No. 753,591. PATENTED MAR. 1, 1904.

A. LANGERFELD.

ART OF SEPARATING LUMP MATERIAL.

APPLICATION FILED MAY 3, 1900.

NO MODEL. 2 SHEETS—SHEET 1.

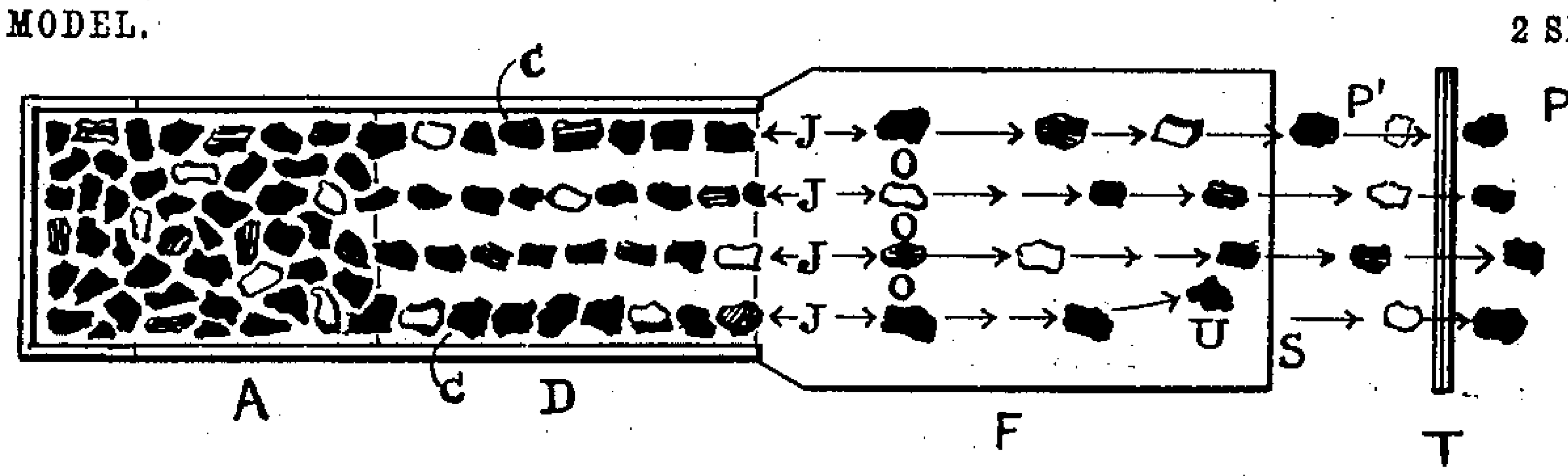


Fig. 1

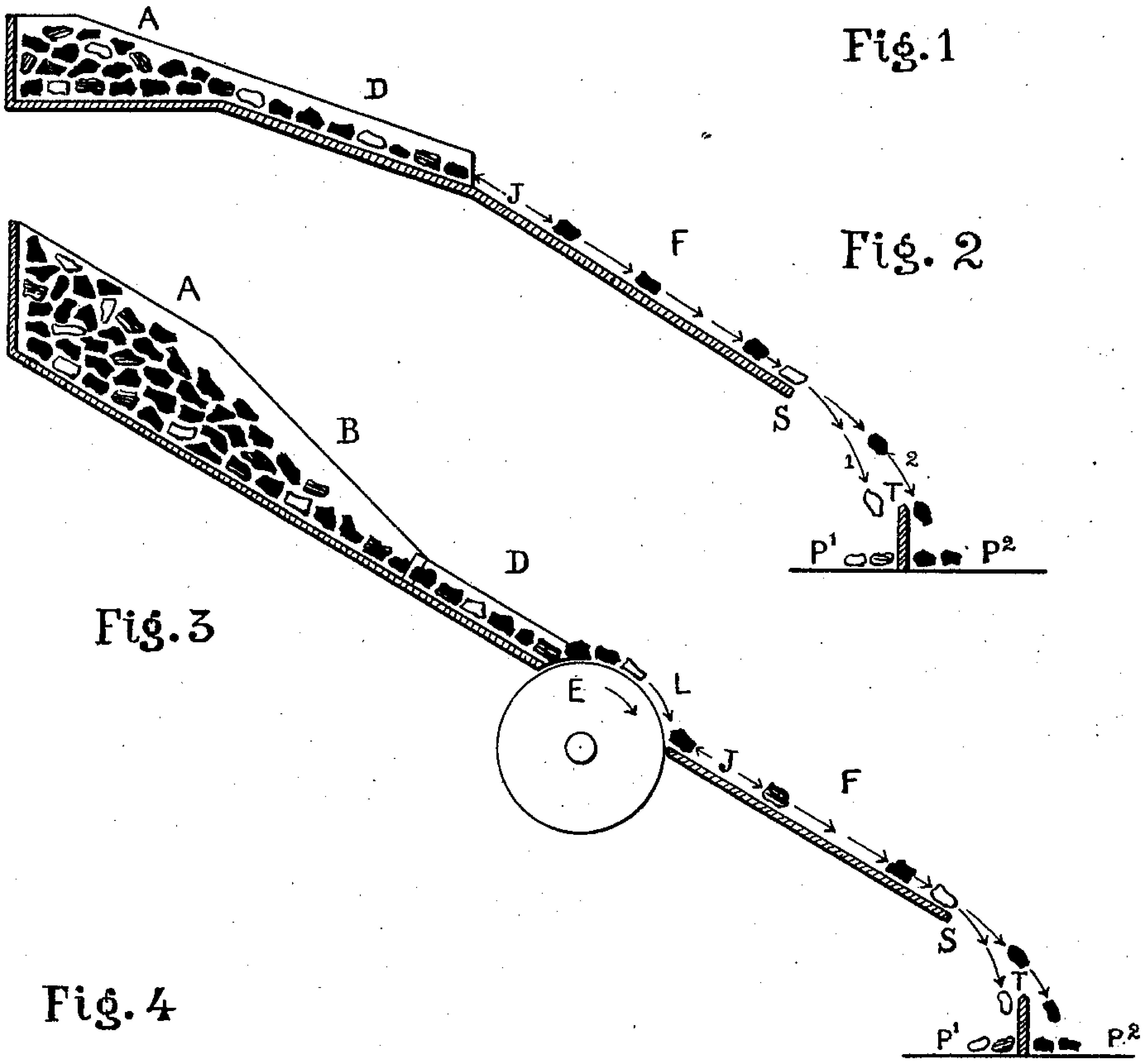
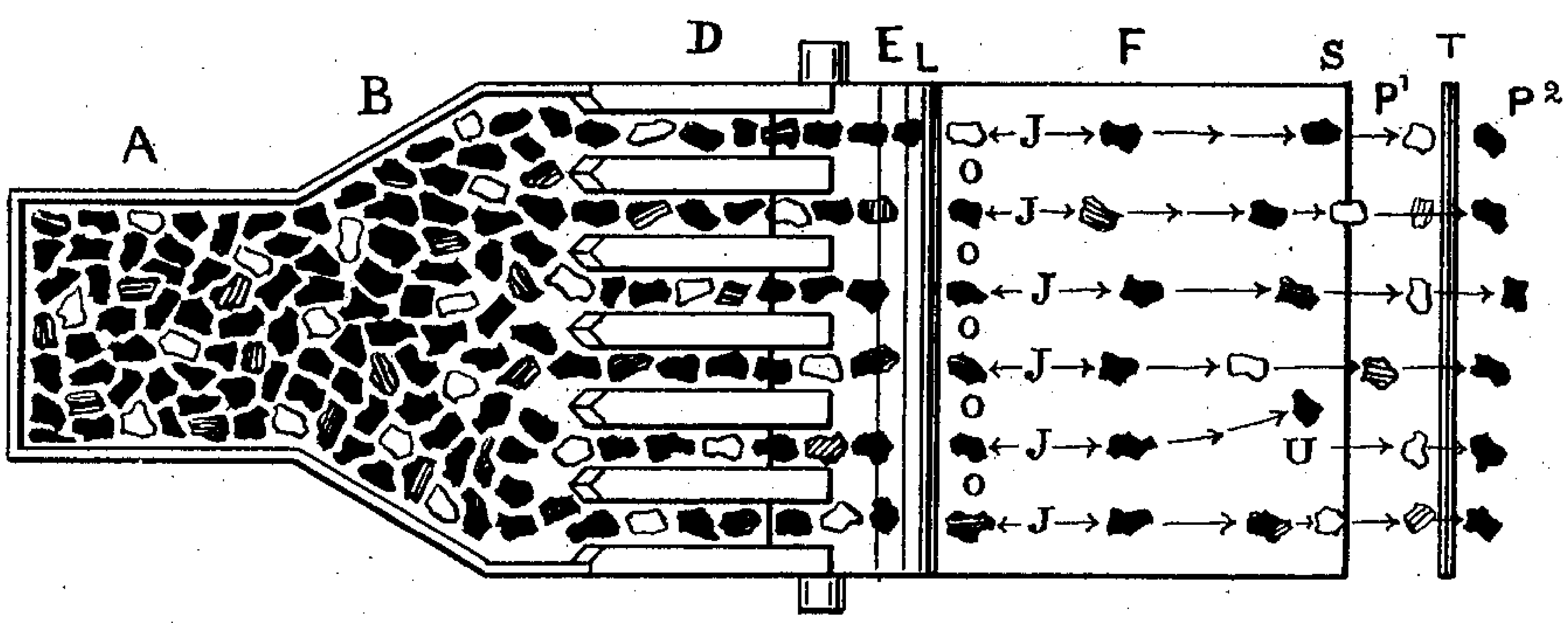


Fig. 2

Fig. 3

Fig. 4



Witnesses
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Flora Levi

Inventor
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2 SHEETS—SHEET 2.

Fig. 5

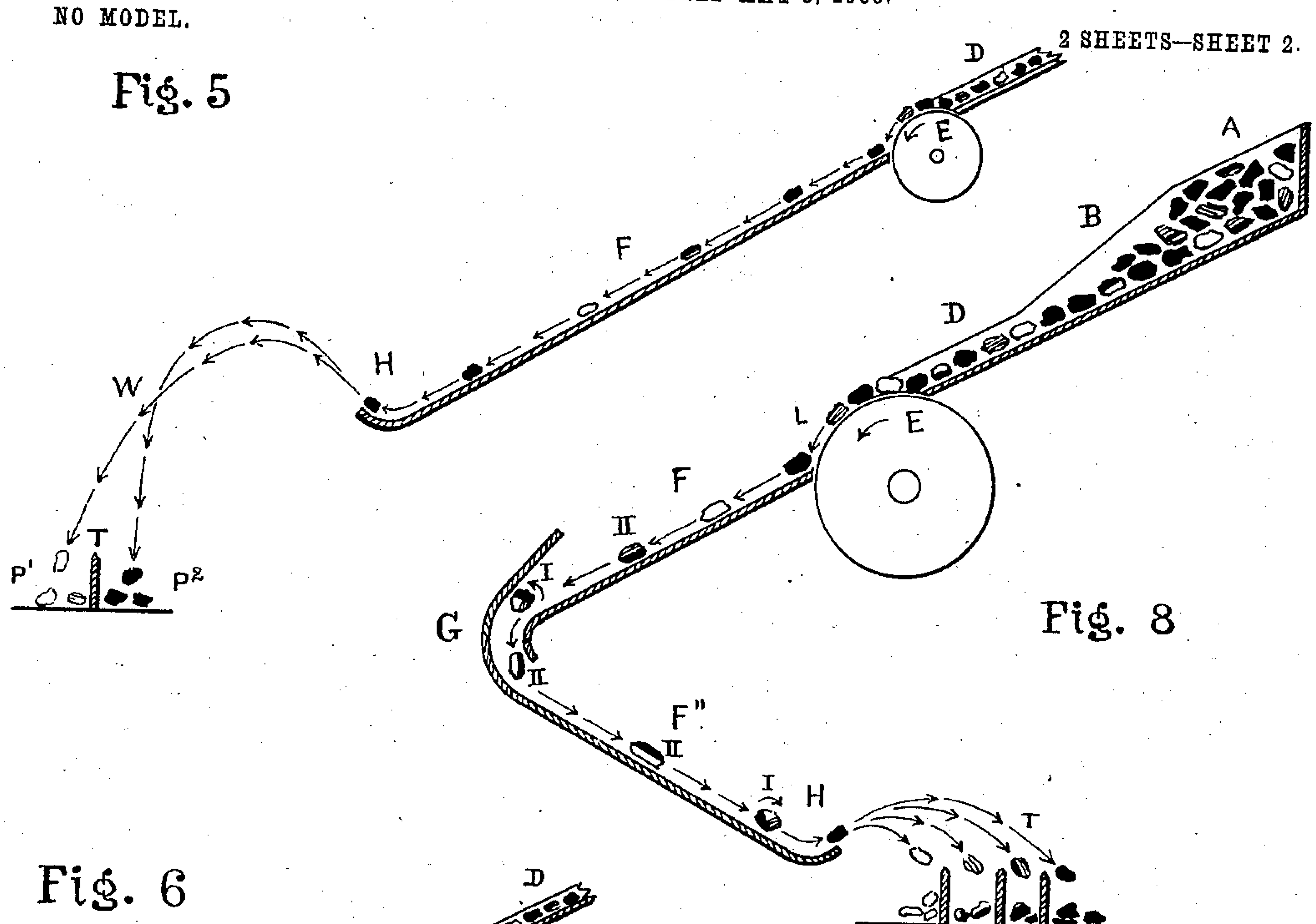


Fig. 8

Fig. 6

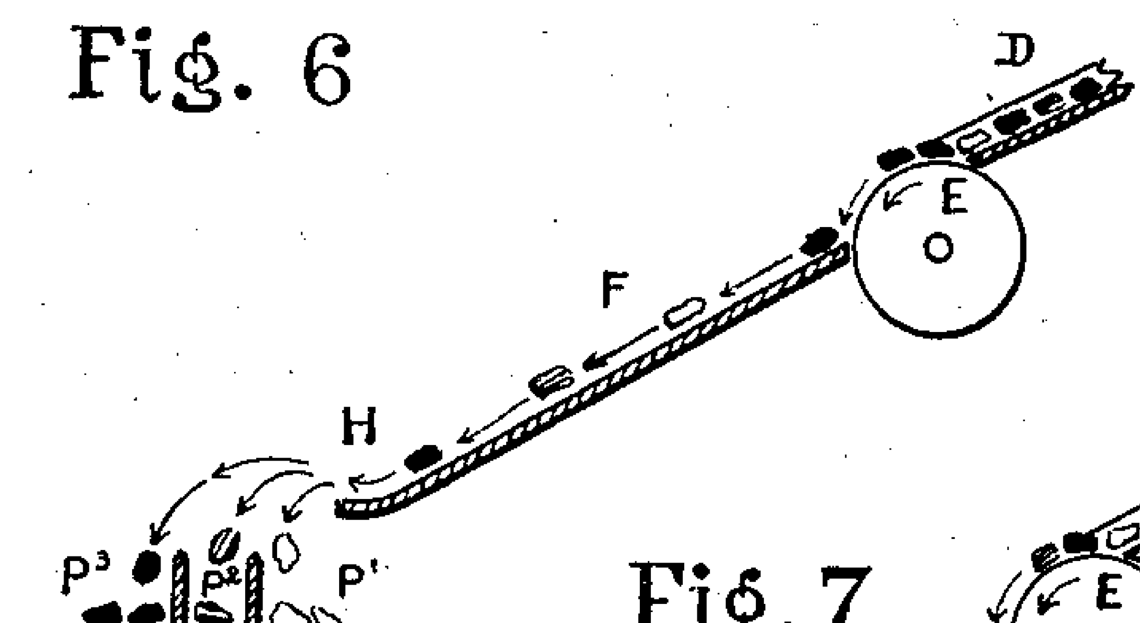


Fig. 7

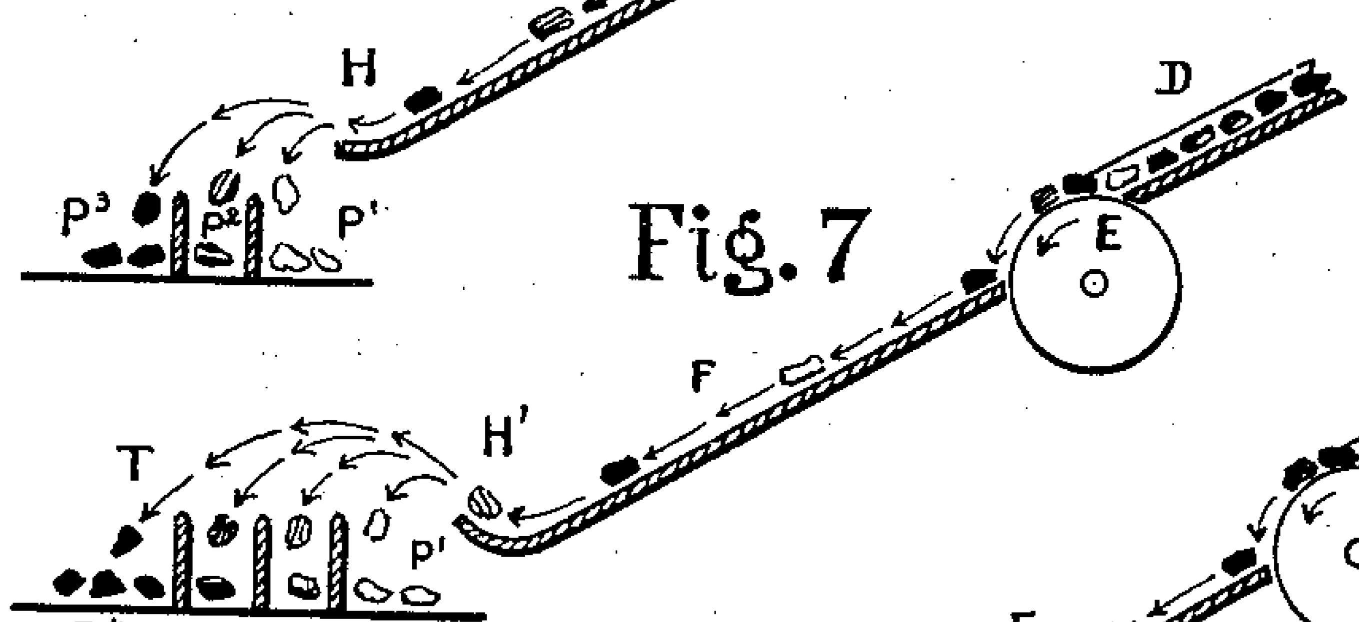
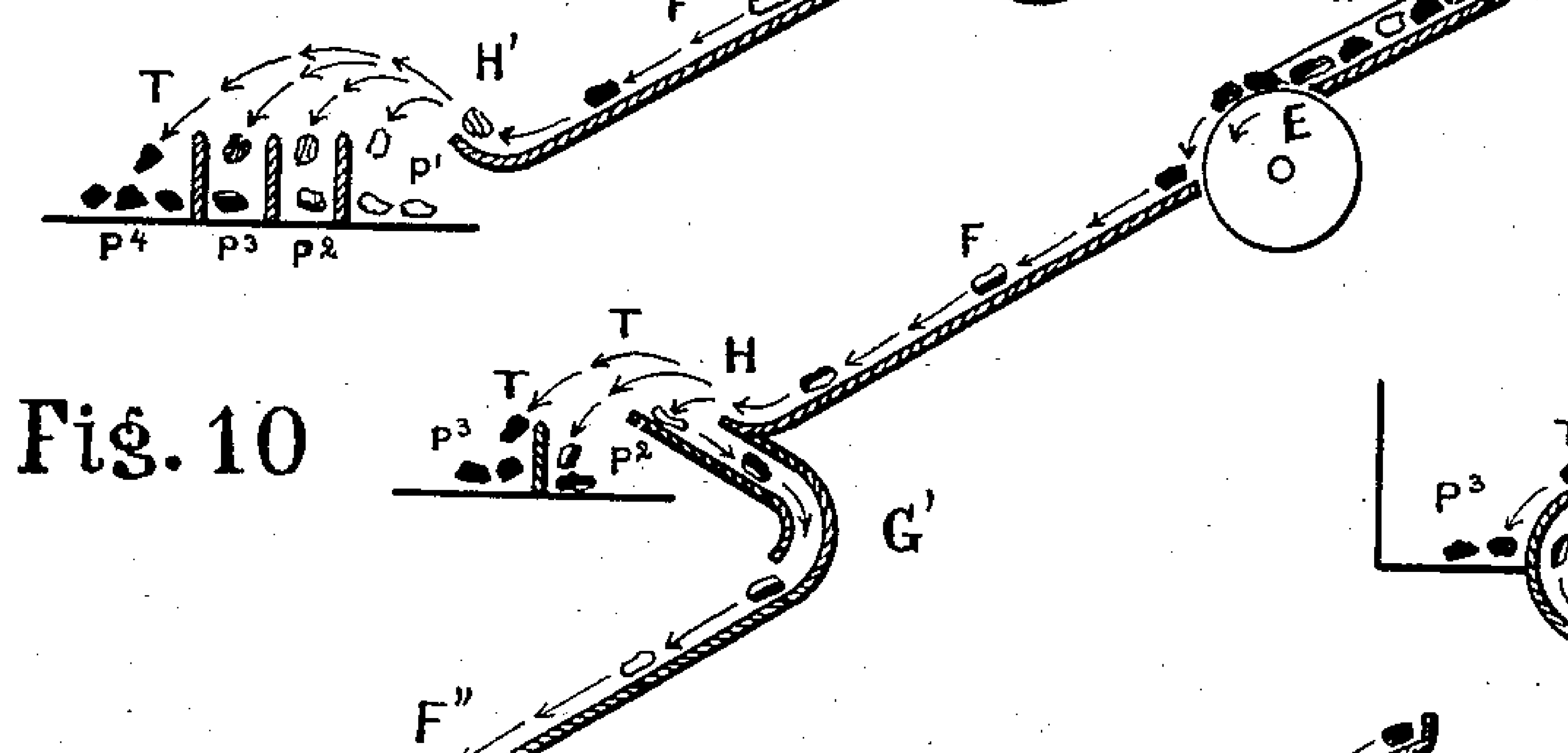


Fig. 10



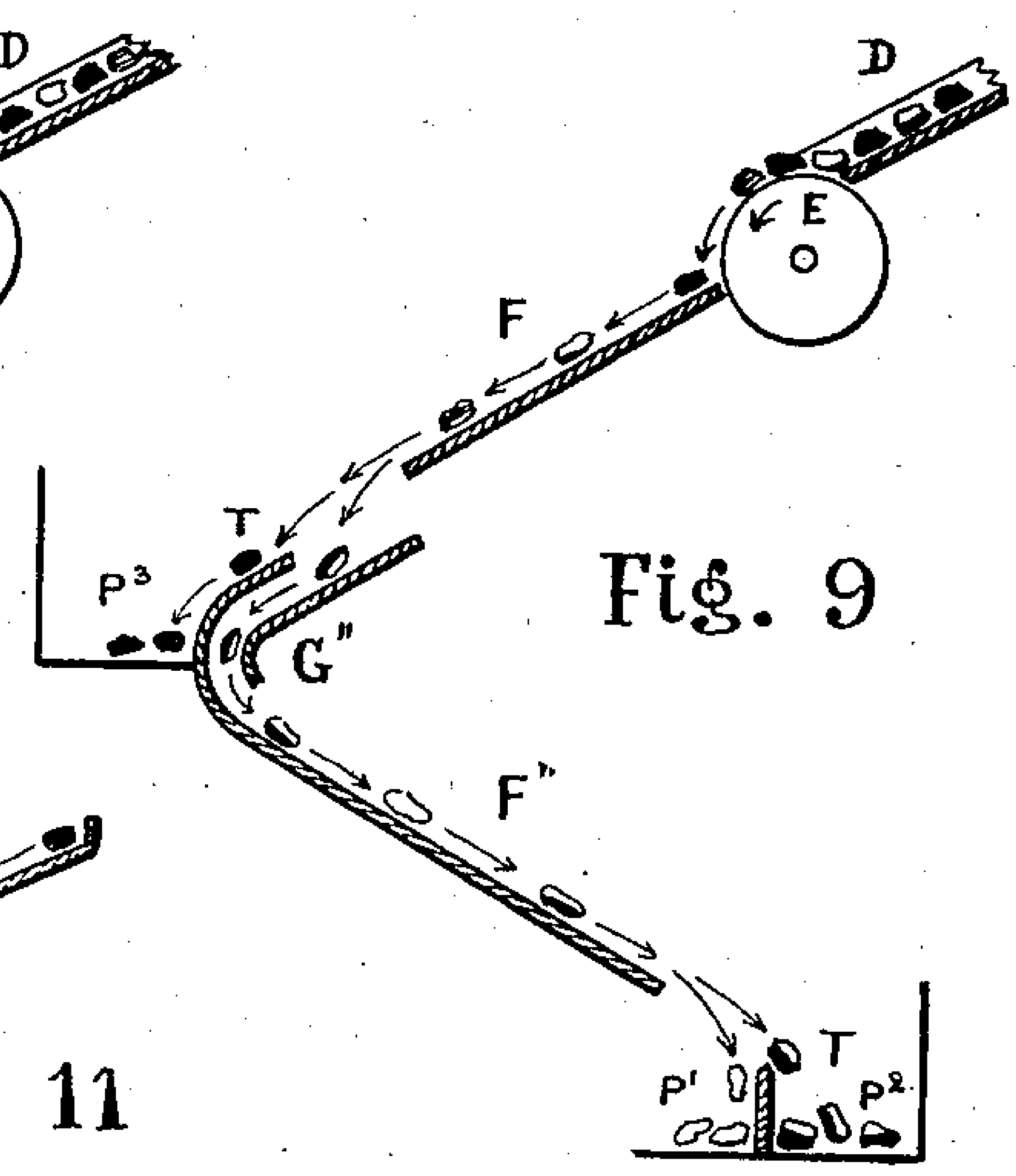


Fig. 9

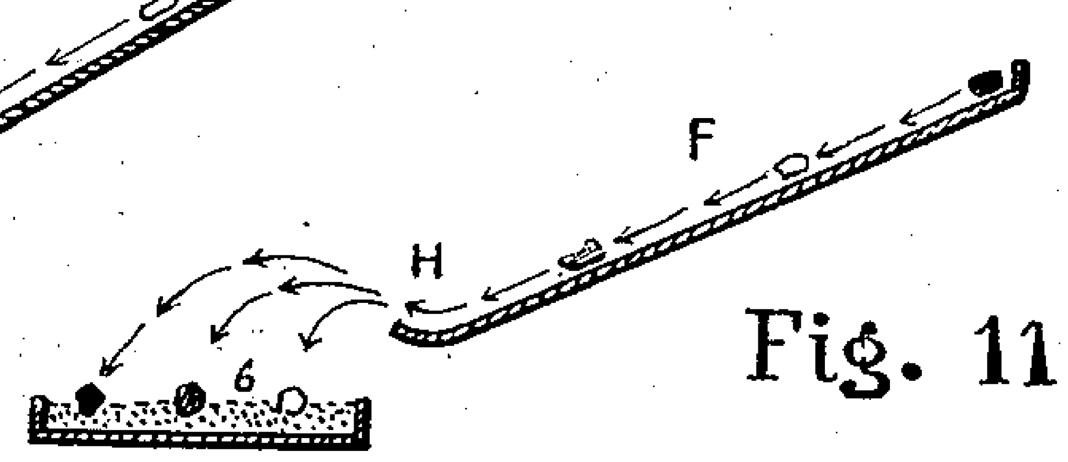


Fig. 11

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No. 753,591. Patented March 1, 1904.

UNITED STATES PATENT OFFICE.

ARTHUR LANGERFELD, OF SCRANTON, PENNSYLVANIA.

ART OF SEPARATING LUMP MATERIAL.

SPECIFICATION forming part of Letters Patent No. 753,591, dated March 1, 1904.

Application filed May 3, 1900. Serial No. 15,406. (No model.)

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 new and useful Improvements in the Art of Separating Lump Material, of which the following is a specification.

This invention relates to separating, picking, assorting, or concentrating mixtures of pieces or other masses in lump, in which the pieces wholly or partly differ in their specific gravities, or in the retardative natures of their surfaces, or in their forms and sizes, or in any or all of these qualities or attributes, and it is especially useful for separating or picking the natural output from anthracite-coal mines, from which I separate the pure coal, the fairly pure coal, the impure coal, (called "bone,") the bony coal, (called "black caps,") which varies on different sides, and the refuse, which is slate or stone.

The objects of my invention are to separate the said different sorts or kinds of pieces completely from each other or only to a certain extent, as may be desired, and to do this positively, quickly, continuously, and cheaply without much abrasion or breakage.

By only partly applying my improvements better separations than those now resulting will be obtained, and for some purposes such partial applications of my invention will bring about a sufficient separation. As my improved method of separation is positive when fully applied, it is also useful for testing a mixture when it is desired to find out what percentage or percentages of the said sorts or kinds of pieces the mixture contains.

Several methods are now in use for separating such material as broken anthracite coal. The method which I have improved and perfected is the one by which such lump material has heretofore been imperfectly separated by passing it down in chutes either in a thin stream, in a broken or intermitting stream, in small lots or in a scattering manner, without spacing all the pieces apart from each other, then letting the stream of pieces project, and separating them by dividing the stream of flying pieces. In some cases the course of the pieces is at present deflected into a higher direction before letting the stream of pieces project. When pieces of material are permitted to slide down on a declivous surface which is not very steep, each piece naturally acquires a certain velocity within a certain length of such a surface. These velocities vary similarly as the specific gravities of the pieces, and as the retardative natures or forms of those sides of the pieces which come into contact with the said declivous surface I found that frequent collisions occur on such declivous surfaces between the pieces, both endwise and sidewise, in these present methods of separating and that these collisions disturb the pieces to such an extent that they will not separate properly. I also found that such interferences and collisions between the pieces were especially frequent in the operation of deflecting the stream of pieces, thereby more than counteracting the advantage of deflecting the course of the pieces into a higher direction than the end of a declivous surface. This is especially the case when the deflection is abrupt. Besides these defects I found that pieces which vary on different or opposite sides were very imperfectly separated by the said present method, because the velocity they acquire depends on the side on which each piece happens to slide. The separation of such pieces is therefore a matter of accident in the said present method of separation. The usually irregular shapes of pieces of lump material cause many pieces to swerve aside from the otherwise straight downward courses which gravity tends to cause the pieces to follow when they are regular in form and not disturbed. Small fragments which frequently get under pieces in sliding down on a declivity also cause the pieces to swerve from their straight downward courses, and thereby cause frequent interferences by side collisions with other pieces. As the velocities acquired by the pieces in sliding down on said surfaces determine the relative positions in which the pieces will be in the flying stream after their projection, the said collisions and interferences alter these positions from what they would be if the velocities of the pieces were spontaneous and solely resulting from the gravity and surface-friction of each piece. I obviate all these defects of the said method now in use and accomplish my said purposes by improvements consisting of new elementary operations and their conjunctions with certain operations heretofore imperfectly applied, thus producing new processes and new, useful, and superior results. I do this as hereinafter described and as illustrated by the accompanying drawings, in which—

Figure 1 is a plan view from above, showing material in process of separation by my new method. Fig. 2 is an elevation of a longitudinal section of Fig. 1. Fig. 3 is an elevation of longitudinal section through Fig. 4. Fig. 4 is a plan view from above, showing one way of carrying out my method by the aid of simple appliances. Fig. 5 illustrates my method, including projection and retardation by the air. Fig. 6 illustrates short projection. Fig. 7 illustrates projection at an angle of forty-five degrees. Fig. 8 illustrates my method, including the operation of inverting and reversing pieces. Figs. 9 and 10 illustrate special forms of applying inversion and reversion, and Fig. 11 shows my method as applied for testing. Figs. 5 to 11, both inclusive, are all elevations of longitudinal sections; and Figs. 5, 6, 7, 9, 10, and 11 are drawn to a smaller scale than the others.

As I have invented this method more particularly for separating anthracite coal, I will describe its application to that purpose. Its application for separating other materials will be similar or analogous.

In sliding pieces of material that come from anthracite-coal mines down on a declivity pieces of slate and stone travel the slowest, because they are specifically heavier than the coal and bone, thereby causing greater friction by their greater weight, and also because their surfaces are either hard and cutting or soft and retardative. Slate is also usually more flat than coal. Pieces of pyrite also travel slowly for similar reasons, except that these are not generally flat. Good pieces of coal pass the quickest down on a declivity, because they are the lightest and have hard and smooth surfaces, which are the least retardative. Bone being intermediate in gravity and nature of its surfaces passes down on a declivity at a velocity intermediate between the velocities of slate and coal. Fairly good pieces of coal which have a coal surface, but are specifically heavier than the best pieces of coal, will acquire a velocity intermediate between bone and pure coal. Black caps if slid part way on their coal side and part way on their other side will either attain the same velocity as fair coal or as bone, accordingly as the combined gravity and retardative nature of the surfaces of the pieces results in a velocity equal to that of fair coal or of bone. Mixtures in which the pieces vary very much in size I first assort into lots of approximately equally large pieces. This will facilitate the separating process; but whether such a separation into sizes is indispensable or not depends on the particular means employed for carrying out the first steps in my process.

In Fig. 1 I illustrate one way of separating the small pieces from the large ones during the process, the largest pieces having been placed in the separate files C C. If the largest pieces are not over twice the size of the smallest ones, it is not necessary to first assort the pieces into lots of pieces more nearly equal in size, and as in the present regular market sizes of anthracite coal the pieces in any one of these sizes do not vary that much any such market size of coal is ready to be separated by my method into lots by qualities without first sorting out the pieces by size. I spread out the mass of pieces into a loose stream of single pieces, all spaced apart from each other, as illustrated at F, Fig. 1, so that there is a distance J between every two succeeding pieces and room O between all pieces traveling aside of each other. This loose stream may be formed by hand or by any special means adopted for that purpose. I prefer to bring about this formation of a loose stream by first ranging the pieces in line with the stream into compact single-piece files spaced apart from each other sidewise, as shown at D, Fig. 1, and then spreading the pieces apart from each other lengthwise in each file, as shown at J. If only a small quantity of materials is to be separated, I range all the pieces in one single-piece file. This ranging and spreading may be done by hand or by any special means adapted for forming a loose stream in this manner. One way to form said files is to spread the mass of pieces A out into a thin stream or layer, as at B, Fig. 4, and then divide this thin stream lengthwise into files, as shown at D, by means of teeth, prows, or ranging-blades, or by other suitable means. The pieces in each file may be spaced apart by hand or by any suitable means. One way to spread the pieces apart in each file is to move the compact files along their lines slowly and then let the pieces travel more quickly by their own gravity, as illustrated at E L, Fig. 3. There the files D are slowly moved toward the declivous surface F by means of a traveling surface, which is the surface of a rotating cylinder E, as here shown, (the curved arrow at E indicating the motion,) and the pieces are permitted to slide off this traveling surface at L and enter upon the surface F apart from each other, as illustrated by the spaces J. By ranging the said files in line with the line of descent of the declivity F, I obtain a positive spacing apart sidewise between all the pieces on the declivity F, as shown at O, Figs. 1 and 4. This prevents pieces from colliding or interfering with each other when any of them do not pass straight down on F as a result of irregular forms or particles rolling under a piece and swerving it, as illustrated at U. If the lengthwise spacing J on F is made long enough to preclude end collisions or interferences between pieces, which would otherwise catch up with each other before they reach the end S of F, then all possible collisions or interferences between the pieces traveling at different velocities are avoided. By making the spaces O and J only large enough to just prevent collisions the greatest possible number of pieces that can be spontaneously accelerated or retarded, as the case may be, by their own gravity and friction free from any interference can be passed over a declivity of a certain length and width, thus insuring a perfectly spontaneous individualization of the velocity of each piece in the shortest possible time and in the smallest possible space. If a perfect separation is not desired, either the spaces O or J, or both of these spaces, may be made less than those described above for a perfect separation. Such a reduction will increase the quantity separated in a given time, and proportionally or relatively to this increase the accuracy of the separation will be decreased. The declivity F is not a chute with sides, but merely a declivous surface. If a chute with sides is used, pieces colliding with the sides will not be perfectly separated. When the pieces have reached the end S of the declivity F, I let them project with their individual velocities as their initial velocities and divide the stream of flying pieces crosswise in depth or thickness, as illustrated at T, so that the pieces which project with the greatest initial velocities, and therefore fly the highest and farthest, will be separated from the others and fall together, as at P^2, Fig. 1, and those projecting with the least initial velocities will also fall together, as at P. When it is desired to separate the mass into more than two kinds or sorts of pieces, I project the pieces in a higher direction than that of the declivity F by gradually turning the course of the pieces around into a higher direction immediately before projecting them, as illustrated at H in Fig. 6. I make this turn gradual, so as not to interrupt or materially retard the velocities of the pieces. In this case I cause the spaces J to be longer than in the case illustrated in Figs. 2 and 3, so as to preclude collisions in turning the course of the pieces at H. If the difference in the nature of the pieces is not very great or if the pieces are large or if it is desired to separate the mass of pieces into more than two or three kinds or sorts of pieces, I turn the course of the pieces from that of the differentiating declivity F into a direction at an angle of substantially forty-five degrees upward from horizontal, so as to take advantage of the fact that a projectile will fly the farthest if projected at that angle, as illustrated in Fig. 7 at H'. This turn is also brought about in a gradual manner, so as not to interrupt or materially alter the velocities of the pieces. In this manner the stream of flying pieces will become deep or thick enough to permit its separation or division depthwise into two or three parts if the pieces are large or differ but little and the stream may be divided into three or more parts if the pieces are small or differ sufficiently. This latter division can be made before the retardative action of the air has materially altered the order of the positions of the various pieces in the depth or thickness of the stream of flying pieces, as shown at T, Fig. 7. The intermediate pieces P^2 and P^3 are each such as have combinations of specific gravities and surfaces which are equivalently related to each other, so as to give these pieces equal velocities on the differentiating declivity. Fig. 5 shows that an opposite result comes about if the pieces are projected at a high velocity and parted at so great a distance from where they are projected that the resistance of the air materially alters the otherwise approximately parabolic courses of all the pieces, as is the case in the illustration Fig. 7. In the case shown in Fig. 5 I make the spaces J long enough to prevent collisions at the intersection W of the courses when a perfect separation is wanted. This manner of applying my said improvement is not useful for anthracite coal, but is applicable for separating mixtures containing pieces which have a low specific gravity and a little retardative surface—as, for instance, graphite—and pieces having a high specific gravity and a little retardative surface—as, for instance, stones coated with graphite. If a mixture contains pieces which are different on opposite sides, as is largely the case in anthracite coal, I bring the retardative action of the different sides of these pieces into action by inverting the pieces if they slide and by reversing their rotary motion if they roll or tumble. I prefer to do this by gradually turning the course of the pieces down and around from one declivity to a succeeding one without materially altering their momentums, as illustrated in Fig. 8 at G; but this turning over may also be done separately after first partly separating the mass of pieces, as shown in Figs. 9 and 10 at T. In such cases the momentums of the pieces are either entirely stopped, as at T, Fig. 10, and the pieces turned over by hand, or, as shown at G', in the same manner as at G, Fig. 8, or by other means, and then the pieces are separated, as above, or the pieces may be partly separated and a part without stopping them, as shown at T and G'', Fig. 9, or other means than those shown here may be employed for inverting the said pieces, as may be most suitable for the kind of material that is being separated. All the pieces which slide and have different sides will slide on one side during their first differentiation on F and on their opposite side during their second differentiation, as illustrated by the pieces I I on F''. The pieces which roll or tumble will also bring both sides or all their sides to bear by being turned over and around at G, as shown by the curved arrows around the pieces I, so that all their surfaces will take part in causing the friction that retards their velocity while their rotation is being reversed.

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

1. The improvement in the art of separating lump material, the pieces of which differ in their specific gravities or in the frictional natures of their surfaces, which comprises forming the pieces into a loose stream of single pieces by spacing the pieces individually apart from one another both lengthwise and crosswise of the stream, imparting an individual velocity to each piece peculiar to its properties by subjecting the pieces thus spaced apart to the combined actions of gravitation and the frictional retardation of the pieces on a declivous surface, and separating the pieces according to their acquired individual velocities.

2. The improvement in the art of separating lump material, the pieces of which differ in their specific gravities or in the frictional natures of their surfaces, which comprises forming the pieces into a loose stream of single pieces by spacing the pieces individually apart from one another both lengthwise and crosswise of the stream, imparting an individual velocity to each piece peculiar to its properties by subjecting the pieces thus spaced apart to the combined actions of gravitation and the frictional retardation of opposite sides of the pieces on a declivous surface, and separating the pieces according to their acquired individual velocities.

3. The improvement in the art of separating lump material, the pieces of which differ in their specific gravities or in the frictional natures of their surfaces, which comprises forming the pieces into a loose stream of single pieces by spacing the pieces individually apart from one another both lengthwise and crosswise of the stream, imparting an individual velocity to each piece peculiar to its properties by giving substantially equal initial velocities to all of the pieces, subjecting the pieces to the combined actions of gravitation and their frictional retardation on a declivous surface, and separating the pieces according to their acquired individual velocities.

4. The improvement in the art of separating lump material, the pieces of which differ in their specific gravities or in the frictional natures of their surfaces, which comprises forming the pieces into a loose stream of single pieces by spacing the pieces individually apart from one another both lengthwise and crosswise of the stream, imparting an individual velocity to each piece peculiar to its properties by giving substantially equal initial velocities to all of the pieces, subjecting the pieces to the combined actions of gravitation and the frictional retardation of opposite sides of the pieces on a declivous surface, and separating the pieces according to their acquired individual velocities.

5. The improvement in the art of separating lump material containing composite pieces which differ in the frictional nature of their opposite sides, which comprises imparting individual velocities to the pieces by subjecting them to the combined actions of gravitation and the frictional retardation of their opposite sides on a declivous surface, and separating the pieces according to their acquired individual velocities.

ARTHUR LANGERFELD.

Witnesses:
FLORA LEVI,
ROBERT WATSON.