

(No Model.)

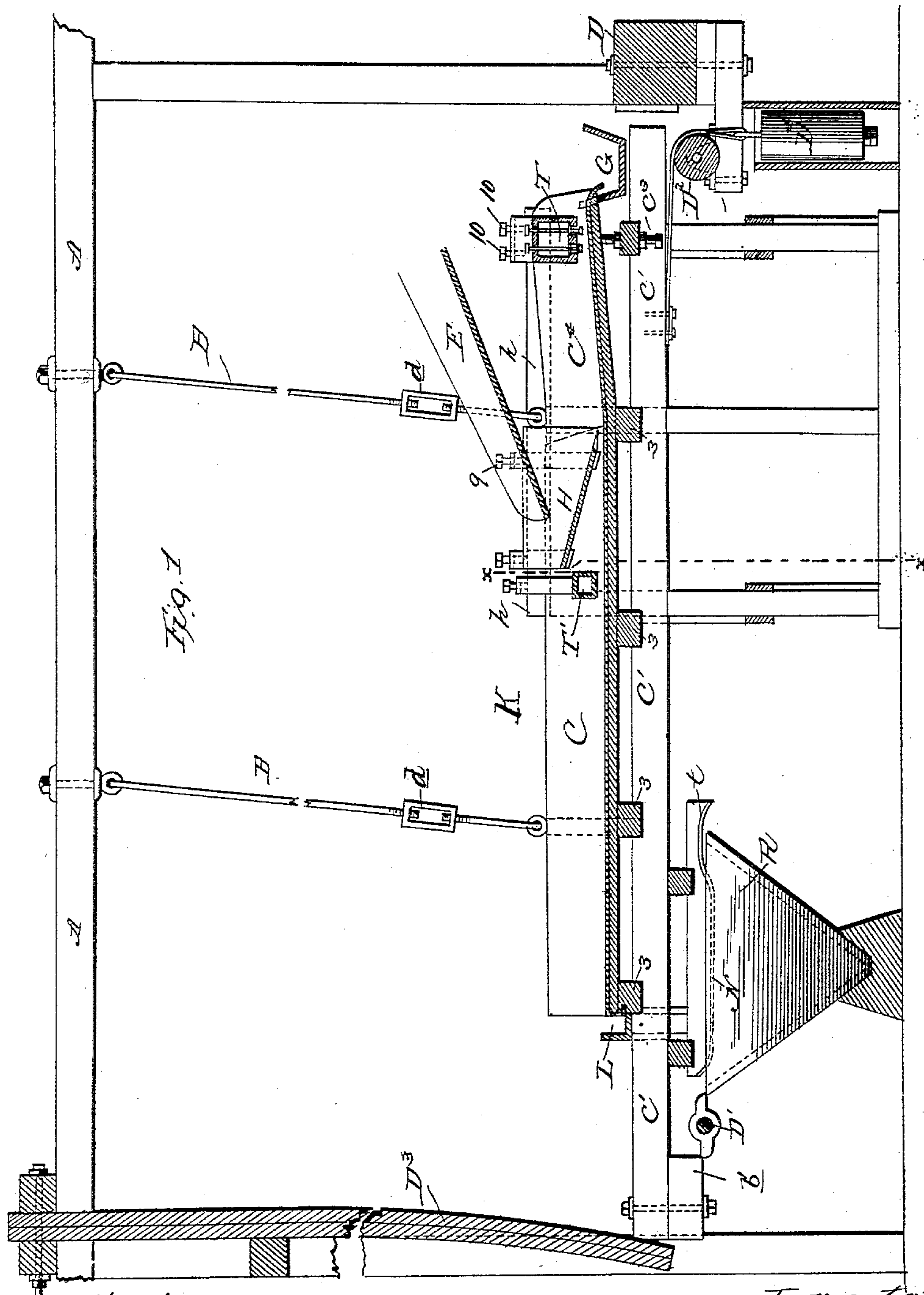
2 Sheets—Sheet 1.

H. BRADFORD.

PROCESS OF SEPARATING OR CONCENTRATING ORES.

No. 504,666.

Patented Sept. 5, 1893.



Attest
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J. L. Middleton

Inventor
Hezekiah Bradford
by Ellis Spear
Atty.

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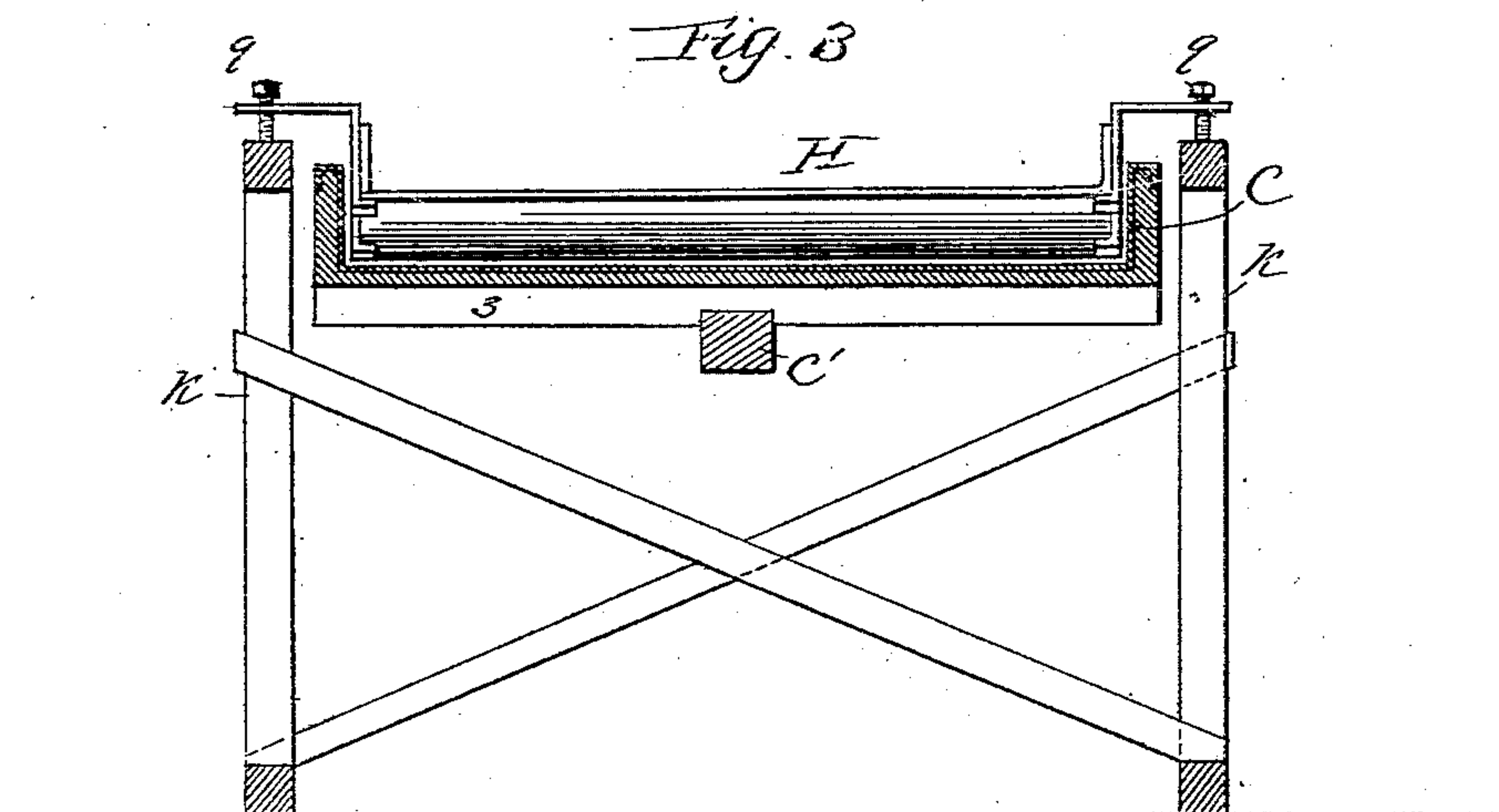
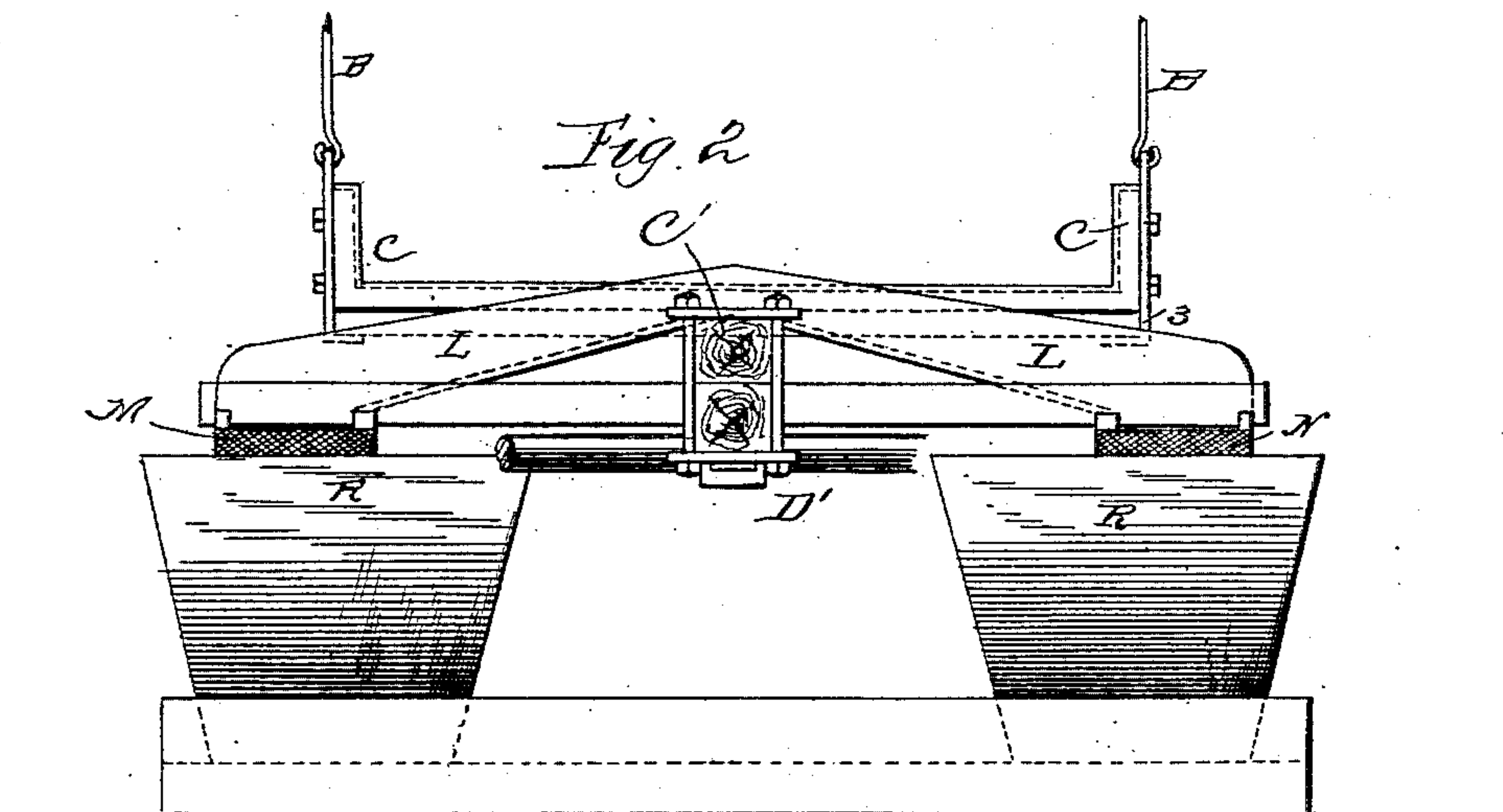
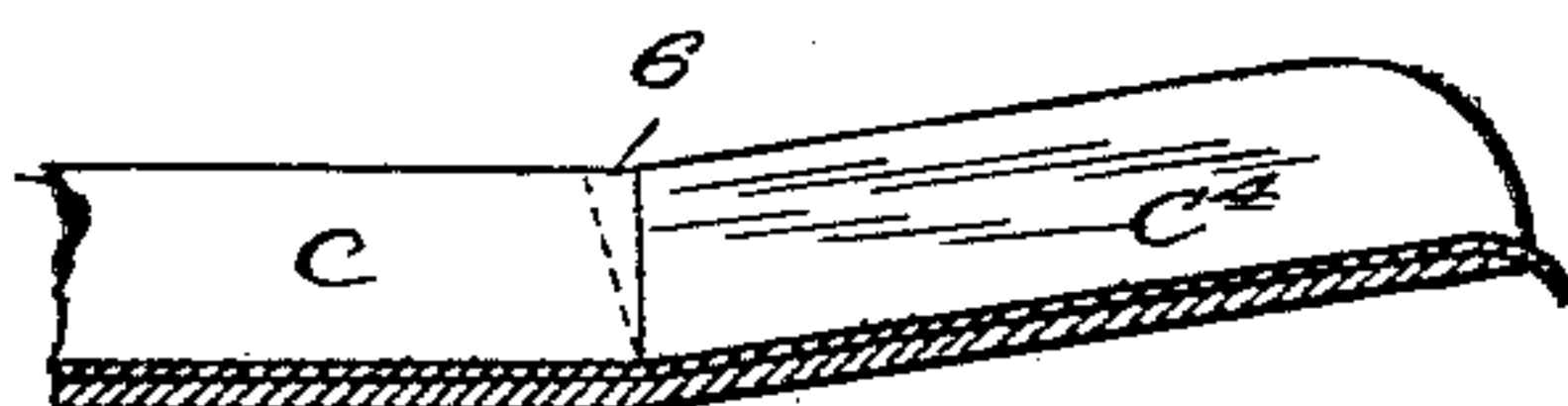


Fig. 4.



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UNITED STATES PATENT OFFICE.

HEZEKIAH BRADFORD, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO
SAMUEL E. GRISCOM, OF SAME PLACE.

PROCESS OF SEPARATING OR CONCENTRATING ORES.

SPECIFICATION forming part of Letters Patent No. 504,666, dated September 5, 1893.

Application filed June 20, 1888. Renewed February 18, 1893. Serial No. 462,924. (No specimens.)

To all whom it may concern:

Be it known that I, HEZEKIAH BRADFORD, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and useful Process of Separating or Concentrating Ores; and I do declare that the following is a full, clear, and exact description of the same.

My invention relates to the separation of ore from the gangue by the wet process, and by utilizing jointly the effects of gravity, momentum, and a current of water.

Heretofore it has been a common practice to deliver crude pulverized ore mingled with water upon an inclined table over which it had a tendency to rapidly flow by reason of its gravity to the lower end or tail. It was the custom to reciprocate these tables longitudinally, and to suddenly arrest their motion in one direction with a bumping action to the end that the ore particles of greater specific gravity than the gangue should be carried by their momentum toward the head or elevated end of the table.

In the operation of these machines there was no intentional or perceptible vibration or movement of the table in a vertical direction, and in consequence of this fact there was but slight tendency of the light and heavy matters to stratify or separate vertically. It was found that the light and heavy matters, that is to say, the ore and the gangue, remained in a mixed or mingled condition on the surface of the table, so that the gangue urged toward the tail by the water had a tendency to carry with it the heavier ore, while the ore, on the contrary, carried by its momentum toward the head, had a tendency to take with it the gangue. The result was an imperfect separation, the ore delivered at the head being accompanied by more or less gangue while the gangue delivered at the tail contained an objectionable quantity of ore. Now it is the aim of my invention to secure a more perfect separation. To this end I have devised a process or mode of treatment which includes the subjection of the ore at one time to several distinct influences. This process, which may be carried into effect by machines variously constructed, consists in causing the crude ore

and water to be fed on and flow over a flat horizontal or practically horizontal surface, and imparting to this surface, continuously, first, a horizontal reciprocation with a bump or concussion in one direction and, second, a vibration or tremor in a vertical direction. This vibratory, tremulous or quivering action of the supporting surface in a vertical direction is of the essence of my invention. Its effect is to cause the overflowing body of ore and water to be thrown repeatedly upward with the effect of loosening the mass and allowing the heavier portion or ore proper to gravitate to and remain in contact with the supporting surface while the lighter portion or gangue is kept in suspension in the water above, so that the suspended matters may be floated tailward without interfering with the movement of the underlying purified ore in a reverse direction, that is to say, toward and over the head. In other words, the vertical vibration effects and maintains a peculiar bubbling, boiling or effervescing action of the water, and the consequent stratification of the light and heavy matters, so that while the one may be carried at a high level by the water the other is carried off in a reverse direction at a lower level by reason of its momentum and inertia.

My process may be carried into effect by mechanism variously organized, the only essential requirement being that the supporting surface shall be flat and horizontal or substantially so (the nearer level, the better the separation); that there shall be a constant and decided vibration to separate the matters and keep them in suspension, and that there shall be a flow of water over the supporting surface in one direction and a bumping of the support in the other direction. In order, however, that the nature of the invention may be the more readily understood I have represented herein a machine adapted for working the process. This machine forms no part of the present invention, being separately claimed in an application, Serial No. 225,278, filed in my name on the 27th day of January, 1887.

In the accompanying drawings,—Figure 1 is a longitudinal vertical section of the machine. Fig. 2 is a view looking against the tail end of the table. Fig. 3 is a cross-section

on the line $x-x$ of Fig. 1. Fig. 4 is a longitudinal section through the head of the table.

Referring to the drawings,—A is a rigid frame within which there is suspended by swinging rods, B B, the flat table C, securely mounted on cross pieces 3, which are firmly fastened to a central longitudinal bumping beam C', projecting at both ends beyond the table, in line with its length and with the movement of the ore and water thereover.

D is a rigid bumping block against which the end of the beam abuts as the table completes its stroke in one direction the effect of this blow being to set up in the beam a strong vibratory or tremulous motion which is in turn communicated to the table, the entire surface of which is thus caused to vibrate in a vertical direction. The rods are inclined so that the beam and table gravitate toward the bumper block. To increase the force of the blow a weight, D⁴, is connected with the beam by a strap passing over a pulley, D². A spring, D³, may also be employed to act against the opposite beam.

The movement of the table from the bumping block is effected by lugs or cams preferably by the former carried by shaft D', acting against block b, secured firmly to the lower side at the end of the bumping beam. The body of the table is arranged in a horizontal as distinguished from an inclined position, although of course, a mere colorable departure from the horizontal is immaterial. The table is constructed with raised longitudinal edges to confine the material thereon, and with both ends open to permit the discharge of the ore at one end and the tailings at the other. The end C⁴, of the table, known as the head, is given a slight upward inclination in order to prevent the escape of the water, and also to prevent the possibility of any portion of the gangue passing thereover with the ore. Desirable proportions for the table are a length of about five feet for the horizontal part and thirty inches for the inclined head, with a width throughout of about three feet in the clear. These dimensions may, however, be greatly varied. The table is covered throughout with a sheet metal lining presenting a perfectly smooth and unobstructed surface.

The crude ore to be concentrated or separated is delivered mingled with water by a chute, E, to an inclined feed-board, H, and thence, mingled with water, to the table C. The feed-board should be adjusted as near the table as possible without touching the water in order to allow the material to flow gently to the table without disturbing the ore thereon. A trough, T, having a perforated bottom delivers an additional supply of water across the entire width of the elevated head to wash back any particles of gangue which may chance to find their way thereto. Another water trough, T', extending entirely across the table is arranged between the ore

delivery and the tail end. It is pierced with numerous holes which deliver water in a fine gentle spray upon the material on the table. This supply of water should be limited as much as possible consistent with a perfect separation. At the tail end of the table are gutters L L to deliver the tailings laterally to screens M N firmly attached to the beam C' and to the table. The delivery ends of the screens t are curved over the ends of vats v' , forming delivery chutes and the bottoms of the screens are slightly beneath the surface of the water in the vats. The screens moving back and forth in the water receive the same sharp and vigorous bumps that are communicated to the table.

The operation of the machine is as follows: The crude ore and water are delivered upon the table and the water flows in a continuous stream toward the tail. The water stands upon the table to a considerable depth, covering its surface from one end to the other. The table is moved horizontally backward by the lug or cam away from the bumping block and as it returns the beam striking with great force against the block causes a sudden stoppage of the table and at the same time sets up in the beam in a vertical direction a strong vibration which is imparted to the table. The blows are of such frequency and of such force that this vibratory or tremulous motion of the beam is unceasing. As a result the vertical vibration of the table is continued so that the ore and water thereon are given a constant dancing movement, or, in other words, thrown rapidly upward, and this at the same time that the water is moving horizontally toward the tail. The result is to effect the vertical separation and horizontal stratification of the light and heavy particles, the heavy purified ore passing over the bumping end of the table and the lighter matters passing over the tail end as before explained.

Having thus described my invention, what I claim is—

1. The process of separating or concentrating ore, consisting in distributing the crude ore in a shallow horizontal flowing sheet of water, maintaining a depth sufficient to hold the lighter particles in free suspension, subjecting the water to rapidly succeeding lifting actions from beneath to produce a bubbling or effervescing motion, and carrying the precipitated purified ore in the opposite direction from the flow of the water and tailings by imparting thereto successive horizontal impulses.

2. The process of concentrating ore consisting in flowing the tailings and ore slowly in one direction over a substantially horizontal surface, maintaining a sufficient depth of water thereon to hold the lighter matters in suspension, imparting to the surface a constant tremor or vibration in a vertical direction, and also imparting to the surface rapid horizontal reciprocations with a sudden and

violent stoppage of movement in the direction opposite to the flow of the water and tailings.

3. The process of concentrating the heavy particles in a bed of ore, which consists in causing a flow of water in one direction through the ore bed, maintaining a depth of water sufficient to hold the lighter particles in suspension, intermittently jarring said bed in a direction opposite to the flow of the water and lighter particles, and causing a constant tremulous vertical motion in the particles forming the bed: whereby the ore is maintained in a loose condition and a free movement of the heavy and light particles in reverse directions past each other permitted.

4. An improved process of separating or concentrating ores, consisting in continuously feeding upon a bumping table adapted and arranged to receive its operative shocks or blows endwise in a line with the movement of the table and with the level of the water, ore and tailings thereon, the crude pulverized ore mixed with water upon the middle or thereabout of the table; in furnishing upon the ore-delivery end of the table a second and constant supply of water just sufficient to wash back the particles of gangue that may be mixed with the ore when the latter arrives at the ore-delivery end of the table; in distributing a third and constant supply of water as a fine and gentle rain, across the whole

width of the table at a proper point over the concentrated ore, in just sufficient quantity to maintain on the table such a depth of water that it may be kept in a constant state resembling effervescence or boiling by the ceaseless, jarring motion of the table, and in imparting to the table constant successive shocks or blows in line with the movement of the table and of the travel of the ore, water and tailings thereon, as set forth.

5. The herein described process of separating or concentrating ore, which consists in discharging said ore mixed with a proper quantity of water on a suitable table or receiver, and subjecting it to a continuous and equally distributed jarring or bumping which causes the water, ore and tailings to have a motion resembling effervescence or the gentle boiling of shallow water, and in applying to the ore and tailings on the table or received during the process of separating or concentrating two other independent supplies of water, substantially as described, whereby the tailings are prevented from packing and are effectually separated from the ore as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HEZEKIAH BRADFORD.

Witnesses:

F. L. MIDDLETON,
C. L. STURTEVANT.