

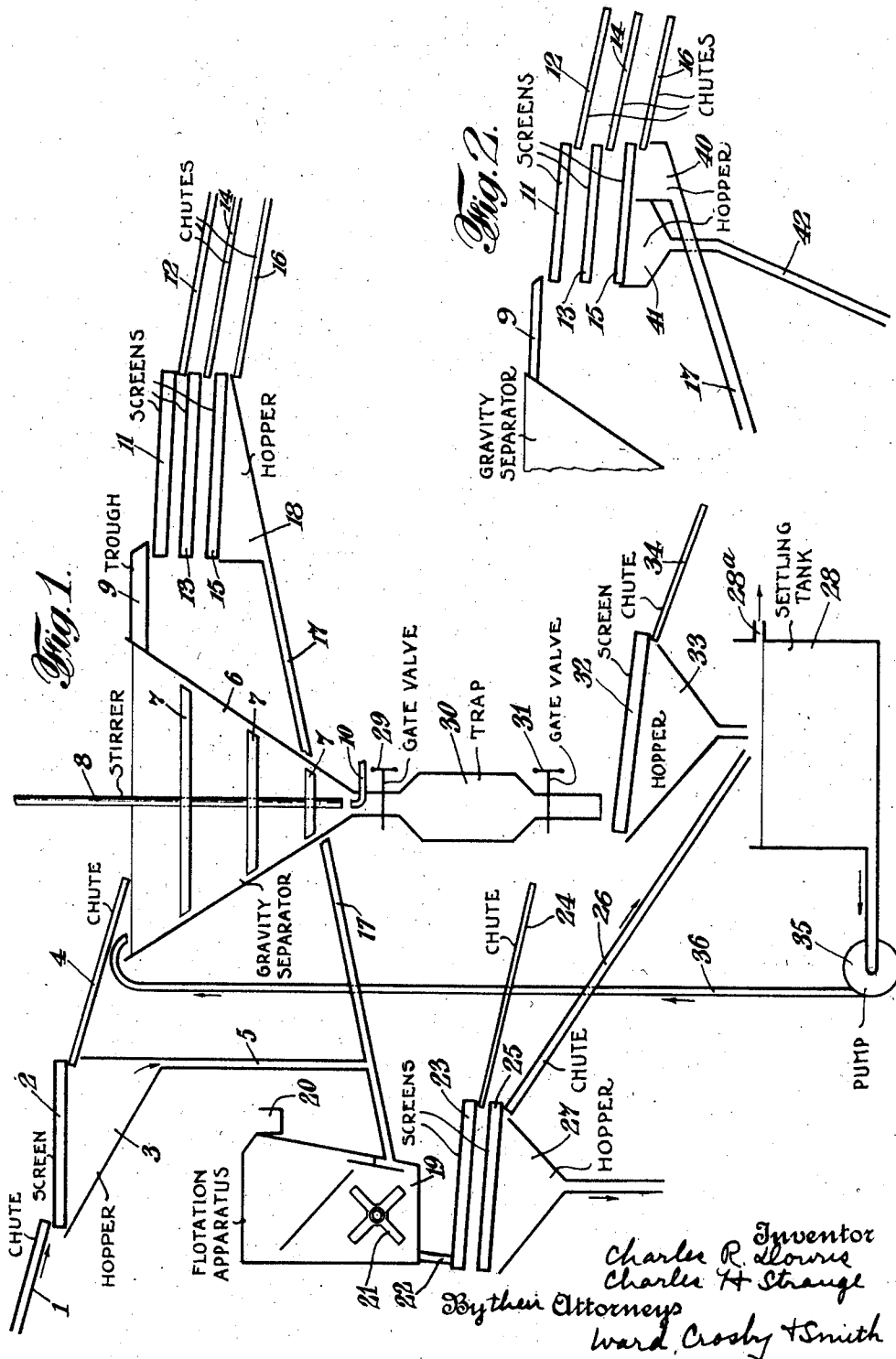
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CLEANING OF COAL

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CLEANING OF COAL.

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Our invention relates to the cleaning of coal. In order to remove slate and the like from coal it has been suggested that the coal as it comes from the mine be first screened to remove the so-called silt consisting largely of finely divided impurities, and then the mixture of coal and slate, etc., subjected to a gravity separation. For this purpose a fluid mass having a specific gravity intermediate the specific gravity of the coal and the specific gravity of the impurities, is used and the mixture supplied thereto whereupon the coal rises and floats near the top of the fluid mass and the heavier impurities sink in the same. In order to provide such a fluid mass, a mixture of water and sand has been suggested, the proportions of water and sand being so adjusted as to bring the specific gravity of the fluid mass to a value between that of the specific gravity of the coal and that of the specific gravity of the slate or other impurities. The fluid mass is kept in agitation in order that the specific gravity of the same may remain substantially uniform throughout the entire mass. The use of a dissolved soluble material to produce a fluid of sufficiently high specific gravity to float the coal and allow impurities such as slate to sink has been suggested, but has not proved commercially successful, and a fluid mass comprising a mixture of sand in water has proved the more advantageous. In such method the coal is drawn off at the top of the fluid mass with more or less of the water and sand while the slate is drawn out separately from the bottom of the fluid mass also with considerable water and sand. Therefore, fresh sand and water must be continuously supplied in order to keep the volume and specific gravity of the fluid mass up to the necessary amount. The slate or similar impurities which are drawn off from the body of the fluid mass with considerable sand and water are separated therefrom by washing screens and the sand returned to the cycle. Also the coal which is drawn off from the top of the fluid mass with more or less of the sand and water, is separated therefrom by washing screens and the sand returned to the cycle. In the coal to begin with, there is considerable finely divided coal or coal dust and also a certain amount of degradation of the coal takes place during the process which thus produces some finely divided coal, which is too fine to be separated from the sand on the screens and passes through the screens with the sand. Therefore, this finely divided coal or coal dust is returned to the fluid mass along with the sand. As the proportion of fine coal or coal dust in the fluid mass thus increases, a condition is reached where the specific gravity of the fluid mass (due to the accumulation of fine coal therein of relatively low specific gravity) is reduced to a point so that the fluid mass no longer efficiently floats the coal in order to separate it from the slate and similar impurities. Therefore it has been the practice at short intervals and after the fluid mass has thus become degraded by the inclusion of fine coal, to allow the fluid mass containing sand and finely divided coal to run to waste and introduce fresh clean sand to form the fluid mass in order to maintain the proper specific gravity of the fluid mass. The cost of such sand replacement is a very important matter especially with coal which tends to form an appreciable amount of dust and also the finely divided coal or coal dust is lost. A similar loss of value also takes place even if other materials or other liquids are used to produce the fluid mass. The main object of our invention is to substantially avoid these losses and thus render the process less expensive and more efficient. For this purpose we propose to use as finely divided material to bring about the proper specific gravity in the fluid mass, finely divided solid matter which comes in with the coal, and which would otherwise go to waste, thus making the process far less expensive. Further and more specific objects, features and advantages will more clearly appear from the detail description given below taken in connection with the accompanying drawings which form a part of this specification. In the drawings, Fig. 1 is a diagram illustrating a system for carrying out our improvements in one form thereof and Fig. 2 is a diagrammatic detail illustrating a modification. Referring to Fig. 1 the run of mine coal is run from the chute 1 onto a screen 2 in order to separate the silt therefrom. The silt, comprising mostly finely divided impurities passes into the hopper 3, while the

coal with such impurities as slate and the like is discharged into a chute 4 and into the conical gravity separator 6. The separator 6 is provided with stirring blades 7 operated by a shaft 8 in order to keep the mass in the separator 6 thoroughly agitated. The silt which is deposited in the hopper 3 is run through pipe 5 into the flotation cell or apparatus 19. This is provided with an agitator 21 in the lower part thereof whereby the mass is agitated in the bottom part of the cell, but suitable baffle plates are provided whereby the mass in the upper part of the cell remains relatively quiescent. This flotation apparatus may, however, be of any suitable kind and operated in any other suitable manner, to separate from the silt finely divided coal which may remain therein after passing through the screen 2. This separation, however, is preferably effected with the aid of a froth flotation agent, i. e., by the use of a relatively small quantity of oil or frothing agent as distinguished from the use of a relatively large quantity of oil, which latter method is commonly known in the art as "bulk" oil flotation, while the first method using a relatively small quantity of flotation agent is commonly known as froth flotation. However, the bulk oil flotation may be found advantageous in certain cases. Various selective agents may be used in the flotation apparatus such as insoluble collectors and soluble frothing agents. Modifying agents such as organic compounds, acids, alkalis and salts may also be used to favorably affect the surfaces of the particles in order that the finely divided coal will be more effectively preferentially floated from the rest. Air may be supplied to the flotation apparatus under pressure or may be beaten in by the action of agitators. We have found that a combination of air under pressure and mechanical agitation gives very good results. The flotation step may be carried out under atmospheric pressure or under increased or diminished pressures. It is not necessary to remove all of the finely divided coal from the rest, at least in most cases. The degree of purity of the recovered material will be governed by the special conditions controlling the coal washing in various cases. The frothing agent may be introduced at the bottom of the apparatus and also air under pressure may be introduced at the bottom of the apparatus in order to aid in the separation. Likewise other chemicals may be introduced to aid in the separation. The finely divided coal rises to the top of the apparatus 19 and is removed or flows out over the top thereof and may be removed through the trough 20. The remaining finely divided solids, thus freed of finely divided coal, are removed from the bottom

of the cell 19 through conduit 22 and fed onto screen 23 which separates therefrom the particles which are too large for use in the gravity separator 6 and discharges them to waste down the chute 24. The smaller particles are deposited on the screen 25 which separates therefrom those of proper size to be used in the separator 6 and discharges them onto the chute 26 which deposits them in the settling tank 28. The liquid and matter too fine to be used in the separator 6 is discharged into hopper 27 and run to waste.

The finely divided solids with some water are pumped from the bottom of the tank 28 by means of pump 35 and forced up through pipe 36 and into the separator 6. Water is introduced into the bottom of the separator 6 through pipe 10 and this water with the finely divided solid matter from pipe 36 forms a fluid mass therein which is kept in agitation by the stirring blades 7 and is of a specific gravity between that of the coal and the slate etc. whereby the coal floats at the top part thereof and flows off through trough 9 and onto sizing screens 11, 13, 15, which separate the coal according to size and discharge the various sizes of coal onto chutes 12, 14 and 16 respectively.

Such finely divided solid matter and water as flow off with the coal and such finely divided coal as passes the screens 11, 13 and 15, is deposited in hopper 18 whence it flows back to the flotation apparatus 19 by pipe 17, where it is subjected to the froth or other flotation separation which removes the finely divided coal at the top and the other finely divided solids are returned to the screens 23 and 25 and to the tank 28 as before for reuse.

The slate and similar impurities fall by gravity to the bottom of the separator 6 and with the gate valve 29 open, are deposited in the trap 30. Periodically the valve 29 is closed and valve 31 opened to permit the slate, etc. with some of the finely divided solid and water to fall upon the screen 32 which separates the slate etc. and discharges them on the chute 34 from which they are run to waste, while the finely divided solid matter and water pass the screen 32 and are deposited in the hopper 33 from which they are run into the tank 28 to be reused like the finely divided solid matter and water received therein from the flotation apparatus 19. Excess water, with possibly some very finely divided solid matter, is run out of the tank 28 through the overflow 28^a.

Thus the finely divided solid matter which flows off with the coal at 9 is returned to the flotation apparatus 19 where finely divided coal is separated therefrom and recovered as a useful by-product, and the finely divided solid matter is then fed

to the tank 28 whence it is pumped back through pipe 36 to be again used in the gravity separation of coal from slate, etc. Likewise the finely divided solid matter escaping from the bottom of the separator 6 is discharged into the tank 28 to be again similarly returned and used in the gravity separation.

The finely divided solid matter used to bring about the desired specific gravity of the fluid mass in the separator 6 should have a greater specific gravity than that of the coal. If the finely divided solid matter coming in with the coal to be treated, is more than is needed for use in the separator 6, the excess may be removed from the tank 28, or by running the discharge through pipe 17 to waste or the discharge from the hopper 33 to waste, or otherwise, or only part of this material which is discharged into the hopper 3 may be fed to the flotation apparatus 19, the remainder being run to waste. If the amount of finely divided solid matter coming in with the coal is insufficient in weight or amount for the requirements of the separator 6, sand or other finely divided solid matter from the neighborhood or elsewhere may be added to make up the deficiency. This may be added to the tank 28 or directly to the separator 6. The amount of water introduced through the pipe 10 and the amount of finely divided solid introduced is so regulated as to keep the specific gravity of the fluid mass at the desired or required value. In some cases the finely divided solid matter coming in with the coal may be run directly into the separator 6 with the coal and without first running it through the flotation apparatus 19, etc.

With regard to the finely divided solid matter which falls through the screens 11, 13 and 15, we believe that most of the coal is found at the right hand of the hopper 18 as viewed in Fig. 1, while finely divided solid matter substantially free from finely divided coal will be found in the left hand end of the hopper. Therefore, the latter portion may need no treatment in the flotation apparatus and in order to avoid waste of energy etc. in purifying this, the arrangement illustrated in Fig. 2 may be used wherein the hopper is divided into two parts 40 and 41, the part 40 catching the finely divided solid matter which contains most of the finely divided coal and returning it through pipe 17 to the flotation apparatus 19 for separation etc. while the finely divided solid matter which is substantially free of finely divided coal is discharged directly to the tank 28 by pipe 42.

In our copending application Ser. No. 28,776 filed May 8, 1925, we have described and claimed broadly the use of a finely divided solid in suspension for producing gravity separation of the coal and the with-

drawing of finely divided solid from the gravity separation and treating it to remove finely divided coal and other impurities therefrom and returning the cleaned solid for further gravity separation of coal, and we do not claim the same broadly herein, this application being directed specifically to the use of finely divided matter coming in with the coal for the gravity separation thereof.

The invention may be applied to the treatment of a great variety of coals and also for the separation therefrom of many other impurities and slate. It may be applied to the recovery of coal or similar fuel from waste dumps of various kinds, and by the term "coal" we include such similar fuel as coke and the like.

While we have mentioned the use of screens such as 32 for separating slate from the fine solid material and water and screens such as 11, 13 and 15 for separating the sized coal from the fine solid material and water, nevertheless, any other suitable separating or classifying apparatus or devices may be used for these purposes. Likewise any other suitable form of flotation apparatus may be used, and other forms of apparatus may be substituted for the screen 2.

Also for example, the coal fed in at 1 may be subjected to the action of a plurality of screens, the top one passing all coal including pea size and smaller and the lower one passing only the silt. The coal above pea size may go directly to the separator 6, and likewise one-half the coal held on the silt removing screen. The other half of the latter may be mixed, without cleaning, with the discharge from the separator at 9. If desired soluble material may be dissolved in the water in, or supplied to, the separator 6 to aid in increasing the specific gravity thereof. If too much water is returned to the flotation apparatus through pipe 17, a settling tank may be introduced to remove part of the water before the material is introduced into the flotation apparatus. Or if necessary more water may be added to the pipe 17. The silt fed to the flotation apparatus may be screened before instead of by the screens 23 and 25 afterward. Also many other changes and modifications may be made and the invention embodied in widely different forms without departing from the spirit and scope thereof in its broader aspects. Hence we desire to cover all forms and modifications coming within the language or scope of any one or more of the appended claims.

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

1. The method of cleaning coal which consists in separating impurities from the coal by gravity in a liquid having finely divided solid matter in suspension therein,

to form a fluid mass having a specific gravity between that of the coal and the impurities to be separated therefrom, said finely divided matter comprising in a large measure, finely divided solid matter found with the coal, withdrawing finely divided solid matter from the gravity separation and treating it by flotation to remove finely divided coal therefrom, and returning the solid matter from which finely divided coal has been thus removed by flotation, for further gravity separation of coal from impurities.

2. The process of cleaning coal which consists in separating therefrom impurities of higher specific gravity than the coal, by gravity in a fluid having a specific gravity between that of the coal and that of the impurities, the fluid mass being agitated and comprising water carrying in suspension finely divided solid matter, said finely divided solid matter comprising, in a large measure, finely divided solid matter found with the coal, withdrawing finely divided solid matter from said gravity separation step, and treating the same by froth flotation to remove finely divided coal therefrom, and returning the solid matter from which finely divided coal has been thus removed by

flotation, for further gravity separation of coal from impurities.

3. The process of cleaning coal containing substantial quantities of finely divided impurities of higher specific gravity than the coal, which consists in feeding the impure coal into an agitated fluid mass comprising water and finely divided solid matter in suspension therein, whereby said finely divided impurities aid in forming a fluid mass of such specific gravity that the coal will float in the upper part of said mass and slate or the like will sink to the lower part of said mass, removing purified coal from the top of the mass, separating therefrom finely divided solid matter which is removed therewith, subjecting the finely divided solid matter to froth flotation to separate therefrom finely divided coal which is retained therein from the gravity separation, and returning the solid matter from which finely divided coal has been thus removed by flotation, for further gravity separation of coal from impurities.

In testimony whereof we have signed our names to this specification.

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