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PROCESS FOR THE LIQUID SEPARATION OF SOLID CONSTITUENTS.

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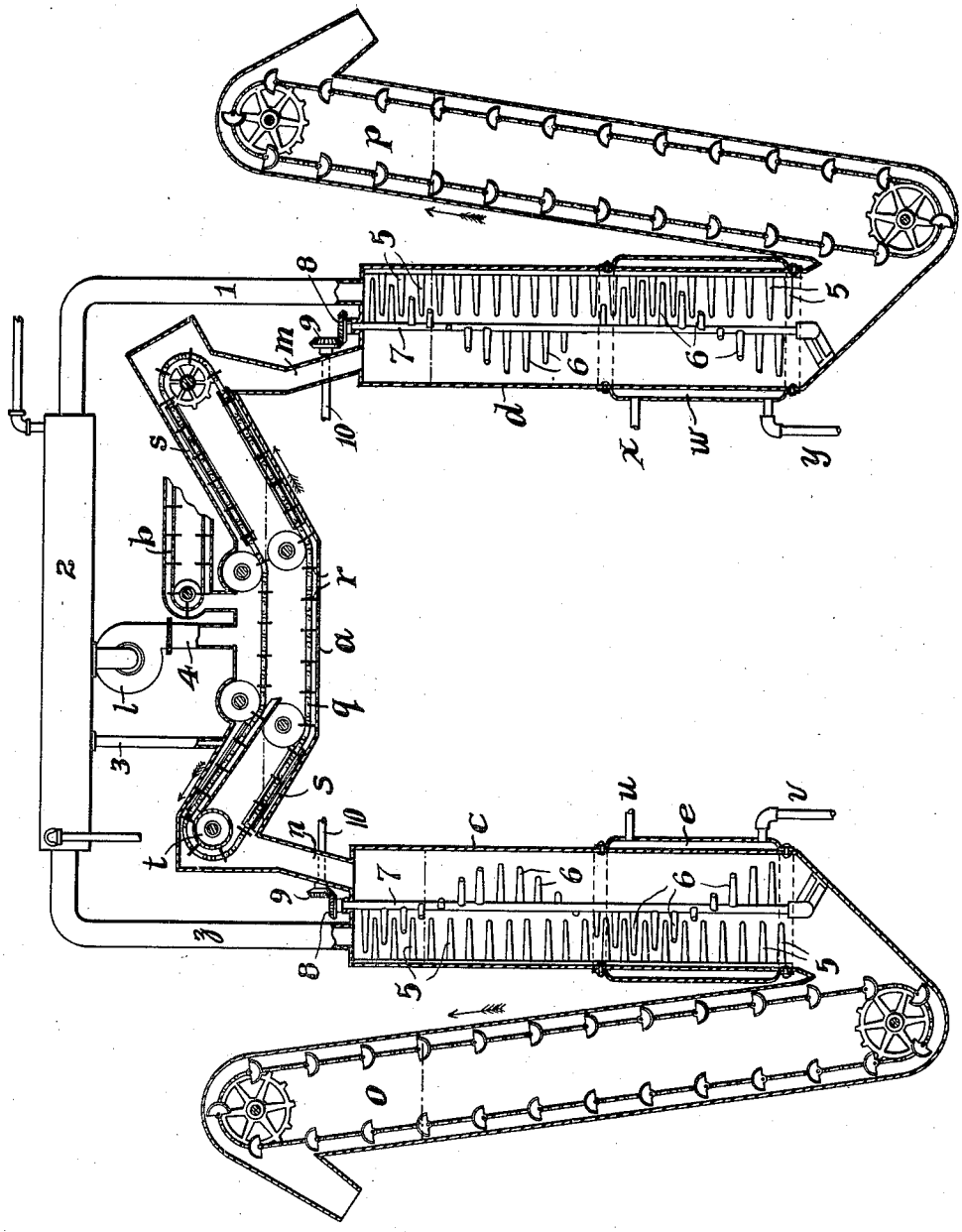

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994,950. Specification of Letters Patent. Patented June 13, 1911.

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To all whom it may concern:

Be it known that I, FRANCIS I. DU PONT, a citizen of the United States, residing at Wilmington, county of Newcastle, and State of Delaware, have invented a new and useful Improvement in Processes for the Liquid Separation of Solid Constituents, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form a part of this specification.

Speaking generally, my invention consists in using as the separating liquid a liquid capable of being volatilized and then passing the separated solids into a liquid which has a higher boiling point than the separating liquid and in which the separating liquid is substantially insoluble. This enables the liquid carried over with the solids to be volatilized and separated therefrom, and such vapor may be carried to a condenser and returned to the separating liquid.

This process is especially adapted for separating coal from slate and shale.

The separating liquid which I prefer to use is carbon tetra-chlorid and which is a liquid quite insoluble in water and whose boiling point is considerably below that of water. This liquid is, however, quite volatile at ordinary temperatures, and, therefore, care has to be exercised in handling it or the materials wet with it at ordinary temperatures to prevent loss.

I will now describe the apparatus illustrating the accompanying drawings and which may be used to carry out this invention.

In the drawing, the figure represents a sectional elevation of my invention.

a is the separating tank having a horizontal portion and the inclined portions as shown. The separating liquid which, as before stated, is preferably carbon tetrachlorid, is placed in the central tank.

q is a conveyer which passes through the horizontal portion and up the inclines and is provided with the flights *r* and guides *s*, the lighter constituents being carried up the left-hand incline and the heavier constituents up the right-hand incline, the former passing around the wheel *t* and into the chute *n*, the latter constituents passing up the right-hand incline and into the chute *m*.

b is a conveyer arranged to carry the material, coal admixed with slate and shale, into the tank *a*.

In connection with the chute *n* is the tank *c* formed of two limbs. In one limb is the elevator *o*. The chute *m* opens into the tank *d*, one limb of which is provided with the elevator *p*. These tanks *c* and *d* are filled with water to the level indicated by the water line.

e is a jacket for the tank *c* having the steam inlet *u* and the steam discharge *v*. A similar steam jacket *w* is provided for the tank *d*, said jacket having the steam inlet *x* and the steam outlet *y*.

In each of the tanks *c* and *d* is an arrangement to prevent the coal from sinking too rapidly in the heated liquid in order that it may, with certainty, be heated up to the point of volatilization of the separating liquid. This arrangement consists in a number of spikes or projections 5 intermeshing with a number of similar spikes or projections 6, arranged spirally around a central shaft 7. This is slowly rotated and by its action the coal is allowed to slowly sink through the heated liquid. The driving is accomplished by the bevel gear 8 on the shaft 7 meshing with the bevel 9 on shaft 10, said shaft 10 being driven by any desired means, not shown. The rate of rotation will vary for each kind of coal and is adjusted so that the coal issuing from the elevators in *o* and *p* shows no evidence of carbon tetra chlorid.

From the upper portion of the tank *c* extends the conduit or pipe *z* and from the upper end of the tank *d* extends the conduit or pipe 1, both conduits or pipes leading to the cendenser 2.

3 is a pipe leading from the condenser back to the separating tank.

4 is a pipe in connection with the fan *l* for the purpose of circulating air in the tank *a* to maintain the temperature of the separating liquid low, by determining the flow of heated vapors directly to the condenser instead of back through chutes *m* and *n*.

The material, coal filled with shale and slate, is fed in by the conveyer *b*. The pure coal floats on the carbon tetra-chlorid and is carried up by the conveyer *q* and discharged into the chute *n*. The slate and shale, which is heavier than the coal, and coal containing more than a certain percentage of slate and shale sink in the carbon tetra-chlorid and are carried up the opposite incline by the conveyer and fall into the chute *m*. The

material passing through the chute *n* falls into the tank *c*, the water in which is maintained at a temperature above that which will vaporize the liquid carried in by the coal. In like manner the material passing through the chute *m* falls into the water in tank *d* which is maintained at a temperature sufficiently high to volatilize the liquid carried by said constituents. The idea is that the separated constituents shall be subjected to the action of the fluid, while the separated constituents are prevented from remixing. In the construction shown this is accomplished by using separate tanks. The vaporized separating liquids will pass up through the pipes *z* and 1 to the condenser 2 where they are condensed and the liquid returned to the separating liquid in the tank *a*. The coal on the one side and the slate on the other, after sinking to the bottom of the tanks *d* and *c* respectively, are raised out of the water by means of the elevator *o* and *p* and may be disposed of as desired.

The fan *l* is useful only for the purpose of maintaining the separating liquid in the tank at a low temperature and to counteract the effect of the steam.

It may be that some vapor of the water may be carried up and condensed with the vapors of the carbon tetra-chlorid, but this is a matter of no moment as the water passing into the separating tank would float on the top of the carbon tetra-chlorid and would overflow down the passages *n* and *m* into the tanks *c* and *d* when sufficient had collected in the separator *a*.

Having now fully described my invention, what I claim and desire to protect by Letters Patent is:

1. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then treating the separated constituents in a heated liquid of higher boiling point than the separating liquid while said constituents are prevented from remixing, subjecting the vapors of the separating liquid to condensation and returning the liquid to the body of separating liquid.

2. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then passing the separated constituents into separate bodies of heated liquids of higher boiling point than the separating liquid, subjecting the vapors of the separating liquid to condensation and returning the liquid to the body of separating liquid.

3. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then passing a separated constituent into a heated liquid whose boiling point is higher than that of the separating liquid, then subjecting the vapor of the separating liquid to condensation and returning the liquid to the body of separating liquid.

4. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then treating the separated constituents into a heating liquid of higher boiling point than the separating liquid while said constituents are prevented from remixing, subjecting the vapors of the separating liquid to condensation and returning the liquid to the body of separating liquid, and removing the solids from the vaporizing liquid.

5. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then passing the separated constituents into separate bodies of heated liquids of higher boiling point than the separating liquid, subjecting the vapors of the separating liquid to condensation and returning the liquid to the body of separating liquid, and removing the solids from the vaporizing liquid.

6. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then passing a separated constituent into a heated liquid whose boiling point is higher than that of the separating liquid, then subjecting the vapor of the separating liquid to condensation and returning the liquid to the body of separating liquid, and removing the solids from the vaporizing liquid.

7. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then treating the separated constituents in a heated liquid of higher boiling point than the separating liquid and of less specific gravity than the constituent passing therein while said constituents are prevented from remixing, subjecting the vapors of the separating liquid to condensation and returning the liquid to the body of separating liquid.

8. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then passing the separated constituents into separate bodies of heated liquids of higher boiling point than the separating liquid and of less specific gravity than the constituent passing therein, subjecting the vapors of the separating liquid to condensation and returning the liquid to the body of separating liquid.

9. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then treating the separated constituents in a heated liquid of higher boiling point than the separating liquid and of less specific gravity than the constituent passing therein, while said constituents are prevented from remixing, subjecting the vapors of the separating liquid to condensation and returning the liquid to

the body of separating liquid, and removing the solids from the vaporizing liquid.

10. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then passing the separated constituents into separate bodies of heated liquids of higher boiling point than the separating liquid and of less specific gravity than the constituent passing therein, subjecting the vapors of the separating liquid to condensation and returning the liquid to the body of separating liquid, and removing the solids from the vaporizing liquid.

11. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then passing a separated constituent into a heated liquid whose boiling point is higher than that of the separating liquid and whose specific gravity is less than that of the solid passed therein, then subjecting the vapor of the separating liquid to condensation and returning the liquid to the body of separating liquid.

12. The process of liquid separation of solids, which consists in first separating the solids in a liquid, then passing a separated constituent into a heated liquid whose boiling point is higher than that of the separating liquid and whose specific gravity is less than that of the solid passed therein, then subjecting the vapor of the separating liquid to condensation and returning the liquid to the body of separating liquid, and removing the solids from the vaporizing liquid.

In testimony of which invention, I have hereunto set my hand, at Philadelphia, on this 22nd day of January, 1910.

FRANCIS I. DU PONT.

Witnesses:
M. M. HAMILTON,
E. E. WALL.