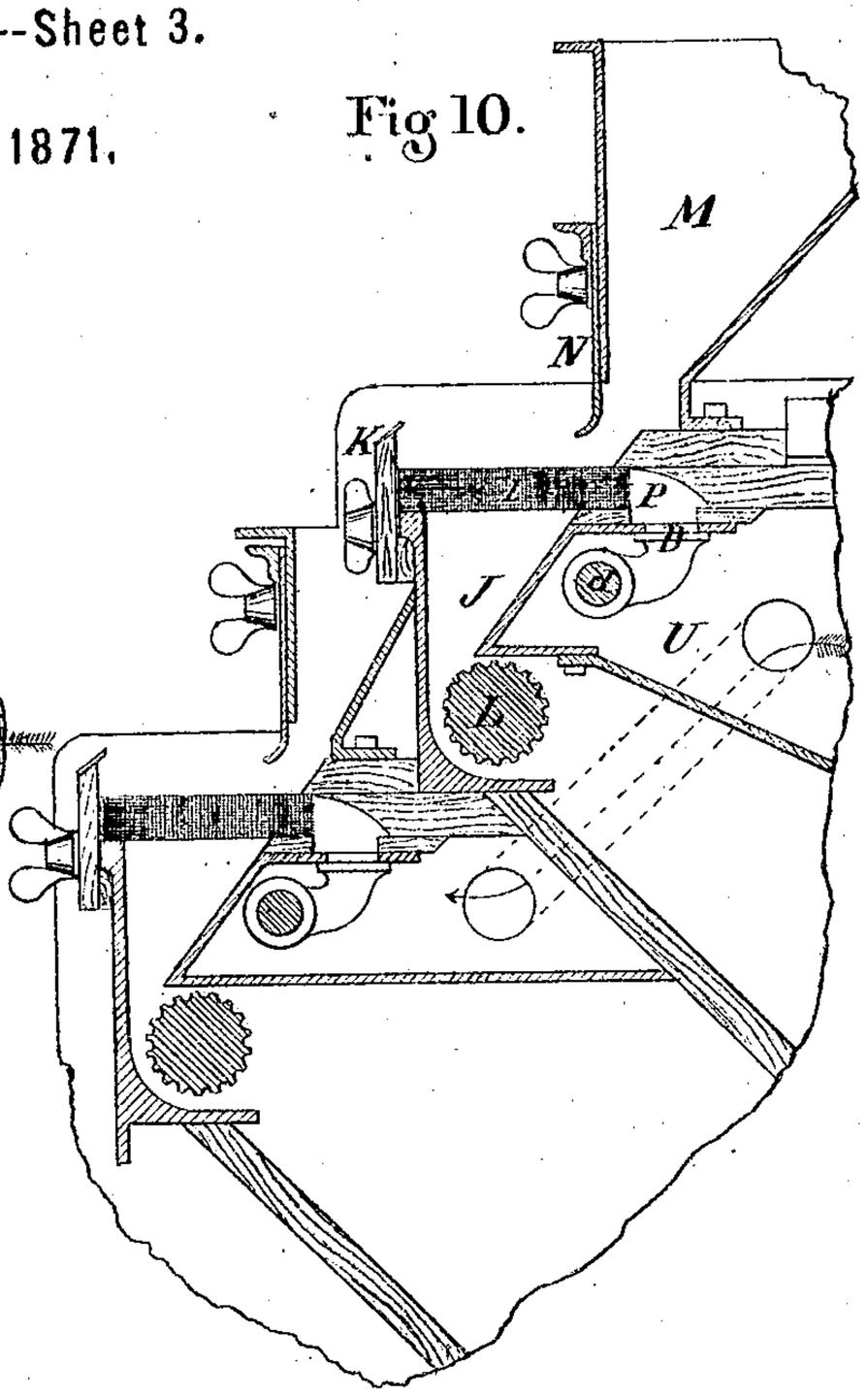


Fig 7.

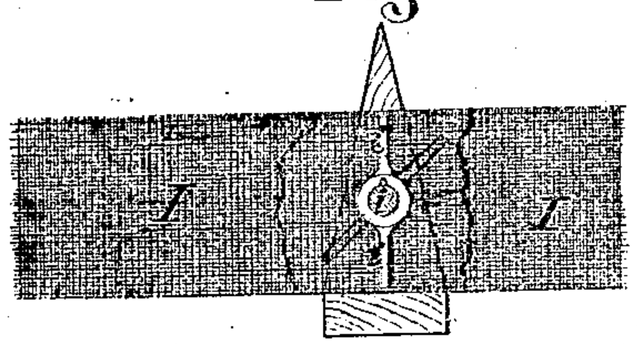
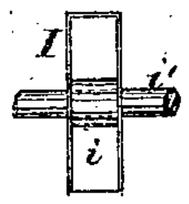


Fig 8.



Witnesses,

A. Hoermann

C. C. Livings

Inventor,

S. R. Krom

by his attys J. L. Stetson

4 Sheets--Sheet 4.

S. R. KROM.

Separating Machine.

No. 121,526.

Patented Dec. 5, 1871.

Fig 11.

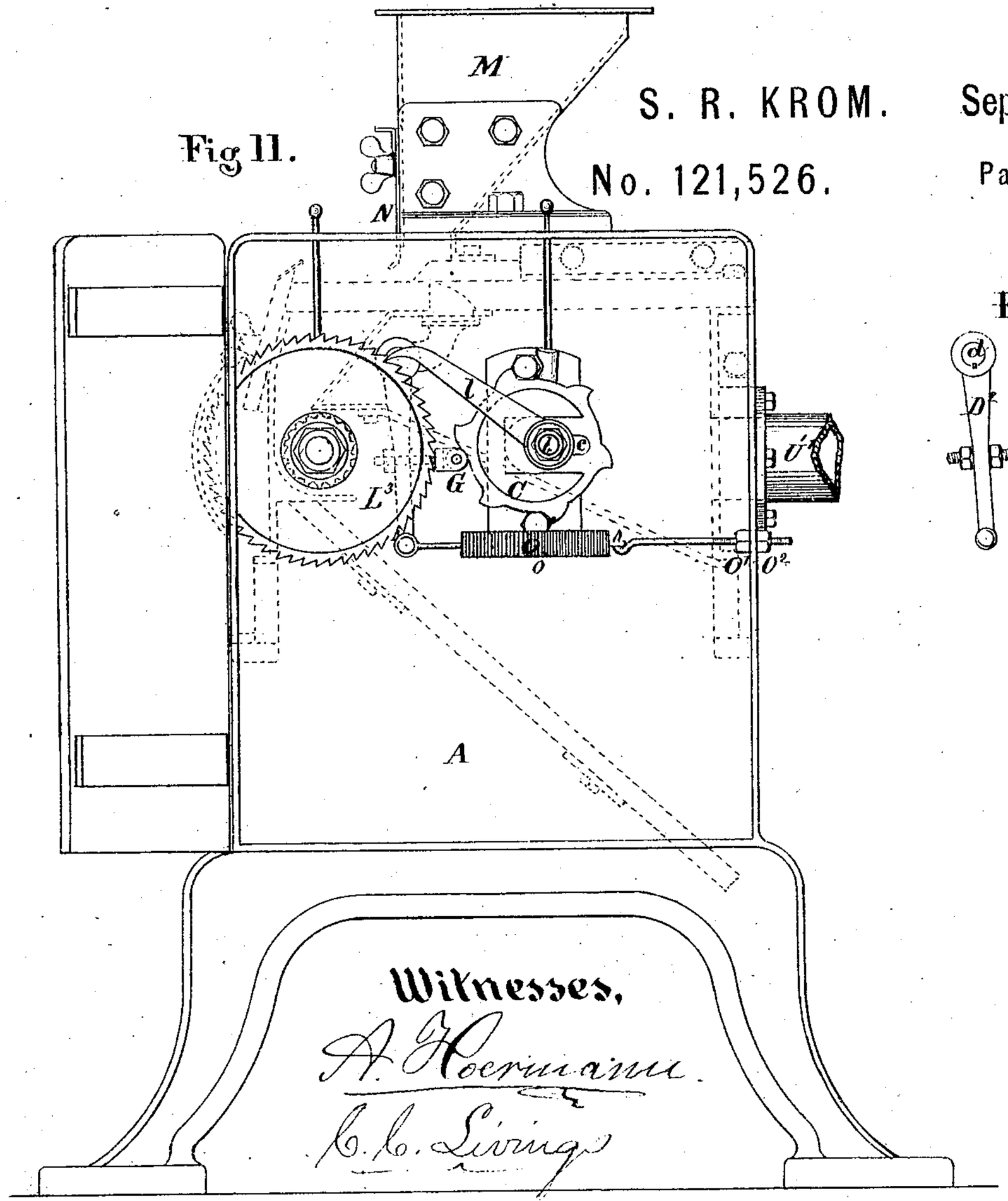


Fig 13.

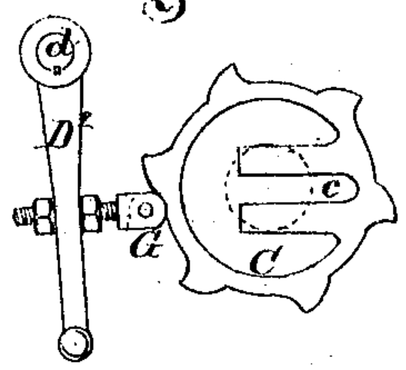
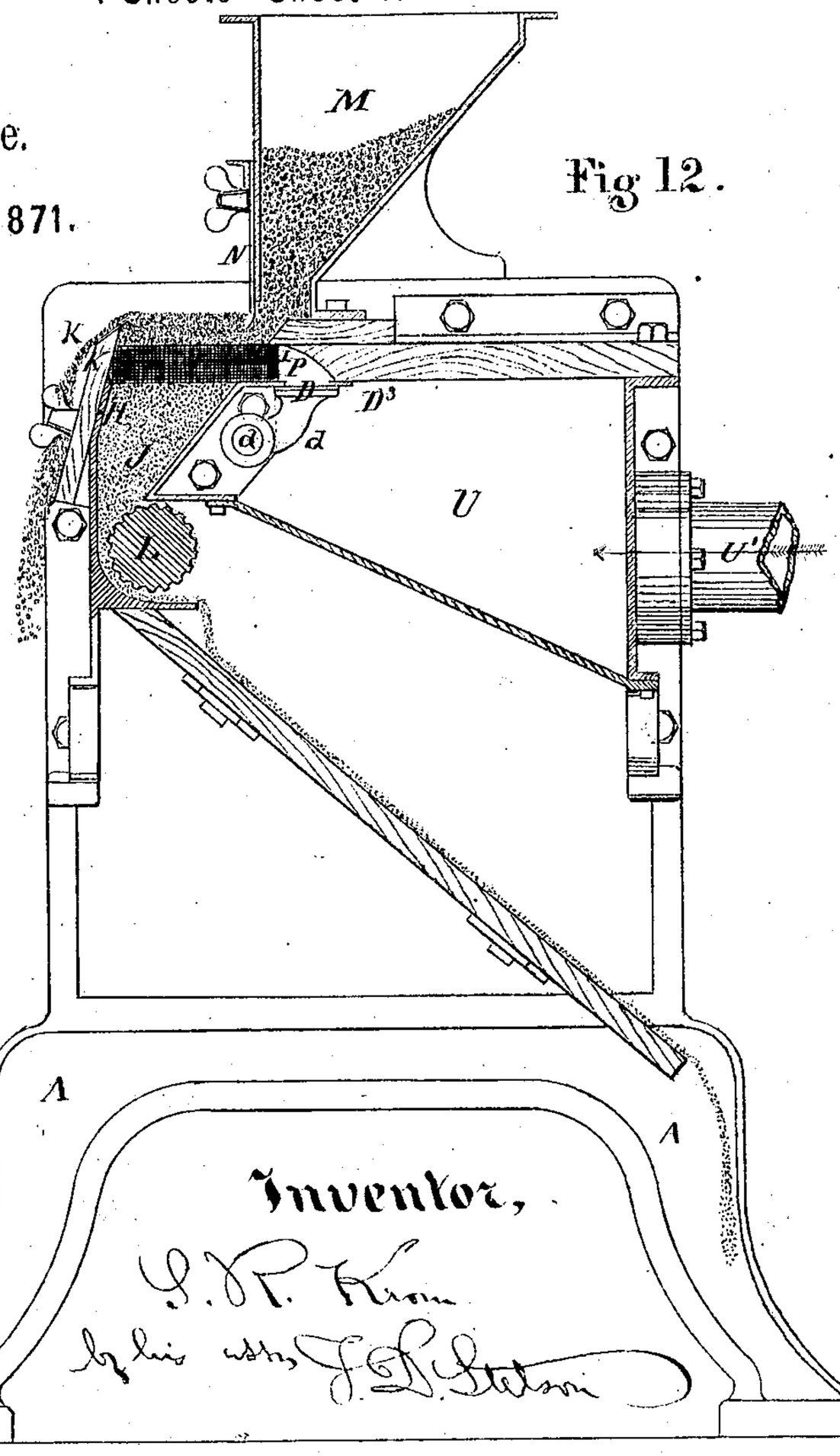


Fig 12.



Witnesses,

A. Hoeriman

C. C. Livingston

Inventor,

S. R. Krom

by his attys J. D. Stetson

UNITED STATES PATENT OFFICE.

STEPHEN R. KROM, OF NEW YORK, N. Y.

IMPROVEMENT IN MACHINES FOR SEPARATING AND TREATING ORES.

Specification forming part of Letters Patent No. 121,526, dated December 5, 1871.

To all whom it may concern:

Be it known that I, STEPHEN R. KROM, of the city and county of New York, State of New York, have invented certain new and useful Improvements in Separating-Machines for the Treatment of Ores and analogous material, of which the following is a specification:

The improved machine is intended, like those described in former patents to me, to separate material according to its specific gravity, and, to a great extent, independently of the varying size of the particles. It operates like those by the aid of intermittent jets of air blown upward through a layer of the mixed material, which travels slowly along on a perforated bed.

The improvements are intended to increase the efficiency and perfection of the separation, and to overcome the difficulties which have been heretofore experienced.

One of the difficulties has been a tendency of the air to blow upward through or past the layer of material at the edges. The air seems to find an easier passage along the smooth side of a gate oven-closing surface than through the more sinuous spaces through the center of the same layer. It is a frequent occurrence to find the material along each edge blown up more violently than upon the other portions of the layer. I have overcome this by simple and novel means; have devised means for increasing the suddenness with which the air is thrown up through the bed; have arranged to interpose a valve between a continuous blowing means and the bed in a position practically nearer to the bed than in any former machine; have devised means for closing the valve more promptly and completely; have provided a capacious chamber for the air close to the valve, which serves to equalize the flow of the air from the blowing means and increase the vigor of the intermittent jets; have devised a new form for the delivery passage or passages which graduates the delivery from the different portions of the ore-bed; have provided means for more delicate and convenient variations of the rate of delivery; have provided duplicate deliveries separately controllable; and have provided a duplicate bed and a duplicate separation in the same machine.

I will proceed to describe what I consider the best means of carrying out the invention in its several parts.

The accompanying drawing forms a part of this specification.

Figure 1 is an end elevation of an entire machine. Fig. 2 is a cross-section of the same. Fig. 3 is a portion of a longitudinal section, and Fig. 4 is a front view.

The above figures show what I esteem the simplest form of the construction, and, on some accounts, the best. The succeeding figures show some of the details and some very desirable modifications.

Fig. 5 is a cross-section of a form with a bed in two parts, one receiving the light matter passing off from the other. Fig. 6 presents a section of the bed, showing a barred or hollow-grated construction, which I prefer for all the modifications. Fig. 7 shows a controlling valve in such barred bed. Fig. 8 is a view of the same at right angles to Fig. 7. Fig. 9 shows the gearing at the end of the machine to be used when two separate delivering-rolls are employed, as in Fig. 5. Fig. 10 shows a form in which the two parts of the divided bed are placed at different levels, with the other parts correspondingly arranged. Fig. 11 is an end view, and shows a different mode of operating the valve which admits puffs of air. Fig. 12 is a corresponding cross-section, and Fig. 13 is a view of certain parts of the mechanism detached.

Similar letters of reference indicate like parts in all the figures.

A A is a fixed frame-work. T is a main driving-shaft, and C is a trip-wheel fixed thereon, which operates the valve for inducing the puffs, and also the pawl for operating the delivery. D is the valve. It is fixed on arms D^1, which extend from a rocking-shaft, *d*, governed by an arm, D^2, which is fixed on an overhanging end of the shaft, as will appear further on. I is the ore-bed. It is constructed of hollow bars or tubes of rectangular sides, as shown in Fig. 6, and as set forth in detail in the patent issued to me dated the 4th day of August, 1868. The several tubes or bars are composed of wire-gauze or analogous fine open-work material, extending along lengthwise of the travel of the material. These open-work bars thus form hollows or channels in which the air flows freely along, and passes upward and outward laterally through the perforations, and the lighter material, forming the stratum above, works along at the top,

while its heaviest particles, descending by gravity, pass through the spaces between the bars. The particles, after descending past the bars, close together and form a dense body of granular particles. The descending or sinking of the heavy particles is controlled by the discharging device.

The air for my puffs is furnished by a blower, air-pump, or other efficient means for inducing a sufficiently-strong pressure. The blowing means, not represented, forces the air through a pipe, U′, into a capacious chamber, U, which is near the bed I. The valve D controls the passages between this chamber U and the interiors of the several hollow bars in the bed. The valve is a long flat strip of wood or metal, made true and straight on the upper surface and fitted air-tight to the valve-seat D^3, and preferably faced with rubber or analogous soft material, which allows it to strike suddenly at rapidly-recurring intervals without injury, and comparatively noiselessly. The valve opens downward, admitting compressed air from the reservoir U into the space P immediately above the valve, which is merely a channel extending along the ends of the hollow bars in the bed, and, without any room for expansion and softening of the shock, darts directly into the hollow bars and upward and outward therefrom through the perforations. The construction provides the smallest possible space between the valve and the hollow bars of the bed. The reservoir U, by the elasticity of the air therein, equalizes the action, so that the flow through the passage U may be constant or nearly so, while the discharge through the valve D is opened and closed at rapidly-recurring intervals, preferably at the rate of four hundred and fifty to five hundred or even more per minute.

I open the valve by the percussion of a moving weight, and make the action thereby unusually rapid and efficient. The several projections on the trip-wheel C alternately depress and liberate a roller, G, which turns on a pin fixed in the hammer F. This latter slides in the fixed guides *a a* so that it can move only in a vertical direction, and is pressed upward with a graduated force by means of the spiral spring E, which surrounds its lower end and acts against a collar fixed in variable positions by means of a nut, *e*, and a jam-nut which holds it securely in position. When it is desired to increase the force of the ascent of the hammer F it is necessary simply to unscrew the jam-nut and depress the nut *e*, then tighten the jam-nut again. The upper end of the hammer F is provided with a cushion, *f*, of leather, raw-hide, rubber, wood, or any substance which allows the hammer to impart its velocity to the lever D^2 with slight noise. At each passage of a tooth on the trip-wheel C the hammer rises actively, and, striking the lever D^2, opens the valve D in opposition to the tension of a spring, O, which immediately afterward closes the valve D again. There is an adjustable stop, A′, correspondingly cushioned, and adjustable by means of a screw-thread and jam-nut, as will be readily understood, which arrests the motion of the lever D^2 when the hammer tends from any cause to open the valve too wide. I prefer to adjust the nut *e* on the hammer F, so that the spring E tends to throw the hammer actively upward to a position very close to but not quite touching the lever D^2. The hammer rises above that position at each blow, but only by its momentum, and the spring E offers no resistance to the descent of the lever D^2 again. The descent of the lever, and consequently the closing of the valve, is effected with sufficient force and rapidity by the tension of the spring O, which is adjustable in force by means of the nuts O^1 O^2 on the threaded rod represented. When it is desired to close the valve D more rapidly the nuts O^1 O^2 are screwed upward on the rod, thereby causing the spring O to be drawn down with more force. It will be understood that the nuts O^1 O^2 act on the opposite faces of a suitable boss or arm on the frame-work A of the machine.

The discharging-passage J is peculiarly formed to equalize the descent of the heavy material and make it correspond with the quantity of heavy material which is separated along each portion of the hollow bars of the bed. The heavy matter will generally become separated as soon as the material descends from the hopper and reaches the bed I, and I have in former machines made my discharge for the heavy particles more rapid near the hopper M or gate N; but I now consider it an advantage to make the most rapid descent of the heavy particles near or at the front gate K, for the reason that it obviates the danger of ore accumulating at the front gate K and being lost in the overflow of tailings. In other words, I have discovered that it is desirable to discharge more rapidly from the front or advanced portions of the bed than from the back or first portions thereof; and I effect these ends by giving an oblique form to the back of the discharging-passage, so that the material is largely supported by the bounding walls of the passage on that side, while it is free to descend vertically on the front side. The above is the form shown in Fig. 2; but it is desirable to still further draw downward upon the heavy material at the extreme front edge of the bed. I effect this important end by making the front side of the passage to overhang, as shown at H in Figs. 5 and 12. Fig. 12 shows the most complete form of these parts, the back side of the passage being inclined, as shown, so as to partially support the material, the middle of the passage being left free and the front being overhung. By this form there is more space for the particles to descend for a given area at the extreme front edge than at any other point therein, and it follows that the material from the middle and back is compelled to tumble forward and fill that space. The resistance from the mutual friction of the granular particles tends to hold back on the central portions and back portions in addition to the retardation due to the oblique position of the back, while the particles at the immediate front of the passage experience none of this retardation and descend with the most freedom. The descent, therefore, is unusually rapid at the front. In the form of the apparatus shown in Figs. 2 and 12 a single

discharging-wheel, L, controls the discharge from the passage from the entire bed. In Fig. 5 I have represented what I esteem the preferable form, particularly for some kinds of material. In that figure the bed is divided into two distinct portions, and there are two discharging-passages for heavy material and two wheels L, which, it will be understood, are turned by means which may be separately controlled, if desired; but I have preferred to represent the second roller L^2 as being driven by the roller L^1, through the medium of gearing, as represented in Fig. 9. On the end of roller L^1 is a small gear, l^1, which drives the large wheel l^2 on roller L^2, through the intermediate wheel l^3 at a slower speed. I can employ two ratchet-wheels and two pawls. They may be on the same end or on opposite ends of the machine, and in either case they are separately adjustable, so that when it is desirable to discharge more heavy material from the first bed without affecting the discharge from the second it is necessary simply to change the extent of the motion of the pawl which works the first discharging-wheel, or, in case of the gearing as represented, change the size of the wheels. By means of this double discharge I can make two complete separations, so as to divide the matter into three separated quantities or sorts in a single machine. This is obviously important in cases where there may be two kinds of metals, as, for example, lead and zinc, mingled with the lighter earthy matter. The heaviest material (the ore of lead) will descend from the first bed and be discharged by the first discharging-wheel, while the remaining matter, composed of the earthy matter, quartz, or other rock, and the slightly-heavier zinc, pass off together from the first bed and are separated on the second. The second discharging means will discharge downward the zinc, while the stony or earthy matter alone will flow over from the top of the second bed. The same action is beneficial where only one metal is found. In such cases the first discharging means will give pure ore; the second discharging means will deliver the richest of the remaining matter—that is to say, those grains where rock or earthy matter are combined; and the discharge or refuse will be merely waste—that is, quartz or earthy matter having no ore attached. With this double discharge, as with the single, the form of each discharge should be as shown more fully in Fig. 12—that is to say, the front overhung and the back shelving, so as to partially support the material. My means for regulating the motion of the discharge-roller L is shown very fully, as applied to a single discharging-wheel, in Fig. 1. The trip-wheel C has a radial slot, *c*, which carries an adjustable pin, *b;* and this pin carries the pawl *l*, which at each reciprocation induced by the crank-motion of the adjustable pin *b* takes or engages in fine teeth on the surface of a large wheel, L^3. I have represented these teeth as being quite coarse, but they may be graduated to any degree of fineness; or, what is preferable in some cases, I have two or more of these toothed wheels of different-sized teeth. By this means the action of the device may be controlled with almost mathematical nicety in a great variety of intermediate positions. In my previous machines I used coned pulleys to graduate the speed of the discharge-rollers L^1 L^2; but the belts were liable to slip and the discharges were sudden and great, and the entire system not perfectly reliable. My present discharge gives a positive movement to the roller and allows of delicate adjustments, and is besides more simple and compact, and is more cheaply made. I overcome the difficulty due to the blowing of the air idly upward along the edges by obstructing the air along those lines. The gate N, which controls the discharge from the hopper M, is represented in my former patents as merely a plane plate made sharp at its lower edge. I prefer to retain a sharp edge at the bottom, though this is not very important; but, whether sharpened or not, I bend the lower edge forward so as to describe a quick curve, as shown in Figs. 2, 5, and 10. The granular material spreads itself on the upper side of this curve, and the air, in consequence, is no longer liable to blow upward with extra force along the face of the gate. I make an overhanging in the opposite direction at the upper edge of the back of the adjustable gate K, which controls the discharge of the light material. In my former patents I represent this gate as plane on the back face or that which forms the front boundary of the stratum of material on the ore-bed. The bend or overhanging backward near the upper edge of my present invention produces an effect somewhat different from that of the curve at the other, the receiving end of the bed, but agreeing in its result. It prevents the too violent blowing upward of the air. The extent of the curvature and overhanging of the gates may be varied somewhat, but I prefer the form represented; it serves to prevent the undue blowing up. I avoid any such evil at the sides of the bed by providing a plane portion or strip which is unperforated along each edge.

It will be understood that the forms and proportions of the parts may be varied somewhat; but I have found that the success of the separation is dependent on nice conditions, particularly with some material. I have given the best proportions known to me.

Where the bed is double the second bed may be lowered somewhat below the level of the first, and this will be an advantage with some kinds of material. It will also be obvious that in such case there should be a hanging partition analogous to the adjustable gate N on the front of the hopper delivery, to compel the material which rises over the first delivery-gate K to descend close to the second bed before it moves forward much thereon. I have in Fig. 10 represented the two beds as very greatly out of level, and having a separate valve, D, for each. I prefer this construction in some cases. Where they are on an exact level, as in Fig. 5, there should be a somewhat corresponding hanging partition, as shown.

In each of the hollow bars of the bed I is a damper, *i*, (see Figs. 7 and 8,) which can be turned to check the force of the blast. This may,

if preferred, be mounted at the end of the bar which receives the air, and thus control the force of the blast along the entire length of the bar; or, if preferred, it may be mounted at some point so as to only control the air in the space beyond, which is less than the whole length. Where the bed is single and divided in two parts, as in Fig. 5, I prefer to mount these dampers directly under the dividing-dam. All the several dampers are fixed in a single shaft, i', which may be turned from the outside, and thus the force of the air beyond the damper may be charged at a single operation for the entire series of bars.

It is important that the force of the puff be sufficient and that the puffs be sharply made; but it is not absolutely essential to success that the valve be opened by percussion. The percussion-opening is very important where, from crude driving-power or from other cause, the motion is irregular, because, however slowly the machine may operate, the percussion-opening will always operate with the same suddenness or sharpness; and as the valve shutting is effected with springs it will always shut with equal speed, and the variation will be all in the length of time during which the valve remains shut, which is not important, except in economy of time, so long as it is sufficient to allow the material to fall after each puff. Where the speed may be steady, as when a separator is driven by a well-regulated engine, the valve may be opened by projections on a wheel, as shown in Figs. 11 and 13, and the machine will be simpler. The other features of the invention are not affected by this substitution of one opening device for another in different cases. Fig. 13 shows how, by means of the nuts, as shown, the extent of opening of the valve may be graduated with any desired degree of nicety.

Some of the advantages due to certain features of the invention may be separately enumerated, as follows: First, by reason of the fact that my valve D is worked as a poppet-valve, opening and closing by a direct movement to and from its seat, and is faced with rubber or analogous soft material, and is opened rapidly to a nicely-adjustable extent, I am enabled to receive a sharper and more perfectly-controllable action, with less friction and more endurance, than would be otherwise possible, and at the same time to work rapidly without much noise. Second, by reason of the fact that the valve D communicates with the slender cross-chamber P', which is of very limited area and delivers the air directly into the hollow bars in the bed, I am able to induce a sharper action of the puffs than is possible where, as usual, more cubical space is contained between the valve and the perforations in the ore-bed. Third, by reason of my hammer F, thrown upward by the spring E to a position close to the lever D^2 and then striking the lever by its accumulated velocity or momentum, I am able to open the valve more rapidly than would be otherwise possible with equally simple mechanism. Fourth, by reason of the valve D opening and shutting by a direct movement without friction, and shutting by means of the adjustable spring O, I am able to shut the valve more rapidly and noiselessly than would be possible with otherwise equally simple mechanism. Fifth, by reason of the large chamber U for the air, I receive the air continuously and almost uniformly through the pipe U' and discharge it intermittently through the valve D. The vigor of the puffs is greater than would be possible without this reservoir. Sixth, by reason of the oblique back of the delivery-passage J, I retard the descent from the back portion of the ore-bed, while allowing the air to drive upward the light matter with its full effect, and, practically, almost arrest the descent of the heavy matter from that position, thus devoting the back portion of the bed almost entirely to the moving upward of the light matter. Seventh, by reason of the overhung front H of the delivery-passage J, I facilitate the descent of the heavy matter at the extreme front edge of the passage, so that the greatest proportion of the heavy matter descends at or near the extreme front of the bed, having been separated or cleaned from the light matter during its traverse along the other portions of the bed, as specified. Eighth, by reason of my pawl and adjustable crank-pin, arranged and operating as represented relatively to the wheel L^3 and roller L, which control the discharge of the heavy material, I am able to adjust the ratio of the puffing to the discharging mechanisms with any required degree of nicety. Ninth, by reason of the duplicate delivery mechanisms, L and their connections, I am able to divide the material into more than two sorts at a single operation and with simple mechanism, and, by means of the other parts of the invention in connection therewith, to determine the ratio of each to the other two or more sorts. Tenth, by reason of the mounting of the second ore-bed at a lower level than the first, where two are placed to serve in connection, as shown, I am able to provide the second as well as the first with the means, as represented, for delivering the material thereon close to the ore-bed, and to employ on both beds the curved gates or their equivalents for preventing the blowing up of the material at the point of entering or leaving. Eleventh, by reason of the curved bottom of the gate N or the delivering edge of the hopper, I am able to resist the upward motion of the air through the materials along that edge and prevent any too great disturbance of the particles. Twelfth, by reason of the overhang or backward lip or extension of the upper edge of the front gate K, I am able to resist the upward motion of the air through the material along that edge, and prevent any undue disturbance of the particles there. Thirteenth, by reason of my dampers $i\ i$, mounted in the hollow bars of the ore-bed, I am able to retard the passage of the air so as to control or graduate its force, and to effect this important function at a single operation in all the bars.

I claim as my invention—

1. The poppet-valve D, faced with soft material, operating in combination with an ore-bed and constant-blowing means, as specified.

2. The arrangement of the valve D along the

bottom of the slender space P, communicating directly with the bed so as to work the valve in close contact with the bed, as specified.

3. The hammer F, operating, as represented, to open the valve D by percussive action, as set forth.

4. The spring O, arranged and operated, as represented, relatively to the valve D and to an ore-bed and suitable blowing means.

5. The chamber U between the pipe U′ and valve D, in combination with an ore-bed and blowing means, as specified.

6. The oblique back of the delivery-passage J, in combination with the ore-bed I and means for puffing air up through the same, as specified.

7. The overhung front H of the delivery-passage J, in combination with the ore-bed I and means for puffing the air, as set forth.

8. In combination with the bed I and means for puffing air through and feeding forward material to be separated therein, the wheel L^3, pawl *l*, and adjustable crank-pin *b*, operating to allow a delicate adjustment of the velocities, as specified.

9. The employment of two or more independent delivering devices, L, and their connections, mounted in a single frame, the one serving to discharge the denser portions of the material which is unaffected by the other, as specified.

10. The double ore-bed mounted at different levels, the second and lowest receiving the material thrown over from the first in the same manner as the first receives it from the elevated hopper, as and for the purposes specified.

11. The curve or lip, extending forward from the lower edge of the delivering-gate N on the hopper into and under a quantity of the material on the bed, as and for the purposes specified.

12. The backward curve or overhang of the delivering-gate K at the front of the ore-bed, extending into and covering a quantity of the material on the bed, as and for the purposes specified.

13. The dampers *i i* mounted on the single shaft *i′*, and arranged to serve within the hollow bars of the ore-bed, as and for the purposes herein set forth.

In testimony whereof I have hereunto set my name in presence of two subscribing witnesses.

S. R. KROM.

Witnesses:
THOMAS D. STETSON,
A. HOERMANN.

(3)