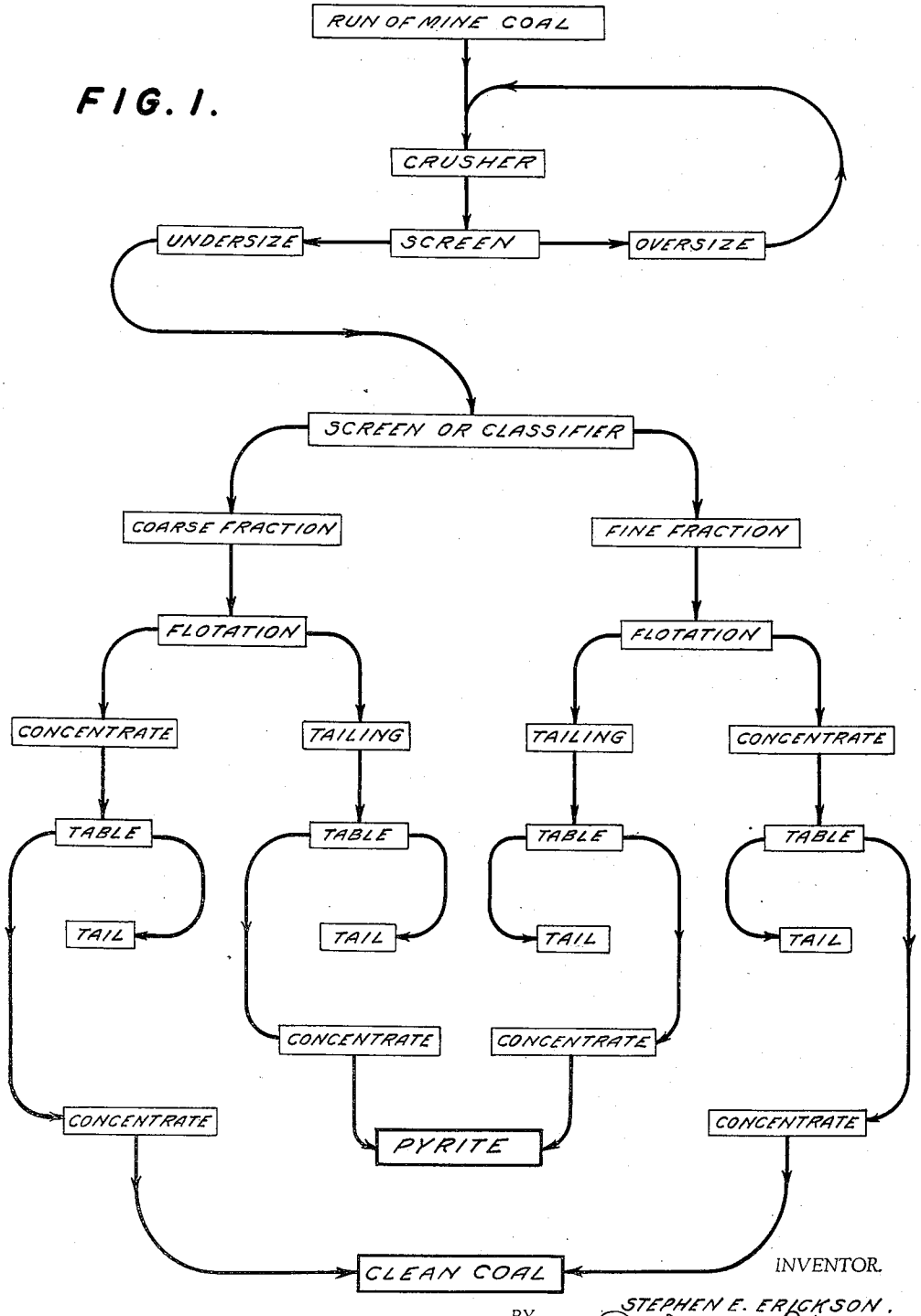
Sept. 28, 1943. S. E. ERICKSON 2,330,479

BENEFICIATION OF LOW GRADE COAL

Filed Jan. 29, 1941 2 Sheets-Sheet 1

FIG. 1.



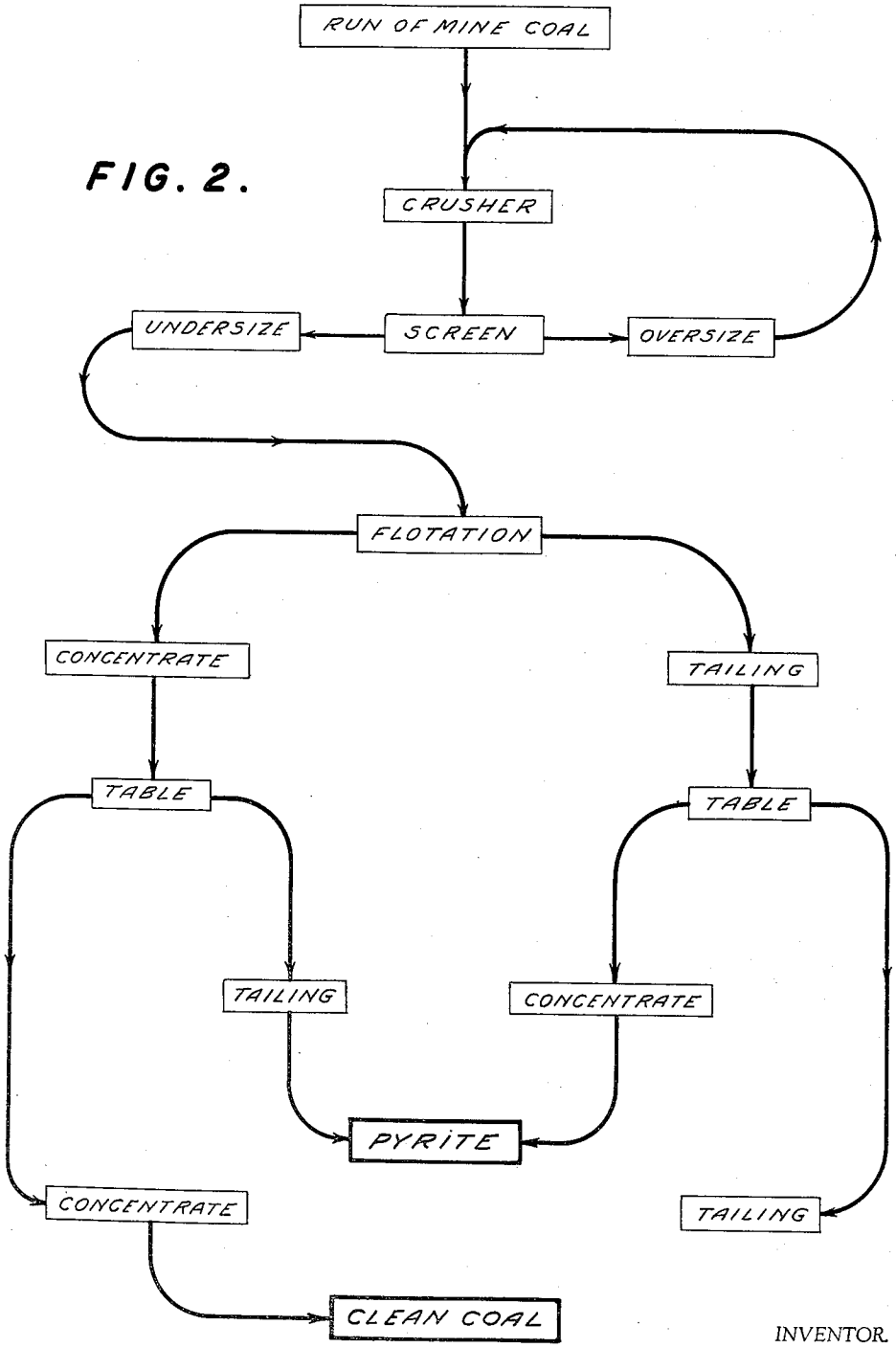
INVENTOR.
STEPHEN E. ERICKSON.
BY John W. Lee
ATTORNEY.

Sept. 28, 1943. S. E. ERICKSON 2,330,479

BENEFICIATION OF LOW GRADE COAL

Filed Jan. 29, 1941 2 Sheets-Sheet 2

FIG. 2.



INVENTOR.
STEPHEN E. ERICKSON,
John W. Lee
ATTORNEY.

BY

Patented Sept. 28, 1943

2,330,479

UNITED STATES PATENT OFFICE

2,330,479

BENEFICIATION OF LOW GRADE COAL

Stephen E. Erickson, Springdale, Conn., assignor to Chemical Construction Corporation, New York, N. Y., a corporation of Delaware

Application January 29, 1941, Serial No. 376,447
In Brazil April 5, 1940

1 Claim. (Cl. 83—94)

This invention relates to the beneficiation of low grade coal. More particularly the invention relates to the recovery of both coal and pyrite values from a low grade coal composed of good coal, bone coal, slate, and pyrite. In particular this invention relates to the treatment of low grade coal in which the good coal occurs in fine grains and therefore requires crushing to a comparatively fine degree in order to liberate the good coal from the accessory material.

A coal of this type occurs in Brazil. For some time attempts have been made to produce a low ash coal suitable for locomotive fuel from this low grade material but ordinary coal washing methods on this type coal do not give a satisfactory low ash coal and also do not permit the recovery of the pyrite as a secondary product which is suitable for use in acid manufacture. When the procedure of the present invention is applied to crude coal of this type, a relatively high grade coal, suitable for combustion purposes, and a pyrite by-product which can be used for acid manufacture are readily produced. The term "pyrite" as used in this application refers to any or all sulfide bearing materials occurring in low grade coal.

The flotation of coal using standard flotation reagents which are for the most part hydrocarbons such as kerosene accompanied if necessary by suitable frothers has been used on a rather large scale in the past for reducing the ash content of the coal. More recently flotation procedures have been used to recover the coal values from waste slush or culm, such procedures being described in the Crawford and Grine U. S. Patent 2,136,074 in which the culm is separated into two or more size fractions and each size floated separately using different flotation procedures for each of the sizes. The Headley U. S. Patent 2,136,341 describes a process for recovering coal values from a slush culm by flotation which comprises flotation of the coal fines followed by screening or classification of the flotation tailing, rejecting the fine sizes and then subjecting the coarse portion to flotation to recover a low ash coal concentrate.

Various gravity separation methods have also been employed in the past for recovering coal values from coal contaminated with high ash material. Among such specific gravity concentration methods are those such as tabling, jigging, and float and sink methods.

The primary purposes of the above coal treating processes were for the purpose of obtaining a clean coal concentrate having a low ash value and were not concerned with the recovery of materials other than coal that might be present, as for example the pyrites. While many of these past procedures are commercially successful in obtaining a high grade coal concentrate from certain types of coal, they are not at all successful in recovering the coal and pyrite values from a low grade coal containing good coal, which is present in relatively fine-size particles, bone coal, slate and a relatively high percentage of pyrite.

The beneficiation of such low grade coal has been a serious problem in the coal industry heretofore as there has been no economical method for recovering the values therefrom. While the problem is of little economical importance in the United States it is of very great importance in countries that do not have an abundance of high grade coal such as, for example, Brazil, but do have large amounts of low grade pyrite containing coal.

In accordance with the present invention a coal treating process is provided which is particularly useful for the beneficiation of low grade coals containing pyrite. The flow scheme employed in the present invention results in the recovery of a clean coal product having a relatively low ash content and also the recovery of a pyrite product suitable for acid manufacture.

In carrying out the present invention a low grade coal containing good coal, bone coal, slate, and pyrite is subjected to a crushing operation and the crushed coal is subjected to froth flotation producing a concentrate and tails. The flotation concentrate is then subjected to a gravity concentration method resulting in the production of a relatively clean coal concentrate. The flotation tailings are also subjected to a gravity concentration method and result in the production of a pyrite concentrate, suitable for use in acid manufacture.

The present invention is not concerned with any particular type of flotation reagent and it is an advantage of the invention that it is applicable to the standard reagent combinations. Similarly the invention may be used with various types of flotation equipment.

The invention is also not broadly concerned with the particular type of crushing equipment that is employed to crush the coal, nor in any particular type of screen or classifier that may be used to effect sizing of the crushed coal prior to flotation. The invention likewise is not particularly concerned with a particular type of gravity concentration apparatus which is employed to treat the flotation concentrates and tails.

The invention will be described in greater detail in conjunction with typical flow schemes which have been found to result in good recovery of clean coal and pyrite products from low grade coals.

Figure 1 is a diagrammatic flow sheet of a process in which the crushed coal is divided into a coarse fraction and a fine fraction, each fraction being then subjected to a flotation treatment followed by gravity concentration of flotation products.

Figure 2 is a diagrammatic flow sheet of a process in which the crushed coal is subjected to a screening operation prior to flotation, the oversize being returned to the crushing circuit and the undersize being subjected to flotation followed by gravity concentration of the flotation products.

The operation of the present invention will be readily apparent by referring specifically to the flow scheme of Figure 1 in which a run of mine low grade coal containing pyrite from a Brazilian coal deposit in which the good coal particles were —35 mesh in size and in which the pyrite was satisfactorily liberated from attachments by crushing to —10 mesh is fed into a suitable crushing circuit which may consist of a coarse jaw crusher followed by a roll crusher or mod-mill, if desirable, which results in the production of a —35 mesh material. The crushed material is then fed onto a screen which permits the —35 mesh material to pass through and the oversize or plus 35 mesh is returned to the crushing circuit. The undersize or —35 mesh material is then subjected to a suitable classifying operation which results in the production of a coarse fraction approximately plus 65 mesh and a fine fraction which is approximately —65 mesh. This classifying process may be accomplished by any suitable classifier preferably, however, a screen is used because of the more desirable size control obtained. The coarse fraction, plus 65 mesh, is now subjected to a froth flotation treatment in the presence of any suitable collector and frothing reagent such as, for example, fuel oil and an alcohol frother. The flotation concentrate contains a high percentage of coal which, however, has also a high percentage of ash. The clean coal is then recovered from this concentrate by subjecting to a gravity concentration treatment. The gravity concentration is preferably carried out by tabling.

The flotation tailing from the coarse fraction contains a relatively high percentage of pyrite, which upon treatment by gravity concentration tabling results in the production of a pyrite concentrate which is suitable for acid manufacture.

The fine fraction is likewise subjected to a flotation operation under conditions most suitable for finer material. The fine fraction flotation concentrate and tailings are then separately subjected to tabling concentrations to result in the production of a fine fraction clean coal concentrate and a fine fraction pyrite product respectively. The data in the following table will illustrate in greater detail the operation of the present invention in accordance with the flow scheme of Figure 1.

EXAMPLE 1

A Brazilian crude coal was crushed and classified into —35 plus 65 mesh, and —65 mesh sizes. Each size was then separately subjected to flotation and the flotation products separately subjected to a tabling treatment.

Minus 35 plus 65 mesh size (coarse fraction)

Condition pulp with 0.50 lb./ton fuel oil prior to float.
Float at 20% solids.
Reagents—lbs./ton—alcohol frother—0.15 to rougher, 0.10 to cleaner.
Rougher time—3 minutes. Cleaner time—2 minutes.
Cleaned conc. tabled for removal pyrite.

Results

Product	Weight	Ash
	Per cent	*Per cent*
Feed		34.44
Rougher tail	44.88	50.04
Cleaner tail flot	6.53	38.26
Cleaner conc. flot	48.57	19.50
Table conc	42.12	15.26
Table tail flot	6.45	47.19

Minus 65 mesh size (fine fraction)

Condition pulp with 0.64 lb./ton Na_2SiO_3.
Float at 25.7 solids.
Reagents—lbs./ton—alcohol frother—0.126 to rougher, 0.54 to cleaner.
Rougher time—4 minutes. Cleaner time—3 minutes.

Results

Product	Weight	Ash
	Per cent	*Per cent*
Feed		31.18
Rougher tail	27.98	50.16
Cleaner tail	9.61	42.28
Cleaner conc	62.41	20.96
Table conc	55.43	17.02
Table tail	6.98	52.25

Referring now specifically to the flow scheme of Figure 2, a second flow scheme is described in which the same crude Brazilian run of mine coal is crushed and the crushed coal subjected to a screening operation to produce an undersized —35 mesh and an oversize plus 35 mesh which is returned to the crushing circuit. The undersize or —35 mesh feed is subjected to a froth flotation treatment without further sizing to produce a concentrate and tail. The flotation concentrate is then subjected to a tabling operation to produce a clean coal concentrate and a tailing containing a relatively high percentage of pyrite. The flotation tailing is likewise subjected to a separate tabling operation to produce a concentrate of pyrite suitable for acid manufacture and a tailing waste. The data in the following example illustrates the recovery of clean coal and pyrite product when the flow scheme of Figure 2 is followed.

Example 2

Straight flotation —35 mesh feed—cleaning of cleaned concentrate on table, also flotation tailing cleaned on table.
Condition pulp with 0.50 lb./ton Na_2SiO_3 and 0.53 lb./ton #2 fuel oil.
Rougher float—22% solids for 3 minutes.
Cleaner float—22% solids for 1½ minutes.
Reagents — lbs./ton — alcohol frother — 0.105 lb./ton to rougher, 0.042 lb./ton to cleaner.

Results

Product	Weight	Ash	S
	Per cent	*Per cent*	*Per cent*
Feed		32.12	
Flot. cl. conc	56.05	21.00	
Flot. cl. tail	14.82	37.42	
Flot. R. tail	29.13	30.33	
Table conc. (cl. conc.)	52.54	18.62	
Table tail (from cl. conc.)	3.51	56.60	
Table conc. (R. tail retreat)	11.00	62.84	42.91
Table tail (R. tail retreat)	18.13	43.54	

What I claim is:

A method of recovering pyrite and coal values from a low grade coal containing pyrite which comprises the steps of crushing the coal to —35 mesh, separating the crushed coal into a —35+65 mesh fraction and a —65 mesh fraction, subjecting each fraction to a separate froth flotation operation and tabling separately the flotation concentrates to recover the coal values and tabling separately the floatation tailings to recover the pyrite values, said flotation operations being carried out employing a reagent combination comprising a hydrocarbon oil and a frothing agent.

STEPHEN E. ERICKSON.

CERTIFICATE OF CORRECTION.

Patent No. 2,330,479. September 28, 1943.

STEPHEN E. ERICKSON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 28, for "mod-mill" read --rod-mill--; page 2, second column, line 27, for "25.7" read --25.7%--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 16th day of November, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)