No. 873,951. PATENTED DEC. 17, 1907.

A. LANGERFELD.

SEPARATOR FOR LUMP MATERIAL.

APPLICATION FILED OCT. 17, 1902.

4 SHEETS—SHEET 1.

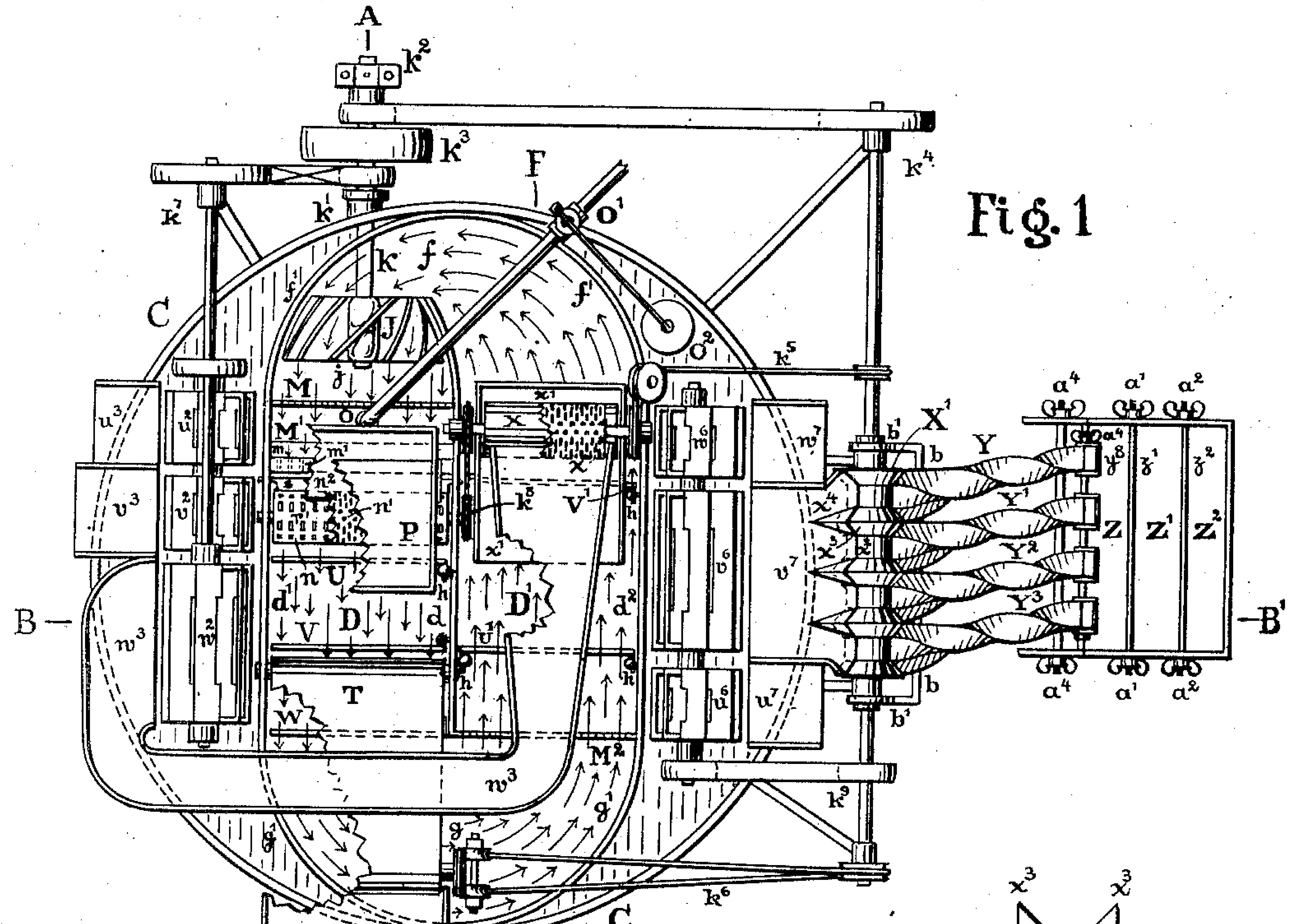

Fig. 1

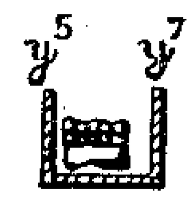

Fig. 4

Fig. 5

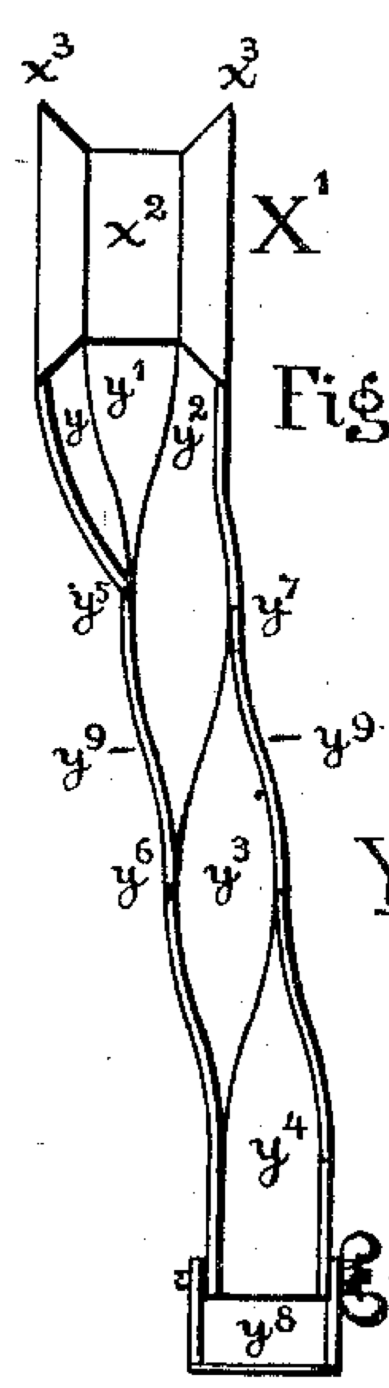

Fig. 3

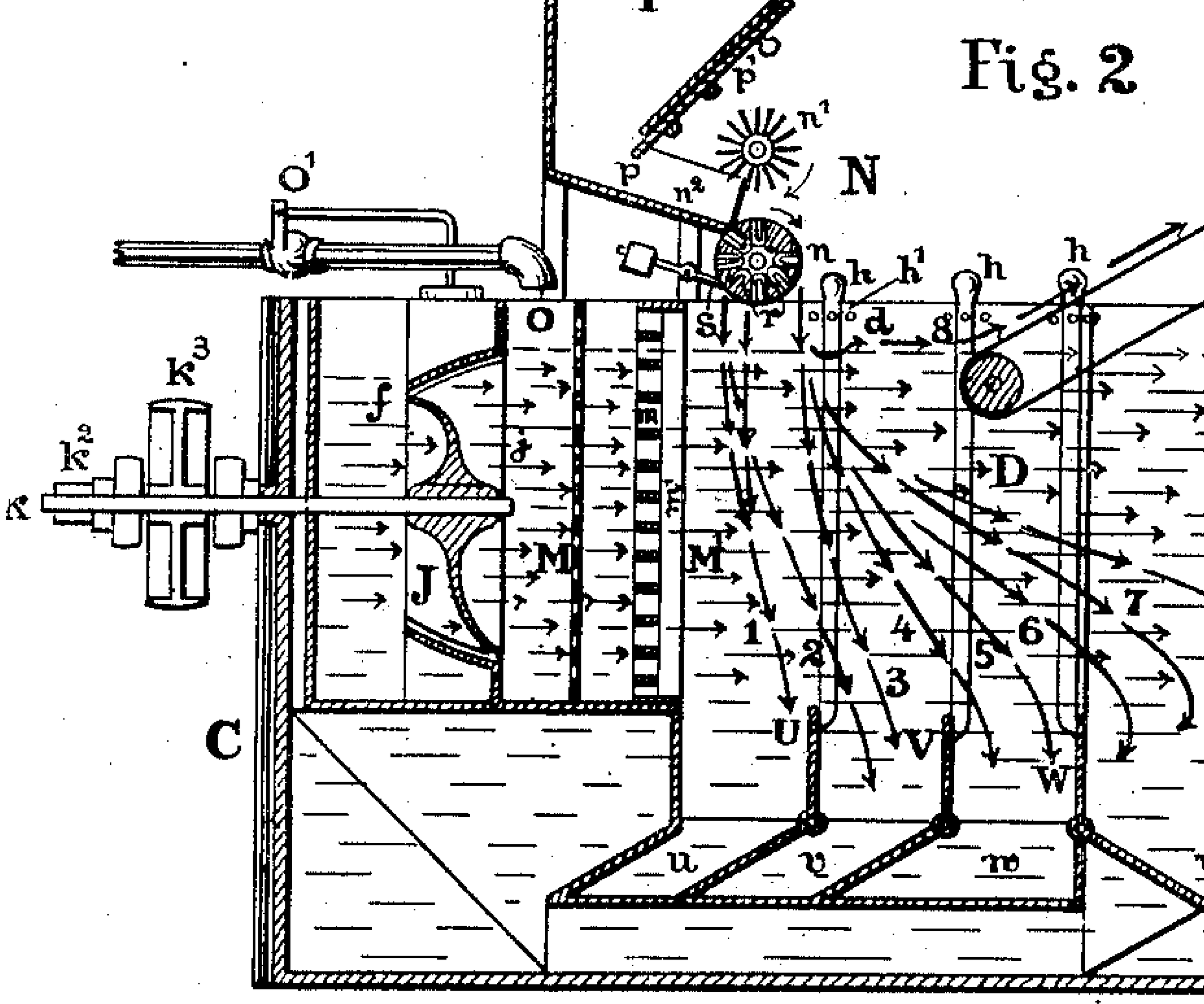

Fig. 2

Witnesses

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4 SHEETS—SHEET 2.

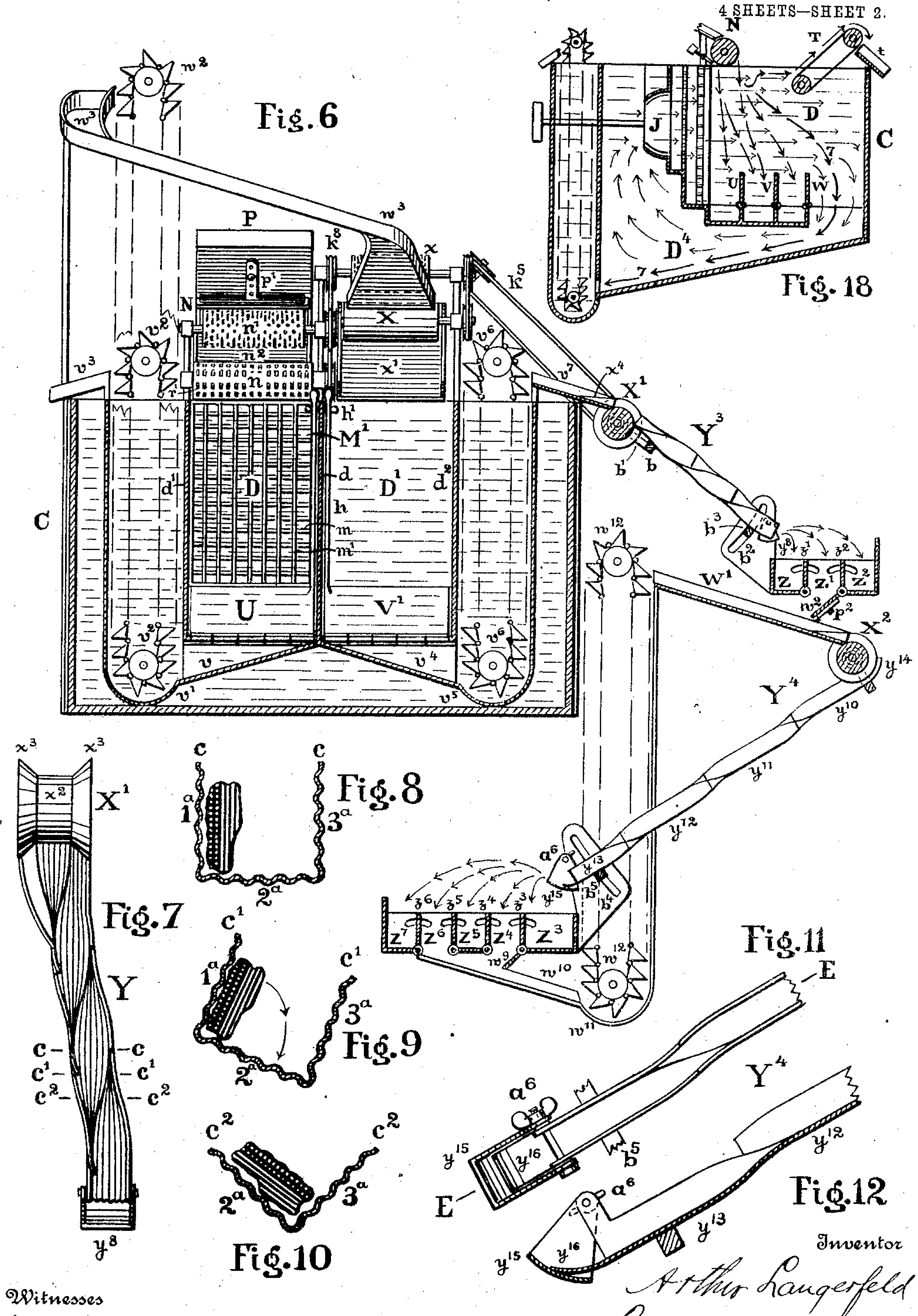

Fig.6

Fig.18

Fig.7

Fig.8

Fig.9

Fig.10

Fig.11

Fig.12

Witnesses

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4 SHEETS—SHEET 3.

Fig. 13

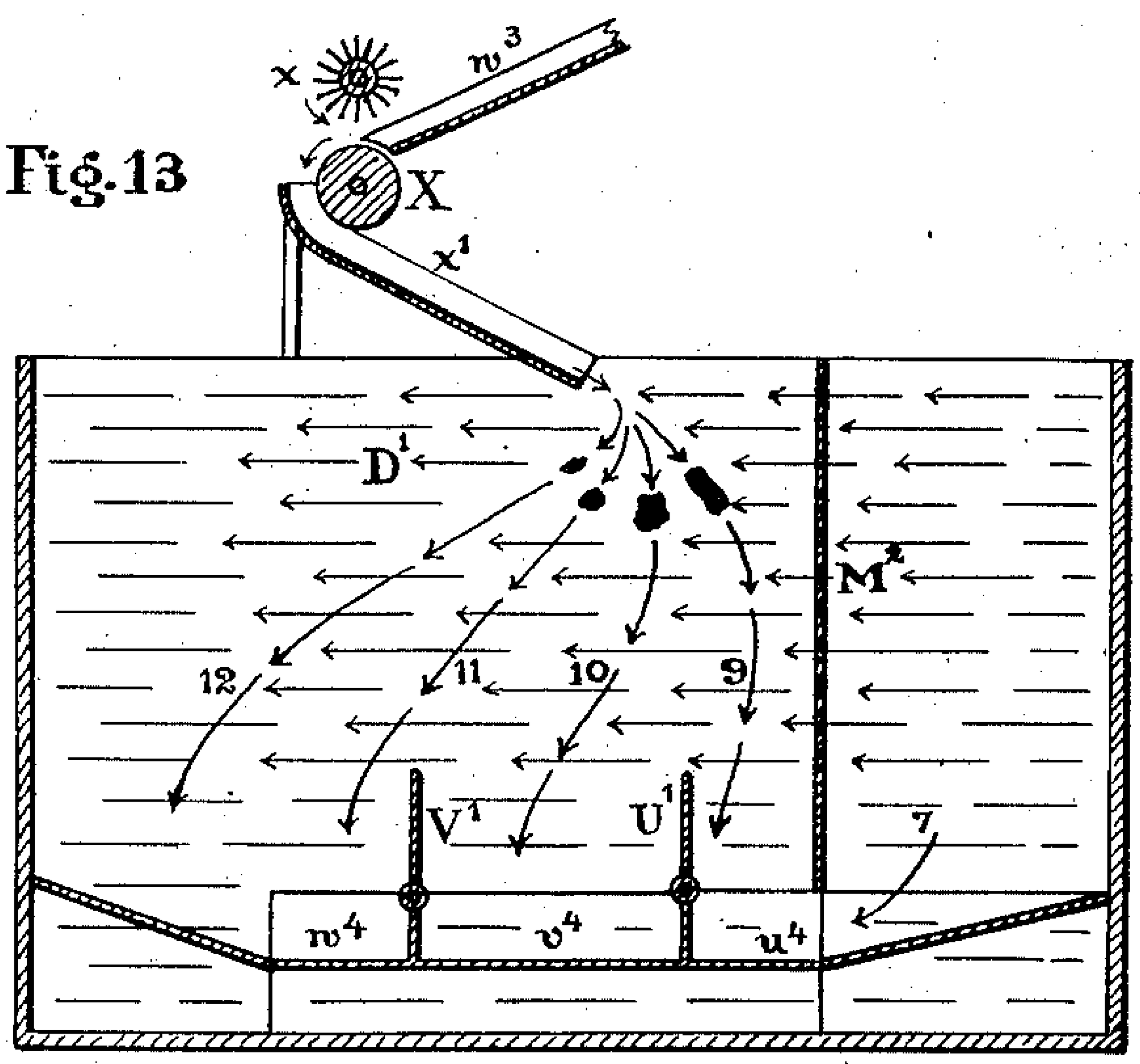


Fig. 15

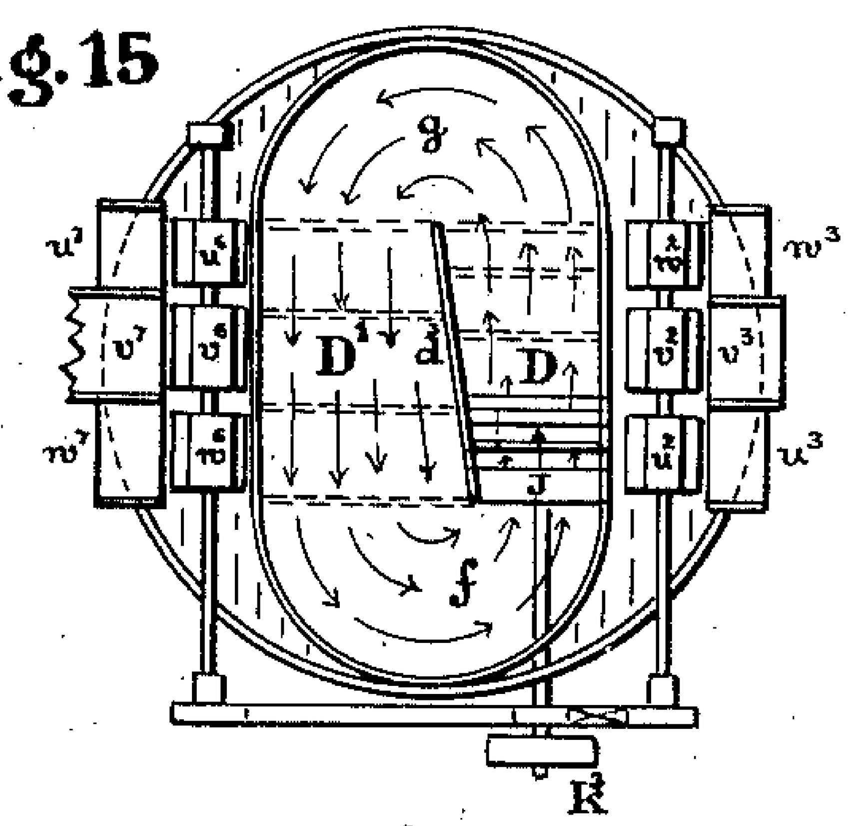


Fig. 16

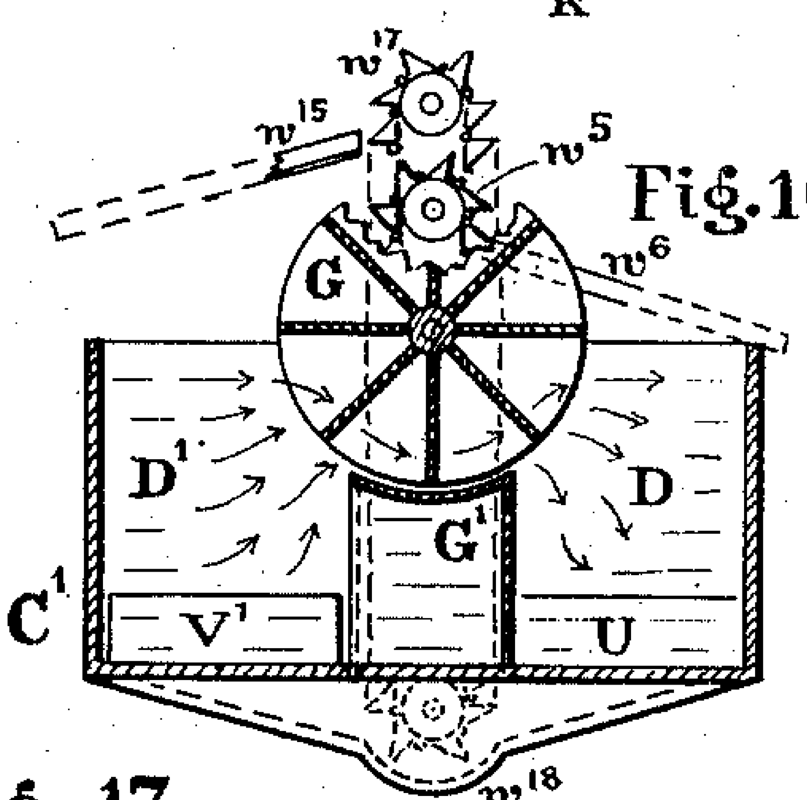


Fig. 14

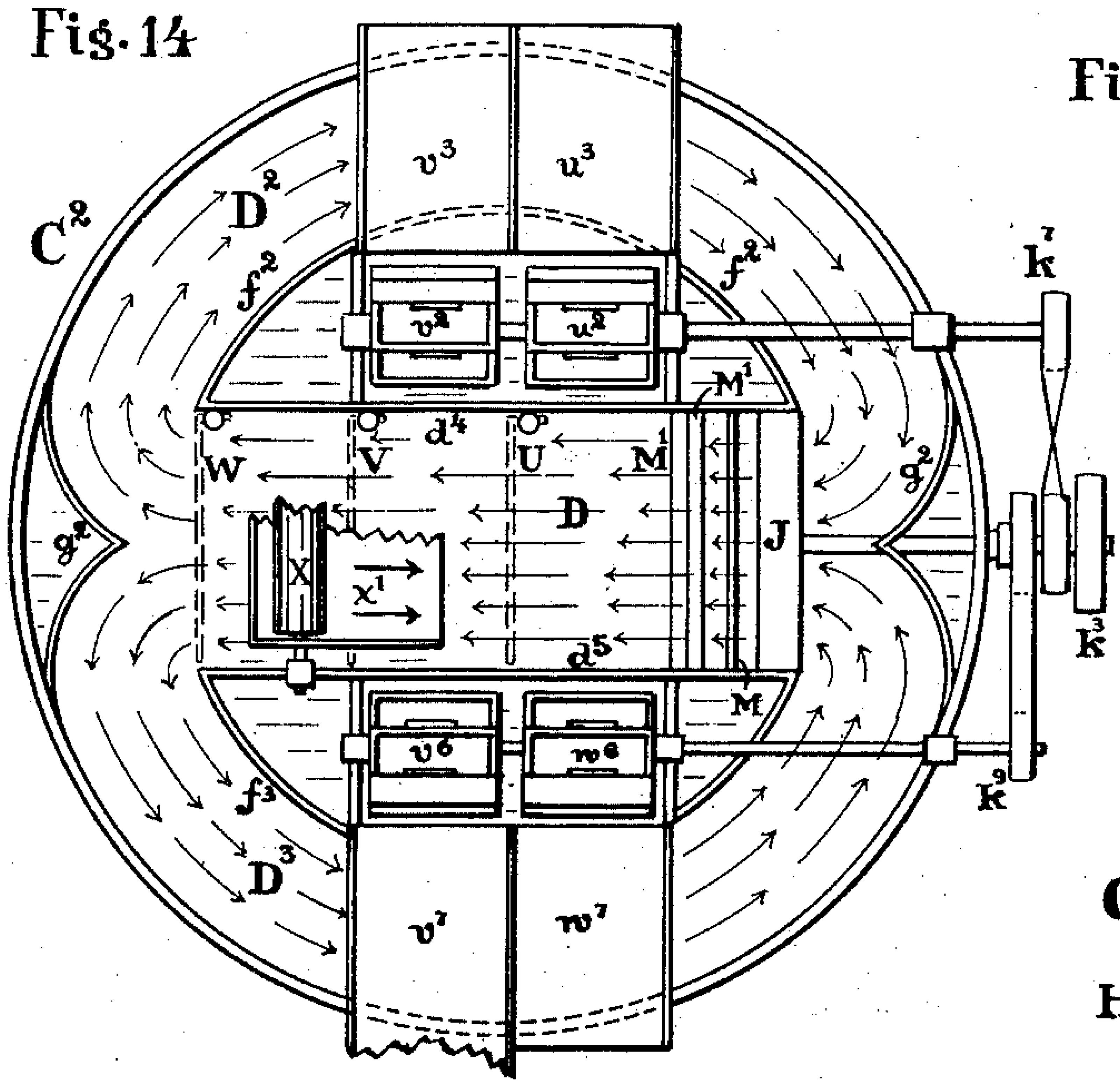
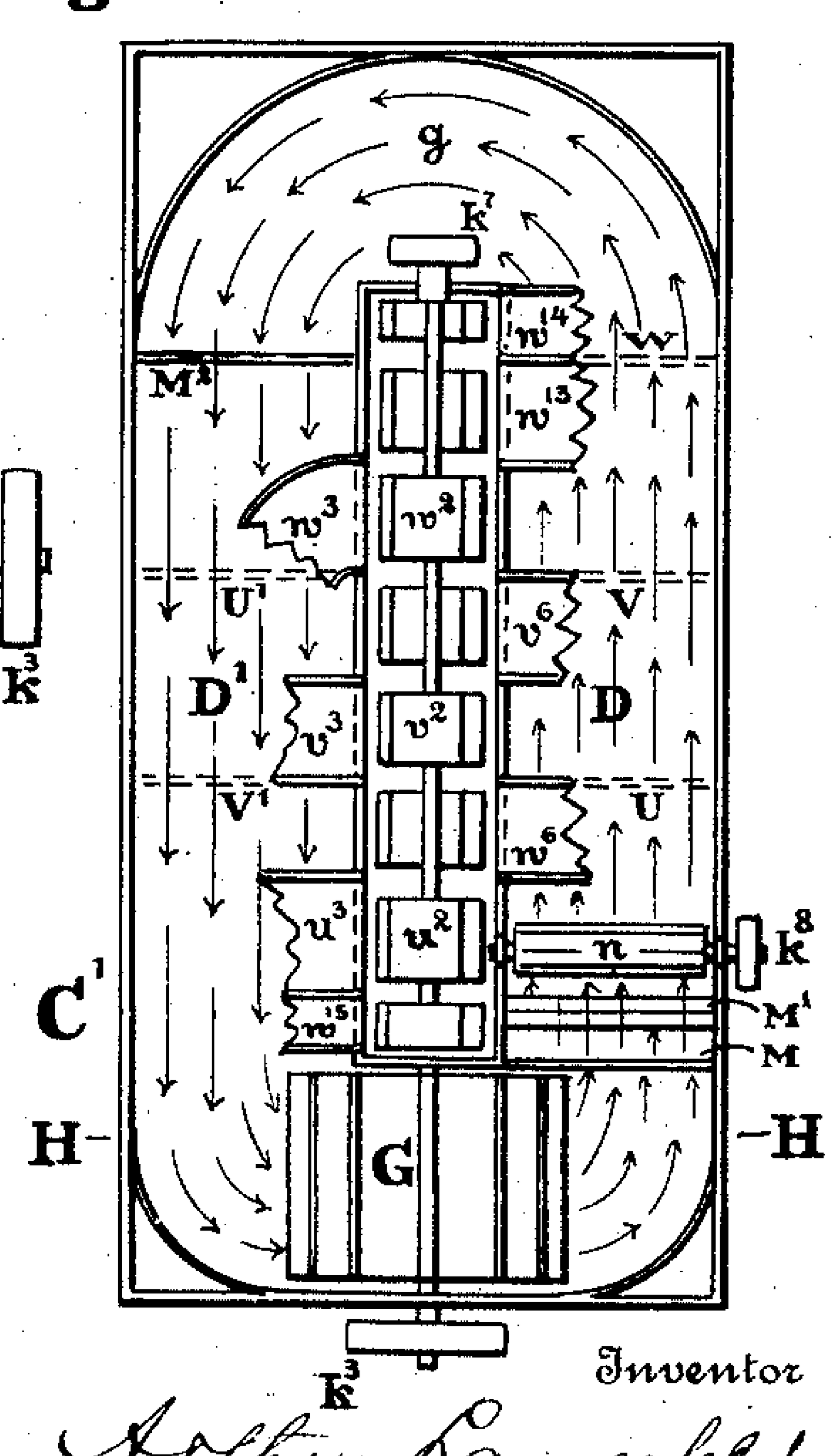


Fig. 17



Witnesses

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No. 873,951. PATENTED DEC. 17, 1907.

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APPLICATION FILED OCT. 17, 1902.

4 SHEETS—SHEET 4.

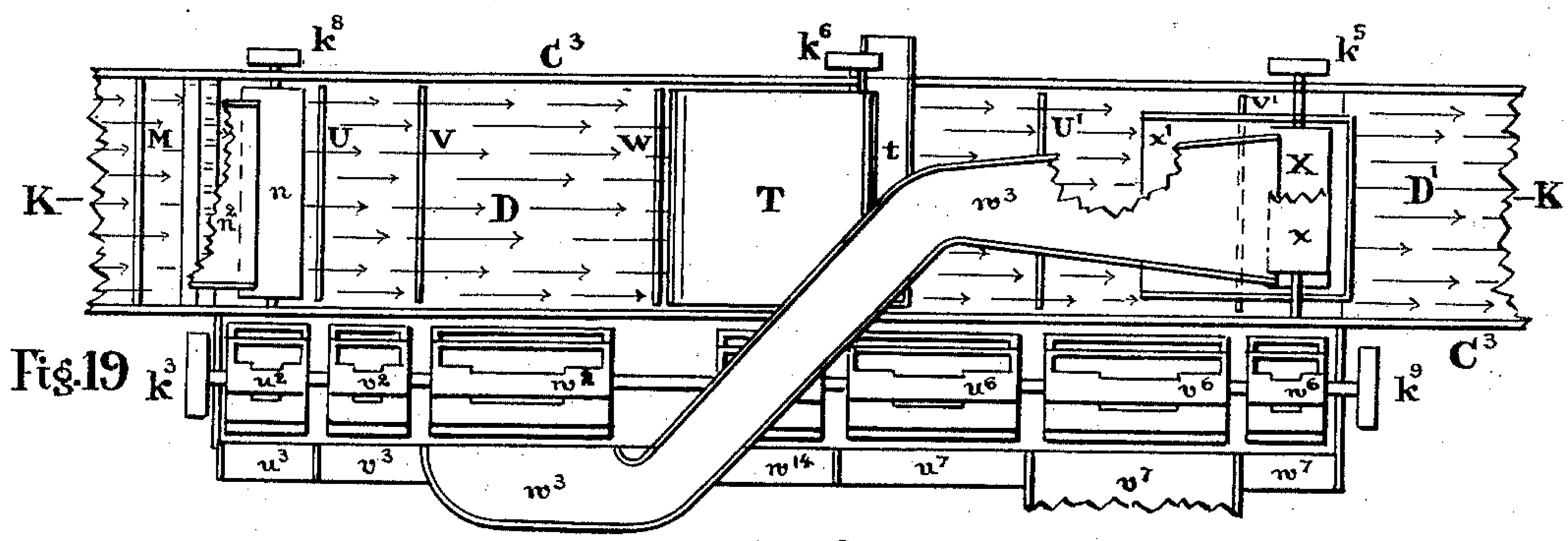

Fig. 19

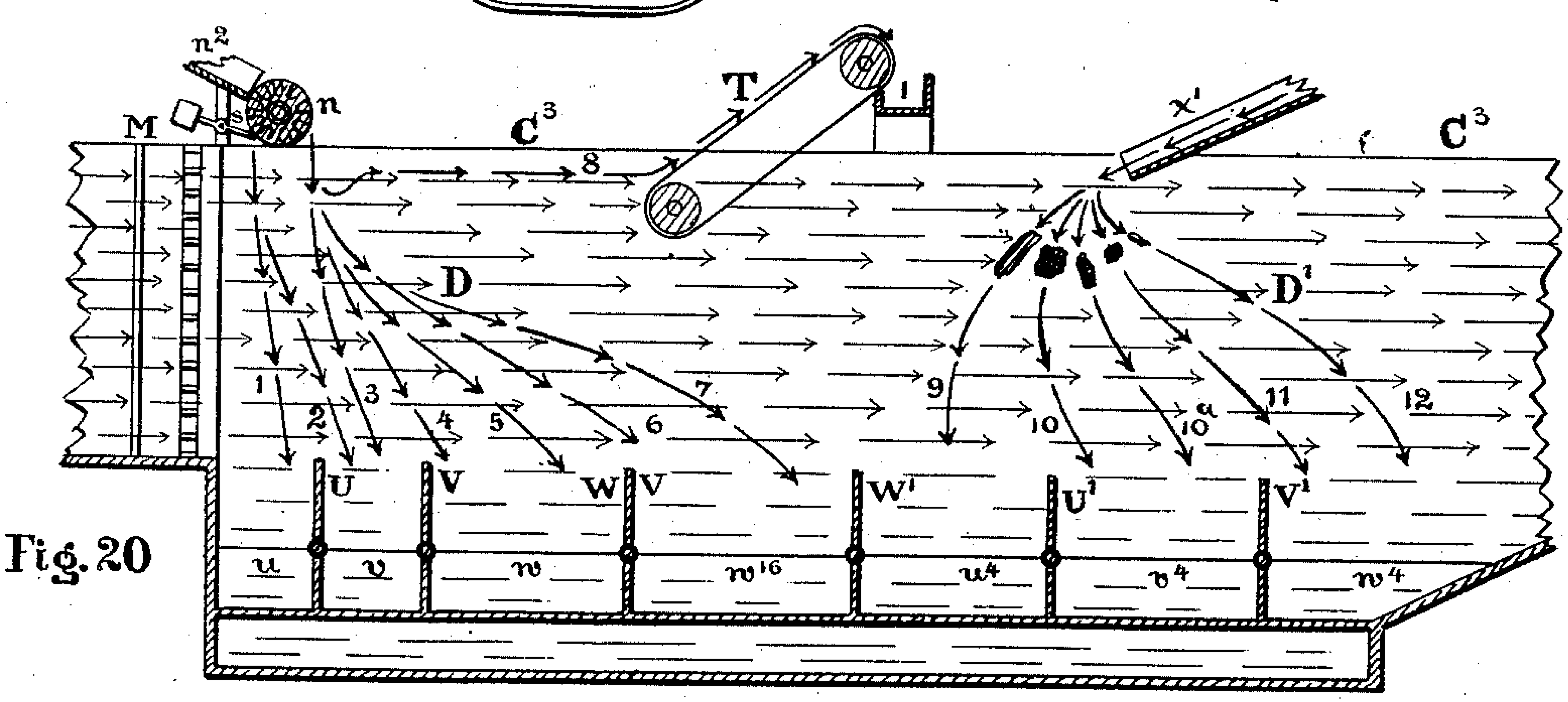

Fig. 20

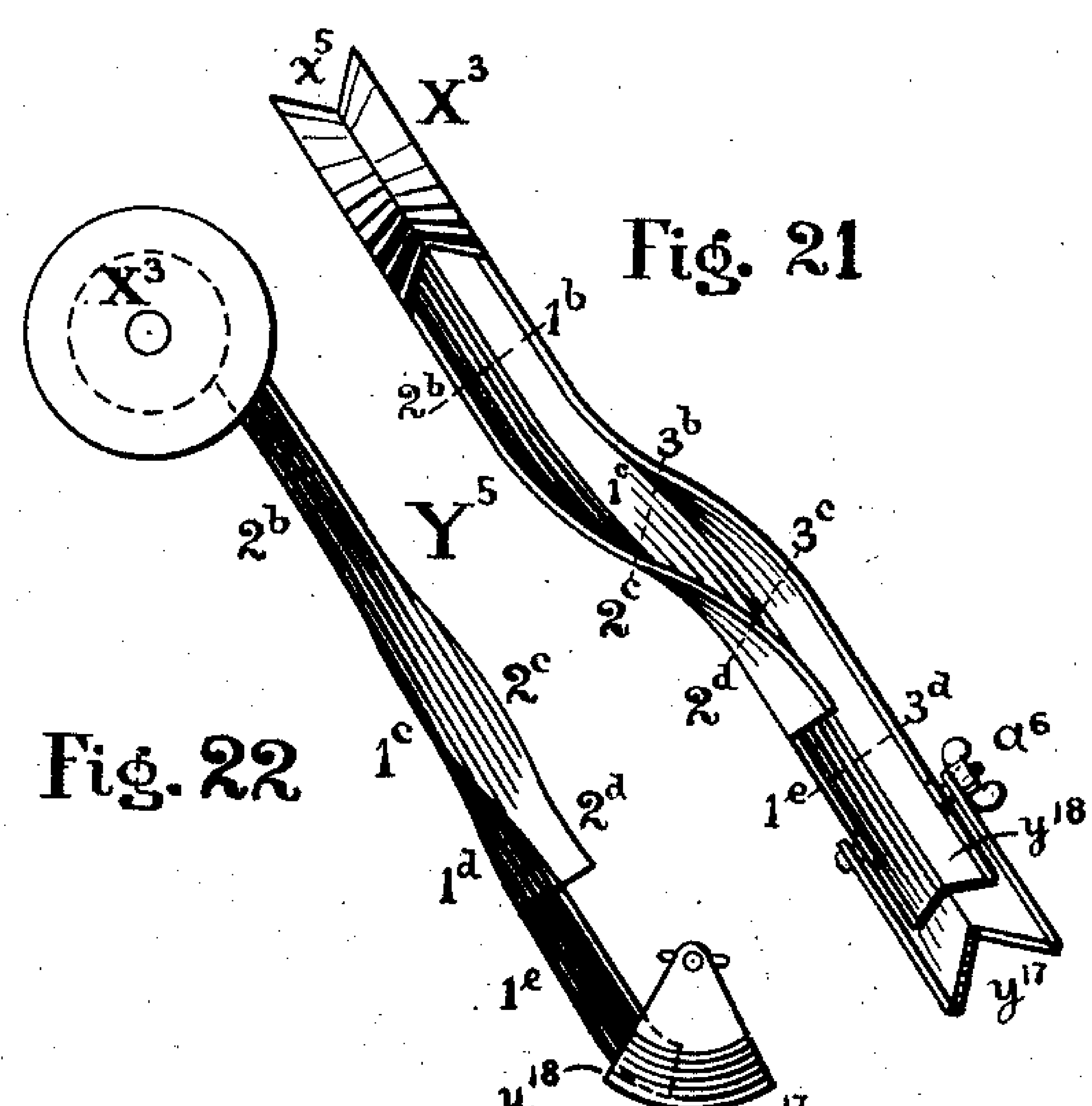

Fig. 21

Fig. 22

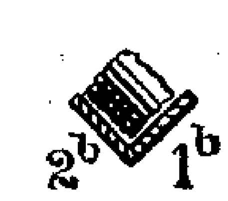

Fig. 23

Fig. 24

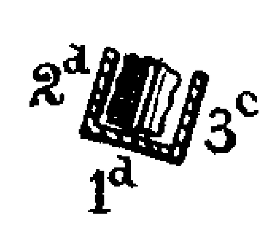

Fig. 25

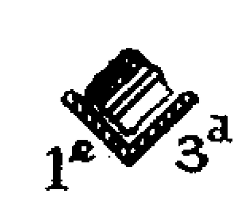

Fig. 26

Witnesses
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UNITED STATES PATENT OFFICE.

ARTHUR LANGERFELD, OF SCRANTON, PENNSYLVANIA.

SEPARATOR FOR LUMP MATERIAL.

No. 873,951. Specification of Letters Patent. Patented Dec. 17, 1907.

Application filed October 17, 1902. Serial No. 127,615.

To all whom it may concern:

Be it known that I, ARTHUR LANGERFELD, a citizen of the United States, residing at Scranton, in the county of Lackawanna and State of Pennsylvania, have invented certain new and useful Improvements in Separators for Lump Material, of which the following is a specification.

My invention relates to improvements in separating machines by which pieces that are alike are separated from a mixture or mass of lumps or pieces of various sizes, shapes, and kinds of materials.

My separator is especially intended for separating valuable materials from the so-called culm, slate, or rock that is now, and has heretofore been thrown away at anthracite collieries as worthless refuse, although it contains a considerable percentage of pieces of coal and pieces of slaty coal called bone, all of which pieces were not picked out or separated, because it would have been too expensive to completely pick them out by hand, and they could not be completely separated by the jigs and other imperfect separators heretofore used. Besides the slate, rock, bone and coal that is thrown on the culm dumps at the collieries many other things are thrown onto these dumps, such as chips of wood, bark, old iron, rags, waste, rubber, leather and ashes; and when such culm is shoveled up to be repicked or separated, then pebbles, sandstones and clay from the ground on which the dump rests also get mixed with the culm.

The objects of my invention are to provide means for separating pieces of coal and good bone from all the other kinds of pieces, and to wash the coal clean and free from dirt and small bits, and also to separate the bony coal and the valuable old iron, and do all this in a continuous manner automatically and economically without relying on the attention of an operator, and without previously screening the material so carefully that all are of one size; and without previously taking out flat pieces. I attain these objects by the means and mechanism illustrated in the accompanying drawings, in which:

Figure 1 is a plan view from above of a complete separator with some of the upper parts partly cut away to show some of the underlying parts; Fig. 2 is a vertical sectional view taken on the line A—A[1] of Fig. 1, looking towards B[1], with some of the rear parts omitted; Fig. 3 is a plan view of the chute Y and one part of the roller X[1], drawn to a larger scale than Fig. 1; Fig. 4 is a cross section of the chute Y on the line y^5—y^7, of Fig. 3; Fig. 5 is a cross section of the chute Y on the line y^8—y^6 of Fig. 3; Fig. 6 is a vertical sectional view taken on the line B—B[1] of Fig. 1, looking towards, A, with some parts partly cut away to show parts behind; Fig. 7 is the same as Fig. 3, but showing the slide surfaces corrugated; Figs. 8, 9 and 10 are cross sections of Fig. 7 on the lines c—c, c^1—c^1, and c^2—c^2, respectively. These sections are drawn to a larger scale than Fig. 7, and show how a flat composite piece of material turns over sidewise; Fig. 11 is a plan view of the lower part of one of the chutes Y[4], drawn to a larger scale than Fig. 6; Fig. 12 is a vertical sectional view taken on the line E—E[1] of Fig. 11; Fig. 13 is a vertical sectional view taken on the line F—F[1] of Fig. 1, looking towards B[1] and showing only the parts in and above the channel D[1]; Fig. 14 is a plan view of the tank part of a separator with one main channel D, and two return channels D[2], and showing a part of only the one feeder X x^1, like the one shown in section in Fig. 13; Fig. 15 is a plan view of the tank part of a separator showing a channel gradually changing in width. This figure is drawn to a smaller scale than Fig. 1; Fig. 16 is a vertical sectional view taken on the line H—H of Fig. 17, looking towards *g;* Fig. 17 is a plan view of an oblong tank with elevators arranged in the middle of the tank, and showing a waterwheel G. Some of the upper parts are omitted and some are partly cut away in this view; and it is drawn to the same scale as Fig. 15; Fig. 18 is a vertical section of the tank part of a separator having the return channel D[4] under the main channel D. This figure is drawn to the same scale as Fig. 15; Fig. 19 is a plan view of the channel part of a separator with some of the upper parts partly cut away, and with the elevators arranged alongside of the channel; Fig. 20 is a vertical sectional view taken on the line K—K of Fig. 19; Fig. 21 is a plan view of a twisted **V** shaped chute and projector drawn to the same scale as Fig. 11; Fig. 22 is a side view of Fig. 21; Fig. 23 is a cross section of Fig. 21 on the line 2^b—1^b; Fig. 24 is a cross section of Fig. 21 on the line 2^c—3^b; Fig. 25 is a cross section of Fig. 21 on the line 2^d—3^c; Fig. 26 is a cross section of Fig. 21 on the line 1^c—3^d.

The machine shown in Fig. 1 is a complete separator for fully separating anthracite culm. The main body is a tank C C with a main partition d through the middle. This partition commences and ends a short distance from the walls of the tank, leaving the spaces f and g at its ends. There are also two side partitions d^1, d^2, parallel to d which together therewith form the channels D and D^1. At each end of each one of the partitions d^1 and d^2 these partitions are extended around the ends of the partition d by the curved parts f^1 and g^1 which connect the ends of the partitions d^1 and d^2, thus also connecting the channels D and D^1 at each end. All these partitions run from the bottom of the channels to the top of the tank in height, as shown in Fig. 6.

The tank is filled with a liquid, usually water, by the supply pipe o. The float o^2 will keep the tank full by opening and closing the valve O^1. At the head of the channel D there is a propeller J designed to set the liquid in motion so that it will flow from the propeller J through the channel D, around through g, through D^1 and f, back to J. The shaft k which carries the propeller J runs in suitable bearings k^1, k^2, and is provided with means for driving it, illustrated by the pulley k^3. Any other suitable means for causing the liquid to flow may be used, as for instance the paddle wheel G over the partition G^1 shown in Figs. 16 and 17.

A short distance from the discharging side j of the propeller J there is a screen M designed to distribute the pressure and flow of the liquid uniformly; and a short distance from this screen is the device M^1 for further equalizing the flow, and for directing the current horizontally and in the direction of the channel D, so that the current in the channel D will be free from eddies. This device as here shown consists of a number of parallel slats arranged in the two sets, of which the first set m lies horizontally, and the second set m^1 stands vertically edgewise.

Above the device M^1 is a feeding device N designed for feeding the pieces of materials that are to be separated into the flowing liquid at the head of the channel D a short distance beyond the device M^1 where the flow of the liquid is uniform and steady. This feeding device consists of the receiving pocket P, the outlet p in the lower part of this pocket, the gate p^1 for adjusting the size of the outlet p, the chute n^2 running down from the outlet p, the feed roller n protuberating at the lower end of the chute n^2, and the revolving strickler n^1 above the feed roller n. The feed roller n and revolving strickler n^1 are driven by suitable means, such as the sprocket wheel or pulley k^8, so that the roller will turn away from the chute n^2 on its upper side, and the strickler will turn towards this chute on its under side. The roller and strickler therefore turn in the same direction.

The lump material that is to be separated is dumped into the pocket P, and the gate p^1 is opened far enough not to become clogged and to let out only as much material as the separator is designed to separate properly. The material passes down in the chute n^2 of its own gravitation and is carried forward and around by the traveling surface of the feed roller n. The strickler n^1 is set at such a distance over the roller that it will push back off the roller onto the chute n^2 all but a single piece layer of pieces of materials, so that each piece will come into contact with the poles of magnets r that are embedded in the body of the roller n and so placed that the poles are flush with the surface of the roller.

Pieces of iron will be held to the surface of the roller by the magnets until they reach the stripper s which rests lightly against the back of the roller, and all the pieces of iron will here be stripped off the roller and dropped into the flowing liquid below. The material is therefore partly separated by this feed roller and will drop from it at different distances from the head of the channel D into the flowing liquid.

At some distance from the feeder N, downstream in the channel D is a traveling band or elevator T arranged to dip into the flowing liquid deep enough to lift out floating pieces of materials, such as wood and bark. These materials drop from the head of the elevator T into a discharge chute or conveyer t. This elevator as here illustrated is driven by the belt k^6.

In the bottom of the channel D are short separating partitions U, V, and W. The pieces of various materials that drop from the feed roller n and do not float will be carried by the current of the liquid to various distances before they have sunk to the tops of the partitions U, V and W. These distances depend on the rapidity with which each piece sinks, and this rapidity depends on the specific gravity, the size, and the shape of each piece. A complete separation according to kind, quality or specific gravity alone does therefore not take place here. Thus a thin, flat piece of slate whose specific gravity is twice that of coal will nevertheless sink no quicker than a thick lump of coal whose length and width are the same as that of a thin piece of slate; and a small lump of bone will sink at the same rate as a larger lump of coal, although the bone is specifically heavier than the coal; and all small pieces will sink slower than larger pieces of the same kind and shape. Equally large pieces having substantially the same shape but differing in specific gravity will be carried to distances in inverse proportion to their specific gravities, and will therefore be separated according to kind by the partitions U, V, W. So the lightest pieces will be carried the furthest in all cases, no matter whether the lightness is because a piece is thin, or small, or specifically light.

As pieces of iron are dropped nearer the head of the channel D than the other pieces they enter the current further upstream than all the other pieces, and as they also sink quicker than all the others on account of their much greater specific gravity, they will all sink near the partition U, as indicated by the heavy lines of arrows 1 and 2. Thick pieces of iron will sink the quickest and will not get washed over the partitions U, as indicated by the line 1, but very rusty and thin pieces will be carried a little further than thick ones and the most worthless pieces will therefore be washed over the partition U, as indicated by the line 2.

Pieces of sulfur which are carried partway under the feed roller n will sink between the lines 2 and 3 if they are large lumps, but small lumps and thin pieces will be carried further by the wash of the current. The pieces which drop off the feed roller at n will be dispersed as indicated by the lines 3 to 7. The largest and specifically heaviest lumps of stone, slate, and sulfury bone will therefore follow line 3 and sink between the partitions U and V. Thin pieces of slate, flat pieces of bone, and large lumps of coal will follow lines 4 and 5 and sink between the partitions V and W. Dirt will be carried the furthest as indicated by lines 7, and small bits of coal etc. will be washed over the partition W as indicated by the line 6.

The partitions U, V, W, are made adjustable so that their upper edges can be set nearer to or further from the head of the channel D to bring about the desired separation. As shown these partitions are hinged at their lower edges so that they can be swung back and forth by the levers h, and they are held in place by these levers and the pegs h^1 stuck into the holes in the partition d.

Between the partitions U and V the bottom of the channel D slopes and forms a chute v leading to an elevator boot v^1 as shown in Fig. 6; and an elevator v^2 is arranged to lift material out of the boot v^1 and drop it into the chute v^3 by which it is conveyed over the liquid and discharged.

The bottom of the channel D between the partitions U and the device M^1 slopes and forms a chute u leading to an elevator boot similar to v^1, and an elevator u^2 is arranged to lift material out of this boot and drop it into the discharge chute u^3.

The bottom of the channel D between the partitions V and W slants and forms a chute w leading to an elevator boot similar to v^1, and an elevator w^2 is arranged to lift material out of this boot and discharge it into the transfer chute w^3. The elevators w^2 etc. are driven by suitable means, such as the pulley and shaft k^7. The bottom of the part g of the channel beyond the partition W slants and forms a chute u^4 leading down to the bottom of the channel D^1.

The transfer chute w^3 crosses to the channel D^1, and at its lower end a feed roller X protuberates enough to stop the pieces of materials and feed them regularly. Above this roller is a revolving strickler x the same as the strickler n^1 over the roller n. The roller X and strickler x are driven by suitable means, as illustrated by the shaft, pulleys, and belts k^4, k^5. The chute x^1 is arranged to receive the materials from the roller X and shoot the pieces into the liquid against the current in the channel D^1. By shooting these various pieces against the current instead of dropping them into it as was done in the channel D, a wider dispersion and different separation is obtained, by which this mixture is further separated. The largest and heaviest pieces will have the greatest momentum and will therefore shoot further against the stream than the smaller and lighter pieces. A more complete separation by size will therefore take place here. Flat pieces will tend to separate from lumps of the same length and width, because they enter the current edgewise and will scale against it further than lumps. The largest and heaviest flat pieces which are slate will therefore scale the furthest against the current and sink on the line 9, as illustrated in Fig. 13, before being washed back over the partition U^1. The largest lumps of coal will sink on the line 10 and strike bottom between the partitions U^1 and V^1; and all the smallest pieces will be carried back the furthest by the current, as indicated by the lines 11 and 12, and sink beyond the partition V^1. At the head of the channel D^1 is a screen M^2 similar to the screen M^1, and designed to distribute the flow of the liquid equally into the channel D^1 and counteract the disturbance caused in the current by its turning around in g. The partitions U^1, V^1, are made adjustable similarly as U and V.

The bottom of the channel D^1 before the partition U^1 slants so as to form a continuation of the chute u^4 leading to an elevator boot similar to the one v^5, shown in Fig. 6; and an elevator u^6 is arranged to lift the material out of this boot and drop it into the discharge chute u^7. The bottom of the channel D^1 between the partitions U^1 and V^1 slopes and forms a chute v^4 leading to the elevator boot v^5, and the elevator v^6 takes up the material out of this boot and drops it into the chute v^7. The bottom of the channel D^1 beyond the partition V^1 slopes and forms a chute w^4 leading to an elevator boot similar to v^5 from which the elevator w^6 takes the material and drops it into the chute w^7. The elevators u^6, v^6, and w^6, as shown in Fig. 1 are all driven by one shaft which is driven by the belt and pulley k^9.

At the lower end of the chute v^7 a feed roller X^1 protuberates enough to stop the pieces of material and feed them regularly.

This roller is driven by the pulley and shaft k^4. There are annular ribs x^3 with slanting sides on this roller, and the annular channels x^2 are formed by these sides of the ribs and by the intervening parts of the surface of the roller.

Preceding each one of the annular ribs x^3 and in line therewith is a prow or breaker x^4 consisting of a ridge gradually growing out of the bottom of the chute v^7, and designed to divide the stream of pieces coming down this chute and guide these pieces into the channels x^2. These breakers prevent two or more pieces from arching against the ribs x^3 and thus get carried over the roller together.

Below the roller X^1 are twisted slides or chutes Y, Y^1, etc., each commencing in line with one of the channels x^2, and constructed in the following manner: At the upper end each chute has a declivous bottom y^1, and sides y and y^2 whose upper ends correspond with the sides of the respective channel x^2 in the feed roller, thus forming a channel, or chute, in line with the channel in the roller, as illustrated on a large scale in Fig. 3. The bottom y^1 is twisted so that it will be vertical further down, as shown at y^5. The side y^2 is also twisted so that at y^5 its lay will be the same as that of y^1 at the top. Below y^5 the twist in y^2 is continued uniformly so that at y^6 the surface of y^2 is vertical. The side y is also twisted in a similar manner but ends at y^5. At y^7 another surface, y^3, begins. It is as wide as y^1 and twisted in the same manner. The edges of y^3, y^2, and y^1 are joined together so that these surfaces form a channel, as shown in the cross section Fig. 4. Further down at y^9 only the two surfaces y^2 and y^3 form the chute, as shown by the cross section Fig. 5 taken on the line y^9—y^9. Most of the pieces of materials in culm have four sides, or two sides and two edges, and I therefore make the slides Y, Y^1 etc. in four parts, y^1, y^2, y^3 and y^4 to correspond to the four sides of such pieces. The object of the twists in these chutes is to turn pieces over sidewise without interrupting their motion along the chutes, so that the friction of four sides of each piece will come into play and contribute equally to the retardation of the pieces, caused by their friction on the surfaces of these chutes. The manner in which four sided lumps turn over sidewise is illustrated by the composite piece shown in Figs. 4 and 5, and also in Figs. 23 to 26. Substantially round lumps will tumble but the twists will throw them sidewise and alter their rolling and cause about as much all around friction as a sliding piece gets.

I prefer to make the surfaces of y^1, y^2, etc. longitudinally corrugated as shown in Fig. 7, and as is further illustrated on a larger scale in the cross sections Figs. 8, 9, and 10. The purpose of these corrugations is to keep flat pieces from slipping sidewise on their lower edges across the twisted surfaces when they are in the position shown in Fig. 9.

At c^1 I show the vertical side of the slide continued twisted from c to c^1. This is to surely overturn flat pieces, as is fully illustrated in the cross section shown on a larger scale in Fig. 9. The flat piece shown in Figs. 8, 9, and 10 slides on the surface 1^a above c; at c it is sliding on one edge on the surface 2^a; at c^1 the surface 1^a pushes it over far enough to overbalance it, and the corrugations on the surface 2^a prevent its under edge from slipping across the surface 2^a, which would bring its black side down on the surface 2^a the same as it was on the surface 1^a above c.

The upper ends of the chutes Y, Y^1, etc. are supported by a carrier b to which the chutes are rigidly fastened, and this carrier is supported by arms b^1 whose upper ends are journaled concentrically with the roller X^1. The lower ends of these chutes are adjustably supported in a suitable manner, such as the bar or beam b^3 whose ends are adjustably clamped by the nuts a^4 in an arcuate slot b^2, concentric with the roller X^1, so that the pitch or slope of these chutes can be adjusted by swinging them up or down a little way around the roller X^1 and clamping the carrier b^3 where it is wanted.

Beyond the end of the projectors y^8 I place a pair of separating partitions z^1 and z^2. The first partition z^1 is placed a short distance from the end of the projectors, leaving a space or pocket Z between the ends of these projectors and the partition z^1. The partition z^2 is placed a short distance from the partition z^1 leaving the space or pocket Z^1 between them, and beyond the partition z^2 is a pocket Z^2. The partitions z^1 and z^2 are made adjustable so that their upper edges can be set nearer to or further from the ends of the projectors y^8. As shown in Fig. 6 these partitions are made adjustable by being hinged at their lower edges and held in position by clamp screws a^1, a^2, on studs passing through arcuate slots a, a^3, respectively, in boards or plates at the ends of the partitions, but any other suitable means for adjusting these partitions can be used here.

Each piece of material will fly from the end of the projector y^8 to a distance substantially proportional to the speed it has acquired in the chute Y, Y^1, etc., respectively. Stones and pieces of slate slide the slowest, because they are heaviest and because their surfaces cause the greatest friction; they will therefore fly the shortest distance, and the partition z^1 is set where no stones or slate will fly over it. Smooth and regularly shaped pieces of coal will slide the quickest, because they are lightest and their surfaces cause the least friction; they will therefore fly the furthest, and the partition z^2 is set where only pieces of coal will fly over it. Many odd shaped pieces of coal will fall between the pair of partitions z^1 and z^2 into the pocket Z^1; and also all the other pieces which are bone, or composite pieces.

In the bottom of the pocket Z^1 is an outlet w^2 to a feed chute W^1. This outlet is provided with an adjustable gate p^2 designed to regulate the passage of the pieces of materials.

At the lower end of the feed chute W^1 a feed-roller X^2 protuberates and is provided with annular ribs the same as the feed roller X^1; and on the lower part of the chute W^1 are stream breakers the same as x^4 on the chute v^7. Adjacent to the feed roller X^2 I place a twisted declivous frictional differentiating chute like Y^4 in line with each channel in the roller X^2. These chutes may be constructed the same as the one Y, but made longer, or they may be provided with straight sections inserted between the twists as illustrated by y^{11}, y^{12}, y^{13} in Fig. 6, and further shown on a larger scale in Figs. 11 and 12.

There is some advantage in inserting straight V shaped chute sections 2^b, Fig. 22, instead of the straight three sided channel sections y^{10}, y^{11}, etc. shown in the secondary frictional differentiating chutes Y^4; because in these V shaped sections the pieces slide on two sides simultaneously as illustrated in Figs. 5, 10, 23 and 26. When such straight V shaped sections are inserted the channels x^5 in the feed roller and the first section of the slide should be V shaped, as illustrated in Fig. 21.

Composite pieces of anthracite nearly always consist of parallel layers of various grades of coal, bone, and slate, and such pieces nearly all have two flat sides parallel to the layers. On their other sides, commonly called the edges, all the layers are exposed, so that the surfaces of these "edges" are all alike in kind. For these reasons such pieces can be properly separated by sliding them on only their two flat sides and twice on their said edges. It is sufficient to turn such pieces over sidewise only once in V shaped chutes as fully illustrated in Figs. 23 to 26, because then the friction of the two flat sides each comes into play once, and the friction of the edge twice on the long straight sections of the slide. The advantages of this are that the slide is shorter and simpler, and that the projector y^{18}, y^{17}, is also V shaped in section, which causes the pieces to surely fly straight out from the end of the projector, while on a flat curved projector, y^{16}, the pieces coming from a twisted slide are apt to fly a little obliquely. I run all the twists a little obliquely as at 2^c, Fig. 21, because then flat pieces will more certainly slide against the 2^c 2^d side that turns them over the same as the side 1^a in Fig. 9.

In the position shown in Fig. 6 the chutes Y^4 pass back under the roller X^2, because that arrangement economizes room, but these chutes may also be placed in the same position as Y, Y^1, etc. As shown the chutes Y^4 are each provided with a curved chute y^{14} at their heads arranged to deflect the pieces coming from the channels in the roller X^2 and guide them into the chutes Y^4. At the lower end of each one of the chutes Y^4 is a rounding projector y^{15} similar to the projector y^8, but preferably made in two sections, as shown, so that it can be so set that its end will point slanting well upward, as much as 45° up from horizontal, if desired, because pieces projected at that angle will fly farther apart than at any other angle. It is sufficient to make only the second or end section y^{15}, Fig. 12, (and y^{17}, Fig. 22) adjustable and make the first section y^{16}, Fig. 12 (and y^{18}, Fig. 22) a fixed part of the chute as shown. In these figures a clamp screw a^6 is shown, by which the adjustable section y^{15} is held in position. I prefer to make the two sections of this curved projector not quite concentric, as shown, so that there will not be much of a step at the end of the section y^{16}, but when they are made of thin sheets they may as well be made concentric. Adjacent to the end of the projector y^{15} I place 2 pairs of separating partitions z^3, z^4, and z^5, z^6, with spaces or pockets Z^4 and Z^6 between each pair, respectively, and with a pocket Z^5 between these pairs of partitions; and I also leave a space or pocket Z^3 between the end of the projector y^{15} and the partition z^3. Beyond the partition z^6 I place a pocket Z^7.

The partitions z^3 to z^6 are made adjustable in a similar manner as the partitions z^1, z^2. The partition z^3 is placed where all good pieces of bone and coal will fly over it; then all the pieces that fall into the pocket Z^3 are worthless. The partition z^4 is placed where no pieces of slate or worthless bone will fly over it. Then the pieces falling into the pocket Z^4 will be slate and bone mixed. The partition z^5 is placed where all the pieces of coal will fly over it. Then only pieces of bone will fall into the pocket Z^5. The partition z^6 is placed where only pieces of coal will fly over it; then the pieces that fall into the pocket Z^6 will be coal and bone mixed.

From the pockets Z^4 and Z^6 chutes w^9 and w^{10}, respectively, lead to an elevator boot w^{11}, and an elevator w^{12} runs from this boot up to an extension of the feed chute W^1, so that the materials thus elevated will again be conveyed to the roller X^2 and fed to the frictional separating chutes Y^4, etc. Thus the mixtures from the pockets Z^4 and Z^6 are reseparated by the same means, but they will not all fly the same each time, partly because most of them are odd shaped pieces which seldom slide twice exactly alike, and partly because the wide dispersion by means of the high projection emphasizes their frictional differentiation so much that they seldom fly twice alike. All these pieces will therefore soon become distributed in the final pockets where they most nearly belong.

The operation of the separator in separating anthracite culm is as follows: The culm is first screened so that it contains no pieces larger than the maximum sized pieces for which the separator is designed; but it is not necessary to screen out small pieces or flat pieces. This partly screened culm is put into the pocket P. The feed is regulated partly by the gate p, partly by the speed of the strickler n^1, and partly by the speed of the feed roller n. Rain water is the most desirable liquid to use in the channels D, D^1 etc., because that will not corrode iron parts of the machine, but river water or mine water will favor the separation. All floating pieces will be removed by the elevator T and no adjustment is required here. The partition U is set where required to separate the valuable iron; the partition V is set where it will separate only worthless stones, slate, sulfur, and bone; and the partition W is set where it will separate only dirt and small bits of coal which are not wanted. The partition U^1 is set where it will separate pieces larger than can be properly separated in the frictional chutes Y, etc.; and the partition V^1 is set where it will separate pieces smaller than will separate properly in the separating chutes Y, etc.

The speed of the feed roller X^1 must be so regulated that it will keep the chute v^7 clear without crowding the pieces in the frictional chutes Y, etc. If too much material comes into the chute v^7, the feed must be reduced at N. Experience will show the most advantageous pitch at which the chutes Y, etc. should be set, and samples will show whether the partitions z^1, etc., are in their proper places.

It is obvious that this separator may be modified in various ways by omitting some of the features shown, or by adding more of some of the parts. Thus more partitions like U^1, V^1 may be added in the bottom of the channel D^1 when the channel is made deep enough and the current swift enough to cause a very wide dispersion of the pieces of materials. Then one or more additional elevators like v^6, each together with a feeding means and suitable frictional differentiating slides can be added. This is especially desirable when the pieces fed into the separator are a mixture of several distinct sizes. This will increase the capacity of the machine without adding anything new to the invention.

The tank C need not be made round, but may be made square or oblong like C^1, Fig. 17. In such an oblong tank the elevators can all be placed in the middle as shown. In this illustration the elevators and chutes w^{14} and w^{15} are arranged to take out dirt and small particles, and the chute and elevator w^{13} is arranged to take out separately the large flat pieces that will pass over the partition U^1 against the stream.

In case there is a steady supply of water at hand that is sufficient to cause a suitable current in the main channel, then the propeller J or waterwheel G may be omitted and the water discharged from the end of the channel D^1; and instead of making D^1 a return channel it is then better to make it a continuation of the channel D, as shown in Figs. 19 and 20, and the other parts are then arranged accordingly, as shown. In this arrangement the sides C^3 of the channel D D^1 take the place of the partitions d, etc. and of the walls of the tank C. When there is no iron to be separated the magnets r in the roller n may be omitted, although they aid in separating pieces high in sulfur, and for that magnets are always useful.

The stricklers n^1 and x can be made fixed, or yielding a little to prevent jamming instead of revolving, but a yielding, moving strickler in the form of a revolving brush, as illustrated is best.

A considerable percentage of bone is allowed in commercial medium and small sizes of coal and for that reason the partition z^6 may be omitted in separators for such sizes, and only the mixture from the pocket Z^4 reseparated, so that no good pieces of bone nor any small odd shaped pieces of coal will go to waste. Or in case it is not desired to save all the bone, then only one partition needs to be put in place of the pair of partitions z^3 and z^4.

When it is not desired to separate the bone at all, then the separating chutes Y, Y^1, etc. may be omitted and the separating chutes Y^4 together with the elevator w^{12} put in the place of the chutes Y, Y^1, etc., and only one pair of separating partitions like z^1, z^2, used. In that case the chute w^8 will lead directly to the elevator boot w^{11}, and the elevator w^{12} will discharge into the chute v^7. The partition z^1 is then so set that the worst pieces of bone will not fly over it, and the partition z^2 is set so that as much bone as is wanted in the coal will fly over it.

The novel twisted form of frictional differentiating slides Y, Y^1, etc. may be substituted by simpler slides when a complete separation, which necessitates turning the pieces over, is not desired; but the combination of the means for partly separating the culm by dispersion in a flowing liquid and thereby wash it and take out pieces which would clog a slide, such as wood, bark and rags, or which would not separate properly by sliding, such as soap stone and iron, and means for completing the separation by frictional differentiation is necessary for a complete separation of culm and similar mixtures.

By placing the partitions d, etc. in divergent positions, as shown in Fig. 15, the current will run slower at the further end of the channels D and D^1 and therefore cause more of the smallest pieces of coal to sink to the bottom before passing out of the channel D^1. When this is not desired these partitions are set parallel to each other, or if need be in converging positions, which will cause the current to run swifter towards the end and therefore carry more of the smallest pieces away.

The disposition of the partitions and elevators shown in Fig. 1 may be modified as shown in Fig. 14 in which two partitions d^4 and d^5 run through the tank, so that there will be two return channels D^2 and D^3. In this case it is most convenient to place the elevators in the tank as shown and slope the bottom of the channels accordingly. The partitions f^2 and f^3 here form the channels D^2 and D^3 respectively.

In small sizes of marketable anthracite coal a large percentage of slate and bone is permitted and some such small sizes can therefore be separated well enough by the wash of the water without eliminating all or any of the remaining bone and thin slate by frictional differentiation, and for such work the tank part of my separator is therefore sufficient; and either only the feeder N with channel D etc., or only the feeder X x^1 with the channel D^1 etc.; or both may be used, together with the corresponding partitions, chutes and elevators.

If only materials that will float on the liquid used are to be separated from a mass of lump material, then only the combination of feeding means, a water channel thereunder, means for causing a body of liquid to flow in said channel, the elevator T, and means for removing the pieces that sink, is sufficient.

What I claim as new and desire to secure by Letters Patent is:—

1. In a separator for lump material, a tank having main and return channels, means for maintaining a circulation of liquids through said channels, separating partitions arranged across the bottoms of said channels, means arranged at the head of the main channel for feeding material into said channel, devices for shooting the material into the return channel against the flow of liquid, and means for conveying the partly separated material from the main channel to said devices.

2. In a separator for lump material, a channel adapted to contain a flowing liquid stream, means for shooting pieces of material into said liquid stream against the current flow, and separating partitions arranged in the bottom of the channel under the current of the liquid.

3. In a separator for lump material, the combination with a channel adapted to contain a flowing liquid stream, and separating partitions in the bottom of the channel, of means for dropping the material to be separated into the flowing liquid in said channel, whereby the material becomes partly separated by dispersion, means for removing the so separated materials from the liquid, and means arranged to shoot part of the separated materials into the flowing liquid against the current of the liquid.

In testimony whereof I affix my signature, in presence of two witnesses.

ARTHUR LANGERFELD.

Witnesses:
M. F. SANDO,
J. W. SANDO.