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-9 JUL 1953

No. 40 of 1950
INSTITUTE OF ADVANCED
LEGAL STUDIES

In The Privy Council

ON APPEAL FROM THE SUPREME COURT OF CANADA

BETWEEN :

MINERALS SEPARATION NORTH AMERICAN
CORPORATION,

Appellants

—AND—

NORANDA MINES, LIMITED,

Respondents.

RECORD OF PROCEEDINGS

VOLUME 5

PAGES 912—1151

BIRD & BIRD,
5-11 Theobald's Road,
London, W.C.1,
Appellants' Solicitors.

LAWRENCE JONES & CO.,
Winchester House,
Old Broad Street,
London E.C.2,
Respondents' Solicitors.

In The Supreme Court of Canada

ON APPEAL FROM THE EXCHEQUER COURT OF CANADA

BETWEEN :

NORANDA MINES, LIMITED,

Appellant;

— AND —

MINERALS SEPARATION NORTH AMERICAN
CORPORATION,

Respondent.

APPEAL CASE

— VOLUME 5 —

HOLDEN, MURDOCH, WALTON, FINLAY & ROBINSON,
Solicitors for Appellant.

SMART & BIGGAR,
Ottawa Agents for Solicitors for Appellant.

EWART, SCOTT, KELLEY & HOWARD,
Solicitors for Respondent.

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LEGAL STUDIES

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M-4J	Lr. Plf. to Dft.	Nov. 17, 1932	V	993
M-4K	Lr. Plf. to Dft.	April 4, 1934	V	994
M-4L	Lr. Plf. to Dft.	April 24, 1934	V	994
M-4M	Lr. Dft. to Plf.	May 23, 1934	V	995
M-4N	Lr. Plf. to Dft.	May 25, 1934	V	995
M-4O	Lr. Plf. to Dft.	July 16, 1934	V	996
M-4P	Lr. Dft. to Plf.	July 18, 1934	V	996
M-4Q	Lr. Plf. to Dft.	July 20, 1934	V	997
M-4R	Lr. Dft. to Plf.	Nov. 2, 1934	V	997
M-4S	Lr. Plf. to Dft.	Nov. 14, 1934	V	998
M-4T	Lr. Dft. to Plf.	Nov. 21, 1934	V	999

EXHIBITS — (Continued)

EXHIBIT No.	DESCRIPTION	DATE	APPEAL BOOK		EXHIBIT BOOK		FIRST REFERRED TO	
			VOL.	PAGE	VOL.	PAGE	VOL.	PAGE
M-4U	Lr. Plf. to Dft.	Nov. 26, 1934	V	999				
M-4V	Lr. Dft. to Plf.	Jan. 15, 1935	V	1000				
M-4W	Lr. Dft. to Plf.	Feb. 12, 1935	V	1000				
M-4X	Lr. Plf. to Dft.	Feb. 14, 1935	V	1001				
M-4Y	Lr. Plf. to Dft.	Feb. 7, 1936	V	1001				
M-4Z	Lr. Dft. to Plf.	Feb. 12, 1936	V	1002				
M-4AA	Lr. Plf. to Dft.	Feb. 13, 1936	V	1003				
M-4BB	Lr. Dft. to Plf.	Feb. 17, 1936	V	1004				
M-4CC	Lr. Plf. to Dft.	Feb. 18, 1936	V	1004				
M-4DD	Lr. Plf. to Dft.	Mar. 31, 1936	V	1005				
M-4EE	Lr. Dft. to Plf. (Duplicate of Ex. M-3) ...	April 1, 1936	V	1005				
M-4FF	Lr. Plf. to Dft.	April 2, 1936	V	1006				
M-4GG	Lr. Plf. to Dft.	April 23, 1936	V	1006				
M-4HH	Lr. Dft. to Plf.	April 25, 1936	V	1007				
M-4II	Lr. Plf. to Dft.	April 27, 1936	V	1007				
M-4JJ	Lr. Plf. to Dft.	May 26, 1936	V	1008				
M-4KK	Lr. Dft. to Plf.	May 28, 1936	V	1008				

PART IV — JUDGMENTS, ETC.

DESCRIPTION	DATE	PAGE
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Formal Judgment of Exchequer Court.	May 28, 1947	1110
Consent as to contents of case.	Aug. 23, 1948	1111
Order of Supreme Court dispensing with printing of certain exhibits.	June 25, 1948	1113
Order of Supreme Court dispensing with printing of Exhibit P-104.	Aug. 23, 1948	1114
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Formal Judgment of Supreme Court of Canada.	Dec. 5, 1949	1149
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Exhibit—D-83.

EXHIBIT D-83

DOMINION OF CANADA

PATENT OFFICE

CERTIFIED TO BE a true and correct copy of the original Record File, remaining on record in this office, relating to Patent No. 247,576 bearing date the 10th day of March, 1925 and granted to Minerals Separation North American Corporation, assignee of Cornelius H. Keller, for "Froth Flotation Concentration of Ores",

10 (S E A L)

AS WITNESS the seal of the Patent Office hereto affixed at the City of Ottawa in the Dominion of Canada this 12th day of March in the year of our Lord one thousand nine hundred and forty-three.

J. T. MITCHELL,
Commissioner of Patents.

Application No. 296,151

Filed Oct. 23, 1924.

Class 75

Assignment.

20 Sub-Class 17

Title FROTH FLOTATION CONCENTRATION OF ORES

Inventor

C. H. KELLER

Referred to Division 3

Dec. 4, 1924.

Notice of Allowance

Publish Claims 4, 5, 6.

Dated Jan. 6, 1925.

Allowed Jan. 3, 1925.

J. MITCHELL,
Examiner.

30

CANADA
(Non-resident Inventor)

P E T I T I O N

TO THE COMMISSIONER OF PATENTS

OTTAWA

The petition of CORNELIUS H. KELLER, of the City of San Francisco, in the County of San Francisco, State of California, United States of America, sheweth:

Exhibit—D-83.

That he has invented certain new and useful improvements in
 FROTH FLOTATION CONCENTRATION OF ORES

not known or used by others before his invention thereof, and not patented or described in any printed publication in this or any foreign country more than two years prior to this application and not in public use or on sale in this country for more than two years prior to this application.

Said petitioner therefore prays that a patent may be granted to him for the said invention, as set forth in the specification in
 10 duplicate relating thereto.

Said petitioner hereby names and appoints J. EDWARD MAYBEE, of 156 Yonge St. in the City of Toronto, Province of Ontario, Canada, Patent Attorney, to represent him and stand in his place and stead for all the purposes of the Patent Act including the service of any proceedings taken thereunder.

Signed at City and County of San Francisco, Calif., U.S.A., this Fifth day of December, 1924.

Sign here first Christian name IN FULL.

CORNELIUS H. KELLER.

20

P E T I T I O N .

TO THE COMMISSIONER OF PATENTS,
 OTTAWA.

The Petition of CORNELIUS H. KELLER, a citizen of the United States of America, Chemist, and a resident of San Francisco, County of San Francisco, State of California, Showeth:

That he has invented certain new and useful improvements in Froth Flotation Concentration of Ores, not known or used by others before his invention thereof and not patented or described in any printed publication in this or any foreign country for more
 30 than two years prior to this application and not in public use or on sale in this country for more than two years prior to this application.

Said petitioner therefore prays that a patent may be granted to him for the said invention, as set forth in the specification in duplicate relating thereto.

Said petitioner hereby names and appoints the firm of Williams & Pritchard, composed of Henry D .Williams and William S. Pritchard, of 61 Broadway, City, County and State of New York, Patent Attorneys, to represent him and stand in his place and
 40 stead for all the purposes of the Patent Act, including the service of any proceedings taken thereunder.

Signed at San Francisco this 11th day of October, 1924.

CORNELIUS H. KELLER.

POWER OF ATTORNEY
TO THE COMMISSIONER OF PATENTS
OTTAWA

The undersigned CORNELIUS H. KELLER, of the City of San Francisco, in the County of San Francisco, State of California, United States of America hereby appoints J. Edward Maybee, practising under the firm name of Ridout and Maybee, in the City of Toronto, Province of Ontario, Canada, as Solicitor of Patents, his attorney with full power of substitution or revocation, to prosecute
10 an application for a Patent for certain new and useful improvements in FROTH FLOTATION CONCENTRATION OF ORES to make alterations and amendments therein, to sign the drawings, to receive the Patent and to transact all business in the Patent Office connected therewith.

Signed at City and County of San Francisco, Calif., U.S.A., this Fifth day of December 1924.

SIGN HERE, FIRST CHRISTIAN NAME IN FULL:

CORNELIUS H. KELLER

In the presence of—
30 (One witness)
A. McGOWN.

ASSOCIATE POWER OF ATTORNEY

We, the undersigned, hereby appoint J. Edward Maybee, practicing under the firm name of Ridout & Maybee, in the City of Toronto, Province of Ontario, Canada, as Solicitor of Patents, associate attorney, in the application of Cornelius H. Keller, for a patent for certain new and useful improvements in Froth Flotation Concentration of Ores, with full power of substitution or revocation, to prosecute said application, and to make alterations and amend-
30 ments therein, to sign the drawings, to receive the patent and to transact all business in the Patent Office connected therewith.

WILLIAMS & PRITCHARD,
Attorneys.

Dated New York, New York, U.S.A., this 21st day of October, 1924.

Exhibit—D-83.

ASSOCIATE POWER OF ATTORNEY
TO THE HON. COMMISSIONER OF PATENTS
OTTAWA

Dear Sir:—

In the matter of the application of CORNELIUS H. KELLER, for Letters Patent, for Improvements in FROTH FLOTATION CONCENTRATION OF ORES, I hereby appoint Messrs. CARON & CARON, of 14 Metcalfe Street, in the City of Ottawa, County of Carleton, Province of Ontario, Canada, my Associate Attorneys,
10 for the purpose of filing the application and obtaining the filing date and serial number therefor, and to transact all business in the Patent Office connected therewith.

Dated at Toronto, Canada, this 23rd day of October, 1924.

J. EDW. MAYBEE
Attorney of Record.

OATH

UNITED STATES OF AMERICA,
CITY AND COUNTY OF SAN FRANCISCO,
STATE OF CALIFORNIA. } ss.;

20 I, CORNELIUS H. KELLER, a citizen of the United States of America, of San Francisco, County of San Francisco, State of California, Chemist, make oath and say, that I verily believe that I am the inventor of the new and useful improvements in Froth Flotation Concentration of Ores, described and claimed in the specification relating thereto, and for which I solicit a patent by my petition dated 11th, day of October, 1924. That no application for a patent has been filed by me or others with my knowledge or consent in any foreign country except as follows:

United States, Serial No. 870,242, Filed October 23, 1923.

30 And I further say that the several allegations contained in the said petition are respectively true and correct.

CORNELIUS H. KELLER.

Subscribed and sworn to before me at the City and County of San Francisco, State of California, the 11th day of October, 1924.

O. A. EGGERS,
*Notary Public in and for the City and County
of San Francisco, State of California.*

SPECIFICATION

BE IT KNOWN, that I, CORNELIUS H. KELLER, a citizen of the United States of America, and a resident of San Francisco, County of San Francisco, State of California, Chemist, have invented certain new and useful improvements in Froth Flotation Concentration of Ores, and do declare that the following is a clear, full, and exact description of the same.

This invention relates to the froth-flotation concentration of ores, and is herein described as applied to the concentration of certain
 10 ores with mineral-frothing agents in the presence of certain organic compounds containing sulphur.

It has been found that certain sulphur derivatives of carbonic acid greatly increase the efficiency of the froth-flotation process when used in connection with mineral-frothing agents. The increased efficiency shows itself sometimes in markedly better recoveries, sometimes in effecting the usual recoveries with greatly reduced quantities of the usual mineral-frothing agents, and sometimes in greatly reducing the time needed for agitation to produce the desired recoveries.

The invention is herein disclosed in some detail as carried out
 20 with salts of the sulphur derivatives of carbonic acid containing an organic radical, such as an alkyl radical and known as xanthates, as the new substance. These form anions and cations in solution. Excellent results were also obtained by agitating ore pulps with the complex mixture produced when 33 1/3% of pine oil was incorporated with an alcoholic solution of potassium hydrate, and xanthates or analogous substances were produced by adding carbon disulphide to this mixture.

The galena-bearing froth obtained with xanthates or analogous
 30 substances used at the rate of 0.2 pounds per ton of ore had a characteristic bright sheen, like a plumbago-bearing froth, and seemed to make a more coherent froth than when other materials were used on the same ore.

In general the substances referred to are not mineral-frothing agents,—producing only a slight scum, and some evanescent frothy bubbles, when subjected to agitation which would produce mineral-bearing froth on an ore pulp in the presence of a mineral-frothing agent. The substances are effective in enabling a selective flotation of lead and zinc; and cause uncombined silver, if present, to tend to go into the lead concentrate rather than with the zinc, where these
 40 are separated in separate concentrates. Usually pre-agitation is unnecessary, the brightening and other effects seeming to be practically instantaneous. The pulps may be either acid, alkaline or neutral according to circumstances.

Two sticks of caustic potash weighing perhaps 15 grams were partly immersed in about 80cc. of commercial carbon disulphide and kept for about ten days in a closed bottle containing some air in the

warm region of the laboratory where were the hot plates used for drying. These eventually yielded a yellow or orange salt which was used with pine oil at the rate of approximately half a pound to a ton of ore in concentrating Hibernia ore from Timber Butte Mining Company. The test was with a neutral pulp, and the concentrates were seen to be clean with brightened lead sulphide particles.

For laboratory purposes potassium xanthate was prepared as follows:

- 198.4 grams of 88.5% caustic potash was dissolved in 524 grams ethyl alcohol (denatured No. 5 formula) at a temperature of 124°F., in a reflux condenser. The solution was cooled to 58°F. It contained a large excess of alcohol over the theoretical amount needed for the subsequent reactions. To this was added, while stirring, and in a cooling bath, the theoretical amount of carbon disulphide. The reaction was substantially instantaneous, producing a thick pulp of potassium xanthate. The pulp was cooled and centrifuged in a laboratory machine, yielding crystals containing about 20% moisture. The yield thus obtained was 74.7%. Another 17.5% was obtained by evaporation of the mother liquor. Both the centrifuged crystals and the residue from the mother liquor gave excellent results in flotation. It was found in cases where sulphuric acid was used that the centrifuged material yielded better results than the uncentrifuged.

- A pulp of Anaconda slimes which had been stored for several days assaying 2.95% copper (a part being oxidized copper mineral) was treated with cresylic acid as frothing agent and potassium xanthate, the latter used at the rate of half a pound to a ton of the slimes. With no pre-agitation, and fifteen minutes agitation in a laboratory subaeration machine, these slimes yielded a concentrate containing 15.6% copper, a middling containing 0.48% copper and a tailing containing 0.082% copper. The small proportion of silver present was recovered in about the same proportions. Similar results were obtained with the use of sodium xanthate and General Naval Stores No. 5 flotation oil, a steam distilled pine oil.

- A pulp of Cash mine ore subjected first to agitation for ten minutes with a mixture of 0.3 pounds per ton of potassium xanthate with a small proportion of a 10% or a saturated solution of naphthalene in xylene, to yield a lead concentrate, and then subjected to agitation for ten minutes with copper sulphate 0.2 pounds per ton, Barrett No. 4 flotation oil 1.0 pound per ton, and General Naval Stores No. 5 flotation oil 0.1 pounds per ton, yielded the results shown in the following table. Attention is called to the recovery of 95% of the lead in a concentrate containing 87% of the silver but containing only 5% of zinc, while 70% of the zinc was recovered in the zinc concentrate.

Cash Mine Ore Assays

	% Wt.	Au. (oz.)	Ag. (oz.)	Cu.	Pb.	Zn.	Fe.
Heads	100.0	.154	10.7	3.18	14.9	7.7	11.9
Pb. Conc.	38.0	.24	24.6	7.12	37.4	5.0	21.4
Zn. Conc.	15.4	.36	6.3	2.56	3.0	35.2	12.0
Tails.	46.6	.015	0.9	.26	0.5	0.8	4.2

% Recoveries

	Au.	Ag.	Cu.	Pb.	Zn.	Fe.
10 Pb. Conc.	59.4	87.1	85.2	95.3	24.7	68.4
Zn. Conc.	36.0	9.0	11.0	3.1	70.5	15.5
Tails.	4.6	3.9	3.8	1.6	4.8	16.4

A pulp of San Francisco Mines of Mexico ore was agitated for ten minutes with potassium xanthate 0.15 pound per ton and the same amount of coal tar creosote to yield a lead concentrate. The remaining pulp was agitated for fifteen minutes with 0.2 pounds per ton of copper sulphate, 1.2 pounds per ton of water-gas tar, and 0.05 pounds per ton of steam distilled pine oil. The results are shown in the following table:

20

San Francisco Mines of Mexico

	% ASSAYS				% RECOVERIES		
	% Wt.	Ag. (oz.)	Pb.	Zn.	Ag.	Pb.	Zn.
Heads	100.0	16.5	9.4	16.1	.....	.....	.....
Pb. Conc.	12.2	67.0	64.0	12.0	49.4	83.2	9.1
Zn. Conc.	28.9	23.6	3.6	43.4	41.2	11.1	78.0
Tails.	58.9	4.5	1.5	6.0	9.4	5.7	12.9

Similar results were obtained with this ore by agitating for five minutes with 0.15 pounds each of sodium xanthate and Barrett No. 2 flotation oil per ton of ore, to yield a lead concentrate, and then agitating for ten minutes with 0.3 pounds copper sulphate, 1.3 pounds Barrett No. 4 flotation oil, and General Naval Stores No. 5 flotation oil 0.1 pounds, all per ton of ore, to yield a zinc concentrate.

During a seven and one-half hours run on Current Anaconda Slimes at the rate of one hundred and eleven tons per twenty-four

Exhibit—D—83.

hours in a Minerals Separation Standard Machine from a feed containing 3.28% copper, 0.26% being acid soluble copper, there was recovered a concentrate containing 11.43% Cu. and 36.9% insolubles, —the latter being a proportion desirable for smelting. The tailings contained 0.29% copper of which 0.20% was acid soluble copper. This test was run at a temperature of 82°F., using for reagents, 7.89 pounds of kerosene acid sludge, 21.6 pounds of chamber sulphuric acid, 2.36 pounds of hard wood creosote, and 2.92 pounds of a twenty per cent. solution of potassium xanthate in water, all quantities being
 10 in pounds per short ton of ore.

Anaconda old gravity concentration tailings reground for flotation were treated at the rate of four hundred and eleven tons per twenty-four hours in a Minerals Separation Standard Machine provided with a porous bottom in the spitzkasten through which air was admitted. From a feed containing 0.52% copper, of which 0.12% was acid soluble copper, there was recovered a concentrate containing 5.72% copper and 48% insolubles. The tailings from this contained 0.13% copper of which 0.08% was acid soluble. This
 20 test was run at a temperature of 50°F, using for reagents per ton of solids, 0.67 pounds of a 30% solution of potassium xanthate in water, 3.96 pounds of kerosene acid sludge, and 11.45 pounds of chamber sulphuric acid.

Anaconda ore slimes containing 3.28% copper, of which 0.45% was acid soluble, were subjected to froth-flotation concentration at 70°F, with 7.8 pounds per ton of dry hydrated lime, 0.132 pounds per ton of steam distilled pine oil, 0.38 pounds per ton of destructively distilled pine oil (G.N.S. No. 11 flotation), and 0.69 pounds per ton of potassium xanthate in solution, yielding concentrates containing
 30 13.76% copper and 34.7% insolubles, with a tailing of 0.31% copper of which 0.173% was acid soluble. This represented a recovery of 92.2.%

The lime was mixed with water and fed as a watery paste with the slimes to the first agitator of a series of nine Standard Minerals Separation agitators or mixing compartments through which the pulp passed in series at the rate of 97 tons in 24 hours. The No. 11 pine oil was added at the seventh agitator, and 0.6 pounds per ton of the xanthate at the ninth. The pulp returned through fourteen spitzkastens, each equipped with a Brown aerator and circulating
 40 device. At the sixth spitzkasten the balance of the xanthate was added. At the tenth spitzkasten the steam distilled pine oil was added. The froth from the first nine spitzkastens was collected as a finished concentrate, that from the remaining five was returned to the first as a middling.

It has also been found that for the froth-flotation concentration of certain ores, such as Calumet & Hecla, Britannia, Cananea and Mochtazuma, mother liquor obtained from centrifuging the above

Exhibit—D—83.

described xanthates in the process of manufacture of said xanthates may be used with about the same proportions of mother liquor as of the xanthate crystals specified with results as good or better than those above given.

A pulp of 80 mesh Calumet and Hecla slimes containing 0.45% copper, mostly native, with considerable mineral occluded in the coarser particles of gangue, was agitated five minutes with 0.3 pounds potassium xanthate, then was agitated for twenty minutes with 0.4 pounds steam distilled pine oil, all per ton of ore. The concentrate
10 thus obtained was agitated for five minutes and the froth separated to form a finished concentrate, the remainder forming a middling. The results are shown in the following table:

	% ASSAYS		% RECOVERIES
	% Wt.	Cu.	Cu.
Heads.....	100.0	0.45	.....
Conc.	0.7	41.72	64.5
Midd.	3.9	1.44	12.3
Tails.	95.4	0.11	23.2

A Chinese graphite ore containing 49% carbon as graphite,
20 chiefly in amorphous state, ground to 80 mesh, was agitated ten minutes with 0.2 pounds potassium xanthate and 0.15 pounds pine oil, both per ton of ore, yielding a froth concentrate and a tailing. The concentrate was reagitated for five minutes to yield a finished concentrate and a middling.

The finished concentrate contained 72.8% carbon as graphite, the middling 36.8%, and the tailing 15.2%. These represented respectively 79.2%, 10.2% and 10.6% of the original graphite content of the ore.

In the absence of xanthate the same ore required a larger amount
30 of mineral-frothing agent and longer agitation to produce the same results.

Having thus described certain embodiments of the invention, what is claimed is:

1. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and a sulphur derivative of carbonic acid adapted to form in solution anions and cations and adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so
40 conducted as to form such a froth, and separating the froth.

2. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and a salt of a

Exhibit—D-83.

sulphur derivative of carbonic acid adapted to form in solution anions and cations and adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

3. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and a salt of an alkyl sulphur derivative of carbonic acid adapted to co-operate with the mineral-frothing agent to produce by the action of both a
10 mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

4. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and a salt of an ethyl-sulphur derivative of carbonic acid adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

20 5. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and an alkali-metal salt of an ethyl-sulphur derivative of carbonic acid adapted to co-operate with the mineral-frothing agent to produce by the actions of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

6. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and an alkaline xanthate adapted to co-operate with the mineral-frothing agent to
30 produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

7. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of a xanthate.

8. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of potassium xanthate.

9. The improvement in the concentration of minerals by flotation
40 which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of a xanthate and a frothing agent.

10. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and a sulphur derivative of carbonic acid containing an organic radical and adapted to co-operate with the mineral-frothing agent to produce by the

Exhibit—D-83.

action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

11. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and a salt of a sulphur derivative of carbonic acid containing an organic radical and adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth, said agitation being so conducted as to form such a froth, and separating the froth.

10 Signed at San Francisco, City and County of San Francisco, State of California this 11th day of October, 1924.

CORNELIUS H. KELLER

WITNESSES:

A. MCGOWN

L. MILLARD

CORRESPONDENTS IN ALL COUNTRIES

20	<p>A. E. CARON FOR THIRTY YEARS EXAMINER OF PATENTS IN THE CANADIAN PATENT OFFICE</p> <hr/> <p>MAURICE A. CARON MECHANICAL & ELECTRICAL ENGINEER</p>	<p>CABLE ADDRESS "CARPAT" OTTAWA</p> <hr/> <p>OFFICES OPP. PATENT OFFICE</p> <hr/> <p>EXPERTS IN PATENT CAUSES PATENT LITIGATION, VALIDITY SEARCHES AND OPINIONS</p>
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CARON & CARON
SOLICITORS OF
CANADIAN AND FOREIGN PATENTS
TRADE MARKS ETC.

14, METCALFE STREET
OTTAWA
CANADA

30

October 23rd, 1924.

The Commissioner of Patents,
Ottawa.

Sir:—

RE: NEW APPLICATION, CORNELIUS H. KELLER.

Find herewith Petition, Oath, and Specification of this Application for a Method for the Concentration of Ores, also the fee of \$15.

Exhibit—D-83.

A new Specification, which may be amended to correspond with the case filed in the United States, will be substituted as soon as completed.

Yours respectfully,

CARON & CARON

AEC/MB
Enc ls:

CARON & CARON
SOLICITORS OF PATENTS
OTTAWA CANADA

10

O A T H

DOMINION OF
CANADA
PROVINCE OF
ONTARIO
COUNTY OF
CARLETON

I, ALBERT E. CARON, of the City of Ottawa, in the Province of Ontario, Canada, duly appointed attorney for CORNELIUS H. KELLER, of New York City, *in the County of New York, in the State of New York, make oath and say, that I verily believe that he is the inventor of the new and useful Improvements in a Method for the Concentration of Ores,*

described and claimed in the specification relating thereto, and for which I solicit a Patent by his petition dated the 23rd day of October, 1924.

That no application for a patent for the said invention has been filed by him or others with my knowledge or consent in any foreign country, except in the United States on October 23rd, 1923, under serial number 670,242.*

30 *And I further say that the several allegations contained in the said petition are respectively true and correct.*

CORNELIUS H. KELLER,
per A. E. CARON, Attorney.

Sworn before me, at Ottawa, Ontario, this 23d day of Oct., 1924.

LEE A. KELLEY

A. COMITE.

If applications have been filed in foreign countries, insert here the words "except as follows": and the name of each country in which an application has been filed and the date of filing in each case.

Exhibit—D-83.

PATENT OFFICE, CANADA

Received from C. H. KELLER

\$15.00
Pat. FeeNo. 454376
J. P. BEAUDOIN,
ACCOUNTANT

CORRESPONDENTS IN ALL COUNTRIES

10 A. E. CARON
FOR THIRTY YEARS EXAMINER
OF PATENTS IN THE CANADIAN
PATENT OFFICECABLE ADDRESS
"CARPAT" OTTAWA
OFFICES OPP. PATENT OFFICEMAURICE A. CARON
MECHANICAL & ELECTRICAL
ENGINEEREXPERTS IN PATENT CAUSES
PATENT LITIGATION, VALIDITY
SEARCHES AND OPINIONSCARON & CARON
SOLICITORS OF
CANADIAN AND FOREIGN PATENTS
TRADE MARKS ETC.20 14, METCALFE STREET
OTTAWA
CANADA

October 24, 1924.

The Commissioner of Patents,
Ottawa.

Sir:—

RE: APPLICATION CORNELIUS H. KELLER

We enclose herewith a new Petition signed by the inventor and an Oath, as well as the Specification in duplicate, and a third copy of the Claims, to be substituted for those filed yesterday.

30 The Associate Power of Attorney to us will be filed as soon as received, as well as a formal Petition.

We also enclose an Assignment from the inventor to the Mineral Separation North American Corporation, and fee of \$2.

Yours respectfully,

CARON & CARON

AEC;MB

DOMINION OF CANADA
 PETITION AND POWER OF ATTORNEY.

TO THE COMMISSIONER OF PATENTS,
 OTTAWA.

The petition of CORNELIUS H. KELLER,

*in the City of New York, and State of New York,
 United States of America,*

, showeth:

*That he has invented new and useful Improvements in a Method
 for the Concentration of Ores, not
 10 known or used by others before his invention thereof, and not patented or
 described in any printed publication in this or any foreign country more
 than two years prior to this application and not in public use or on sale
 in this country for more than two years prior to this application.*

*Said petitioner, therefore, prays that a Patent may be granted to him
 for the said invention, as set forth in the specification in duplicate
 relating thereto.*

*Said petitioner hereby names and appoints Albert Edward Caron, of
 the Firm of Caron & Caron, Patent Attorneys of No. 14 Metcalfe Street,
 in the City of Ottawa, Province of Ontario, to represent him and stand in
 20 his place and stead for all purposes of the Patent Act including the
 service of any proceedings taken thereunder.*

*Said petitioner, hereby appoints MESSRS. CARON & CARON
 of the City of Ottawa, in the Province of Ontario, Canada,*

*his attorneys, with full powers of substitution and revocation, to prosecute
 an application for Patent for the above invention, to make alteration and
 amendments therein, to sign the drawings, to receive the Patent and to
 transact all business in the Patent Office connected therewith.*

Signed at OTTAWA this 23d day of October, 1924.

In the presence of

30

WITNESS

}

CORNELIUS H. KELLER

Signature of Inventor.

per A. E. CARON,

Attorney.

S P E C I F I C A T I O N

TO ALL WHOM IT MAY CONCERN:

Be it known that I, CORNELIUS H. KELLER, a citizen of the United States and resident of New York, in the State of New York, have invented certain new and useful Improvements in a Method for the Concentration of Ores, of which the following is a specification.

My invention relates to the Concentration of Ores by Flotation, and more particularly to a method for which I have applied for a
 10 Patent in the United States of America under serial number 670,242, on October 23rd, 1923, by which the floatable minerals are separated from the materials with which they are associated.

The ore is concentrated by means of mixing the same into a body of water and progressively raising it to the surface of the water and mixing the emerging top layer by a film of aerated water, thus floating the top layer into the main body of water at the surface.

What I claim as my invention is:—

A method of separation of floatable minerals from the material
 20 with which they are associated consisting in feeding the mixture into a body of water, progressively raising it through the surface of the water and meeting the emerging layer by a down-flowing film of water, substantially as described.

Signed at Ottawa, this 23rd day of October, 1924.

CORNELIUS H. KELLER,
 per A. E. CARON,

Attorney.
 247576

PATENT OFFICE, CANADA

30 RECEIVED FROM M Caron & Caron

\$2.00

Asst. Fee.

No. 454487

J. P. BEAUDOIN,
Accountant.

Exhibit—D-83.

Communications should be addressed
 "The Commissioner of Patents"
 "Ottawa"

247576
 PATENT OFFICE

When writing on this subject refer to
 serial number of application.

OTTAWA, Oct. 28th, 1924.

	Applicant	C. H. Keller.
	Title of invention	"Froth Flotation Concentration of Ores"
10	Filing date	Oct. 23rd, 1924.
	Serial number	296,151.

Gentlemen:—

You are hereby advised of the filing of the above application
 for patent.

Your obedient servant,

GEO. F. O'HALLORAN,
Commissioner.

To Messrs. Caron & Caron,
 14 Metcalfe St.,
 20 Ottawa, Ont.

Exhibit—D-83.

CORRESPONDENTS IN ALL COUNTRIES

247576

A. E. CARON
FOR THIRTY YEARS EXAMINER
OF PATENTS IN THE CANADIAN
PATENT OFFICE

CABLE ADDRESS
"CARPAT" OTTAWA

—
OFFICES OPP. PATENT OFFICE
—

MAURICE A. CARON
MECHANICAL ELECTRICAL
ENGINEER

EXPERTS IN PATENT CAUSES
PATENT LITIGATION, VALIDITY
SEARCHES AND OPINIONS

10

CARON & CARON
SOLICITORS OF
CANADIAN AND FOREIGN PATENTS
TRADE MARKS ETC.

—
14, METCALFE STREET
OTTAWA
CANADA
—

October 29, 1924.

The Commissioner of Patents,
Ottawa.

20 Sir:—

RE Application 296,151, filed Oct. 23, 1924; C. H. KELLER.

We are enclosing herewith a Power of Attorney to act in this matter with regards to the filing of this Application.

We also enclose Power of Attorney to Messrs. Ridout & Maybee and would ask you to communicate with them in the future.

Yours respectfully,

CARON & CARON

AEC/NB

Enc ls: 2.

Exhibit—D-88.

Associate powers of attorney from Messrs. Williams & Pritchard to Messrs. Ridout & Maybee, and from Messrs. Ridout & Maybee to Messrs. Caron & Caron have been received but no power of attorney from the applicant to Messrs. Williams & Pritchard has been filed. Before the associate powers can be recognized this will have to be submitted.

When the above requirements have been fulfilled the application will receive consideration as to the patentability of the alleged invention.

Your obedient servant,

10
 To Messrs. Caron & Caron,
 14 Metcalfe St.
 Ottawa, Ont.

GEO. F. O'HALLORAN,
Commissioner of Patents.

CIRCULAR 2
 5,000—1-10-24

J. EDWARD MAYBEE

ESTABLISHED 1893
 247576

GEORGE P. MACKIE
 NORMAN R. TYNDALL

20
 EXPERTS IN PATENTS CAUSES
 SPECIAL ATTENTION TO PATENT LITIGATION
 REPORTS PREPARED FOR COUNSEL

RIDOUT & MAYBEE

MEMBER OF

THE CHARTERED INSTITUTE OF PATENT AGENTS, ENGLAND
 THE INSTITUTE OF PATENT AGENTS OF AUSTRALIA
 REGISTERED UNITED STATES ATTORNEY
 SOLICITORS OF HOME AND FOREIGN PATENTS

30
 HEAD OFFICE: KENT BUILDING, 156 YONGE STREET
 TORONTO, CANADA

AGENCIAS IN PRINCIPAL FOREIGN COUNTRIES
 CABLE ADDRESS "RIDBEE" TORONTO
 CODES USED:
 WESTERN UNION, SINGERS, PATENT
 TORONTO, Dec. 13, 1924.

The Commissioner of Patents,
 Ottawa.

—:Re Keller's Can. Application
 296151:—

Dear Sir:

40 We are sending you herewith new Petition and Power of Attorney for this case, which please acknowledge.

Yours truly,

G.P.M.-R.

RIDOUT & MAYBEE,
 Per G. P. M.

PATENT AND COPYRIGHT OFFICE

Communications should be addressed
 "The Commissioner of Patents"
 "Ottawa"

247576
 PATENT OFFICE

When writing on this subject refer to
 Serial number of application

CANADA

OTTAWA, Dec. 18. 1924.

10 Gentlemen,— *Application Serial No. 296151*
 Applicant C. H. KELLER

*I have the honour to acknowledge the receipt of your letter of the
 13th inst., with enclosures.*

and in reply to inform you that the same will meet with due attention.

Your obedient servant,

GEO. F. O'HALLORAN,
Commissioner.

To Messrs. Ridout & Maybee,
 156 Yonge St.
 Toronto, Ont.

20 CIRCULAR NO. 3
 15,000—27-8-24

PATENT AND COPYRIGHT OFFICE

Communications should be addressed
 "The Commissioner of Patents"
 "Ottawa"

247576
 PATENT OFFICE

When writing on this subject refer to
 serial number of application

CANADA

OTTAWA, Jan. 6th, 1925.

30 NOTICE OF ALLOWANCE

APPLICATION } Serial No. 296151
 FOR PATENT } Inventor C. H. Keller.
 } Invention Froth Flotation Concentration of Ores.

I beg to inform you that the above application for patent has
 been examined and allowed.

The final fee, TWENTY DOLLARS, must be paid not later than
 six months from the date of this notice of allowance.

The Serial Number of Application, full Name of Inventor, Title
 of Invention, and Date of Allowance MUST be given when paying
 40 final fee.

Exhibit—D—83.

The preparation of the patent for signing and sealing will require about six weeks, and such work will not be undertaken until after the payment of the final fee. The Office delivers the Patent upon the day of its date.

The Patent will be published in the Canadian Patent Office Record of the date of the issue of the Patent.

Your obedient servant,

GEO. F. O'HALLORAN,
Commissioner.

To Messrs. Ridout & Maybee,
10 156 Yonge St.,
Toronto, Ont.
Circular 12—15,000—7-5-24.

J. EDWARD MAYBEE

ESTABLISHED 1893
247576

GEORGE P. MACKIE
NORMAN R. TYNDALL

EXPERTS IN PATENT CAUSES
SPECIAL ATTENTION TO PATENT LITIGATION
REPORTS PREPARED FOR COUNSEL

20

RIDOUT & MAYBEE

MEMBER OF

THE CHARTERED INSTITUTE OF PATENT AGENTS, ENGLAND
THE INSTITUTE OF PATENT AGENTS OF AUSTRALIA
REGISTERED UNITED STATES ATTORNEY
SOLICITORS OF HOME AND FOREIGN PATENTS

HEAD OFFICE: KENT BUILDING, 156 YONGE STREET
TORONTO, CANADA

CABLE ADDRESS "RIDBEE" TORONTO

AGENCIES IN
30 PRINCIPAL FOREIGN COUNTRIES

CODES USED:
WESTERN UNION, SINGERS, PATENT
TORONTO, 16th January, 1925.

Commissioner of Patents,
Ottawa,

Dear Sir,

RE KELLER CAN. APP. 296151. Jan. 6th, 1925.

We are including in our cheque No. 8822 sent you to-day \$20.00 covering the final Government fee on the above application.

Please have the patent issued, and oblige.

Yours truly,

40

RIDOUT & MAYBEE.

Exhibit—D-83.

PATENT OFFICE, CANADA

Received from M C. H. Keller

\$
Pat. Fee

No. 461063
J. P. BEADOUIN
ACCOUNTANT

PATENT AND COPYRIGHT OFFICE

Communications should be addressed
"The Commissioner of Patents"
"Ottawa"

247576
PATENT OFFICE

10 When writing on this subject refer to
serial number of application

CANADA

OTTAWA, Jan. 20, 1925.

Gentlemen,—

*I have the honour, by direction of the Commissioner, to acknowledge
the receipt of the final fee in application for patent serial No. 296151
filed by C. H. Keller
and in reply to inform you that the patent will issue in due course.*

Your obedient servant,

20

GEO. F. O'HALLORAN,
Commissioner.

To Messrs. Ridout & Maybee,
156 Yonge St.,
Toronto, Ont.

P A T E N T OFFICE
APPLICATION FOR PATENT
 No. 296151 FILED Oct. 23/23, 1924

P A T E N T
 No. 247576
 Date Mar. 10, 1925

<p>FEE RECEIVED</p> <p>Filing Fee \$15.00 ASST. FEE</p> <p>Final Fee \$20.00 (1) \$2.00</p>	<p>ASSIGNMENTS RECORDED</p> <p style="text-align: center;">122601</p>	<p>APPLICANT</p> <p>C. H. Keller, Assignor to Minerals Separation North American Corporation.</p>
<p>COST OF COPIES</p> <p>Patent Specification \$3.25</p> <p>Petition 50 Oath 50</p> <p>Corres., etc. \$4.00</p>	<p>CARDBOARD DRAWINGS</p> <p style="text-align: center;">—</p>	<p>INVENTION</p> <p>FROTH FLOTATION CONCENTRATION OF ORES</p>
<p>READY FOR ISSUE</p> <p>Jan. 6, 1925</p> <p>NOTICE OF ALLOWANCE</p> <p>Jan. 6, 1925</p> <p>PATENT MAILED</p> <p>Mar. 10, 1925</p>	<p>ACTION Asst. \$2.00 & Papers rec'd. Oct. 24/24. Acknowledged by Circular I, and receipt mailed Oct. 28th, 1924. Ass't. by 122601 Oct. 24/24.</p> <p>er Oct. 31/24 Let. P A & assoc. P A from C & C Oct. 29/29/24 Ack. by Cir. 3, Nov. 14/24 — New rep. & P/A called for by Cir. 2 —Nov. 25/24. New Pet. P/A Dec. 13/15/24 from Ridout & Maybee. Ack'd. Dec. 18/24 Let & 20.00 Jan. 16/17/25. Rec. mld. Jan. 20/25.</p>	

Exhibit—P-50.

EXHIBIT P-50

DOMINION OF CANADA

PATENT OFFICE

CERTIFIED that the annexed is a true copy of a Patent registered in the Patent Office under number 247,576 granted to Minerals Separation North American Corporation, assignee of Cornelius H. Keller, and bearing date the 10th day of March, 1925, for "Froth Flotation Concentration of Ores", (Application for which was filed October 23, 1924) with true copy of the specification remaining on
 10 record in this office, duplicate copy of which was attached to the Patent above mentioned.

(S E A L)

AS WITNESS the seal of the Patent Office hereto affixed at the City of Ottawa in the Dominion of Canada this 25th day of February in the year of our Lord one thousand nine hundred and forty-three.

J. T. MITCHELL,
Commissioner of Patents.

20

DOMINION OF CANADA

Number 247,576

TO ALL TO WHOM THESE PRESENTS SHALL COME

WHEREAS CORNELIUS H. KELLER, of San Francisco, California, U.S.A., has petitioned the COMMISSIONER OF PATENTS, praying for the grant of a Patent for an alleged new and useful improvement in Froth Flotation Concentration of Ores, and has assigned to the Minerals Separation North American Corporation, a Maryland corporation, of New York, New York, U.S.A., all his
 30 right, title and interest, in and to the said invention, a description of which invention is contained in the specification of which a duplicate is hereunto attached, and made an essential part hereof, and has complied with the requirements of The Patent Act.

NOW THEREFORE THE PRESENT PATENT grants to the said Minerals Separation North American Corporation, its executors, administrators, legal representatives and assigns, for the period of Eighteen Years from the date of these presents, the exclusive right, privilege and liberty of making, constructing and using, and vending to others to be used, in the Dominion of Canada, the said invention,
 40 subject nevertheless to adjudication before any Court of competent jurisdiction.

Exhibit—P-50.

PROVIDED that the grant hereby made is subject to the conditions contained in the Act aforesaid.

(L.S.)

IN TESTIMONY WHEREOF, I have hereunto set my hand, and caused the Seal of the Patent Office to be hereunto affixed, at the City of Ottawa, in the Dominion of Canada, this Tenth day of March, in the year of Our Lord, one thousand nine hundred and twenty-five.

10

(Sgd.) GEO. F. O'HALLORAN,
Commissioner of Patents.

Patent No. 247,576
Dated March 10, 1925
Filed Oct. 23, 1924
3¼
26—2—43
O. P.

SPECIFICATION

1. BE IT KNOWN, that I, CORNELIUS H. KELLER, a
20 citizen of the United States of America, and a resident of San Francisco, County of San Francisco, State of California, Chemist, have invented certain new and useful improvements in

FROTH FLOTATION CONCENTRATION OF ORES

and do declare that the following is a clear, full, and exact description of the same.

2. This invention relates to the froth-flotation concentration of ores, and is herein described as applied to the concentration of certain ores with mineral-frothing agents in the presence of certain organic compounds containing sulphur.

30 3. It has been found that certain sulphur derivatives of carbonic acid greatly increase the efficiency of the froth-flotation process when used in connection with mineral-frothing agents. The increased efficiency shows itself sometimes in markedly better recoveries, sometimes in effecting the usual recoveries with greatly reduced quantities of the usual mineral-frothing agents, and sometimes in greatly reducing the time needed for agitation to produce the desired recoveries.

40 4. The invention is herein disclosed in some detail as carried out with salts of the sulphur derivatives of carbonic acid containing an organic radical, such as an alkyl radical and known as xanthates, as the new substance. These form anions and cations in solution. Excellent results were also obtained by agitating ore pulps with the complex mixture produced when 33½% of pine oil was incor-

— Higgins p. 45 L 21 — word certain
not clear at this point.

Exhibit—P-50.

porated with an alcoholic solution of potassium hydrate, and xanthates or analogous substances were produced by adding carbon disulphide to this mixture.

5. The galena-bearing froth obtained with xanthates or analogous substances used at the rate of 0.2 pounds per ton of ore had a characteristic bright sheen, like a plumbago-bearing froth, and seemed to make a more coherent froth than when other materials were used on the same ore.

10 6. In general the substances referred to are not mineral-frothing agents, — producing only a slight scum, and some evanescent frothy bubbles, when subjected to agitation which would produce mineral-bearing froth on an ore pulp in the presence of a mineral-frothing agent. The substances are effective in enabling a selective flotation of lead and zinc; and cause uncombined silver, if present, to tend to go into the lead concentrate rather than with the zinc, where these are separated in separate concentrates. Usually pre-agitation is unnecessary, the brightening and other effects seeming to be practically instantaneous. The pulps may be either acid, alkaline or neutral according to circumstances.

20 7. Two sticks of caustic potash weighing perhaps 15 grams were partly immersed in about 80 cc. of commercial carbon disulphide and kept for about ten days in a closed bottle containing some air in the warm region of the laboratory where were the hot plates used for drying. These eventually yielded a yellow or orange salt which was used with pine oil at the rate of approximately half a pound to a ton of ore in concentrating Hibernia ore from Timber Butte Mining Company. The test was with a neutral pulp, and the concentrates were seen to be clean with brightened lead sulphide particles.

30 8. For laboratory purposes potassium xanthate was prepared as follows:

40 198.4 grams of 88.5% caustic potash was dissolved in 524 grams ethyl alcohol (denatured No. 5 formula) at a temperature of 124° F., in a reflux condenser. The solution was cooled to 58° F. It contained a large excess of alcohol over the theoretical amount needed for the subsequent reactions. To this was added, while stirring, and in a cooling bath, the theoretical amount of carbon disulphide. The reaction was substantially instantaneous, producing a thick pulp of potassium xanthate. The pulp was cooled and centrifuged in a laboratory machine, yielding crystals containing about 20% moisture. The yield thus obtained was 74.7%. Another 17.5% was obtained by evaporation of the mother liquor. Both the centrifuged crystals and the residue from the mother liquor gave excellent results in flotation. It was found in cases where sulphuric acid was used that the centrifuged material yielded better results than the uncentrifuged.

*Potassium
Hydroxide*

Notionally say P_2O_5 is PO_4^{3-}
principally potassium tri-thiocarbonate

→ H p 58 "It does for the laboratory; quite a good
method."

Exhibit—P-50.

9. A pulp of Anaconda slimes which had been stored for several days assaying 2.95% copper (a part being oxidized copper mineral) was treated with cresylic acid as frothing agent and potassium xanthate, the latter used at the rate of half a pound to a ton of the slimes. With no pre-agitation, and fifteen minutes agitation in a laboratory subaeration machine, these slimes yielded a concentrate containing 15.6% copper, a middling containing 0.48% copper and a tailing containing 0.082% copper. The small proportion of silver present was recovered in about the same proportions. Similar results were obtained with the use of sodium xanthate and General Naval Stores No. 5 flotation oil, a steam distilled pine oil.

10. A pulp of Cash mine ore subjected first to agitation for ten minutes with a mixture of 0.3 pounds per ton of potassium xanthate with a small proportion of a 10% or a saturated solution of naphthalene in xylene, to yield a lead concentrate, and then subjected to agitation for ten minutes with copper sulphate 0.2 pounds per ton, Barrett No. 4 flotation oil 1.0 pound per ton, and General Naval Stores No. 5 flotation oil 0.1 pounds per ton, yielded the results shown in the following table. Attention is called to the recovery of 95% of the lead in a concentrate containing 87% of the silver but containing only 5% of zinc, while 70% of the zinc was recovered in the zinc concentrate.

Cash Mine Ore Assays

	% Wt.	Au. (oz.)	Ag. (oz.)	Cu.	Pb.	Zn.	Fe.
Heads	100.0	.154	10.7	3.18	14.9	7.7	11.9
Pb. Conc.	38.0	.24	24.6	7.12	37.4	5.0	21.4
Zn. Conc.	15.4	.36	6.3	2.56	3.0	35.2	12.0
30 Tails.	46.6	.015	0.9	.26	0.5	0.8	4.2

% Recoveries

	Au.	Ag.	Cu.	Pb.	Zn.	Fe.
Pb. Conc.	59.4	87.1	85.2	95.3	24.7	68.4
Zn. Conc.	36.0	9.0	11.0	3.1	70.5	15.5
Tails.	4.6	3.9	3.8	1.6	4.8	16.4

11. A pulp of San Francisco Mines of Mexico ore was agitated for ten minutes with potassium xanthate 0.15 pounds per ton and the same amount of coal tar creosote to yield a lead concentrate. The remaining pulp was agitated for fifteen minutes with 0.2

7c 558

Exhibit—P-50.

pounds per ton of copper sulphate, 1.2 pounds per ton of water-gas tar, and 0.05 pounds per ton of steam distilled pine oil. The results are shown in the following table.

San Francisco Mines of Mexico

	% ASSAYS				% RECOVERIES		
	% Wt.	Ag. (oz.)	Pb.	Zn.	Ag.	Pb.	Zn.
Heads	100.0	16.5	9.4	16.1	.....	.....	.....
Pb. Conc.	12.2	67.0	64.0	12.0	49.4	83.2	9.1
10 Zn. Conc.	28.9	23.6	3.6	43.4	41.2	11.1	78.0
Tails.	58.9	4.5	1.5	6.0	9.4	5.7	12.9

12. Similar results were obtained with this ore by agitating for five minutes with 0.15 pounds each of sodium xanthate and Barrett No. 2 flotation oil per ton of ore, to yield a lead concentrate, and then agitating for ten minutes with 0.3 pounds copper sulphate, 1.3 pounds Barrett No. 4 flotation oil, and General Naval Stores No. 5 flotation oil 0.1 pounds, all per ton of ore, to yield a zinc concentrate.

13. During a seven and one-half hours run on Current
20 Anaconda Slimes at the rate of one hundred and eleven tons per twenty-four hours in a Minerals Separation Standard Machine from a feed containing 3.28% copper, 0.26% being acid soluble copper, there was recovered a concentrate containing 11.43% Cu. and 36.9% insolubles, — the latter being a proportion desirable for smelting. The tailings contained 0.29% copper of which 0.20% was acid soluble copper. This test was run at a temperature of 82° F. using for reagents, 7.89 pounds of kerosene acid sludge, 21.6 pounds of chamber sulphuric acid, 2.36 pounds of hard wood creosote, and 2.92 pounds of a twenty per cent. solution of potassium xanthate in water, all quantities being in pounds per short
30 ton of ore.

14. Anaconda old gravity concentration tailings reground for flotation were treated at the rate of four hundred and eleven tons per twenty-four hours in a Minerals Separation Standard Machine provided with a porous bottom in the spitzkasten through which air was admitted. From a feed containing 0.52% copper, of which 0.12% was acid soluble copper, there was recovered a concentrate containing 5.72% copper and 48% insolubles. The tailings from this contained 0.13% copper of which 0.08% was acid soluble.
40 This test was run at a temperature of 50° F. using for reagents per ton of solids, 0.67 pounds of a 30% solution of potassium xanthate

Exhibit—P-50.

in water, 3.96 pounds of kerosene acid sludge, and 11.45 pounds of chamber sulphuric acid.

15. Anaconda ore slimes containing 3.28% copper, of which 0.45% was acid soluble, were subjected to froth-flotation concentration at 70° F. with 7.8 pounds per ton of dry hydrated lime, 0.132 pounds per ton of steam distilled pine oil, 0.38 pounds per ton of destructively distilled pine oil (G.N.S. No. 11 flotation), and 0.69 pounds per ton of potassium xanthate in solution, yielding concentrates containing 13.76% copper and 34.7% insolubles, with
10 a tailing of 0.317% copper of which 0.173% was acid soluble. This represented a recovery of 92.2%.

16. The lime was mixed with water and fed as a watery paste with the slimes to the first agitator of a series of nine Standard Minerals Separation agitators or mixing compartments through which the pulp passed in series at the rate of 97 tons in 24 hours. The No. 11 pine oil was added at the seventh agitator, and 0.6 pounds per ton of the xanthate at the ninth. The pulp returned through fourteen spitzkastens, each equipped with a
20 Brown aerator and circulating device. At the sixth spitzkasten the balance of the xanthate was added. At the tenth spitzkasten the steam distilled pine oil was added. The froth from the first nine spitzkastens was collected as a finished concentrate, that from the remaining five was returned to the first as a middling.

17. It has also been found that for the froth-flotation concentration of certain ores, such as Calumet & Hecla, Britannia, Cananea and Moctezuma, mother liquor obtained from centrifuging the above described xanthates in the process of manufacture of said xanthates may be used with about the same proportions of mother liquor as of the xanthate crystals specified with results
30 as good or better than those above given.

18. A pulp of 80 mesh Calumet and Hecla slimes containing 0.45% copper, mostly native, with considerable mineral occluded in the coarser particles of gangue, was agitated five minutes with 0.3 pounds potassium xanthate, then was agitated for twenty minutes with 0.4 pounds steam distilled pine oil, all per ton of ore. The concentrate thus obtained was agitated for five minutes and the froth separated to form a finished concentrate, the remainder forming a middling. The results are shown in the following table:

40	% Wt.	% ASSAYS Cu.	% RECOVERIES Cu.
Heads.....	100.0	0.45	
Conc.....	0.7	41.72	64.5
Midd.....	3.9	1.44	12.3
Tails.....	95.4	0.11	23.2

Exhibit—P-50.

19. A Chinese graphite ore containing 49% carbon as graphite, chiefly in amorphous state, ground to 80 mesh, was agitated ten minutes with 0.2 pounds potassium xanthate and 0.15 pounds pine oil, both per ton of ore, yielding a froth concentrate and a tailing. The concentrate was reagitated for five minutes to yield a finished concentrate and a middling.

The finished concentrate contained 72.8% carbon as graphite, the middling 36.8%, and the tailing 15.2%. These represented respectively 79.2%, 10.2% and 10.6% of the original graphite content of
10 the ore.

In the absence of xanthate the same ore required a larger amount of mineral-frothing agent and longer agitation to produce the same results.

Having thus described certain embodiments of the invention, what is claimed is:

1. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and a sulphur derivative of carbonic acid adapted to form in solution anions and cations and adapted to co-operate with the mineral-frothing agent
20 to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

2. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and a salt of a sulphur derivative of carbonic acid adapted to form in solution anions and cations and adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a larger proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating
30 the froth.

3. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and a salt of an alkyl sulphur derivative of carbonic acid adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

4. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and a salt of an ethyl-sulphur derivative of carbonic acid adapted to co-operate
40 with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

5. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and an alkali-

1. Sulphur dioxide ing

2. Salt - -

3. alkyl

4. Ethyl - Sulphur

Exhibit—P-50.

metal salt of an ethyl-sulphur derivative of carbonic acid adapted to co-operate with the mineral-frothing agent to produce by the actions of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

6. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and an alkaline xanthate adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

7. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of a xanthate.

8. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of potassium xanthate.

9. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of a xanthate and a frothing agent.

10. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and a sulphur derivative of carbonic acid containing an organic radical and adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

11. The process of concentrating ores which consists in agitating suitable pulp of an ore with a mineral-frothing agent and a salt of a sulphur derivative of carbonic acid containing an organic radical and adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth, said agitation being so conducted as to form such a froth, and separating the froth.

Signed at San Francisco City and County of San Francisco, State of California this 11th day of October, 1924.

(Sgd. CORNELIUS H. KELLER

WITNESSES:

40 A. MCGOWN
L. MILLARD

Exhibit—D-82.

EXHIBIT D-82

DOMINION OF CANADA

PATENT OFFICE

CERTIFIED TO BE a true and correct copy of the original specification remaining on record in this office, duplicate copy of which was attached to Patent No. 247,791 bearing date the 7th day of March, 1925, and granted to Minerals Separation North American Corporation, assignee of Carl Pierce Lewis, for "Concentration of Ores," (Application for which was filed October 23,
10 1924).

(S E A L)

AS WITNESS the seal of the Patent Office hereto affixed at the City of Ottawa in the Dominion of Canada this 3rd day of July in the year of our Lord, one thousand nine hundred and forty-four.

20

J. T. MITCHELL,
Commissioner of Patents.

S P E C I F I C A T I O N

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN, that I, CARL PIERCE LEWIS, a citizen of the United States of America, and a resident of Burlingame, County of San Mateo, State of California, Flotation Engineer, have invented certain new and useful improvements in the Concentration of Ores, and do declare that the following is a full, clear, and exact description of the same.

The invention is herein disclosed in some detail as carried out with
30 salts of the sulphur derivatives of carbonic acid containing an organic radical, such as an alkyl radical and known as xanthates, as the new substance. These form anions and cations in solution. Excellent results were also obtained by agitating ore pulps with the complex mixture produced when $33\frac{1}{3}\%$ of pine oil was incorporated with an alcoholic solution of potassium hydrate, and xanthates or analogous substances were produced by adding carbon disulphide to this mixture.

The present application is in part a continuation of the application of Cornelius H. Keller and myself, filed October 23, 1923,
40 Serial No. 670,242, which has been changed to a sole application of the said Cornelius H. Keller with claims for that part of the invention described and claimed in said joint application which was in fact the

Exhibit—D-82.

sole invention of the said Cornelius H. Keller. The present application claims that part of the invention described and claimed in said joint application which was in fact my sole invention.

According to the present invention these sulphur derivatives of carbonic acid may be used in alkaline ore pulps or in ore pulps in which alkali has been added, and this or other procedure may be used to effect differential flotation of the various metalliferous minerals of complex ores.

10 The galena-bearing froth obtained with xanthates or analogous substances used at the rate of 0.2 pounds per ton of ore had a characteristic bright sheen, like a plumbago-bearing froth, and seemed to make a more coherent froth than when other materials were used on the same ore.

In general the substances referred to are not mineral-frothing agents, producing only a slight scum, and some evanescent frothy bubbles, when subjected to agitation which would produce mineral-bearing froth on an ore pulp in the presence of a mineral-frothing agent. The substances are effective in enabling a selective flotation of lead and zinc; and cause uncombined sliver, if present, to tend to
20 go into the lead concentrate rather than with the zinc, where these are separated in separate concentrates. Usually pre-agitation is unnecessary, the brightening and other effects seeming to be practically instantaneous.

For laboratory purposes potassium xanthate was prepared as follows:

198.4 grams of 88.5% caustic potash was dissolved in 524 grams ethyl alcohol (denatured No. 5 formula) at a temperature of 124° F., in a reflux condenser. The solution was cooled to 58°F. It contained a large excess of alcohol over the theoretical amount needed for the
30 subsequent reactions. To this was added, while stirring, and in a cooling bath, the theoretical amount of carbon disulphide. The reaction was substantially instantaneous, producing a thick pulp of potassium xanthate. The pulp was cooled and centrifuged in a laboratory machine yielding crystals containing about 20% moisture. The yield thus obtained was 74.7%. Another 17.5% was obtained by evaporation of the mother liquor. Both the centrifuged crystals and the residue from the mother liquor gave excellent results in flotation. It was found in cases where sulphuric acid was used that the centri-
fuged material yielded better results than the uncentrifuged.

40 A pulp of Cash mine ore subjected first to agitation for ten minutes with a mixture of 0.3 pounds per ton of potassium xanthate with a small proportion of a 10% or a saturated solution of naphthalene in xylene, to yield a lead concentrate, and then subjected to agitation for ten minutes with copper sulphate 0.2 pounds per ton, Barrett No. 4 flotation oil 1.0 pound per ton, and General Naval Stores No. 5 flotation oil 0.1 pounds per ton, yielded the results shown

Exhibit—D—82.

in the following table. Attention is called to the recovery of 95% of the lead in a concentrate containing 87% of the silver but containing only 5% of zinc, while 70% of the zinc was recovered in the zinc concentrate.

Cash Mine Ore, Assays

	% Wt.	Au. (oz)	Ag. (oz)	Cu.	Pb.	Zn.	Fe.
Heads.....	100.0	.154	10.7	3.18	14.9	7.7	11.9
Pb. Conc.....	38.0	.24	24.6	7.12	37.4	5.0	21.4
10 Zn Conc.....	15.4	.36	6.3	2.56	3.0	35.2	12.0
Tails.....	46.6	.015	0.9	.26	0.5	0.8	4.2

% Recoveries

	Au.	Ag.	Cu.	Pb.	Zn.	Fe.
Pb Conc...	59.4	87.1	85.2	95.3	24.7	68.4
Zn Conc...	36.0	9.0	11.0	3.1	70.5	15.5
Tails.....	4.6	3.9	3.8	1.6	4.8	16.4

A pulp of San Francisco Mines of Mexico ore was agitated for ten minutes with potassium xanthate 0.15 pounds per ton and the same amount of coal tar creosote to yield a lead concentrate. The remaining pulp was agitated for fifteen minutes with 0.2 pounds per ton of copper sulphate, 1.2 pounds per ton of water-gas tar, and 0.05 pounds per ton of steam distilled pine oil. The results are shown in the following table:

San Francisco Mines of Mexico

	ASSAYS				% RECOVERIES		
	% Wt.	Ag. (oz)	Pb.	Zn.	Ag.	Pb.	Zn.
Heads.....	100.0	16.5	9.4	16.1			
Pb. Conc.....	12.2	67.0	64.0	12.0	49.4	83.2	9.1
30 Zn. Conc.....	28.9	23.6	3.6	43.4	41.2	11.1	78.0
Tails.....	58.9	4.5	1.5	6.0	9.4	5.7	12.9

Similar results were obtained with this ore by agitating for five minutes with 0.15 pounds each of sodium xanthate and Barrett No. 2 flotation oil per ton of ore, to yield a lead concentrate, and then agitating for ten minutes with 0.3 pounds copper sulphate, 1.3 pounds Barrett No.4 flotation oil, and General Naval Stores No. 5 flotation oil 0.1 pounds, all per ton of ore, to yield a zinc concentrate.

Anaconda ore slimes containing 3.28% copper of which 0.45% was acid soluble, were subjected to froth-flotation concentration at 70°F. with 7.8 pounds per ton of dry hydrated lime. 0.132 pounds per ton of steam distilled pine oil 0.38 pounds per ton of destructively distilled pine oil (G.N.S. No. 11 flotation), and 0.69 pounds per ton of potassium xanthate in solution, yielding concentrates containing 13.76% copper and 34.7% insolubles, with a tailing of 0.317% copper of which 0.173% was acid soluble. This represented a recovery of 92.2%.

- 10 The lime was mixed with water and fed as a watery paste with the slimes to the first agitator of a series of nine Standard Minerals Separation agitators or mixing compartments through which the pulp passed in series at the rate of 97 tons in 24 hours. The No. 11 pine oil was added at the seventh agitator and 0.6 pounds per ton of the xanthate at the ninth. The pulp returned through fourteen spitzkastens each equipped with a Brown aerator and circulating device. At the sixth spitzkasten the balance of the xanthate was added. At the tenth spitzkasten the steam distilled pine oil was added. The froth from the first nine spitzkastens was collected as a
20 finished concentrate, that from the remaining five was returned to the first as a middling.

It has also been found that for the froth-flotation concentration of certain ores, such as Calumet & Hecla, Britannia, Cananea and Moctezuma, mother liquor obtained from centrifuging the above described xanthates in the process of manufacture of said xanthates may be used with about the same proportions of mother liquor as of the xanthate crystals specified with results as good or better than those above given.

- In one test a freely flowing pulp containing 1200 grams of
30 Anaconda slimes assaying 2.95% copper was agitated 15 minutes in a sub-aeration machine at 17°C. with 5 pounds of soda ash, 0.7 pounds of potassium xanthate, and 0.2 pounds of steam distilled pine oil, all per ton of ore, yielding a concentrate containing 13.68% copper. The ratio of concentration was 5.2. The concentrate contained 91.5% of the copper, and an additional 4.1% was contained in a middling which held 0.68% of copper. The tailings contained 0.20% of copper which was 4.4% of that present in the heads.

- The xanthate may be used to replace a part of the alkali normally used in the concentration of certain ores, and in differential flotation
40 it may be used to replace either a part or all of the alkali normally used.

A pulp of Park Utah Lead-Zinc ore was agitated for ten minutes with potassium xanthate 0.15 pounds, and Barrett No. 2 flotation oil 0.15 pounds, to yield a lead concentrate. The remainder of the pulp was then agitated fifteen minutes with soda ash, 1.5 pounds, copper sulphate, 0.5 pounds, water gas tar, 1 pound, and pine oil, 0.05

Exhibit—D-82.

pounds, to yield a zinc concentrate. The zinc concentrate was then reagitated with added water for five minutes to yield a finished zinc concentrate and a zinc middling. All flotation and frothing agents were measured in pounds per ton. The results are shown in the following table:

	% ASSAYS				RECOVERIES		
	% Wt.	Ag. (oz.)	Pb.	Zn.	Ag.	Pb.	Zn.
Heads.....	100.0	5.39	8.24	12.55			
10 Pb Conc.....	11.7	31.3	60.0	10.4	68.0	85.2	9.7
Zn Conc.....	29.3	4.2	1.7	32.0	22.8	6.1	75.3
Zn. Midd.....	3.0	3.6	3.5	12.4	2.0	1.3	4.6
Tails.....	56.0	0.7	1.1	2.3	7.2	7.4	10.4

A pulp of Sullivan ore was agitated for seven minutes with potassium xanthate 0.1 pounds, and coal tar creosote, 0.1 pounds, to yield a lead concentrate. The remaining pulp was then agitated fifteen minutes with soda ash, 2 pounds, sulphate of copper, 0.5 pounds, and water gas tar, 1.3 pounds, to yield a zinc concentrate. All these quantities were in pounds per ton of ore. These concentrates were reagitated with the addition of water to produce respectively a lead finished concentrate and middling and a zinc finished concentrate and middling. The results are shown in the following table:

	% ASSAYS				
	% Wt.	Ag. (oz.)	Pb.	Zn.	Fe.
Heads.....	100.0		12.06	15.3	30.6
Pb. Conc.....	15.0	13.1	60.4	9.2	8.2
Pb. Midd.....	5.3	3.6	15.6	12.0	35.5
Zn. Conc.....	29.3	2.1	6.0	43.0	13.3
30 Zn. Midd.....	4.6	1.1	3.6	6.4	45.2
Tails.....	45.8	0.4	.6	.8	47.2

	% RECOVERIES		
	Pb.	Zn.	Fe.
Heads.....			
Pb. Conc.....	75.2	9.0	4.0
Pb. Midd.....	6.8	4.2	6.0
Zn. Conc.....	14.4	82.4	12.6
Zn. Midd.....	1.4	2.0	6.8
Tails.....	2.2	2.4	70.6

Exhibit—D—82.

A pulp of the highly refractory ore of the North Star Mine of the Federal Mining & Smelting Co. was agitated for ten minutes with an added mixture of 90% potassium xanthate and 10% Barrett No. 2 creosote, 0.2 pounds, and with 0.1 pounds of separately added Barrett No. 2 creosote, to yield a lead concentrate. The remaining pulp was reagitated for fifteen minutes with copper sulphate, 0.7 pounds, soda ash, 1.5 pounds, Barrett No. 4 flotation oil, 1.4 pounds, to yield a zinc concentrate. All weights are per ton of ore. The results are shown in the following table:

			% ASSAYS		
	% Wt.	Ag. (oz.)	Pb.	Zn.	Fe.
10 Heads.....	100.0	10.1	7.9	18.4	14.8
Pb. Conc.....	13.7	37.4	31.2	10.8	13.2
Zn. Conc.....	57.7	7.9	5.0	27.0	17.0
Tails.....	28.6	1.5	2.5	4.6	11.2

	% RECOVERIES			
	Ag.	Pb.	Zn.	Fe.
20 Heads.....				
Pb. Conc.....	50.7	54.9	8.0	12.2
Zn. Conc.....	45.0	36.9	84.9	66.2
Tails.....	4.3	8.2	7.1	21.7

A pulp of 80 mesh Calumet and Hecla slimes containing 0.44% copper, mostly native, with considerable mineral occluded in the coarser particles of the gangue, was agitated for twenty-five minutes with caustic soda 1. pound, potassium xanthate 0.25 pounds, N.T.U. oil 0.25 pounds, and 0.25 pounds pine oil and rosin mixed, all in pounds per ton. The results are shown in the following table:

	% ASSAYS		% RECOVERIES
	% Wt.	Cu.	Cu.
30 Heads.....	100.0	0.44	
Conc.....	1.6	12.24	44.8
Midd.....	21.4	0.88	43.2
Tails.....	77.0	0.068	12.0

Other tests indicated that in commercial operations it would be possible to take off a concentrate containing 30% to 40% of copper, returning some or all the remainder of the concentrate as a middling for retreatment or diverting it to separate treatment.

To preferentially float copper and not iron it has been found advantageous to add lime or slaked lime during fine grinding so that the pulp shows an alkalinity of 0.5% to 1% in the filtrate from the ore pulp when titrated against 1/10N. H_2SO_4 using phenolphthalein as indicator. Pulp thus treated when subjected to agitation with 0.1 to 0.15 pounds of a xanthate per ton and a minimum of mineral-frothing agents selects copper over iron more effectively than has hitherto been possible.

Phelps-Dodge table concentrates were ground with 5 pounds of lime per ton to make about 300-mesh material and then agitated in a pulp for five minutes with potassium xanthate, 0.10 pounds per ton, and steam distilled pine oil, 0.05 pounds per ton, to yield a concentrate. The pulp was then further agitated for fifteen minutes with an addition of potassium xanthate, 0.05 pounds per ton, and the same pine oil, 0.05 pounds per ton, to yield a middling. The results are shown in the following table:

	% ASSAYS			% RECOVERIES
	% Wt.	Cu.	Fe.	Cu.
20 Heads.....	100.0	3.71		
Conc.....	8.5	26.88	31.4	61.7
Midd.....	9.4	8.68	40.7	22.0
Tails.....	82.1	.74	43.3	16.3

It will be noted that there was effective concentration of the copper, but no concentration of the iron even in this highly refractory ore.

Having thus described certain embodiments of this invention what is claimed is:

1. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of an alkaline pulp to a flotation operation in the presence of a xanthate.

2. The improvement in the concentration of minerals by flotation which comprises subjecting the minerals in the form of a pulp made alkaline by the addition of lime to a flotation operation in the presence of a xanthate.

3. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of an alkaline pulp to a flotation operation in the presence of potassium xanthate.

4. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a pulp made alkaline by the addition of lime to a flotation operation in the presence of potassium xanthate.

5. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of an alkaline pulp to a flotation operation in the presence of potassium xanthate and a frothing agent.
6. The process of concentrating an ore which consists in agitating a pulp of the ore with a sulphur derivative of carbonic acid adapted to yield anions and cations in solution and a mineral-frothing agent and an added alkaline substance to form a mineral bearing froth, and separating the froth.
- 10 7. The process of concentrating an ore which consists in agitating an alkaline pulp of the ore with a sulphur derivative of carbonic acid adapted to yield anions and cations in solution and a mineral-frothing agent to form a mineral-bearing froth, and separating the froth.
8. The process of concentrating a complex ore which consists in agitating a pulp of the ore with a sulphur derivative of carbonic acid adapted to yield anions and cations in solution and a mineral-frothing agent to form a mineral-bearing froth relatively rich in one mineral, separating the froth, further agitating the froth with further
20 added flotation agent to form a mineral-bearing froth relatively rich in another mineral, and separating the second froth.
9. The process of concentrating a complex ore which consists in agitating a pulp of the ore with a sulphur derivative of carbonic acid adapted to yield anions and cations in solution and a mineral-frothing agent to form a mineral-bearing froth relatively rich in one mineral, separating the froth, further agitating the pulp with further added flotation agent including an alkaline substance to form a mineral-bearing froth relatively rich in another mineral, and separating the second froth.
- 30 10. The process of concentrating an ore which consists in agitating a pulp of the ore with a xanthate and a mineral-frothing agent and an added alkaline substance to form a mineral-bearing froth and separating the froth.
11. The process of concentrating a complex ore which consists in agitating a pulp of the ore with a xanthate and a mineral-frothing agent to form a mineral-bearing froth relatively rich in one mineral, separating that froth, and further agitating the pulp with further added mineral-frothing agent to form a second mineral-bearing froth relatively rich in another mineral, and separating the second froth.
- 40 12. The process of concentrating a complex ore which consists in agitating a pulp of the ore with a xanthate and a mineral-frothing agent to form a mineral-bearing froth relatively rich in one mineral, separating that froth, further agitating the pulp with an alkaline substance to form a second mineral-bearing froth relatively rich in another mineral and separating the second froth.

Exhibit—D-82.

13. The process of concentrating a complex ore which consists in agitating a pulp of the ore with a xanthate and a mineral-frothing agent to form a mineral-bearing froth relatively rich in one mineral, separating that froth, further agitating the pulp with added flotation agent including an alkali to form a second mineral-bearing froth relatively rich in another mineral, and separating the second froth.

14. The process of concentrating a lead-zinc ore which consists in agitating a pulp of the ore with a xanthate and a mineral-frothing agent to form a lead-bearing froth, separating the froth, further
10 agitating the pulp with further added mineral-frothing agent to form a zinc-bearing froth, and separating the second froth.

15. The process of concentrating ore which consists in agitating a pulp of the ore with a sulphur derivative of carbonic acid containing an organic radical and with a mineral-frothing agent and an added alkaline substance to form a mineral-bearing froth, and separating the froth.

16. The process of concentrating an ore which consists in agitating an alkaline pulp of the ore with a sulphur derivative of carbonic acid containing an organic radical and with a mineral-
20 frothing agent to form a mineral-bearing froth, and separating the froth.

Signed at San Francisco, County of San Francisco, State of California. This 6th day of October, 1924.

CARL PIERCE LEWIS.

WITNESSES:

CARL F. WILLIAMS
ARTHUR MCGOWN

Exhibit—D—81.

EXHIBIT—D—81

Patented Sept. 22, 1925.

UNITED STATES PATENT OFFICE

CARL PIERCE LEWIS, OF BURLINGAME, CALIFORNIA, ASSIGNOR TO
MINERALS SEPARATION NORTH AMERICAN CORPORATION, OF
NEW YORK, N.Y., A CORPORATION OF MARYLAND.

CONCENTRATION OF ORES

No Drawing. Application filed March 27, 1924. Serial No. 702,367.

To all whom it may concern:

10 Be it known that I, CARL PIERCE LEWIS, a citizen of the United States, and a resident of Burlingame, county of San Mateo, State of California, have invented certain new and useful Improvements in Concentration of Ores, of which the following is a specification.

This invention relates to the froth-flotation concentration of ores, and is herein described as applied to the concentration of certain ores with mineral-frothing agents in the presence of certain organic compounds containing sulphur.

It has been found that certain sulphur derivatives of carbonic acid greatly increase the efficiency of the froth-flotation process when
20 used in connection with mineral-frothing agents. The increased efficiency shows itself sometimes in markedly better recoveries, sometimes in effecting the usual recoveries with greatly reduced quantities of the usual mineral-frothing agents, and sometimes in greatly reducing the time needed for agitation to produce the desired recoveries.

The invention is herein disclosed in some detail as carried out with salts of the sulphur derivatives of carbonic acid containing an organic radical, such as an alkyl radical, and known as xanthates as the new substance. These form anions and cations in solution.
30 Excellent results were also obtained by agitating ore pulps with the complex mixture produced when $33\frac{1}{3}\%$ of pine oil was incorporated with an alcoholic solution of potassium hydrate, and xanthates or analogous substances were produced by adding carbon disulphide to this mixture.

The present application is in part a continuation of the application of Cornelius H. Keller and myself, filed October 23, 1923, Serial Number 670,242, which has been changed to a sole application of the said Cornelius H. Keller with claims for that part of the invention described and claimed in said joint application which was in fact
40 the sole invention of the said Cornelius H. Keller. The present application claims that part of the invention described and claimed in said joint application which was in fact my sole invention.

According to the present invention these sulphur derivatives of carbonic acid may be used in alkaline ore pulps or in ore pulps in which alkali has been added, and this or other procedure may be used to effect differential flotation of the various metalliferous minerals of complex ores.

The galena-bearing froth obtained with xanthates or analogous substances used at the rate of 0.2 pounds per ton of ore had a characteristic bright sheen, like a plumbago-bearing froth, and seemed to make a more coherent froth than when other materials were used
10 on the same ore.

In general the substances referred to are not mineral-frothing agents, producing only a slight scum, and some evanescent frothy bubbles, when subjected to agitation which would produce mineral-bearing froth on an ore pulp in the presence of a mineral-frothing agent. The substances are effective in enabling a selective flotation of lead and zinc; and cause uncombined silver, if present, to tend to go into the lead concentrate rather than with the zinc, where these are separated in separate concentrates. Usually pre-agitation is unnecessary, the brightening and other effects seeming to be practi-
20 ally instantaneous.

For laboratory purposes potassium xanthate was prepared as follows:

198.4 grams of 88.5% caustic potash was dissolved in 524 grams ethyl alcohol (denatured No. 5 formula) at a temperature of 124°F., in a reflux condenser. The solution was cooled to 58°F. It contained a large excess of alcohol over the theoretical amount needed for the subsequent reactions. To this was added, while stirring, and in a cooling bath, the theoretical amount of carbon disulphide. The reaction was substantially instantaneous, producing a thick
30 pulp of potassium xanthate. The pulp was cooled and centrifuged in a laboratory machine yielding crystals containing about 20% moisture. The yield thus obtained was 74.7%. Another 17.5% was obtained by evaporation of the mother liquor. Both the centrifuged crystals and the residue from the mother liquor gave excellent results in flotation. It was found in cases where sulphuric acid was used that the centrifuged material yielded better results than the uncentrifuged.

A pulp of Cash Mine ore subjected first to agitation for ten minutes with a mixture of 0.3 pounds per ton of potassium xanthate
40 with a small proportion of a 10% or a saturated solution of naphthalene in xylene, to yield a lead concentrate, and then subjected to agitation for ten minutes with copper sulphate 0.2 pounds per ton, Barrett No. 4 flotation oil 1.0 pound per ton, and General Naval Stores No. 5 flotation oil 0.1 pounds per ton, yielded the results shown in the following table. Attention is called to the recovery of 95% of the lead in a concentrate containing 87% of the silver but contain-

Exhibit—D-81.

ing only 5% of zinc, while 70% of the zinc was recovered in the zinc concentrate.

Cash Mine ore, assays.

	% Wt.	Au. (oz.)	Ag. (oz.)	Cu.	Pb.	Zn.	Fe.
Heads	100.0	.154	10.7	3.18	14.9	7.7	11.9
Pb. conc.	38.0	.24	24.6	7.12	37.4	5.0	21.4
Zn. conc.	15.4	.36	6.3	2.56	3.0	35.2	12.0
Tails.	46.6	.015	0.9	.26	0.5	0.8	4.2

10

% RECOVERIES

	Au.	Ag.	Cu.	Pb.	Zn.	Fe.
Pb. conc.	59.4	87.1	85.2	95.3	24.7	68.4
Zn. conc.	36.0	9.0	11.0	3.1	70.5	15.5
Tails.	4.6	3.9	3.8	1.6	4.8	16.4

A pulp of San Francisco Mines of Mexico ore was agitated for ten minutes with potassium xanthate 0.15 pounds per ton and the same amount of coal tar creosote to yield a lead concentrate. The remaining pulp was agitated for fifteen minutes with 0.2 pounds per ton of copper sulphate, 1.2 pounds per ton of water-gas tar, and 0.05 pounds per ton of steam distilled pine oil. The results are shown in the following table:

20

San Francisco Mines of Mexico

	ASSAYS.				% RECOVERIES.		
	% Wt.	Ag. (oz.)	Pb.	Zn.	Ag.	Pb.	Zn.
Heads.	100.0	16.5	9.4	16.1	.....	.....	.....
Pb. conc.	12.2	67.0	64.0	12.0	49.4	83.2	9.1
Zn. conc.	28.9	23.6	3.6	43.4	41.2	11.1	78.0
Tails.	58.9	4.5	1.5	6.0	9.4	5.7	12.9

30

Similar results were obtained with this ore by agitating for five minutes with 0.15 pounds each of sodium xanthate and Barrett No. 2 flotation oil per ton of ore, to yield a lead concentrate, and then agitating for ten minutes with 0.3 pounds copper sulphate, 1.3 pounds Barrett No. 4 flotation oil, and General Naval Stores No. 5 flotation oil 0.1 pounds, all per ton of ore, to yield a zinc concentrate.

Exhibit—D-81.

Anaconda ore slimes containing 3.28% copper of which 0.45% was acid soluble, were subjected to froth-flotation concentration at 70° F. with 7.8 pounds per ton of dry hydrated lime, 0.132 pounds per ton of steam distilled oil 0.38 pounds per ton of destructively distilled pine oil (G.N.S. No. 11 flotation), and 0.69 pounds per ton of potassium xanthate in solution, yielding concentrates containing 13.76% copper and 34.7% insolubles, with a tailing of 0.317% copper of which 0.173% was acid soluble. This represented a recovery of 92.2%.

- 10 The lime was mixed with water and fed as a watery paste with the slimes to the first agitator of a series of nine standard minerals separation agitators or mixing compartments through which the pulp passed in series at the rate of 97 tons in 24 hours. The No. 11 pine oil was added at the seventh agitator and 0.6 pounds per ton of the xanthate at the ninth. The pulp returned through fourteen spitzkastens each equipped with a Brown aerator and circulating device. At the sixth spitzkasten the balance of the xanthate was added. At the tenth spitzkasten the steam distilled pine oil was added. The froth from the first nine spitzkastens was collected as a
20 finished concentrate, that from the remaining five was returned to the first as a middling.

It has also been found that for the froth-flotation concentration of certain ores, such as Calumet & Hecla, Britannia, Cananea and Moctezuma, mother liquor obtained from centrifuging the above described xanthates in the process of manufacture of said xanthates may be used with about the same proportions of mother liquor as of the xanthate crystals specified with results as good or better than those above given.

- In one test a freely flowing pulp containing 1200 grams of Ana-
30 conda slimes assaying 2.95% copper was agitated 15 minutes in a sub-aeration machine at 17°C. with 5 pounds of soda ash, 0.7 pounds of potassium xanthate, and 0.2 pounds of steam distilled pine oil, all per ton of ore, yielding a concentrate containing 13.87% copper. The ration of concentration was 5.2. The concentrate contained 91.5% of the copper, and an additional 4.1% was contained in a middling which held 0.68% of copper. The tailings contained 0.20% of copper which was 4.4% of that present in the heads.

- The xanthate may be used to replace a part of the alkali normally used in the concentration of certain ores, and in differential flotation
40 it may be used to replace either a part or all of the alkali normally used.

A pulp of Park Utah lead zinc ore was agitated for ten minutes with potassium xanthate 0.15 pounds, and Barrett No. 2 flotation oil 0.15 pounds, to yield a lead concentrate. The remainder of the pulp was then agitated fifteen minutes with soda ash, 1.5 pounds, copper sulphate, 0.5 pounds, water gas tar, 1 pound, and pine oil,

Exhibit—D-81.

0.05 pounds, to yield a zinc concentrate. The zinc concentrate was then reagitated with added water for five minutes to yield a finished zinc concentrate and a zinc middling. All flotation and frothing agents were measured in pounds per ton. The results are shown in the following table:

	% ASSAYS.				RECOVERIES.		
	% Wt.	Ag. (oz.)	Pb.	Zn.	Ag.	Pb.	Zn.
Heads	100.0	5.39	8.24	12.55	.....	.....	.....
10 Pb. conc.	11.7	31.3	60.0	10.4	68.0	85.2	9.7
Zn. conc.	29.3	4.2	1.7	32.0	22.8	6.1	75.3
Zn. midd.	3.0	3.6	3.5	12.4	2.0	1.3	4.6
Tails.	56.0	0.7	1.1	2.3	7.2	7.4	10.4

A pulp of Sullivan ore was agitated for seven minutes with potassium xanthate 0.1 pounds, and coal tar creosote, 0.1 pounds, to yield a lead concentrate. The remaining pulp was then agitated fifteen minutes with soda ash, 2 pounds, sulphate of copper, 0.5 pounds, and water gas tar, 1.3 pounds, to yield a zinc concentrate. All these quantities were in pounds per ton of ore. These concentrates
 20 were reagitated with the addition of water to produce respectively a lead finished concentrate and middling and a zinc finished concentrate and middling. The results are shown in the following table:

	% ASSAYS.					% RECOVERIES.		
	% Wt.	Ag. (oz.)	Pb.	Zn.	Fe.	Pb.	Zn.	Fe.
Heads.	100.0	.....	12.06	15.3	30.6	.....	.....	.....
Pb. conc. .	15.0	13.1	60.4	9.2	8.2	75.2	9.0	4.0
Pb. midd. .	5.3	3.6	15.6	12.0	35.5	6.8	4.2	6.0
Zn. conc. .	29.3	2.1	6.0	43.0	13.3	14.4	82.4	12.6
30 Zn. midd. .	4.6	1.1	3.6	6.4	45.2	1.4	2.0	6.8
Tails.	45.8	0.4	.6	.8	47.2	2.2	2.4	70.6

A pulp of the highly refractory ore of the North Star Mine of the Federal Mining & Smelting Co. was agitated for ten minutes with an added mixture of 90% potassium xanthate and 10% Barrett No. 2 creosote, 0.2 pounds, and with 0.1 pounds of separately added Barrett No. 2 creosote, to yield a lead concentrate. The remaining pulp was reagitated for fifteen minutes with copper sulphate 0.7 pounds, soda

Exhibit—D-81.

ash, 1.5 pounds, to yield a zinc concentrate. All weights are per ton of ore. The results are shown in the following table:

	% ASSAYS.					% RECOVERIES.			
	% Wt.	Ag. (oz.)	Pb.	Zn.	Fe.	Ag.	Pb.	Zn.	Fe.
Heads..	100.0	10.1	7.9	18.4	14.8	.....	.....	.....	.....
Pb. conc	13.7	37.4	31.2	10.8	13.2	50.7	54.9	8.0	12.2
Zn. conc	57.7	7.9	5.0	27.0	17.0	45.0	36.9	84.9	66.2
Tails...	28.6	1.5	2.5	4.6	11.2	4.3	8.2	7.1	21.7

- 10 A pulp of 80 mesh Calumet and Hecla slimes containing 0.44% copper, mostly native, with considerable mineral occluded in the coarser particles of the gangue, was agitated for twenty-five minutes with caustic soda 1 pound, potassium xanthate 0.25 pounds, N. T. U. oil 0.25 pounds, and 0.25 pounds pine oil and rosin mixed, all in pounds per ton. The results are shown in the following table:

	% ASSAYS.		% RECOVERIES.
	% Wt.	Cu.	Cu.
Heads.....	100.0	0.44	.....
20 Conc.	1.6	12.24	44.8
Midd.	21.4	0.88	43.2
Tails.	77.0	0.068	12.0

Other tests indicated that in commercial operations it would be possible to take off a concentrate containing 30% to 40% of copper, returning some or all the remainder of the concentrate as a middling for retreatment or diverting it to separate treatment.

- 30 To preferentially float copper and not iron it has been found advantageous to add lime or slaked lime during fine grinding so that the pulp shows an alkalinity of 0.5% to 1% in the filtrate from the ore pulp when titrated against 1/10 NH_2SO_4 using phenolphthalein as indicator. Pulp thus treated when subjected to agitation with 0.1 to 0.15 pounds of a xanthate per ton and a minimum of mineral-frothing agents selects copper over iron more effectively than has hitherto been possible.

Phelps-Dodge table concentrates were ground with 5 pounds of lime per ton to make about 300-mesh material and then agitated in a pulp for five minutes with potassium xanthate, 0.10 pounds per ton, and steam distilled pine oil, 0.05 pounds per ton, to yield a concen-

Exhibit—D—81.

trate. The pulp was then further agitated for fifteen minutes with an addition of potassium xanthate, 0.05 pounds per ton, and the same pine oil, 0.05 pounds per ton, to yield a middling. The results are shown in the following table:

	% ASSAYS.			% RECOVERIES.
	% Wt.	Cu.	Fe.	Cu.
Heads.	100.0	3.71	.....	.....
Conc.	8.5	26.88	31.4	61.7
10 Midd.	9.4	8.68	40.7	22.0
Tails.	82.1	.74	43.3	16.3

It will be noted that there was effective concentration of the copper, but no concentration of the iron even in this highly refractory ore.

Having thus described certain embodiments of this invention what is claimed is:

1. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of an alkaline pulp to a flotation operation in the presence of a xanthate.
- 20 2. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a pulp made alkaline by the addition of lime to a flotation operation in the presence of a xanthate.
3. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of an alkaline pulp to a flotation operation in the presence of potassium xanthate.
4. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a pulp
30 made alkaline by the addition of lime to a flotation operation in the presence of potassium xanthate.
5. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of an alkaline pulp to a flotation operation in the presence of potassium xanthate and a frothing agent.
6. The process of concentrating an ore which consists in agitating a pulp of the ore with a sulphur derivative of carbonic acid adapted to yield anions and cations in solution and with a mineral-frothing agent and an added alkaline substance to form a mineral-
40 bearing froth and separating the froth.
7. The process of concentrating an ore which consists in agitating an alkaline pulp of the ore with a sulphur derivative of

Exhibit—D—81.

carbonic acid adapted to yield anions and cations in solution and with a mineral-frothing agent to form a mineral-bearing froth and separating the froth.

8 The process of concentrating a complex ore which consists in agitating a pulp of the ore with a sulphur derivative of carbonic acid adapted to yield anions and cations in solution and with a mineral-frothing agent to form a mineral-bearing froth relatively rich in one mineral; separating the froth, further agitating the pulp with further added flotation agent to form a mineral-bearing froth relatively rich
10 in another mineral, and separating the second froth.

9. The process of concentrating a complex ore which consists in agitating a pulp of the ore with a sulphur derivative of carbonic acid adapted to yield anions and cations in solution and with a mineral-frothing agent to form a mineral-bearing froth relatively rich in one mineral, separating the froth, further agitating the pulp with the addition of flotation agent including an alkaline substance to form a mineral-bearing froth relatively rich in another mineral, and separating the second froth.

10. The process of concentrating an ore which consists in
20 agitating a pulp of the ore with a xanthate and a mineral-frothing agent and an added alkaline substance to form a mineral-bearing froth and separating the froth.

11. The process of concentrating a complex ore which consists in agitating a pulp of the ore with a xanthate and a mineral-frothing agent to form a mineral-bearing froth relatively rich in one mineral, separating that froth, and further agitating the pulp with further added mineral-frothing agent to form a second mineral-bearing froth relatively rich in another mineral, and separating the second froth.

12. The process of concentrating a complex ore which consists
30 in agitating a pulp of the ore with a xanthate and a mineral-frothing agent to form a mineral-bearing froth relatively rich in one mineral, separating that froth, further agitating the pulp with an alkaline substance to form a second mineral-bearing froth relatively rich in another mineral and separating the second froth.

13. The process of concentrating a complex ore which consists in agitating a pulp of the ore with a xanthate and a mineral-frothing agent to form a mineral-bearing froth relatively rich in one mineral, separating that froth, further agitating the pulp with added flotation agent including an alkali to form a second mineral-bearing froth
40 relatively rich in another mineral, and separating the second froth.

14. The process of concentrating a lead-zinc ore which consists in agitating a pulp of the ore with a xanthate and a mineral-frothing agent to form a lead-bearing froth, separating the froth, further agitating the pulp with further added mineral-frothing agent to form a zinc-bearing froth, and separating the second froth.

Exhibit—D-81.

15. The process of concentrating an ore which consists in agitating a pulp of the ore with a sulphur derivative of carbonic acid containing an organic radical and with a mineral-frothing agent and an added alkaline substance to form a mineral-bearing froth, and separating the froth.

16. The process of concentrating an ore which consists in agitating an alkaline pulp of the ore with a sulphur derivative of carbonic acid containing an organic radical and with a mineral-frothing agent to form a mineral-bearing froth, and separating the
10 froth.

In testimony whereof, I have affixed my signature to this specification.

CARL PIERCE LEWIS.

Exhibit—K-44.

EXHIBIT-K—44

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UNITED STATES PATENT OFFICE

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FROTH-FLOTATION CONCENTRATION OF ORES

No Drawing. Application filed January 11, 1926. Serial No. 80.666.

10 This invention relates to froth-flotation concentration of ores and is herein mainly illustrated as applied to the concentration of ores in which iron occurs in considerable proportion but is essentially a gangue ingredient. In concentrating such ores, especially in concentrating iron-bearing lead-zinc ores and certain copper ores, attempts have been made, by using very small quantities of flotation agents, to inhibit flotation of the iron while at the same time effecting a satisfactory flotation of the more valuable mineral. Such a method of conducting the concentration operation usually requires delicate adjustments and may involve considerable loss of valuable mineral which is dropped in dropping the iron.

20 According to the present invention a sulphur-containing organic compound is used which is a sulphhydic derivative of a hydrocarbon and which in examples given below shows a marked effect in cooperating with many mineral-frothing agents in facilitating the flotation of the more valuable mineral in a richer concentrate and also in minimizing the flotation of the iron. The invention is herein disclosed in some detail as carried out with ethyl sodium mercaptide, which is a fairly stable crystalline compound, and with para-thio-cresol, with thio-beta-naphthol, with thio-phenol, and with benzyl mercaptan. Another sulphhydic derivative of a hydro-carbon, to
23 wit, ethyl mercaptan, itself, has also been found to be an effective reagent for the same purposes.

Other features and advantages will hereinafter appear.

Various methods may be found suitable for the commercial preparation of mercaptides, but for the work described herein sodium ethyl mercaptide was prepared by adding metallic sodium to ethyl mercaptan. Mercaptans may be regarded as substituted alcohols, containing sulphur instead of oxygen, thus ethyl mercaptan is C_2H_5SH . A mercaptide may be regarded as a mercaptan in which the sulphhydic hydrogen is replaced by a metal as in sodium ethyl
40 mercaptide C_2H_5SNa .

The following are examples wherein ethyl mercaptide was used:

Example 1.—Utah copper ore already ground was further ground for five minutes in a laboratory ball mill with six pounds of lime,

Exhibit—K-44.

measured as calcium oxide, per ton of ore, and was then made into a pulp with the requisite amount of water and agitated for eight minutes in a minerals separation spitzkasten subaeration testing machine with 0.24 pounds of sodium ethyl mercaptide per ton of ore and with one-tenth of a pound of hardwood creosote per ton of ore. The concentrates was separated in the form of a froth and was reagitated with the further addition of three-tenths of a pound of hardwood creosote per ton of ore. The results are shown in the following table:

10	ASSAYS			RECOVERIES	
	Wt. %	Cu. %	Fe. %	Cu. %	Fe. %
Heads ..	100.0	1.01	2.64	100.0	100.0
Conc. ...	2.0 } 3.6	36.56 } 23.3	25.7 } 17.3	72.4 } 82.9	19.5 } 23.6
Midd. ...	1.6 }	6.60 }	6.8 }	10.5 }	4.1 }
Tail. ...	96.4	.18	2.1	17.1	76.4

Example 2.—A four-charge cycle test on another sample of Utah ore showed that there was no tendency to build up either iron or copper in the middlings. The same reagents were used in slightly different quantities, to wit, sodium mercaptide 0.22 pounds per ton, hardwood creosote 0.15 pounds per ton, lime, as CaO, six pounds per ton. This yielded a rougher concentrate which was retreated with a further addition of one-tenth of a pound of creosote per ton of original ore, and produced a finished concentrate and a middling. A second charge was then made up in all respects the same as that for the first treatment and to it was added the middling obtained from the retreatment last described. This yielded a rougher concentrate which was retreated as before to yield a finished concentrate and a middling. A third charge and thereafter a fourth charge were each treated as above described. The concentrates of the four charges were united and assayed as a single product.

The results are shown in the following table;

Product	ASSAYS.			RECOVERIES	
	Wt. %	Cu. %	Fe. %	Cu. %	Fe. %
Heads ..	100.0	0.60	2.26	100.0	100.0
Conc. ...	2.1	21.36	25.0	75.0	23.0
Midd. ...	0.8	2.28	5.4	3.3	1.8
Tail 1..	23.4	0.12	1.6	5.0	16.4
Tail 2..	24.2	0.12	1.3	5.0	13.7
Tail 3..	24.6	0.12	1.9	5.0	20.8
Tail 4..	24.9	0.14	2.2	6.7	24.3

Example 3.—A test similar to the first example was carried out with a much smaller amount of sodium ethyl mercaptide. In this test the agitation with lime in the ball mill was the same, the first agitation in the flotation machine was with 0.04 pounds of sodium ethyl mercaptide, and 0.2 pounds of hardwood creosote, all per ton of ore, for eight minutes. The concentrate obtained by this treatment was reagitated for three minutes with a further addition of 0.2 pounds of hardwood creosote per ton of original ore. The results are shown in the following table, showing a lower recovery but which was offset
10 by a higher grade of concentrate and an increased rejection of the iron.

	ASSAYS			RECOVERIES	
	Wt. %	Cu. %	Fe. %	Cu. %	Fe. %
Heads ..	100.0	1.04	2.60	100.0	100.0
Conc. ..	1.4 } 3.4	39.84 } 21.98	24.3 } 14.1	53.8 } 71.9	13.1 } 18.5
Midd. ..	2.0 }	9.48 }	7.0 }	18.1 }	5.4 }
Tail. ...	96.6	.30	2.2	28.1	81.5

Large rejection of the iron of the ore and richness of the concentrate brought about by the use of a mercaptide are illustrated in
20 the following test of Engels copper ore.

Example 4.—The ore was ground fifteen minutes in a laboratory ball mill, and then was made into a pulp and agitated for ten minutes with 2.5 pounds of tri-sodium phosphate (enough to make the pulp alkaline), 0.12 pounds of sodium ethyl mercaptide, and 0.2 pounds of hardwood creosote, all per ton of ore. The resulting froth concentrate was reagitated with 0.3 pounds of hardwood creosote per ton of original ore. The results are shown in the following table:

	ASSAYS			RECOVERIES	
	Wt. %	Cu. %	Fe. %	Cu. %	Fe. %
Heads ..	100.0	1.78	.....	100.0	100.0
Conc. ..	3.9 } 6.7	33.68 } 22.4	14.3 } 12.6	73.7 } 84.3	5.6 } 8.5
Midd. ..	2.8 }	6.76 }	10.2 }	10.6 }	2.9 }
Tail. ...	93.3	.30	9.7	15.7	91.5

The complex and refractory silver-lead-zinc iron-bearing ore of the San Francisco mines of Mexico yielded rich lead and zinc concentrates relatively free from iron when concentrated with sodium ethyl mercaptide.

Exhibit—K-44.

Example 5.—The ore was ground for fifteen minutes in a ball mill with half a pound of sodium sulphide per ton of ore. It was then made into a pulp and agitated for seven minutes with three pounds of soda ash, 0.04 pounds of sodium mercaptide, 0.3 pounds of Barrett No. 634 oil, and 0.15 pounds of cresylic acid, all per ton of ore, and a lead-bearing froth was separated. The remainder of the ore pulp was then further agitated for ten minutes with the addition of one-half pound of copper sulphate, 0.1 pounds of sodium mercaptide, 0.3 pounds of Barrett No. 634 oil, and 0.2 pounds of steam distilled pine oil, all per ton of ore, and a zinc-bearing froth separated. The above lead concentrate was separated into a finished concentrate and a middling by reagitation for five minutes with 0.2 pounds of cresylic acid per ton of original ore. The above zinc concentrate was separated into a finished concentrate and a middling by reagitation for three minutes without any added reagent. The results are shown in the following table:

Assays

	Wt. %	Ag. oz. p.t.	Pb. %	Zn. %	Fe. %
Heads	100.0	21.9	10.4	22.7	6.7
Pb. Conc.	11.0	61.3	58.4	15.6	4.3
Pb. Midd.	8.5	50.8	22.8	32.3	8.8
Zn. Conc.	28.1	23.4	3.2	51.0	8.4
Zn. Midd.	6.0	22.8	6.0	23.2	10.4
Tail.	46.4	6.2	1.6	5.4	5.4

Recoveries

	Ag. %	Pb. %	Zn. %	Fe. %
Heads	100.0	100.0	100.0	100.0
Pb. Conc.	30.9	61.9	7.6	7.0
Pb. Midd.	19.7	18.7	12.1	11.2
Zn. Conc.	30.0	8.7	63.2	35.2
Zn. Midd.	6.2	3.5	6.1	9.3
Tail.	13.2	7.2	11.0	37.3

It was found that sodium mercaptide a week old gave nearly the same results as the fresh material.

Extraordinarily complete concentrations have been accompanied by a very large rejection of the iron, as in the following test of California rand ore.

Example 6.—The ore was ground in a ball mill for twenty minutes with 3.3 pounds trona (a natural alkali) per ton of ore, and then made

Exhibit—K-44.

into a pulp with water and agitated for fifteen minutes with 0.17 pounds of sodium ethyl mercaptide, 0.33 pounds of coal tar creosote, and 0.17 pounds of steam distilled pine oil, all per ton of ore. The froth concentrate thus obtained was reagitated for four minutes with the further addition of 0.04 pounds of steam distilled pine oil per ton of original ore and yielded a finished concentrate and a middling. The results are shown in the following table:

Assays

	Wt. %	Au. oz. p.t.	Ag. oz. p.t.	Fe. %
10 Heads	100.0	.29	36.6	5.5
Conc.	5.0 } 11.0	3.64 } 1.96	631. } 303	32.3 } 20.8
Midd.	6.0 }	.57 }	31.7 }	11.2 }
Tail.	89.0	.08	3.6	3.5

Recoveries

	Au. %	Ag. %	Fe. %
Heads	100.0	100.0	100.0
Conc.	63.3 } 75.2	86.1 } 91.3	29.4 } 41.6
Midd.	11.9 }	5.2 }	12.2 }
Tail.	24.8	8.7	58.4

- 20 It has been found that a sulphhydryc derivative of a hydrocarbon is a useful flotation agent in acid and neutral pulps as well as in the alkaline pulps of the above examples.

Example 7.—Ore of the Allenby Copper Company of British Columbia, containing bornite as the principal copper mineral, was reground for twenty minutes in a ball mill, made into a pulp with water, and agitated with 0.11 pounds of sodium ethyl mercaptide and one-tenth of a pound of cresylic acid, both per ton of ore, and yielded a finished concentrate. The results are shown in the following table:

30 PRODUCT	ASSAYS			RECOVERIES	
	Wt. %	Cu. %	Fe. %	Cu. %	Fe. %
Heads	100.0	1.88	4.36	100.0	100.0
Conc.	5.3	27.92	10.8	78.7	13.1
Tail.	94.7	0.42	4.0	21.3	86.9

Example 8.—Classifier overflow of Anaconda copper ore was reground in a ball mill for five minutes, made into a pulp with water, and agitated for eleven minutes with 0.22 pounds of sodium ethyl mercaptide, one-tenth of a pound of steam distilled pine oil and ten pounds of sulphuric acid, all per ton of ore. The results are shown in the following table:

PRODUCT	ASSAYS			RECOVERIES	
	Wt. %	Cu. %	Fe. %	Cu. %	Fe. %
10 Heads	100.0	1.33	4.08	100.0	100.0
Conc.	13.4	9.04	24.6	21.0	80.9
Tail	86.6	0.14	0.9	9.0	19.1

It has also been found that a sulphhydryc derivative of a hydrocarbon is a useful flotation agent when used with such a flotation agent as sodium silicate. It is at times advantageous to add the sodium silicate before the other reagents are added, although this may require a larger quantity of sodium silicate. This procedure has been found to be especially useful in concentrating a copper ore in which a substantial proportion of the copper is oxidized.

20 *Example 9.*—Inspiration ore containing a substantial proportion of oxidized copper was reground for twenty minutes in a ball mill and then made into a pulp with water, and 1.5 pounds of sodium silicate were added to the pulp and mixed therewith. Then were added 0.22 pounds of sodium ethyl mercaptide, 0.6 pounds of hardwood creosote and 0.2 pounds of Barrett coal tar creosote, all per ton of ore, and the pulp agitated for twenty minutes to form a rougher froth concentrate. This concentrate was reagitated for five minutes with half a pound of sodium silicate per ton of original ore, to form a finished concentrate and a middling. The results are shown in the
30 following table:

	ASSAYS				RECOVERIES		
	Wt. %	Cu. %	Ox. Cu. %	Fe. %	Cu. %	Ox. Cu. %	Fe. %
Heads ...	100.0	0.89	0.22	1.81	100.0	100.0	100.0
Conc.	1.4	37.42	0.68	20.4	58.4	4.5	16.0
Midd. ...	4.7	3.22	0.54	6.4	16.9	9.1	16.6
Tail.	93.9	0.24	0.20	1.3	24.7	86.4	67.4

In the following example phenol mercaptan or thiophenol was used:

Exhibit—K-44.

Example 10.—Impact screen undersize of Utah copper ore was reground with 6 pounds of calcium oxide and with 0.4 pounds of thiophenol, both per ton of the material treated, and was then made into a pulp with water and agitated for ten minutes with 0.4 pounds of dark cresylic acid per ton, and a froth concentrate collected. The results are shown in the following table:

PRODUCT	ASSAYS			RECOVERIES	
	Wt. %	Cu. %	Fe. %	Cu. %	Fe. %
10 Heads	100.0	1.25	1.36	100.0	100.0
Conc.	4.42	25.76	13.5	90.8	43.8
Tail.	95.58	.12	0.8	9.2	56.2

In the following example thio-beta-naphthol was used:

Example 11.—Impact screen undersize of Utah copper ore was reground with 6 pounds of calcium oxide and 0.4 pounds of thio-beta-naphthol, both per ton of material treated, and was then made into a pulp with water and agitated for ten minutes with 0.55 pounds of dark cresylic acid per ton and a froth concentrate collected. The results are shown in the following table:

PRODUCT	ASSAYS			RECOVERIES	
	Wt. %	Cu. %	Fe. %	Cu. %	Fe. %
20 Heads	100.0	1.30	1.54	100.0	100.0
Conc.	5.05	23.52	13.6	91.2	44.5
Tail.	94.95	.12	0.9	8.8	55.5

In the following example para-thio-cresol was used:

Example 12.—Impact screen undersize of Utah copper ore was reground with 6 pounds of calcium oxide and 0.4 pounds of para-thio-cresol, both per ton of material treated, and was then made into a pulp with water and agitated for ten minutes with 0.9 pounds per ton of dark cresylic acid and a froth concentrate collected. The results are shown in the following table:

PRODUCT	ASSAYS			RECOVERIES	
	Wt. %	Cu. %	Fe. %	Cu. %	Fe. %
30 Heads	100.0	1.26	1.51	100.0	100.0
Conc.	4.51	23.76	14.4	84.8	43.0
Tail.	95.49	.20	0.9	15.2	57.0

Exhibit—K-44.

Nearly as good results were obtained when the thio-phenol or para-thio-cresol or thio-beta-naphthol were added to the pulp instead of to the material while being ground, although the concentrates were not so rich in copper as when the thio agent was added in the grinding mill.

When potassium phenol mercaptide was substituted for potassium phenol mercaptan or thio-phenol the results of the operation were superior to results obtained in a parallel test wherein it was absent. Similarly, when potassium cresol mercaptide was substituted
10 for potassium cresol mercaptan or thio-cresol the results of the operation were superior to results obtained in a parallel test wherein it was absent.

In the following example benzyl mercaptan was used with a copper ore wherein the iron constituent was negligible.

Example 13.—Anaconda table tailings, 65-mesh, were made into a pulp with water and pre-agitated for half a minute in a neutral pulp with 0.32 pounds of pine oil and 0.58 pounds of benzyl mercaptan, both per ton of solids, and then further agitated to yield a froth-concentrate which was separated for three minutes. The results
20 are shown in the following table:

	Cu. %	
Heads	1.28	
Concs.	7.44	Recovers 90.1%
Tails.	0.15	

Having now particularly described certain embodiments of my invention, I claim:

1. The process of concentrating an ore containing a mineral value and gangue, which consists in agitating a suitable pulp of the ore containing sodium ethyl mercaptide so as to produce a mineral-
30 value-bearing froth, and separating the froth.
2. The process of concentrating an iron-bearing ore containing a mineral value and gangue, which consists in agitating a suitable pulp of the ore with sodium ethyl mercaptide so as to form a mineral-value-bearing froth containing a large proportion of a value and a diminished proportion of the iron of the ore, and separating the froth.
3. A method of effecting the concentration of minerals by flotation, which comprises mixing with the mineral pulp a thioalcohol and subjecting the resulting mixture to a froth flotation operation.
4. A method of effecting the concentration of minerals by
40 flotation, which comprises subjecting the mineral pulp to a froth flotation operation in the presence of a nitrogen-free thioalcohol.
5. A process of concentrating ores by flotation which comprises adding to the ground ore a flotation reagent, comprising a compound of the general type R—S—R' in which R stands for an alkyl radical

Exhibit—K-44.

and R' stands for a metal or hydrogen, and subjecting the mixture to a froth flotation operation.

6. A process of concentrating ores by flotation, which comprises subjecting a pulp of an ore of the mineral to be concentrated to froth flotation in the presence of a mercaptan of the general type R—S—H in which R stands for a non-nitrogenous organic radical.

7. The process of concentrating an ore containing a mineral value and gangue, which comprises subjecting a pulp of the ore to froth flotation in the presence of a sulphhydic derivative of a hydro-
10 carbon of the general type R—S—R', in which R stands for an oxygen free organic radical, and R' stands for a metal or hydrogen.

8. The process of concentrating an ore containing a mineral value and gangue, which comprises subjecting a pulp of the ore to froth flotation in the presence of a sulphhydic derivative of an aliphatic alkyl group of the general type R—S—R', in which R' stands for an oxygen-free organic radical and R' stands for a metal or hydrogen.

9. A process of concentrating ores by flotation which comprises adding to the ground ore a flotation reagent comprising ethyl mer-
20 captan and subjecting the mixture to a froth flotation operation.

10. A process of concentrating ores by flotation, which comprises adding to the ground ore a flotation reagent, comprising a compound of the general type R—S—R', in which R stands for the ethyl group and R' stands for a metal or hydrogen.

11. The process of concentrating an iron-bearing ore containing a mineral value and gangue, which consists in agitating a suitable pulp of the ore with a sulphhydic derivative of a hydrocarbon of the general type R—S—R' in which R stands for an oxygen-free organic radical and R' stands for a metal or hydrogen, so as to form a froth
30 containing a large proportion of a value and a diminished proportion of the iron of the ore, and separating the froth.

12. A process of concentrating ores by flotation, which comprises subjecting a pulp of an ore of the mineral to be concentrated to froth flotation in the presence of a mercaptide of the general type R—S—M, in which R stands for a non-nitrogenous organic radical, and M stands for a metal.

In testimony whereof, I have affixed my signature to this specification.

CORNELIUS H. KELLER.

Exhibit—K-43.

EXHIBIT K-43

Patented June 23, 1936

2,044,851

UNITED STATES PATENT OFFICE

2,044,851

FROTH FLOTATION CONCENTRATION OF ORES

CORNELIUS H. KELLER, SAN FRANCISCO, CALIF., ASSIGNOR TO
MINERALS SEPARATION NORTH AMERICAN CORPORATION, NEW
YORK, N.Y., A CORPORATION OF MARYLAND

No Drawing. Application December 6, 1932, Serial No. 645,947

10 4 Claims. (Cl. 209—166)

This invention relates to the concentration of ores by flotation and is herein illustrated as applied to such method of ore concentration by the aid of a sulpho compound containing a phenyl radical, such as a benzyl xanthate, represented by the formula $R-S-R'$ where R represents a non-nitrogenous carbon ring compound, such as a phenyl group, and R' represents a metal or hydrogen. It has been found that the froth-flotation concentration of ores may be effected very economically in the presence of such an agent, since the amount of mineral-frothing agent required is often considerably reduced from
20 the amount otherwise necessary, and the time required for agitation of the ore pulp is often considerably reduced as compared with that required in the absence of such an agent. Moreover, where the new substance is used, the recoveries are often more complete or the concentrate is richer in values to the exclusion of normally floatable iron and other gangue, or both of these advantages are obtained.

This application is a continuation is part of my prior application Serial No. 82,577, filed January 20, 1926.

In the examples herein given one substance used was potassium benzyl xanthate, which is a non-nitrogenous aromatic compound
30 containing a single phenyl group, and which is a sulphur-containing aromatic derivative of carbonic acid. This substance was prepared by dissolving potassium hydroxide in a small amount of water, adding the resulting solution to benzyl alcohol while stirring, and subsequently adding the carbon disulphide. Molecular proportions of benzyl alcohol, potassium hydroxide and carbon disulphide were used, yielding a product which appeared to contain a little free benzyl alcohol. The resulting potassium benzyl xanthate was soluble in water, slightly hygroscopic, and gave the characteristic xanthate reactions with metallic salts.

40 Sodium benzyl xanthate was also tested. It was prepared as follows:—Benzyl alcohol was dissolved in ether, treated with the requisite amount of metallic sodium to form sodium benzyl alcoholate and the resulting solution mixed with the requisite amount of carbon disulphide to form the sodium benzyl xanthate. The resulting

Exhibit—K-43.

crystals were washed with ether to remove free benzyl alcohol. Potassium benzyl xanthate was also similarly prepared. It was found the potassium and sodium benzyl xanthates thus prepared functioned similarly to the potassium benzyl xanthate as above first described. The phenyl sulpho compound in this form of benzyl xanthate was found to be useful in alkaline and neutral pulps and with copper ores and with complex ores such as silver-bearing lead-zinc ores.

The following tests were carried on in a Minerals separation subaeration spitzkasten testing machine.

- 10 *Example 1.*—Anaconda copper slimes were made into a pulp with the requisite amount of water and agitated for a period of five minutes with 0.4 pound of potassium benzyl xanthate per ton of ore. Then 0.15 pound of pine oil per ton of ore was added and the agitation continued for a further period of ten minutes. It was noted that during the first mentioned period of agitation, and before the pine oil was added, apparently due to the fact that both potassium benzyl xanthate and benzyl alcohol were present, a large proportion of the copper mineral was floated and the float was relatively free of iron. The further float obtained upon the addition of pine oil appeared to
- 20 contain a larger proportion of iron. The whole operation, however, indicated that the potassium benzyl xanthate greatly facilitated the flotation of the copper sulphide present to the exclusion of the iron which was normally floatable. The iron content was determined by inspection. The results in copper concentrate and recovery are shown in the following table:

	ASSAYS		RECOVERIES
	% Wt.	Cu.	Cu.
Heads.....	100.0	3.60	100.0
Conc.	28.6	11.92	94.8
30 Tails.	71.4	.26	5.2

A parallel test using potassium benzyl xanthate from which all benzyl alcohol had been removed was made and no substantial frothing action could be observed. Upon the further addition of a small amount of benzyl alcohol the frothing conditions were as above described. It was also found that the benzyl alcohol alone produced only a small amount of froth with no substantial concentration of mineral. Similar results were obtained with Shattuck-Arizona ore in an alkaline pulp, a rich concentrate being obtained and a tailing which was low in copper content for this particularly refractory ore.

- 40 *Example 2.*—Shattuck-Arizona ore was reground for twenty minutes in a laboratory ball mill with lime, used at the rate of six pounds of calcium oxide per ton of ore. The ground ore was made into

Exhibit—K-43.

a suitable pulp by the addition of water and was agitated for fifteen minutes with 0.2 pound of potassium benzyl xanthate and 0.15 pound of pine oil, both per ton of ore, to form a rougher concentrate. This concentrate was reagitated for five minutes without the addition of further reagents to yield a finished concentrate and a middling. The results are shown in the following table, from which it will appear that there was a large rejection of iron from the concentrate and no objectionable tendency of the iron to build up in the middlings:

10	ASSAYS			RECOVERIES	
	% Wt.	Cu.	Fe.	Cu.	Fe.
Heads	100.0	3.64	39.1	100.0	100.0
Conc.	13.2	17.84	37.7	64.9	12.7
Midd.	15.6	3.56	42.0	15.2	16.8
Tail.	71.2	1.02	38.8	19.9	70.5

In concentrating a lead-zinc-silver ore the results were highly satisfactory and it was found that the amounts required of agents used, and particularly of pine oil, were substantially reduced and that the usual necessity of retreatment of the concentrate was obviated.

20 *Example 3.*—Suitably ground ore from the nine hundred foot level of the Tennessee mine near Chloride, Arizona, was made into a pump with water and agitated for ten minutes with 0.2 pound of benzyl xanthate and 0.1 pound of hardwood creosote, both per ton of ore, and a lead-bearing froth was separated. There was then added 1.4 pounds of water gas tar, 0.1 pound of pine oil, and 0.8 pound of copper sulphate, all per ton of ore, and the pulp was further agitated for fifteen minutes to yield a zinc-bearing froth. The results are shown in the following table:

30	ASSAYS				RECOVERIES		
	% Wt.	Oz. Ag.	% Pb.	% Zn.	Ag.	Pb.	Zn.
Heads ...	100.0	5.45	13.2	14.4	100.0	100.0	100.0
Pb. Conc.	17.3	24.6	64.8	16.4	78.2	86.7	19.8
Zn. Conc.	20.0	2.8	4.6	41.0	10.3	6.7	57.2
Tails. ...	62.7	1.0	1.6	5.3	11.5	7.6	23.0

It was found that while potassium benzyl xanthate prepared as above described was fairly stable, nevertheless, when such material, prepared as first above described, was about a month old, it became somewhat modified in its properties, with the result that it was capable of use without the addition of any other mineral-frothing

Exhibit—K-43.

agent to produce a satisfactory concentration, and was also capable of use as an agent which cooperated with a mineral-frothing agent to facilitate and improve froth-flotation concentration.

Example 4.—Anaconda copper slimes were ground with lime equal to six pounds of calcium oxide per ton of ore and then made into a pulp with water and agitated for twenty minutes, with 0.4 pound per ton of ore of potassium benzyl xanthate upwards of a month old, to yield a finished concentrate. The results are shown in the following table:

10	ASSAYS		RECOVERIES
		Wt. %	Cu.
	Heads	100.0	3.22
	Conc.	23.2	12.72
	Tails.	76.8	.34
			Cu.
			100.0
			91.9
			8.1

Example 5.—Suitably ground Bunker Hill and Sullivan ore was made into a pulp with water and agitated for a period of ten minutes with 0.3 pound per ton of ore of similar old potassium benzyl xanthate. One pound of water gas tar and one-tenth pound of pine oil per ton of ore were then added and the agitation continued for a further 20 period of ten minutes. A satisfactory concentrate was obtained during the first mentioned period of agitation and a satisfactory middling was obtained during the second mentioned period of agitation. The results are shown in the following table:

20	ASSAYS			RECOVERIES		
		% Wt.	Pb.	Zn.	Pb.	Zn.
	Heads	100.0	8.3	2.3	100.0	100.0
	Pb. Conc.	15.2	48.6	13.0	89.0	86.8
	Pb. Midd.	3.3	13.0	9.0	5.2	13.2
	Tails.	81.5	0.6	No	5.8	No

30 Other materials such as thiophenol, parathio cresol, benzyl mercaptan, phenyl-ethyl sulphide and the phenyl-ester of ethyl xanthic acid are also capable of use as agents which cooperate with a miner-frothing agent to facilitate and improve froth-flotation concentration.

Example 6.—Utah Copper Co. ore, reground to 65-mesh with 6 pounds of calcium oxide and 0.4 pound of thiophenol per ton, was made into a pulp with water and agitated with 0.4 pound of cresylic acid all reagents per ton of solids, the cresylic acid being upwards of

Exhibit—K-43.

95% pure. The froth concentrate was separated and collected. The results are shown in the following table:

	ASSAYS			RECOVERIES	
	Wt. %	Cu. %	Fe. %	Cu.	Fe.
Heads	100.0	1.25	1.36	.....	.....
Conc.	4.42	25.76	13.5	90.8	43.8
Tails.	95.58	.12	.8	9.2	56.2

Example 7.—Anaconda table tailings, 65-mesh, were made into a pulp with water and pre-agitated for half a minute in a neutral pulp with 0.32 pound of pine oil and 0.58 pound of benzyl mercaptan, both per ton of solids, and then further agitated to yield a froth-concentrate which was separated for three minutes. The results are shown in the following table:

	Cu. %	RECOVERY %
Heads	1.28	.....
Concs.	7.44	90.1
Tails.	0.15	.....

Example 8.—Utah Copper Co. ore, reground to 65-mesh with 6 pounds of calcium oxide per ton of solids, was made into a pulp with water and agitated with 0.4 pound of a 20% solution of parathio-cresol in cresylic acid and a further 0.4 pound of cresylic acid, both per ton of solids, which was upwards of 95% pure. The froth concentrate was separated and collected. The results are shown in the following table:

	ASSAYS			RECOVERIES	
	% Wt.	Cu. %	Fe. %	Cu. %	Fe. %
Heads	100	1.26	1.63	.....	.....
Conc.	4.91	22.96	13.8	89.4	41.6
Tails.	95.09	.14	1	10.6	58.4

Example 9.—Utah Copper Co. ore of low grade, ground to pass 80-mesh, was made into a pulp with water and preagitated for two minutes with 4 pounds of calcium oxide, 0.32 pound of pine oil, and 0.632 pound of phenyl-ethyl sulphide, all per ton of solids, and then further agitated for three minutes to yield a froth-concentrate which

Exhibit—K-43.

was separated for three minutes. The results are shown in the following table:

	Cu. %	RECOVERY %
Heads	0.88	.....
Concs.	7.25	79.3
Tails.	0.20	.....

Example 10.—The phenyl ester of xanthic acid was prepared by adding amyl nitrite to a solution of aniline hydrochloride in cold acetic acid and precipitating the diazo compound with ether. The precipitate was washed with ether, dried, and dissolved in water cooled with ice. Then, while thus kept cool, an aqueous solution of potassium xanthate was added to make one molecule of potassium xanthate to one of the diazo compound. A yellow compound formed with the evolution of gas, finally forming a yellow oil at the bottom of the solution. This was dissolved in ether, filtered, and the filtered solution washed successively with dilute caustic potash, dilute hydrochloric acid and with water. The resulting reddish oily liquid was then used in froth-flotation procedures as follows:

Utah Copper Co. ore of low grade ground to pass 80-mesh, was made into a pulp with water and pre-agitated for one-half minute with 4 pounds of calcium oxide, 0.32 pound of pine oil, and 0.47 pound of the reddish oily liquid, all per ton of solids, and then further agitated for three minutes to yield a froth-concentrate which was separated for three minutes. The concentrate was reagitated for two minutes to clean it by separating into a middling and finished concentrate. The results are shown in the following table.

	Wt. %	Cu. %	RECOVERY %
Heads.	100	0.83	.....
Concs.	4.8	12.78	73.7
Midd.	5.8	1.31	9.1
Tails.	89.4	0.16	17.2

The results of the foregoing Examples 6 to 10 compare with a recovery approximately 55% in blank tests i.e., tests in which there was added no non-nitrogenous aromatic sulpho compound containing a single phenyl group.

Having thus particularly described certain embodiments of my invention what I claim is:

1. The process of concentrating an ore containing a mineral value and gangue, which consists in agitating an aqueous pulp of the

Exhibit—K-43.
Exhibit—D-109.

ore containing benzyl xanthate so as to form a mineral-value-bearing froth, and separating the froth.

2. The process of concentrating an ore containing a mineral value and gangue including normally floatable iron, which consists in agitating an aqueous pulp of the ore containing benzyl xanthate so as to form a mineral-value-bearing froth carrying a relatively large amount of a mineral value and a smaller proportion of the normally floatable iron, and separating the froth.

3. The process of concentrating an ore containing a mineral
10 value and gangue which consists in agitating an aqueous pulp of the ore containing a flotation agent having a formula including a ring the carbon atoms of which are six in number, such ring forming part of a xanthic acid radical, said agitation being so conducted as to form a mineral-value-bearing float, and separating the float.

4. The process of concentrating an ore containing a mineral value and gangue which consists in agitating an aqueous pulp of the ore containing a flotation agent having a formula including a phenyl group and a xanthic group, said agitation being so conducted as to form a mineral-value-bearing float, and separating the float.

20

CORNELIUS H. KELLER.

EXHIBIT-D-109.

June 3, 1926

Dr. S. Gregory, President,
Minerals Separation N. A. Corp.
61 Broadway, New York.

My dear Dr. Gregory:

I hereby present my resignation to take effect thirty days from date, as provided in our agreement.

I do not feel that I can longer continue with the Minerals
30 Separation, as it has denied my right to the benefit of my inventions, the exploitation of which was the inducement offered by the company to me to join it.

I am retiring so I can devote my entire time to the furtherance of my contention against your company.

With kindest personal regards, I am

Yours very truly,

(Sgd.)

R. B. MARTIN.

Exhibit—D—110.

Exhibit—D—111.

EXHIBIT—D—110.

MINERALS SEPARATION NORTH AMERICAN CORPORATION
61 Broadway
New York.

June 3, 1926
AR:mm

Mr. R. B. Martin,
Minerals Separation N. A. C.,
35 Twelfth Street,
10 Long Island City, N.Y.

My dear Mr. Martin:

Dr. Gregory has handed me your letter of June 3 for reply, which I hereby acknowledge and I wish to advise you that it will be placed before the Board at their next meeting.

Meantime, I will be much obliged if you will give me the particulars which have led you to your conclusion that the Company has denied you the right to the benefit of your inventions, the exploitation of which was the inducement offered by the Company to you to join the staff.

20

Sincerely yours,

(Sgd.)

ALBERT ROBERTS,
Secretary.

EXHIBIT—D—111.

June 5, 1926

Mr Albert Roberts, Secretary,
Minerals Separation N.A. Corp.,
61 Broadway, New York.

My dear Mr. Roberts:

30 Replying to your letter of June 3rd, the particulars about which you inquire can probably best be obtained from Dr. Gregory and Mr. Henry D. Williams, who are fully acquainted with the matter under discussion.

Very truly yours,

(Sgd.)

R. B. MARTIN.

Exhibit—D-112.

Exhibit—D-113.

EXHIBIT-D—112.

MINERALS SEPARATION NORTH AMERICAN CORPORATION
61 Broadway, New York.

June 7, 1926

Mr. R. B. Martin,
Minerals Separation N. A. Corp.,
35 Twelfth Street,
Long Island City.

My dear Mr. Martin:

10 I have received your letter of June 5, and I have consulted with Dr. Gregory and Mr. Williams and they are unable to advise me of any instances covered by your letters.

I would like to do all that I can to straighten matters out, and if you can give me any particulars I will have matters thoroughly investigated.

Sincerely yours,
(Sgd.)
ALBERT ROBERTS,
Secretary.

20 EXHIBIT D-113

Chicago, Ill.,
June 12, 1926

Mr. Albert Roberts, Secretary,
Minerals Separation N.A. Corp.,
61 Broadway,
New York.

My dears Mr. Roberts:

30 This is in reply to your letter of June 7, 1926. In interviews with Dr. Gregory and Mr. Williams some six months ago I stated that I had many years ago invented and disclosed to your company, and to Dr. Gregory and Mr. Williams individually, the use of xanthates in flotation concentration, and that your action in taking out patents on this process in the names of Messrs. Keller and Lewis was illegal and operated to deprive me of both the financial consideration to which I was entitled under my contracts and of the credit of being the inventor of this process. I have resigned my position with your company in order to devote my time to the assertion and prosecution of my rights in this matter. If it is your desire to have a conference with me on this subject I will arrange to have my counsel in New York for that purpose.

40

Very truly yours,
(Sgd.)
R. B. MARTIN

Exhibit—D-114.

Exhibit—D-115.

EXHIBIT D-114

MINERALS SEPARATION NORTH AMERICAN CORPORATION
61 Broadway New York

June 14, 1926

ARs

Mr. R. B. Martin,
35 Twelfth Street,
Long Island City.

My dear Mr. Martin:—

10 This is in reply to your letter of the 12th instant. I have shown that letter to Dr. Gregory and Mr. Williams, and they instruct me to say that it is not true that you disclosed to our company or to Dr. Gregory or to Mr. Williams individually the use of xanthates in flotation concentration, and, further, that the taking out of our patents for the inventions of Messrs. Keller and Lewis in relation to xanthates was regularly and legally done based upon their wholly independent inventions, discoveries and demonstrations.

I regret very much that you have resigned your position in order to devote your time to the assertion and prosecution of what
20 you believe to be your rights in this matter.

Yours very truly,

(Sgd.)

ALBERT ROBERTS
Secretary

EXHIBIT D-115

Colonia
New Jersey

June 28, 1926

30 Mr. E. H. Nutter,
220 Battery Street,
San Francisco, Calif.

Dear Mr. Nutter:

I think it is only fitting and proper that I should advise you at this time that Minerals Separation and myself are terminating our relationship on July first.

They offered me certain inducements to join their organization, which they in a recent letter disclaim. I am retiring in order to devote my efforts to pressing my contention.

40 Thanking you and your staff for the courtesies extended to me during my recent visit, I am

Very truly yours,

(Sgd.) R. B. Martin
R. B. MARTIN

Exhibit—D-116.

Exhibit—W-17.

Exhibit—W-18.

EXHIBIT D-116
CC NYSan Francisco, Calif.,
July 6, 1926.
EHNmR. B. Martin, Esq.,
Colonia, New Jersey.

My dear Martin:

I have your letter of June 28th, and am sorry to learn that you
have decided to leave the Company's employ.

10

Very truly yours,

Chief Engineer.

EXHIBIT W-17

WESTERN UNION
TELEGRAM

AUGUST 20, 1926.

MR. L. O. EVANS,
6TH FLOOR, HENNESSY BLDG.,
BUTTE, MONTANA.20 YOUR NIGHT LETTER RECEIVED YESTERDAY STOP I HAVE NOTIFIED
PLAINTIFFS COUNSEL THAT MR. KENYON AND I HAVE WITHDRAWN
FROM METALS RECOVERY AGAINST ANACONDA STOP PLEASE SEE THAT
COURT RECORD IS ALTERED ACCORDINGLY STOP I AM AT COMMAND OF
MR. NEAVE FOR ANY INFORMATION HE DESIRES.

HENRY D. WILLIAMS

EXHIBIT W-18

August 20th, 1926.

Pennie, Davis, Marvin & Edmonds, Esqs.,
165 Broadway,
30 New York City.

Dear Sirs:—

METALS RECOVERY COMPANY VS.
ANACONDA COPPER MINING CO.This letter is to confirm the oral notice to Messrs. Davis and
Sage yesterday that Mr. William Houston Kenyon and I have with-
drawn from the above suit, and will not further participate therein.Very truly yours,
H. D. W.

981

Exhibit—W-6.

Exhibit—W-7.

EXHIBIT W-6

POSTAL TELEGRAPH

1929 NOV 13 PM 4 24

NA277 72

MF WASHINGTON DC 13 61 OP

EDWARD H NUTTER

220 BATTERY ST. SANFRANCISCO CALIF

10 REQUEST TROTTER IF HE HAS NOT ALREADY DONE SO AND DETERMINED
QUANTITY OF XANTHATE FORMED TO REPEAT MARTINS METHODS
PREPARATION STANOL IN HIS BULLETIN TWO NOT NEGLECTING TO
DIGEST OR BOIL UNDER REFLUX CONDENSER UNTIL CAUSTIC SODA
AND OR RESIN HAS DISAPPEARED STOP REPORT BY AIR MAIL STOP
WILL WANT HIM HERE ABOUT DECEMBER TENTH TO TESTIFY IN MARTIN
AGAINST KELLER INTERFERENCE STOP WILL BE AT MAYFLOWER HOTEL
TOMORROW AND POSSIBLY FRIDAY.

HENRY D WILLIAMS

EXHIBIT W-7

WESTERN UNION

1929 NOV 14 PM 1 17

20 AB283 31 SANFRANCISCO CALIF 14 958 A

H. D. WILLIAMS

MAYFLOWER HOTEL WASHINGTON DC2

PLEASE TELEGRAPH PROPORTIONS INGREDIENTS USED AS STATED IN
BULLETIN TWO STOP SEND COPY ESSENTIAL PART OF BULLETIN BY AIR
MAIL AS WE NEVER HAVE HAD HERE ANY COPY OF THIS BULLETIN

E. H. NUTTER.

Exhibit—G-14.

EXHIBIT G-14

M.S.N.A.C. LICENSEES IN CANADA

Date of License	Licensee	Tonnages milled during the years				
		1930	1933	1936	1939	1942
1912 Nov. 19	Britannia Mng. & Smelting Co.	2,152,000	623,000	943,000	2,112,000	961,000
1917 Jun. 18	Cons. Mng. & Smeltg. Co. of Can. Ltd.	260,000	1,347,000	1,900,000	2,089,000	2,697,000
1924 Dec. 8	Granby Cons. Mng. Smeltg. & Pwr. Co. Ltd.		1,044,000		500,000	
1924 Sep. 3	Treadwell Yukon Corp. Ltd.	110,000		36,000	54,000	
1926 Jun. 30	Int. Nickel Co. of Canada Ltd.	435,000	973,000	3,242,000	5,856,000	9,311,000
1930 Jun. 23	Hudson Bay Mng. & Smeltg. Co. Ltd.		1,604,000	1,636,000	1,721,000	2,189,000
1934 Oct. 11	Falconbridge Nickel Mines Ltd.			36,000	333,000	552,000
1938 Jan. 2	Polaris-Taku Mining Co. Ltd.				70,000	30,000
194 Jul. 1	Buena Vista Mining Co. Ltd.					63,000
		<u>2,957,000</u>	<u>5,591,000</u>	<u>7,793,000</u>	<u>12,735,000</u>	<u>15,803,000</u>

Exhibit—M—A4.

Exhibit—M—4B.

EXHIBIT—M—4A.

NORANDA MINES, LTD.
120 BROADWAY
New York.

December 8, 1925

Mr. E. H. Nutter, Chief Engineer,
220 Battery St.,
San Francisco, Calif.

Dear Sir:

10 Following a conversation with Mr. Albert Roberts today, we
are instructing our mine office to send you two 150 pound sample
of ore representing two classes of copper ore, containing gold and
silver values.

We desire you to make a series of tests to determine the best
extractions you can make by flotation of the copper, gold and silver
values with the highest ratio of concentration.

For your further information we are enclosing copy of tests on
one of these classes of ore made by the Consolidated Smelting & Refin-
ing Company. It goes without saying that we would like to be able
20 to duplicate these results, especially as regards the extraction of gold.

Yours very truly,

H. W. CHADBOURNE
Managing Director.

EXHIBIT—M—4B.

December 11, 1925
AR:mm

Mr. Edward H. Nutter, Chief Enguieer,
Minerals Separation N.A.C.,
220 Battery Street,
30 San Francisco, California.

Dear Sir:—

I had a talk the other day with Messrs. C. S. Thomson and H. W.
Chadbourne, Directors of the Noranda Mines, regarding the con-
centration of their ores, and they are now making arrangements to
send you samples of ores for tests.

They have a large tonnage of what they call their lowgrade ore
which consists of massive sulphide, containing, perhaps, 5% Insol,
1½% Copper, \$6.00 in Gold, no Zinc, the balance of the gangue
being Pyrite and Pyrrhotite. From this they are anxious to make

Exhibit—M—4B.

Exhibit—M—4C.

as high grade a concentrate as possible. The Copper is in the form of Chalcopyrite, and they think it should probably be not too hard to recover this in the form of a good grade concentrate. They seem to feel considerable doubt as to a satisfactory recovery of the Gold. Consolidated Mining and Smelting have made two tests for them, and, although I did not see reports of the tests, they told me that about 80% of the Copper was recovered in what they called a fair grade concentrate. At the same time they said that Trail reported a 99% Gold recovery on both tests, which, naturally, made them feel
 10 some doubt as to the accuracy of the whole work, but further tests are being run.

They will also send you a sample to be somewhat typical of their higher grade ore which may run somewhere between 5 and 10%. As you know perhaps, they have a great variety of ore in the mine, some of it being massive chalcopyrite, running 20% or better, and what they want to determine as soon as possible is what can be done in the way of concentration on the higher grade ore and to arrive at something like an idea of where the breaking point is going to come between milling and direct smelting. I told them that the work
 20 could be done at the cost of the assays, and made no mention, of course, of a deposit on account of their standing. They said they would be glad to get all the help they could from us, and, as you know, they are very high class people, and this will give us the first opportunity we have had, with the exception of the case of the Mond Nickel Company, to do business with some of the Eastern Canadian concerns. They will write you direct at the time they send the samples.

Yours very truly,

ROBERTS

Secretary.

30

EXHIBIT—M—4C.

NORANDA MINES, LTD.

Rouyn, Quebec

Dec. 28th, 1925

Mr. E. H. Nutter, Chief Engineer,
 Minerals Separation Co.,
 220 Battery St.,
 San Francisco, Calif.

Dear Sir:

40 I have been asked by Mr. H. W. Chadbourne, Managing Director, to forward you two 150 pounds samples of ore, one representative of the F orebody and the other prepared from material to run about 5% copper.

Exhibit—M-4C.
Exhibit—M-4D.

These samples are being forwarded to you today by express. The sample from the F orebody assays about \$5.20 gold and 1.1% copper; the other sample assays about 5.9% copper and \$3.60 gold.

Will you please advise this office when you receive these samples.

Yours very truly,

F. HIBBERT,
Manager

EXHIBIT-M-4D.

San Francisco, Calif.,
March 9, 1926
EHN-M

10 CC NY
Noranda Mines Ltd.,
Room 1947,
120 Broadway,
New York.

Gentlemen:

With further reference to your letter of December 8th, the samples of ore which you had shipped to us duly arrived and we have made a number of tests on them.

20 I enclose Mr. Littleford's report to me giving the results of these tests, together with the laboratory sheets which set forth the details.

In Tests Nos. 3 and 5 the ore was ground to pass 150 mesh screen. In the other tests the grinding was to pass 80 mesh screen, Tyler Standard.

You will see therefrom that we probably got commercial results, depending on the other factors, but we did not succeed in getting as low a tailing as reported by Mr. Diamond of the Consolidated Mining and Smelting Co.

30 If there is any further work or further information you would like about these tests, please let us know.

I enclose our bill for the assaying in connection with the tests.

Very truly yours,

EDWARD H. NUTTER,
Chief Engineer.

Exhibit—M—4E.

EXHIBIT—M—4E.

MINERALS SEPARATION NORTH AMERICAN CORPORATION
OFFICE OF THE CHIEF ENGINEER
220 Battery Street, San Francisco, Cal.
Cable Address NOMOLOGY

Toronto, August 2nd, 1930.

Noranda Mines, Ltd.,
Royal Bank of Canada.
Toronto, Ontario

10 ATT: JAMES Y. MURDOCH, PRES.

Gentlemen:

The writer visited your mill at Noranda and discussed in detail with Messrs. Hibbert and MacLachlan the present metallurgy and the possibilities for improvement.

At the present time you are using one of our reagents with good results, namely Amyl xanthate. We are about ready to liberate two new reagents, which I believe will be of benefit to you. I have arranged with Mr. Hibbert to send us a one hundred pound sample for testing with these reagents and samples of them will be sent to
20 Mr. McLachlan to try in your own laboratory.

We developed the xanthates and as it is essential in your mill work, we ask you to sign a license agreement for its use, which does not oblige you to use any of our patents or reagents, but when you do to pay us the nominal royalty of one cent per ton of mill heads. This license also entitles you to the benefit to any new reagent we may develop without additional charge and to our metallurgical assistance at all times.

These agreements will be forwarded to you from our San Francisco office with the objectionable clauses eliminated, for your
30 signature.

Very truly yours,

“J. V. QUIGLEY”

Exhibit—M—4F.

EXHIBIT—M—4F.

MINERALS SEPARATION NORTH AMERICAN CORPORATION
 OFFICE OF THE CHIEF ENGINEER
 220 Battery Street, San Francisco, Cal.
 Cable Address NOMOLOGY

San Francisco, Calif.,
 August 12, 1930
 EHNm

James Y. Murdoch, Esq., President,
 10 Noranda Mines, Limited,
 Royal Bank of Canada Building,
 Toronto, Canada.

Dear Sir:

In accordance with the request of our Mr. Quigley, who recently visited your office, I am enclosing herewith duplicate-original licenses for execution by your good-selves.

Mr. Quigley requested that we delete certain clauses and parts of clauses which we have deleted from other licenses, and this we have done.

20 According to the Paper by Mr. C. G. McLachlan, entitled "Twelve Months' Milling at Noranda" read before the Institute of Mining and Metallurgy, your mill began operation in October, 1928. We have, therefore, dated this license as of October 1, 1928, which I trust is agreeable to you.

If you and the Secretary will kindly execute the license by signing at the bottom of page six where shown, attaching the seal of the company in one of the blank spaces provided there, and then complete the jurat at the bottom of page seven, and return the license to me at this address, it will be completed by this company in due
 30 course. A completed duplicate-original, together with one or more file copies as you may desire, will then be sent to you.

May I suggest that it would be well to check the notary to make sure that all of the blanks in the jurat are correctly filled in, as it is our experience that notaries are sometimes careless in doing this, and it will save correspondence and returning the license if there are no omissions.

Mr. Quigley asked that in our covering letter we give you the numbers of our Canadian xanthate patents. Our general or basic xanthate patent in Canada is that issued to Mr. Cornelius H. Keller,
 40 Canadian Patent No. 247,576, of March 10, 1923.

I have checked in pencil on the Schedule of Canadian Letters Patent, the patents issued to Mr. Cornelius H. Keller and Mr. Carl P. Lewis, as all of our xanthate patents were issued to them. I have

Exhibit—M-4E.

Exhibit—M-4G.

not the information here from which I can say definitely that all of the patents checked are xanthate patents, but I know that most of them cover the use of xanthate or allied substances in different ways. If you want an exact statement of just what these patents cover I will have to get it from our patent lawyers in New York.

Mr. Quigley advised me that he had arranged through Messrs. Hibbert and McLachlan to send us a 100-pound sample for research with certain new reagents which we have been developing, and on arrival of the sample we will give it our very earnest attention and
10 advise you as soon as possible of results.

Very truly yours,

“EDWARD H. NUTTER”
Chief Engineer.

EXHIBIT M-4G

MINERALS SEPARATION NORTH AMERICAN CORPORATION
Office of the Chief Engineer
220 Battery Street, San Francisco, Cal.
Cable Address NOMOLOGY

Noughton Michigan
Nov., 1st, 1931

20 Mr. H. L. Roscoe, Gen. Mgr.
Noranda Mines Ltd.,
Noranda Quebec, Canada.

Dear Sir:

This letter will confirm our conversation in the presence of your mill Sup't., Mr. C. G. McLachlan on the afternoon of October 27th, 1931, relative to the present status of our xanthate patents.

Mr. McLachlan told me that I had not made our position clear when I talked to Mr. Hibbert and himself last fall, that we talked in
30 general terms and no mention was made of royalty at all. Evidently I took it for granted from my conversation with Mr. McLachlan that he was familiar with the use of xanthate and had called on our Chief Engineer Mr. E. H. Nutter on his way up to Noranda and the royalty matter was understood, but as this is not the case, I feel that I owe Mr. Hibbert and Mr. McLachlan an apology for not making our position clear and assure you that it was not done intentionally.

We developed the use of xanthates for flotation work in 1923 in the laboratory. U.S.A. Patent applications were filed October 23rd, 1923 by our Mr. C. H. Keller and March 27th, 1924 both patent
40 applications were allowed and patents granted Sept. 22, 1925 respec-

Exhibit—M-4G.

tively. The corresponding Canadian Patents numbers 247,576 and 247,791 were granted March 10th and 17 respectively in 1925.

The reagent was first introduced into large scale operations late in 1923 and the results obtained immediately placed xanthate as standard practice in the Anaconda Copper Companies mill at Anaconda Montana, where it has been in continual use since.

The licensees of our company were operating under the Soluble Frothing Reagent Patent at that time with a flat royalty charge of five cents per ton of mill heads. This Patent did not expire until
10 June 28th, 1927 and while xanthate was destined to become probably the most valuable flotation reagent developed we did not make any additional royalty charge for it use during the life of the Soluble Reagent Patent as this is a service rendered by the Minerals Separation Company to their Licensees.

When the Soluble Reagent Patent expired we had agreed with our Licensees to allow free use of all Patents issued Prior to 1924, therefore after June 28th, 1927 all we had left was our xanthate patents and new ones that we might develop in the future. In order to make the use of xanthate possible to our Licensees and other operators coming
20 into production, we voluntarily reduced the royalty charge to one cent per ton of mill feed as a flat rate and this rate is and has been in effect every since.

An interference to C. H. Keller was filed by R. B. Martin who was formerly in our research laboratory contending that he should have had the xanthate patents instead of Mr. C. H. Keller. The interference was heard April 15, 1930 and dissolved in favor of Mr. Keller. Martin appealed this decision and the appeal verdict was rendered the latter part of April upholding the Patent commissions decision in favor of Mr. Keller. I was advised by wire April 28th, 1931.

30 Our xanthate patents are clear now and cover the entire xanthate group and it is not necessary to pay royalty to any one else on any xanthate patents which they claim.

We have eliminated the objectionable clauses in our license agreements so that you simply agree to pay us a fee or royalty which ever you wish to call it for the use of xanthate or any new reagent which we may develop that may be useful to you in improving your metallurgy. You are not obliged to use it for any definite time at all if and when you use it you agree to pay us the nominal sum of one cent per ton on the mill feed and when you do not use it you do not
40 pay us a royalty, which we believe is as fair a business proposition as you could wish for. We consider it a service to you, to make money for your company by lowering your reagent costs, or improving you metallurgy, or both and when we can not do this then it is to your interests not to use our reagents and eliminate our royalty.

Your President will undoubtedly wish to verify the status of our patents, etc., and I would suggest that any information we can

Exhibit—M-4G.
Exhibit—M-4H.

furnish will gladly be given if you write our New York office, 11 Broadway, New York.

The following are a few Canadian companies operating under license agreements and paying us for the use of xanthate.

Consolidated Mining and Smelting Company.

Britannia Mining and Smelting Company.

International Nickel Co.

Treadwell Yukon Ltd.

Hudson Bay Mining Company.

10 Hoping this will clear up the matter and you will have it investigated to your own satisfaction, I will call upon you again early next spring.

cc to NY.SF

JVQ.

Yours very truly,

“J. V. Quigley”
J. V. QUIGLEY

EXHIBIT M-4H

NORANDA MINES LIMITED

20

Noranda, Quebec

November 10, 1932

Mr. E. H. Nutter, Chief Engineer,
Minerals Separation N. A. Corporation,
220 Battery Street,
San Francisco, Calif.

Dear Mr. Nutter:

Mr. Allen, when he was here at the end of September, handed me copies of Mr. Carl F. Williams' report covering tests carried out on the sample of Noranda ore which we had sent you.

30 I am afraid you may have gained an impression, due to the refractory nature of the sample, that we had purposely picked this material to “stump” you. We explained, however, to Mr. Allen that this was not our object at all. The ore represented by the material sent to San Francisco is from an ore body at present in course of development, which, as far as its grade is concerned, ought to be concentrated. On the other hand, we have been working on the problem as to how this is to be done—and at the same time obtain a satisfactory gold recovery—since the early part of last year.

40 Our investigation had convinced us that flotation by itself would not solve the problem, but that a combination of flotation and

Exhibit—M-4H.

cyaniding would. On the other hand, if this were the correct solution, it meant we would have to install a cyanide unit. Before doing this, however, it was felt that we should be very sure of our ground before proceeding with such an installation. Consequently, when Mr. Allen asked us to send a sample of ore to San Francisco to be tested it was ore from this orebody which we selected, as we felt that if your laboratory confirmed our conclusion that the gold lost in the copper circuit tailings could not be recovered by flotation, we would have excellent confirmation of our own work. The possibility that you
10 would subsequently send your flotation residues to the Merrill Company was a possibility which we had overlooked, and we wish to thank you for doing so, particularly as the Merrill results supported those obtained here just at a time when our own cyanide work was under fire due to another outside firm having reported that the residual gold could not be recovered by cyaniding.

As far as your laboratory flotation results are concerned, I think we can assure you that they will check mill results in all cases when our tests have been run with soda ash, as they are in excellent agreement with our own and we have no difficulty in duplicating in
20 the mill laboratory tests which have been run with soda ash. This is not true for tests run with lime as we have found that laboratory results with lime are always definitely superior to those obtained in the mill. The explanation for this difference is, we believe, due to the selective absorption of pyrrhotite slime on the surface of chalcopyrite, and possibly gold, brought about by the electro-static charges set up due to grinding in a large diameter mill coupled with the coagulating effect of the divalent calcium ion. This explanation may not be the correct one, but in any case lime doesn't work in the mill circuit, neither does any other coagulating depressant.

30 I trust that this letter will have cleared up any misunderstanding which may have existed in your mind as to the reason for our sending the sample which we did.

As regards the sending of further samples, we shall be extremely glad to furnish them, should you still wish us to send them; on the other hand, after the way in which your results have confirmed our own, we anticipate that additional tests will also do so.

In conclusion, Mr. Roscoe has asked me to express to you our appreciation for the work you have done on our ore, both in your own laboratory and in that of the Merrill Co.

40 With best personal regards, I remain

Yours very truly,

Noranda Mines, Limited.

By C. G. McLachlan
Concentrator Superintendent

Exhibit—M-4I.

EXHIBIT M-4I

CC NY

San Francisco, Calif.,
November 16, 1932
EHmm

C. G. McLachlan, Esq.,
Concentrator Superintendent,
Noranda Mines Limited,
Noranda, Quebec.

Dear Mr. McLachlan:

10 I wish to acknowledge and thank you for your very pleasant letter of November 10th sent me under cover of your letter of the same date to Mr. Allen and also for the copy of Mr. Roscoe's letter of the 7th to the Merrill Company.

I am indeed glad that our work here has confirmed your own work and has strengthened your hand as it were.

I note you do not think that further tests by us now on your actual mill heads would be especially useful, but please be assured that we will be very glad to cooperate with you at any time, and to run tests on any samples which you may send us.

20 It occurs to me that you might find it useful to have installed in your mill a continuous testing machine such as we have in our test plant here which has a capacity of about 200 pounds per hour. This is a 24-cell machine, and almost any combination of circuit and flow can be obtained with it. It is like the one that the International Smelting Co. built from our plans and operated in conjunction with their mill work. They found that they could get practically identical results with it as in their mill. Consequently it was a very useful testing machine for them. Should you be interested we will be glad to send you the drawings of it.

30

Very truly yours,

EDWARD H. NUTTER,
Chief Engineer.

Exhibit—M-4J.

EXHIBIT—M—4J.

COPY

220 Battery Street,
San Francisco, Calif.,
November 17th, 1932.

Mr. C. G. McLachlan,
Concentrator Superintendent,
Noranda Mines, Ltd.,
Noranda, Quebec.

10 Dear Mr. McLachlan:

I was indeed pleased to receive your letter of November 10th, with enclosures, and to note the progress you have made in the further development of your milling plans since I last saw you.

Your letter of the same date, to Mr. Nutter, was passed along to him and no doubt you will have received his reply before this reaches you.

It has been a source of satisfaction to all of us to feel that the experimental work recently performed here on the sample of refractory ore you sent to us was not without tangible and constructive results.

20 If and when you think some useful purpose would be served by submitting further samples for tests, I can assure you that we will be pleased to co-operate to any extent that you may desire.

In the ordinary course of events, I do not expect to visit the Noranda district for several months, but in the meantime I shall be interested in following, as best I can, the further development of of your plans for milling the ore in question. It is my conviction that the treatment scheme finally adopted will embody your early ideas on the subject, as recently confirmed by our tests.

30 I trust that the worst phases of your mill remodelling program are now behind you, and that you are again able to find enough spare time to visit with your family occasionally.

Please remember me to Mr. Roscoe, and with best wishes and regards to yourself, I remain

Cordially yours,

(Sgd.) CHESTER B. ALLEN

ccNy
SF

Exhibit—M—4K.

Exhibit—M—4L.

EXHIBIT—M—4K.

MINERALS SEPARATION NORTH AMERICAN CORPORATION
11 Broadway New York

April 4, 1934

ARs

James Y. Murdoch, Esq.,
Noranda Mines, Limited,
Royal Bank Building,
2 King Street, East,
10 Toronto, 2
Ontario, Canada

Dear Sir:—

I shall be making a trip to Canada about the middle of the month, and would like to have the opportunity to discuss with you the question of our patent rights in connection with the use of xanthate in your company' mill operations.

If you will advise me of a date that will be convenient for you for this purpose, I will endeavour to fit it in with my itinerary.

Yours very truly,

"ALBERT ROBERTS"

Secretary.

20

EXHIBIT—M—4L.

MINERALS SEPARATION NORTH AMERICAN CORPORATION
11 Broadway New York

April 24, 1934

ARs

"XANTHATE"

James Y. Murdoch, Esq., President,
Noranda Mines, Limited,
Royal Bank Building,
2 King Street, East,
30 Toronto, 2.
Ontario, Canada

Dear Sir:—

On April 4 I wrote you regarding a proposed trip to Canada, which I have postponed because of not receiving your reply. In case the letter may not have reached you, I am enclosing under registered cover a carbon copy.

Trusting to hear from you at an early date, I am,

Yours faithfully,

"ALBERT ROBERTS"

Secretary.

40 Enclosure.

Exhibit—M—4M.

EXHIBIT—M—4M.

May 23, 1934

Mr. Albert Roberts, Secretary,
Minerals Separation North American Corporation,
11 Broadway,
New York, N.Y.

Dear Sir:—

Our President, Mr. James Y. Murdoch, has referred to me your letter to him of April 24th. Mr Murdoch has been absent from the office a good deal of late and with the pressure of business it has been impossible to reply to your letter before this date.

Mr. Murdoch will not be able to see you, I regret, any time during the next month but if you will communicate with us in about two or three week's time we will try and arrange an appointment for you.

Yours very truly,

NORANDA MINES, LIMITED,
"T.N.H."
Secretary-Treasurer.

20 TNH:CC

EXHIBIT—M—4N.

MINERALS SEPARATION NORTH AMERICAN CORPORATION
11 Broadway New York

May 25, 1934
ARs

T. N. Hay, Esq.,
Secretary-Treasurer,
Noranda Mines, Limited,
804 Royal Bank Building,
2-8 King Street, East,
Toronto 2.

30

Dear Sir:—

I thank you for your letter of the 23rd instant, and will be glad to do as you suggest.

Yours very truly,
"ALBERT ROBERTS"
Secretary.

Exhibit—M—4O.

Exhibit—M—4P.

EXHIBIT—M—4O.

MINERALS SEPARATION NORTH AMERICAN CORPORATION
11 Broadway New York

July 16, 1934
AR:mm

T. N. Hay, Esq., Secretary-Treasurer,
Noranda Mines, Limited,
804 Royal Bank Building,
2-8 King Street, East,
10 Toronto 2.

Dear Sir:—

I have been postponing writing you, as you suggested in your letter of May 23, in the hope that our Canadian director, Mr. F. Perry, of Montreal, could advise me that he would be able to arrange to call on Mr. Murdoch in the reasonably near future, accompanied by myself, at a time to be set by Mr. Murdoch.

Mr. Perry now advises me that he will be absent in the west until some time in September, and, if agreeable to Mr. Murdoch, I would like to postpone writing you until after his return, with a view to
20 arranging a date that would be mutually convenient to Mr. Murdoch and Mr. Perry, which I would arrange to meet as well.

Yours very truly,
"ALBERT ROBERTS"
Secretary,

EXHIBIT—M—4P.

July 18, 1934

Mr. Albert Roberts, Secretary,
Minerals Separation North American Corporation,
11 Broadway,
30 New York, N.Y.

Dear Sir:—

I note your letter of July 16th, 1934 re appointment with Mr. Murdoch for yourself and Mr. F. Perry of Montreal.

I do not know Mr. Murdoch's plans for the month of September, but if you will write me some time after the first I will endeavour to arrange an appointment for you.

Expecting to hear from you around that date,

Yours very truly,
NORANDA MINES, LIMITED
"T. N. Hay"
Secretary-Treasurer

40

TNH:GLC

Exhibit—M—4Q.
Exhibit—M—4R.

EXHIBIT—M—4Q.

MINERALS SEPARATION NORTH AMERICAN CORPORATION
11 Broadway New York

T. N. Hay, Esquire, July 20, 1934.
Noranda Mines Limited,
804 Royal Bank Building,
2-8 King Street East,
Toronto.

10 Dear Sir,—

I thank you for your letter of July 18, and will write to you some time after the 1st of September.

Yours very truly,
"ALBERT ROBERTS"
Secretary.

EXHIBIT M-4R

C O P Y

Noranda
Albert Roberts, Esq., November 2nd, 1934.
20 Secretary, Minerals Separation North
American Corporation,
11 Broadway,
New York, N.Y.

Dear Sir:

Upon my return to Toronto after my interview in Montreal on Thursday last, the 25th ultimo, with you and Mr. Perry, I have quickly gone through our file in this matter. I cannot say as yet what position we will take in regard to your claim for royalty but will look into the matter further and will then be glad to discuss it with you.

30 I find that we do not appear to have copies of your Canadian patents under which you claim the right to a royalty and apparently we have misplaced the royalty license and agreement which at one time your Company seems to have forwarded to us. Would you be good enough to send me copies of these documents.

One thing strikes me in case we did decide to enter into a royalty agreement with you is the large percentage increase in costs. We concentrated approximately 3,000 tons of ore and I understand the xanthate cost when we use it is somewhere around 3c per ton which means \$90.00 cost per day and at 1c a ton your royalty would be
40 \$30.00 which is an increase cost of 33 $\frac{1}{3}$ %. This seems to me an increase which in justice is too great.

Yours truly,
President.

Per: "G.H.O'R."

JYM/O

Exhibit—M-4S.

EXHIBIT M-4S

Copy

MINERALS SEPARATION NORTH AMERICAN CORPORATION
11 Broadway New York

November 14, 1934.
AR:mm

James Y. Murdoch, Esq., President,
Noranda Mines, Limited,
804 Royal Bank Building,
10 2-8 King Street East,
Toronto.

Dear Sir:

Thanks for your letter of the 2nd inst. which was duly received. I have delayed replying to it until I had secured data regarding the delivered cost of the various xanthates available to you, as from our experience and such tests as we have made on your ore it seemed to us that the figure of 3c per ton of ore treated was high.

I would like to make it clear that we have no financial interest whatever in the manufacture or sale of xanthates, our only connection
20 with it being that we were instrumental in arrangements whereby it has been available in quantity at a reasonable price; and our royalty is quite independent of the quantity or cost of the xanthate used.

We are unable to reduce the amount of royalty, as the rate is uniform to all licensees, without exception, as I explained to you, but we will be glad to do everything we can to assist you in reducing the cost of reagents used or in any other way in connection with your operations, and to this end we will be glad to send some of our staff to your plant to see if they can be of assistance to you, without any expense to yourselves and without any prejudice whatsoever as to
30 what your decision may be in regard to the license matter.

As requested, I have pleasure in sending you herewith a copy of our Canadian basic xanthate patents No. 247, 576 to C. H. Keller, March 10, 1925, and No. 247,791 to C. P. Lewis, March 17, 1925; also, specimen copy of our standard license agreement.

I shall be glad to hear from you, at your convenience, if you care to avail of our offer, so that I can make arrangements to send our men to your plant when desired.

Yours very truly,

"Albert Roberts"

Secretary.

Exhibit—M-4T.
Exhibit—M-4U.

EXHIBIT M-4T

November 21, 1934

Albert Roberts, Esq.,
Secretary,
Minerals Separation North American Corporation,
11 Broadway,
New York, N.Y.

Dear Sir:—

I wish to acknowledge receipt of your letter of November 14th
10 last addressed to our President, Mr. James Y. Murdoch. Mr.
Murdoch is at present out of town and will not return until early in
December.

As Mr. Murdoch has been giving his personal attention to the
xanthate matter I do not feel that we can proceed until he returns.
If it is therefore agreeable to you I propose to let the matter stand in
abeyance until Mr. Murdoch's return.

Yours very truly,

"T.N.H.

Secretary-Treasurer.

20 TNH:GLC

EXHIBIT M-4U

Copy

MINERALS SEPARATION NORTH AMERICAN CORPORATION
11 Broadway New York,

November 26, 1934.
AR:mm

T. N. Hay, Esq., Secretary-Treasurer,
Noranda Mines, Limited,
804 Royal Bank Building,
30 2-8 King Street East,
Toronto 2, Canada.

Dear Sir:

I thank you for your letter of the 21st inst. and quite agree with
your thought that the matter should wait until Mr. Murdoch's
return.

Yours very truly,

"Albert Roberts"

Secretary.

1000

Exhibit—M-4V.
Exhibit—M-W4.

EXHIBIT M-4V

Copy

January 15, 1935

Minerals Separation North American Corporation,
11 Broadway,
New York, N.Y.

ATTENTION: ALBERT ROBERTS, Esq.

Dear Sirs:

Referring to your letter to Mr. Murdoch of November 14th last,
10 Mr. Murdoch, as you know, was in England when your letter was
received and since his return has been absent from the office prac-
tically every day. He is, however, taking the use of xanthates up
with our people at Noranda and you can expect to hear from him
within the course of the next few days.

Yours very truly,

NORANDA MINES, LIMITED
"T. N. Hay"

Secretary-Treasurer

TNH:GLC

20 EXHIBIT M-4W

February 12, 1935

Albert Roberts, Esq.,
Minerals Separation North American Corporation,
11 Broadway,
New York, N.Y.

Dear Sir:

Referring further to your letter to Mr. Murdoch of November
14th last, Mr. Murdoch was unexpectedly called away on business
and although he had started his investigations regarding xanthates he
had not time to complete same before his departure. He has asked
me to write and ask if you will allow the matter to stand until his
return. I am afraid, however, that he will not return until the end
of March.

Yours very truly,

"T. N. Hay"

Secretary-Treasurer

TNH:GLC

Exhibit—M-4X.
Exhibit—M-4Y.

EXHIBIT M-4X

Copy

MINERALS SEPARATION NORTH AMERICAN CORPORATION
11 Broadway New York

February 14, 1935.
ARs

10 T. N. Hay, Esq., Secretary-Treasurer,
Noranda Mines, Limited,
804 Royal Bank Building,
2-8 King Street East,
Toronto 2.

Dear Sir.—

I thank you for your letter of the 12th instant advising of Mr. Murdoch's unexpected absence and his request, and we are quite willing to allow the matter to stand until his return.

Yours very truly,

“Albert Roberts”

Secretary.

EXHIBIT M-4Y

Copy

20 J. A. Boyd
agent for
LAZARD BROTHERS & CO. LTD.
London

302 Bank of Nova Scotia Building,
ST. JAMES STREET
MONTREAL

February 7th, 1936.

30 J. Y. Murdoch, Esq.,
President,
Noranda Mines Limited,
Royal Bank Building,
Toronto, Ontario.

Dear Mr. Murdoch:—

I telephoned your Secretary today and endeavoured to make an appointment with you some time next week. As I explained to your Secretary, I have taken the late Mr. Perry's place here in Montreal, and have also succeeded him on the Board of Minerals Separation North American Corporation.

Exhibit—M-4Y.

Exhibit—M-4Z.

Prior to Mr. Perry's death I understand that he and Mr. Roberts, the Secretary of the Company, had had some discussion with you with respect to the question of royalties, but apparently these were not concluded. As the question has now been outstanding for some time I should like to get it settled as soon as possible.

I understood from your Secretary that you would be returning to Toronto on Monday, the 10th, but would probably be going away again almost immediately, and I therefore asked him if he would try and arrange an appointment for Mr. Roberts and myself with you
10 some time during the week of the 17th of February.

I have just heard from Mr. Roberts, who tells me that there is some Mining Convention in New York City during the whole week of the 17th, and that he would like if possible to be there while it is on. Would it be possible for us to arrange to meet you some time during the week of the 24th of February?

Yours faithfully,

“J. A. Boyd”

JAB:WM

EXHIBIT M-4Z

20 NORANDA

February 12th, 1936.

J. A. Boyd, Esq.,
302 Bank of Nova Scotia Building,
St. James Street,
Montreal, P.Q.

Dear Sir:

Referring to your letter of the 7th instant would state that I expect to be leaving early the week of the 24th for several weeks absence and as a matter of fact will only be at the office one or two
30 days between now and then. Therefore I am afraid we will have to leave the matter of our proposed interview over indefinitely.

I looked into the subject matter to which you referred some months ago and while the points are not clear in my mind I do recollect I came to a fairly definite conclusion that this Company was not liable and therefore should not pay your Company any royalty.

However, if at sometime in the future you care to discuss the matter with me I will endeavour to arrange a time mutually satisfactory.

Yours truly,

Per: “G. H. O’R”

40

JYM/O

Exhibit—M-4AA.

EXHIBIT M-4AA

Copy

J. A. Boyd
agent for
LAZARD BROTHERS & CO. LTD.
LONDON

302 Bank of Nova Scotia Building
ST. JAMES STREET
MONTREAL

February 13th, 1936.

10

James Y. Murdoch, Esq.,
President,
Noranda Mines Limited,
2 King Street East,
Toronto, Ont.

Dear Mr. Murdoch:—

I have your letter of February 12th, and I regret that you are unable to see me before you go away during the week of the 24th. I hope, however, that we will not have to leave the matter of our
20 proposed interview indefinitely. If there is any time during the week of the 17th when you would be free, I should be obliged if you would let me know, rather than let the matter stand indefinitely—I am sure Mr. Roberts would arrange to go up then. If that is not possible, I hope we shall be able to arrange to have a meeting as soon as possible after your return.

I note what you state in the second paragraph of your letter. It might expedite matters somewhat if you could advise me of the grounds upon which you came to the conclusion that your Company was not liable to pay any royalty.

30

Yours faithfully,

“J. A. Boyd”

JAB:WM

Exhibit—M-4BB.

Exhibit—M-4CC.

EXHIBIT M-4BB

NORANDA

February 17th, 1936.

J. A. Boyd, Esq.,
302 Bank of Nova Scotia Building,
St. James Street,
Montreal, P.Q.

Dear Sir:

We have your letter of the 13th instant and wish to advise you
10 that Mr Murdoch has again left the city and will not be available
until well into March.

In reference to the last paragraph of your letter I have been
instructed by Mr. Murdoch to advise you that he does not care to
state his reasons as to why this Company was not liable and therefore
should not pay your Company any royalty.

Yours truly,

"C. H. W."

Secy. to Mr. James Y. Murdoch

CHW:M

20 EXHIBIT M-4CC
J. A. Boyd
agent for
LAZARD BROTHERS & CO. LTD.
LONDON

302 Bank of Nova Scotia Building,
ST. JAMES STREET,
MONTREAL
February 18th, 1936.

30 Sec'y to Mr. James Y. Murdoch,
Noranda Mines Limited,
2-8 King Street East,
Toronto 2, Ont.

Dear Sir:—

I have your letter of the 17th February advising that Mr.
Murdoch has left the City and will not be available until some time
in March. Would you please be good enough to draw the matter to
his attention on his return, and advise me, so that we can arrange an
appointment with Mr. Murdoch at that time.

Yours faithfully,

"J. A. Boyd"

40
JAB:WM

1005

Exhibit—M-4DD.
Exhibit—M-4EE (also Exhibit—M-3)

EXHIBIT M-4DD
copy

J. A. Boyd
agent for
LAZARD BROTHERS & CO. LTD.
LONDON

James Y. Murdoch, Esq.,
Noranda Mines Limited,
10 2-8 King St., E.,
Toronto 2, Ont.

302 Bank of Nova Scotia Building,
ST. JAMES STREET
MONTREAL

March 31st, 1936

Dear Mr. Murdoch:

I had some correspondence with you about the middle of February, when I was trying to arrange suitable time for Mr. Roberts, of Minerals Separation North American Corporation, and myself to have a talk with you. It was impossible to arrange this at that time owing to the fact that you were expected to be away during the greater part of March. If you have now returned, would it be possible for you to advise me of the time when this would be convenient for
20 you.

Yours faithfully,
"J. A. Boyd"

EXHIBIT M-4EE
(ALSO EXHIBIT M-3)

Copy
NORANDA

April 1st, 1936.

J. A. Boyd, Esq.,
302 Bank of Nova Scotia Building,
30 St. James Street,
Montreal, P.Q.

Dear Sir:

Mr. Murdoch wishes to acknowledge receipt of your letter of the 31st ultimo, and states that he could see you and Mr. Roberts on Monday, the 6th instant, at his office in the Royal Bank Building, Toronto, but would *prefer* postponing this meeting until some day during the week after Easter, 20th to 25th.

Would you kindly advise me if this will be agreeable to you and Mr. Roberts or if you would rather the appointment be made for
40 the 6th.

Yours truly,
"C. H. W."
Secy. to Mr. James Y. Murdoch

CHW:M

1006

Exhibit—M-4FF.
Exhibit—M-4GG.

EXHIBIT M-4FF.

COPY

J. A. BOYD
Agent for
LAZARD BROTHERS & Co., LTD.
LONDON

705 Bank of Nova Scotia Building
St. James Street
Montreal.

April 2nd 1936

10 C. H. Windeler, Esq.,
Secretary to Mr. James Y. Murdoch,
Noranda Mines Limited,
2-8 King St., E.,
Totonto 2, Ont.

Dear Sir:—

I beg to acknowledge your letter of April 1st. I have spoken
to Mr. Roberts and any time from the 20th to the 25th April will be
quite satisfactory to both of us. Would you please let me know
what day in this period is satisfactory to Mr. Murdoch, and Mr.
20 Roberts and myself will arrange to be present.

Yours faithfully,

“J. A. BOYD”

EXHIBIT-M-4GG.

COPY

J. A. BOYD
Agent for
LAZARD BROTHERS & Co., LTD.
LONDON

705 Bank of Nova Scotia Building
St. James Street
Montreal.

30

April 23rd 1936

James Y. Murdoch, Esq.,
Noranda Mines Limited,
2-8 King Street, E.,
Toronto 2, Ont.

Dear Mr. Murdoch:—

You were good enough to give Mr. Roberts of New York and
myself an appointment to see you in Toronto some time during this
week, although I have not yet heard from you fixing a definite date.
40 I have however just received word from New York and Mr. Roberts
has been confined to his home with a cold and therefore will not be

1007

Exhibit—M-4GG.
Exhibit—M-4HH.
Exhibit—M-4II.

available this week, although I understand he probably will be available next week or the week after. Could we arrange to see you some time in either of those weeks?

Yours faithfully
"J. A. BOYD"

EXHIBIT-M-4HH.

COPY

NORANDA

April 25th, 1936

10 J. A. Boyd, Esq.,
705 Bank of Nova Scotia Building,
St. James Street,
Montreal, P.Q.

Dear Sir:—

In reply to your letter of the 23rd instant Mr. Murdoch wishes to advise you that possibly the week after next he would be able to arrange an appointment with yourself and Mr. Roberts.

Mr. Murdoch has just left the city and as the date of his return is somewhat indefinite I will again, on his return to the city, bring
20 your letter to his attention and will then advise you of a definite date for the appointment.

Yours truly,
"C. H. W.

Secy. to Mr. James Y. Murdoch

CHW:M

EXHIBIT M-4II

COPY

J. A. BOYD
Agent for
LAZARD BROTHERS & Co., LTD.
30 LONDON

705 Bank of Nova Scotia Building
St. James Street
Montreal

April 27th 1936

C. H. Windeler, Esq.,
Secretary to Mr. James Y. Murdoch,
Noranda Mines Limited,
2-8 King St., E.,
Toronto 2, Ont.

Dear Sir:—

I have your letter of April 25th and note that you will advise me
40 of a definite date for an appointment some time next week.

Yours faithfully,
"J. A. BOYD"

1008

Exhibit—M—4JJ.
Exhibit—M—4KK.

EXHIBIT—M—JJ.

COPY

J. A. BOYD
Agent for
LAZARD BROTHERS & Co., LTD.
LONDON

705 Bank of Nova Scotia Building
St. James Street
Montreal

May 26th 1936

10 James Y. Murdoch, Esq.,
Noranda Mines Limited,
2-8 King St., E.,
Toronto 2, Ont.

Dear Mr. Murdoch:—

For some time past I have been endeavouring to arrange an appointment for Mr. Roberts of Minerals Separation North American Corporation and myself to see you, but so far we have not been successful in arranging one. I appreciate that owing to your frequent absences from Toronto that it is very difficult for you to arrange for
20 appointments a long time ahead. I would however like to have this meeting with you as soon as it can be conveniently arranged. Will you be available during either the week of June 1st or June 8th?

Yours faithfully,

“J. A. BOYD”

ESHIBIT—M—4KK.

COPY

NORANDA

May 28th 1936

J. A. BOYD, Esq.,
30 705 Bank of Nova Scotia Building,
St. James Street,
Montreal, P.Q.

Dear Sir:—

Mr. Murdoch wishes to acknowledge receipt of your letter of the 26th instant and to advise you that he is leaving tonight for the north country and will be returning to the city on Monday, June 1st; however, he expects to leave the city again that evening on a week's business trip and on completion of same spend the following two weeks salmon fishing. On his return to Toronto, as soon as he has had an
40 opportunity of catching up on his business affairs, he will set a date for an appointment with you and Mr. Roberts and will either wire or write you.

Exhibit—M-4KK.
Exhibit—G-16.

I will bring this matter to his attention on his return from his fishing trip and should imagine that possibly an appointment could be arranged for some day during the last week of June.

Yours truly,

“G. H. W.”

Secy. to Mr. James Y. Murdoch

CHW:M

EXHIBIT-G-16.

10 EXCERPTS FROM MINUTES OF MEETINGS OF BOARD OF
DIRECTORS MINERALS SEPARATION NORTH
AMERICAN CORPORATION

MEETING MAY 20, 1936:

“The President reported that he had decided to obtain advice of Counsel on the question of the Company’s xanthate Canadian patent, in connection with the failure of Noranda Mines and others to pay the required royalty, and reported that a meeting had taken place the previous day at the office of Patent Counsel Mr. Henry D. Williams at which Mr. W. L. Scott, K.C., was present. Mr. Scott advised that on the facts presented to him he considered that the
20 Canadian xanthate patent was good and unassailable. It was left to Mr. Boyd to make an appointment for Mr. Roberts and himself to see Mr. Murdoch, the President of Noranda Mines, Limited, to arrange a settlement.”

MEETING OCTOBER 26, 1936:

“The position with respect to Noranda Mines Limited and its failure to pay royalties was discussed at some length. The Treasurer gave an outline of his attempts over the past year and a half to arrange an interview with Mr. Murdoch, the President, and stated that in his
30 opinion it was useless for him to make any further attempt. The President stated that he had been given to understand through an intermediary that Mr. Murdoch at the present time was engaged in making himself familiar with the position, and expected to be ready to discuss the matter within two months at the outside. The favorable legal opinion obtained from Mr. W. L. Scott, K.C., of Ottawa, was also discussed. It was decided to give Mr. Murdoch reasonable opportunity to see Doctor Gregory, and, if no satisfactory settlement is arrived at, the President stated that he would arrange to have Mr. Scott attend a meeting of the Board for the purpose of advising in connection with any action which might then be necessary.”

Exhibit—G-16.

MEETING JUNE 24, 1937:

“The position with respect to Noranda Mines Limited was again discussed. The President and Treasurer reported the result of interviews and correspondence which they had had with Mr. W. L. Scott, K.C., who had given an opinion upholding the contentions of Minerals Separation and stating that successful action could be taken against Noranda. Having regard to other situations with which the Company is dealing at the present time, and as a matter of general policy, the President stated he felt that the taking of action against
10 Noranda should be delayed for the time being, and his recommendation was concurred in by the Board. The Treasurer was instructed to write to Mr. Scott advising him of this conclusion.”

MEETING OCTOBER 28, 1937:

“The President reported that Noranda Mines had once again commenced to use xanthate, and the question with respect to the failure of that company to make any royalty payment was discussed at some length. It was agreed that the decision as to what action, if any, should be taken against Noranda Mines should be left to be dealt with at the next meeting of Directors.”

20 MEETING NOVEMBER 3, 1938:

“There was a general discussion as to the Noranda Mines situation and the Kyanite venture of Phosphate Recovery Corporation.”

MEETING NOVEMBER 27, 1940:

“The matter of the unlicensed use of xanthate in Canada by Noranda and other companies was discussed, and it was decided that this matter should stand for the time being.”

MEETING DECEMBER 16, 1942:

“It was decided to proceed against various firms and companies
30 in Canada who have been using for some years past the process covered by the xanthate patent of the Corporation and who have refused to take out a license or pay royalties. The Secretary was instructed to prepare a statement of the situation and include in the statement a schedule of names of the infringers and the amounts claimed to be owing as nearly as could be made out and submit the statement for consideration of and opinion by Messrs. Cook, Nathan, Lehman & Greenman. The Secretary was instructed likewise to forward this statement to Mr. Boyd, who was requested to take the matter up with Mr. W. L. Scott, K.C., of Ottawa, who had been
40 previously consulted by the Corporation on the subject.”

MEETING FEBRUARY 19, 1943:

“Prior to the meeting, the Directors had a conference with Mr. W. L. Scott, K.C., of Ottawa. As a result of this meeting Mr. Scott

Exhibit—G-16.

was instructed, on behalf of the Company, to commence immediately actions against twenty companies operating in Canada, for damages for infringement of the Company's xanthate patents. At the time of filing the claims, Mr. Scott was instructed to write each of the companies advising them of his instructions. Mr. Scott recommended that Mr. Gowling, K.C., of Ottawa, should be his associate counsel in these actions. This was approved and Mr. Scott instructed to make the necessary arrangements with Mr. Gowling."

MEETING OF APRIL 20, 1943:

- 10 "The President reported on the progress of the actions against certain infringers of the Corporation's xanthate Canadian patents, and a general discussion arising out of this followed. It was agreed that Mr. Cook should keep in close touch with Mr. W. L. Scott, K.C., for consultation and advice of all phases of the proceedings. The present position is that the defendants have four weeks from April 7 in which to file their defense.

EXHIBIT G-15

MINERALS SEPARATION NORTH AMERICAN CORPORATION
AND
LICENSE

THIS INDENTURE

made the _____ day of _____

in the year One thousand nine hundred and _____

10 BETWEEN MINERALS SEPARATION NORTH AMERICAN CORPORATION, No. 11 Broadway, New York, New York, (hereinafter called "the Licensors", which designation shall include its successors and assigns where the context so requires or admits) of the one part and

a corporation organized and existing under the Laws of _____

and having an office or place for the transaction of business situate at _____

and whose Mines and Mills are _____

(hereinafter called "the Licensees") of the other part.

20 WHEREAS the Licensors are entitled to or otherwise control or are interested in Letters Patent for certain inventions for the concentration and treatment of ores described in the Schedule hereto, and are entitled to grant licenses thereunder;

AND WHEREAS the Licensors have agreed to grant to the Licensees a license to concentrate and treat all or any ores or any part thereof and/or dumps now existing in accordance with all or any of the inventions, processes and apparatus described and claimed in the said Letters Patent and any Letters Patent for the concentration of ores that are or may become the property of the Licensors (all of said Letters Patent being hereinafter called "Letters Patent within this License") at the premises of the Licensees situate

and known as _____

Exhibit—G-15.

but not elsewhere.

NOW THIS INDENTURE WITNESSETH That in pursuance of the said Agreement and of the matters aforesaid and in consideration of the royalties hereby reserved and of the covenants on the part of the Licensees hereinafter contained the Licensors hereby grant unto the Licensees full license power and authority to make, use and exercise any or all of the inventions described and claimed in the Letters Patent within this License, at the Licensees' mines or mills aforesaid and any extension thereof

10 for the purpose of treating all or any of the ores or any part thereof and/or dumps now existing, belonging to or controlled by the Licensees won, dug or otherwise produced at the

and to vend the concentrates and other products resulting from the use and exercise of the said inventions during the terms of the Letters Patent within this License or any of them and any extension thereof subject nevertheless to the following conditions:—

AND IT IS HEREBY AGREED as follows:—

1. THE Licensees shall pay royalties to the Licensors
2. THE Licensees shall keep at the counting house or office of their
20 said mines proper books of account and shall enter therein full and complete particulars of all the ores and/or material treated. The said books of account shall at all convenient times be open to the inspection of and subject to verification by an accountant or auditor to be appointed by the Licensors. The Licensees shall quarterly deliver to the Licensors an account in writing showing the quantity of the ores and/or material treated during each quarter under this license. The Licensees shall if so required by the Licensors verify the said accounts by affidavit or by statutory declaration. The said quarterly accounts
30 shall be delivered to the Licensors within thirty (30) days after expiration of each quarter, viz., within thirty (30) days after March 31st, June 30th, September 30th, and December 31st, starting with the quarter day immediately following the date of this license. The Licensees shall within fifteen (15) days thereafter pay to the Licensors free of exchange in New York the full amount thereby shown to be due.
3. The Licensors shall whenever required (on the Licensees paying
40 out of pocket expenses) give all assistance, information and advice in their power as to the working of any of the said inventions and shall use their best endeavors to enable the Licensees to use and exercise said inventions to the best advantage, and in like manner the Licensees shall use their utmost endeavors to promote the success of the said

Exhibit—G-15.

inventions and enable them to be used and exercised to the best advantage.

4. THE Licensees shall not assign or sublet this License without the written consent of the Licensors such consent not to be withheld in the case of a *bona fide* sale of the Licensees' undertaking or a substantial part thereof to a responsible person or company who will undertake to enter into a License when called upon so to do by the Licensors in the same terms as near as may be as are herein contained (but subject to the approval of the Licensors) and the Licensors agree to execute if
10 called upon so to do such a License to such *bona fide* purchaser.

5. THE Licensees shall permit the officers or the duly authorized representatives of the Licensors at all reasonable times during the continuance of this License to enter upon the works and property of the Licensees and inspect the plant and processes there being used according to the inventions contained in the Letters Patent within this License and to take any samples and to make such assays, analyses or tests as may be desirable for the purpose of checking the Licensees' accounts or testing the said plant or processes and will also permit should the Licensors or their agents so desire reasonable access to
20 intending Licensees to see the plant at work.

6. THE Licensors when required by the Licensees but at the cost of the Licensees shall prepare and supply as soon as may be possible plans and specifications of the plant for the working of the said inventions. The Licensors shall if requested by the Licensees and as soon as may be possible send to the Licensees' said works an engineer or member of their staff to advise as to the operation of the said inventions. The Licensees shall pay the salary of the said advisor which shall be at the rate of
dollars (\$) per month for such period of
30 time as he shall be engaged in such advisory capacity including the time spent in travel to and from the works of the Licensees, such period of time to be mutually agreed upon, and the Licensees shall pay all legitimate expenses travelling and otherwise of said advisor from the time the said advisor shall start for such works until he shall return therefrom.

7. THE Licensors hereby covenant with the Licensees that the Licensees paying the royalties hereby reserved and observing and performing the covenants on their part herein contained shall at all times during the term of years for which the Letters Patent within this License are granted or any extension thereof peaceably and quietly hold
40 exercise and enjoy the License hereby granted without any interruption or disturbance by the Licensors or any person lawfully claiming by through or in trust for them.

Exhibit—G-15.

8. PROVIDED ALWAYS that if any royalties payable hereunder by the Licensees or any part thereof respectively shall remain unpaid for thirty (30) days after the time hereinbefore appointed for payment thereof whether demanded or not or if the Licensees shall make default in any other obligation by them herein contained and in case the non-payment of royalties or any breach capable of being made good shall for the space of thirty (30) days after they shall have been served with a notice in writing by the Licensors to make good such non-payment or breach neglect or omit so to do or if the Licensees should cease for the

10 period of twelve calendar months to use and work the said inventions or should be wound up by reason of inability to meet their liabilities then the Licensors at any time thereafter and notwithstanding any merely implied waiver by them of their rights so to do may by serving the Licensees or their liquidator (if any) with a notice in writing for this purpose forthwith revoke this License without prejudice however to the recovery by the Licensors of any money then already due or any right of action by or on behalf of them for past breaches accrued hereunder.

9. THIS Contract shall be construed in all respects and take effect

20 as a contract made in the State of New York, and in accordance with the Laws of said State.

10. ANY notice hereunder may be given by either party to the other of them by sending it through the post in a prepaid registered letter addressed to them at the address designated by the other party and last known to the party sending said notice and such notice shall be deemed to have been served in due course of post, and in proving the service thereof it shall be sufficient to show that the letter containing the same was properly addressed and registered.

SIGNED, SEALED AND DELIVERED by the parties hereto, in

30 duplicate, the day and year first above written.

MINERALS SEPARATION NORTH AMERICAN CORPORATION.

President.

Attest:

 Secretary

 Attest:

Exhibit—G-15.

STATE OF

County of

}
ss.:
}

On the _____ day of _____
in the year One thousand nine hundred and _____
before me personally came

to me known, who, being by me duly sworn, did depose and say that
he resides in

that he is the _____ of the Minerals Separation North
10 American Corporation, the Licensor corporation described in and
which executed the above instrument; that he knows the seal of said
corporation; that the seal affixed to said instrument is such corporate
seal; that it was so affixed by order of the Board of Directors of said
corporation, and that he signed his name thereto by like order; and
he acknowledged the said instrument to be the free act and deed of
the said corporation.

STATE OF

County of

}
ss.:
}

20 On the _____ day of _____
in the year One thousand nine hundred and _____
before me personally came

to me known, who, being by me duly sworn, did depose and say that
he resides in

that he is the _____ of the

the Licensee corporation described in and which executed the above
instrument; that he knows the seal of said corporation; that the seal
affixed to said instrument is such corporate seal; that it was so affixed
by order of the Board of Directors of said corporation, and that he
30 signed his name thereto by like order; and he acknowledged the said
instrument to be the free act and deed of the said corporation.

Exhibit—G-15.

THE SCHEDULE ABOVE REFERRED TO
UNITED STATES LETTERS PATENT

No.	Date	Name	Description
1,532,451,	April 7, 1925,	H. H. Smith,	Apparatus for Making Gas.
1,551,588,	Sept. 1, 1925,	H. H. Smith,	Ore Concentration.
1,554,216,	Sept. 22, 1925,	C. H. Keller,	Froth-Flotation Concentration of Ores.
1,554,220,	Sept. 22, 1925,	C. P. Lewis,	Concentration of Ores.
1,560,170,	Nov. 3, 1925,	C. P. Lewis,	Concentration of Ores.
1,562,863,	Nov. 24, 1925,	Broadbridge, Edser & Sellers,	The Purification or Extraction of Soluble Substances.
1,577,328,	Mar. 16, 1926,	C. P. Lewis,	Ore Concentration.
1,588,077,	June 8, 1926,	Wilkinson & Littleford,	Flotation Machines.
1,595,795,	Aug. 10, 1926,	J. W. Littleford,	Ore Concentration.
1,595,796,	Aug. 10, 1926,	J. W. Littleford,	Ore Concentration.
1,610,298,	Dec. 14, 1926,	C. P. Lewis,	Froth-Flotation Concentration of Ores.
1,628,151,	May 10, 1927,	C. H. Keller,	Concentration of Ores.
1,632,419,	June 14, 1927,	T. R. Simpson,	Concentration of Metalliferous Ores.
1,667,272,	April 24, 1928,	H. H. Smith,	Processes for the Production of Gas.
1,668,917,	May 8, 1928,	C. P. Lewis,	Froth-Flotation Concentration of Ores.
1,671,590,	May 29, 1928,	C. H. Keller,	Froth-Flotation Concentration of Ores.
1,678,403,	July 24, 1928,	R. B. Martin,	Processes for the Production of Oxidized Products.
1,686,529,	Oct. 9, 1928,	R. B. Martin,	Froth-Flotation Concentration of Ores.
1,697,402,	Jan. 1, 1929,	Nutter & Littleford,	The Concentration of Sulphur.
1,723,243,	Aug. 6, 1929,	C. P. Lewis,	Froth-Flotation Concentration of Ores.
1,728,764,	Sept. 17, 1929,	C. H. Keller,	Froth-Flotation Concentration of Ores.
1,833,427,	Nov. 24, 1931,	Lavers & Higgins,	Concentration of Metalliferous Minerals.
1,833,464,	Nov. 24, 1931,	C. H. Keller,	Ore Concentration.
1,843,526,	Feb. 2, 1932,	Stanley Tucker,	Concentration of Metals.
1,850,991,	Mar. 22, 1932,	Wm. Trotter,	Froth-Flotation Concentration of Ores.
1,855,454,	Apr. 26, 1932,	C. H. Keller,	Ore Concentration.
1,902,317,	Mar. 21, 1933,	P. C. Wright,	Froth-Flotation Concentration of Ores.
1,968,008,	July 24, 1934,	Chapman and Littleford,	Concentration of Minerals.
1,969,269,	Aug. 7, 1934,	C. H. Keller,	Furfuryl Xanthate and Process of Making It.
1,976,203,	Oct. 9, 1934,	Trotter & Wilkinson,	Ore Concentration.
2,006,049,	June 25, 1935,	C. H. Keller,	Concentration of Ores by Flotation.
2,011,176,	Aug. 13, 1935,	C. H. Keller,	Ore Concentration.
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2,044,851,	June 23, 1936,	C. H. Keller,	Froth-Flotation Concentration of Ores.
2,047,643,	July 14, 1936,	Mayer & Hale,	Flotation Separation Apparatus.
2,054,643,	Sept. 15, 1936,	Stanley Tucker,	Apparatus for Concentrating Minerals by Flotation.
2,070,076,	Feb. 9, 1937,	E. H. Brown,	Separation of Molybdenite from Copper Sulphides.
2,094,125,	Sept. 28, 1937,	C. H. Keller,	Froth-Flotation Concentration of Ores.

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2,095,967,	Oct. 19, 1937,	E. H. Brown,	Separation of Molybdenite from Copper Sulphides.
2,097,608,	Nov. 2, 1937,	S. Tucker,	Concentration of Gold Bearing Material.
2,097,609,	Nov. 2, 1937,	S. Tucker,	Concentration of Gold Bearing Material.
2,120,535,	June 14, 1938,	E. W. Wilkinson,	Concentration of Minerals.
2,148,475,	Feb. 28, 1939,	C. H. Keller,	Concentration of Metalliferous Ores.
2,162,495,	June 13, 1939,	Trotter & Wilkinson,	Concentration of Ores.
2,169,313,	Aug. 15, 1939,	C. F. Williams,	Concentration of Metalliferous Ores by Flotation.
2,187,930,	Jan. 23, 1940,	E. H. Brown,	Separation of Molybdenite from Copper Sulphides.
2,190,852,	Feb. 20, 1940,	Stanley Tucker,	Froth Flotation Machine.
2,205,503,	June 25, 1940,	Trotter & Wilkinson,	Concentration of Comminuted Materials from their Mixtures.
2,232,388,	Feb. 18, 1941,	Ingalls, Williams & Mayer,	Froth Flotation Apparatus.
2,238,139.	April 15, 1941.	Stanley Tucker,	Agitation and Aeration Apparatus.

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EXHIBIT P-88

Exhibit Title page

ORGANIC CHEMISTRY
OR
CHEMISTRY OF THE CARBON COMPOUNDS

BY
VICTOR VON RITCHER
EDITED BY PROF. R. ANSCHUTZ AND DR. H. MEERWEIN

VOLUME II
CHEMISTRY OF THE CARBOCYCLIC COMPOUNDS

10 TRANSLATED FROM THE 11TH GERMAN EDITION

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A TEXT BOOK
OF
ORGANIC CHEMISTRY

II. CARBOCYCLIC COMPOUNDS

THE methane derivatives, or acyclic carbon compounds, with open carbon chains, dealt with in the first volume of this work, are here followed by organic compounds with closed carbon chains, or carbon rings, and these compounds I call by the name of Carbocyclic Compounds. In contrast with these we have, *e.g.*, the azocyclic compounds with a ring consisting only of nitrogen atoms, such as nitrogen hydride, and its derivatives. The carbocyclic compounds are also called isocyclic compounds, but the latter expression is too comprehensive, since it denotes compounds containing a ring consisting of a number of atoms, of any element. In contradistinction to isocyclic compounds we have the heterocyclic compounds, in which the atoms of several different elements take part in the formation of the ring.

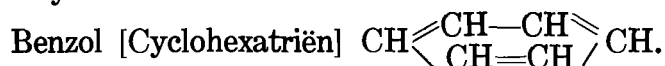
20 The fundamental carbocyclic hydrocarbons are those with a carbon ring consisting of from three to nine methylene groups. They are isomeric with the olefins, with an equal number of carbon atoms. They are designated either as polymethylenes, in accordance with the number of methylene groups which they contain; or by prefixing an "R" or "R—" to the names of the normal olefins with which they are isomeric ("ring olefins"); or, according to the Geneva resolutions, by the names of the normal paraffins containing an equal number of carbon atoms with the word "cyclo-" prefixed (cyclo-paraffins). The first and third of these designations are to be preferred.

30	Trimethylene [Cyclopropane]	$\begin{array}{c} \text{CH}_2 \\ > \\ \text{CH}_2 \end{array}$
	Tetramethylene [Cyclobutane]	$\begin{array}{c} \text{CH}_2-\text{CH}_2 \\ | \quad | \\ \text{CH}_2-\text{CH}_2 \end{array}$
	Pentamethylene [Cyclopentane]	$\begin{array}{c} \text{CH}_2-\text{CH}_2 \\ | \quad | \\ \text{CH}_2-\text{CH}_2 \\ > \text{CH}_2 \end{array}$
	Hexamethylene [Cyclohexane]	$\begin{array}{c} \text{CH}_2-\text{CH}_2-\text{CH}_2 \\ | \quad | \quad | \\ \text{CH}_2-\text{CH}_2-\text{CH}_2 \end{array}$
	Heptamethylene [Cycloheptane]	$\begin{array}{c} \text{CH}_2-\text{CH}_2-\text{CH}_2 \\ | \quad | \quad | \\ \text{CH}_2-\text{CH}_2-\text{CH}_2 \\ > \text{CH}_2 \end{array}$
	Octomethylene [Cyclooctane]	$\begin{array}{c} \text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2 \\ | \quad | \quad | \quad | \\ \text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2 \end{array}$
	Nonomethylene [Cyclononane]	$\begin{array}{c} \text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2 \\ | \quad | \quad | \quad | \\ \text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2 \\ > \text{CH}_2 \end{array}$

Hexamethylene is also called hexahydrobenzol, and heptamethylene. suberane. For the nomenclature of ring substances see also B. 29,587:

As the paraffins are followed by olefins and diolefins, so the cyclo-paraffins are followed by cyclo-olefin, cyclo-diolefin, and cyclo-triolefin.

Among the carbocyclic structures a special significance attaches to benzol (benzene), the fundamental hydrocarbon of the so-called aromatic substances or benzol derivatives, the most numerous class of organic compounds. If, in accordance with A. Kekulé, we assume
 10 in benzol a ring of six carbon atoms linked together in alternate single and double linking—an assumption which the author prefers—benzol is a cyclo-triolefin:



By the addition of hydrogen it is possible to convert benzol into hexahydrobenzol (hexamethylene, or cyclo-hexane). A constantly increasing number of transformation products of aromatic compounds are becoming known, which can be referred to dihydro- or tetrahydrobenzol (cyclo-hexadiene and cyclo-hexene), and which, together with the hexamethylene of hexahydrobenzol derivatives, are termed “hydro-aromatic compounds.” To these belong many natural products,
 20 especially those of the terpene and camphor series. If this system were rigidly followed, every cyclo-paraffin system would be associated with the corresponding cyclo-olefin system having the same number of carbon atoms. But the treatment of the hydro-aromatic substances presupposes a knowledge of the aromatic substance, to such an extent that it is better to deal first with the latter. We therefore treat first of the tri-, tetra-, penta-, hepta-, octo-, and nono-carbocyclic compounds, and afterwards of the hexacarbocyclic compounds.

In many ways the aromatic substances show a peculiar behaviour,
 30 different from that of the aliphatic compounds. But the hydro-aromatic compounds, as well as the other known polycarbocyclic compounds, approach in their chemical properties the saturated aliphatic substances, or the unsaturated ones, if there are any double-linked pairs of carbon atoms in the ring. These compounds are therefore called aliphatic cyclic, or alicyclic saturated, and unsaturated compounds, to distinguish them from the aromatic compounds (B. 22,769).

The study of the carbocyclic compounds has shown that the tri- and tetramethylene ring is more easily split than the more stable
 40 pentamethylene or hexamethylene ring, while hepta- and octomethylene rings are formed with greater difficulty, and can usually be easily transformed into rings of a smaller number of carbon atoms.

We have met similar phenomena in the formation of some heterocyclic derivatives of aliphatic substances, *e.g.* the lactones, lactames, and dicarboxylic anhydrides (Vol. I). In the case of the oxy-acids we

Exhibit—P-88.

indicated a scheme of the space-configuration of carbon chains, designed to explain the rare formation of *a*- and *B*-lactones, in comparison with the ease with which *y*- and *d*-lactones are produced. An attempt at explaining the different stabilities of the tri-, tetra-, penta-

Exhibit page numbered 69

HYDROCARBONS

These constitute the passage from the aliphatic bodies to the *hydro-aromatic* compounds, with which the *aromatic* derivatives are so closely connected.

There are many carbon compounds containing "rings", in the formation of which not only carbon atoms, but also oxygen, sulphur, and nitrogen atoms take part.

Such bodies have been termed *heteracyclic compounds* (from *repon*, foreign). These derivatives will mainly be discussed at the conclusion of the remarks on the open chain bodies, from which they are derived by loss of water, hydrogen sulphide, or ammonia, and into which they can again be changed. A large class of heterocyclic bodies—more especially of the *thiophene*, *fufurane*, and *pyrrole* groups, the parent substances of the plant alkaloids: pyridine, quinoline, isoquinoline, etc.—like the aromatic bodies, possess a very stable ring. In the case of many heterocyclic bodies the open chain compounds, from which they may theoretically be deduced, do not actually exist. Therefore such heterocyclic compounds will be more conveniently discussed after the carbo- or isocyclic derivatives. Thus, the chemistry of the compounds of carbon may be divided into:—

I. FATTY COMPOUNDS: *Aliphatic compounds, methane derivatives, chain or acyclic carbon derivatives.*

II. CARBOCYCLIC COMPOUNDS.

III. HETEROCYCLIC COMPOUNDS.

I. FATTY COMPOUNDS, ALIPHATIC SUBSTANCES OR METHANE DERIVATIVES, CHAIN OR ACYCLIC CARBON DERIVATIVES

I. HYDROCARBONS

The hydrocarbons may be regarded as the parent substances from which all other carbon compounds arise by the replacement of the hydrogen atoms by different elements or groups.

The fundamental conceptions of the linking of carbon atoms were put forward in the introduction. We distinguish, therefore, (1) *saturated* and (2) *unsaturated hydrocarbons*. The first contain only singly linked carbon atoms, whilst the unsaturated contain pairs of carbon atoms united doubly and trebly. As the first series has attained the limit of saturation by hydrogen, they are frequently called the *limit hydrocarbons*, or, after the first member of the series,

Phosgene corresponds with thiophosgene, CSCl_2 .

The two anhydrides, COS and CS_2 , will first be discussed, then the salts and esters of the five acids just mentioned, to which thiophosgene and the sulphur derivatives of the chlorocarbonic esters are connected.

CARBON OXYSULPHIDE, COS (1867 *C. v. Than*, A Spl. 5, 245), occurs in some mineral springs as, for example, in the sulphur waters of Harkány and Parád in Hungary, and is formed (1) by conducting sulphur vapour and carbon monoxide through red-hot tubes; (2) on heating CS_2 with SO_3 ; (3) by the action of COCl_2 on CdS at $260\text{--}280^\circ$ (B. 24, 2971); (4) by the action of fatty acids (p. 276); or (5) sulphuric acid, diluted with an equal volume of water on potassium thiocyanate, $\text{HSNC} + \text{H}_2\text{O} = \text{COS} + \text{NH}_3$ (B. 20; 550).

In order to obtain it pure (B. 36, 1008) the gas may be conducted into an alcoholic potassium hydroxide solution, and (6) the separated potassium ethyl thiocarbonate, $\text{C}_2\text{H}_5\text{OCOSK}$, decomposed with dilute hydrochloric acid.

Carbon oxysulphide is a colourless gas, with a faint and peculiar colour. It inflames readily, and forms an explosive mixture with air. It is soluble in an equal volume of water, and in 6 volumes of toluene at 14° . It is decomposed by the alkalis according to the following equation:



CARBON DISULPHIDE, CS_2 , b.p. 47° , D₄ 1'297, was first obtained in 1796 by *Lampadius*, when he distilled pyrites with carbon. It is prepared by conducting sulphur vapour over ignited charcoal, and is one of the few carbon compounds which can be prepared by the direct union of carbon with other elements. It is a colourless liquid with strong refractive power. It is obtained pure by distilling the commercial product over mercury or mercuric chloride; its odour is then very faint. It is almost insoluble in water, but mixes with alcohol and ether. It serves as an excellent solvent for iodine, sulphur, phosphorus, fatty oils and resins, and is used in the vulcanization of rubber. In the cold it combines with water, yielding the *hydrate* $2\text{CS}_2 + \text{H}_2\text{O}$, which decomposes again at -3° .

Small quantities of carbon disulphide are detected by conversion into *potassium xanthate*, by means of alcoholic potassium hydroxide, from which the copper salt is obtained. The production of the bright-red compound of CS_2 with triethyl phosphine (p. 173, and B. 13, 1732) is a more delicate test. Comp. also the mustard-oil reaction, p. 63.

H_2S and CS_2 conducted over heated copper yield methane (p. 71). Carbon disulphide is fairly stable towards dry halogens, so that it is

frequently used as a solvent in adding halogens to unsaturated carbon compounds.

However, moist chlorine gas converts CS_2 into thiocarbonyl chloride, CSCl_2 and in the presence of iodine into CCl_3SCl , *perchloromethyl mercaptan* and S_2C_2 ; finally into CCl_4 (p. 429). Alcoholates change it into *xanthates*.

THIOCARBONIC ACIDS.—The salts and esters of all these acids, which when free are exceedingly unstable, may be produced (1) by the union of the anhydrides, CO_2 , COS , CS_2 , with (a) the sulphides of the alkali and alkali earth metals, (b) the mercaptides of the alkali metals, (c) and of the last two with alcoholates; (2) by the transposition of the salts thus obtained with alkylogens and alkylene dihalides; (3) by the action of alcohols and alcoholates, mercaptans and alkali mercaptides on COCl_2 , $\text{Cl.CO}_2\text{C}_2\text{H}_5$ (p. 430), CSCl_2 and $\text{Cl.CS}_2\text{C}_2\text{H}_5$ (p. 434).

MONOTHIOCARBONIC ACIDS.

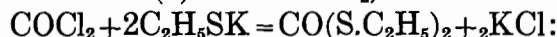
1. ETHYL THIOCARBONIC ACID, *Ethyl Carbon-monothiolic Acid*, $\text{HS.CO.OC}_2\text{H}_5$. The *potassium salt* (*Bender's salt*), $\text{KS.COOC}_2\text{H}_5$ is obtained (1) from ethyl xanthic esters and alcoholic potassium hydroxide (p. 433), and (2) from carbon oxysulphide and alcoholic potassium hydroxide (J. pr. Ch. (2) 73,242). It forms prisms, easily soluble in water and alcohol, and produces a white precipitate with copper sulphate. With ethyl iodide its salt forms *Thio-ethyl Carbonic Ethyl Ester*, $\text{C}_2\text{H}_5\text{S.COOC}_2\text{H}_5$, b.p. 156° , which can also be prepared from chlorocarbonic ester, $\text{ClCOOC}_2\text{H}_5$, and sodium or zinc mercaptide. Alkalis decompose it into carbonate, alcohol and mercaptan (B. 19, 1227). *Thiodicarbonic Ester*, $\text{S}(\text{COOC}_2\text{H}_5)_2$ b.p.²², 118° , is produced from chlorocarbonic ester and Na_2S . (J. pr. Ch. (2) 71,278).

20 2. SULPHOCARBONIC ACID. *Thion-carbonic Acid*, HOCSOH . Its *ethyl ester*, $\text{CS}(\text{O.C}_2\text{H}_5)_2$, b.p. 161° , is produced by the action of sodium alcoholate on thiocarbonyl chloride, CSCl_2 , and in the distillation of $\text{S}_2(\text{CSOC}_2\text{H}_5)$. It is an ethereal smelling liquid. With alcoholic ammonia the ester decomposes into alcohol and ammonium thiocyanate, CN.S.NH_4 .

DITHIOCARBONIC ACIDS.

3. DITHIOCARBONIC ACID, *Carbon-dithiolic Acid*, $\text{CO}(\text{SH})_2$. The free acid is not known.

The *methyl ester*, $\text{CO}(\text{S.CH}_3)_2$, b.p. 169° ; *ethyl ester*, $\text{CO}(\text{S.C}_2\text{H}_5)_2$ b.p. 196° , These result (1) when COCl_2 , acts on the mercaptides:

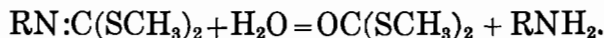


and (2) when thocyanic esters (p. 468) are heated with concentrated sulphuric acid:

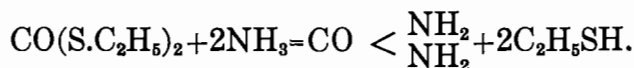


Exhibit—P-88.

(3) from imido-dithio-carbonic ester (p. 450) and dilute hydrochloric acid (C 1905, I. 447):



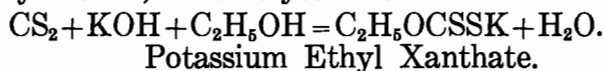
They are liquids with an odour of garlic. Alcoholic ammonia decomposes them into urea and mercaptans:



Dithiocarbonic Ethylene Ester, $\text{CO} < \begin{array}{c} \text{S-CH}_2 \\ \text{S-CH}_2 \end{array}$, m.p. 310°, is produced
10 from trithiocarbonic ethylene ester.

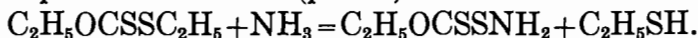
4. SULPHOTHIOCARBONIC ACID, *Thion-carbon-thiolic Acid*, HO. CS.SH. does not exist free. The *xanthates*, RO.C.SSM_e, discovered by Zeise in 1824, are obtained from it.

The XANTHATES are produced by the interaction of CS₂ and alkali hydroxides in alcoholic solution—*e.g.* potassium xanthate, consisting of yellow, silky needles, which crystallize:

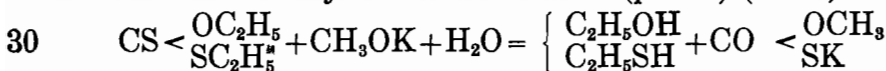


Cupric salts precipitate *yellow* copper salts from solutions of the
20 alkali xanthates together with disulphides S₂(CSOR)₂ (comp. B. 38. 2184; C. 1908. 1. 1092). The acid owes its name, *Xanthos*, yellow, to this characteristic. By the action of alkyl iodides on the salts the esters are formed.

The latter are liquids possessing an odour of garlic, and are not soluble in water. Ammonia decomposes them into mercaptans and esters of sulphocarbamic acid (p. 448):



Alkali alcoholates cause the production of mercaptan and alcohol and salts of the alkyl thiocarbonic acids (p. 432) (B. 13, 530):



Ethyl Xanthic Acid, C₂H₅OCSSH, is a heavy liquid, not soluble in water. It decomposes at 25° into alcohol and CS₂.

Sulphocarboxethyl Disulphide, (S.CS.O.C₂H₅)₂. m.p. 18°, is produced on adding a solution of iodine or copper salts to potassium xanthate (see above, and p. 274, for the formation of acetyl disulphide and the disulphides from the carbithionic acids).

Ethyl Xanthate Ethel Ester, C₂H₅O CSSC₂H₅ b.p. 200°, is a colourless oil.

Methyl Xanthic Ethel Ester, CH₃ OCSSC₂H₅ (C. 1906, II. 502),
40 b.p. 184°, and *Ethyl Xanthic Methyl Ester*, C₂H₅ O.C.S.S.C.H₃ b.p. 184°, are distinguished by their behaviour towards ammonia and sodium alcoholate (see above).

Exhibit—P-88.

Ethylene Xanthic Ester, $C_2H_4(SCSOC_2H_5)_2$, is decomposed by alkalis into the cyclic trithiocarbonic ethylene ester (p. 434) and *Bender's salt* (p. 432:) (B. 38, 488). *Ethyl Xanthic Formic Ester* $C_2H_5OCS(SCOOC_2H_5)$, b.p. 133° , and *Ethyl Xanthic Acetic Acid*, $C_2H_5OCS(SCH_2COOH)$, m.p. 58° , are formed from a xanthate and chloroformic ester and chloroacetic ester respectively (J. pr. Ch. [2] 71, 264).

5. TRITHIOCARBONIC ACID. $CS(SH)_2$ is precipitated by hydrochloric acid as a reddish-brown oily liquid, from solutions of its alkali salts which are the products of interaction between carbon disulphide and alkali sulphide. It is insoluble in water and is very unstable. $C.S_2$ and alkaline solutions of copper form well crystallizable double salts, CS_3CuK , $CS_3Cu(NH_4)$ (B 35, 1140). Other salts such as CS_3Ba , see C. 1907, I. 539; J. pr. Ch. [2] 73, 245.

The alkali salts of the trithiocarbonic acids, reacting with the corresponding halogen compound, give rise to the following esters:

Trithiocarbonic Methyl Ester, $CS(SCH_3)_2$, b.p. $204-205^\circ$.

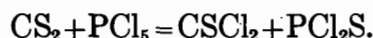
Trithiocarbonic Ethyl Ester, $CS(SC_2H_5)_2$, b.p. 240° , with decomposition.

20 *Trithiocarbonic Ethylene Ester*, $CS < \begin{array}{c} SCH_2 \\ | \\ SCH_2 \end{array}$, m.p. 39.5° , is con-

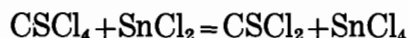
verted by oxidation with dilute nitric acid into *Dithiocarbonic Ethylene Ester* (p. 433) (A. 126, 269).

Trithiocarboxylic Diglycollic Acid, $SC(SCH_2COOH)_2$, m.p. 172° , is formed from potassium trithiocarbonate and chloroacetic acid. Oxidation converts it into *Carbonyl Dithioacetic Acid*, $OC(SCH_2COOH)_2$ m.p. 156 (1 pr. Ch. [2] 71, 287).

30 CHLORIDES OF THE SULPHOCARBONIC ACIDS: *Thiophozgens*, *Thiocarbonyl Chloride*, $CSCl_2$, b.p. 73° , $D-1.508$, is produced when chlorine acts on carbon disulphide, and when the latter is heated with PCl_5 , inclosed tubes to 200° :



It is most readily obtained by reducing perchloromethyl mercaptan, $CSCl_4$, (below), with stannous chloride, or tin and hydrochloric acid (B. 20, 2380; 21, 102):



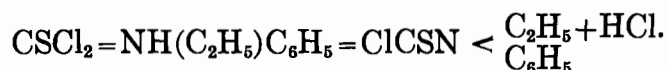
This is the method employed for its production in large quantities.

40 It is a pungent, red-coloured liquid, insoluble in water. On standing exposed to sunlight it is converted into a polymeric, crystalline compound, $C_2S_2Cl_4 = Cl.CS.S.CCl_3$, *methyl perchlorodithioformate*, m.p. 116° , which at 180° reverts to the liquid body (B. 26, R.

Exhibit—P-88.

600). Water decomposes thiophosgene into $\text{CO}_2\text{H}_2\text{S}$ and 2HCl , whilst ammonia converts it into ammonium thiocyanate (p. 467).

Thiocarbonyl chloride converts secondary amines (1 molecule) into dialkyl sulphocarbamic chlorides:



A second molecule of the amine produces tetra-alkylic thioureas (B. 21,102).

Phosgene and thiophosgene, when acted on by alcohols and
10 mercaptans, yield *sulphur derivatives of chlorocarbonic ester*.

Chlorocarbon-thiolic Ethyl Ester . . . Cl.COSC₂H₅
Chlorothioncarbonic Ethyl Ester . . . Cl.CSOC₂H₅
Chlorodithiocarbonic Ethyl Ester . . . Cl.CSSC₂H₅, b.p., 90° (B. 36, 3377)

Perchlorodithiocarbonic Methyl Ester . . Cl.CSSCCl₃ (See above thiophosgene)

SULPHUR DERIVATIVES OF ORTHOCARBONIC ACID

Perchloromethyl Mercaptan, CCl_3SCl , b.p. 147°, results from the screen of chlorine on CS_2 . It is a bright yellow liquid. Stannous
20 chloride reduces it to thiophosgene. Nitric acid oxidises it to

Trichloromethyl Sulphonic Chloride, $\text{CCl}_3\text{SO}_2\text{Cl}$, m.p. 135°, b.p. 170°, which can also be made by the action of moist chlorine on OS_2 . It is insoluble in water, but dissolves readily in alcohol and ether. Its odour is like that of camphor, and excites tears. Water changes the chloride to

Trichloromethyl Sulphonic Acid, $\text{CCl}_2\text{SO}_2 + \text{H}_2\text{O}$, consisting of deliquescent crystals. By reduction it yields $\text{CHCl}_2\text{SO}_3\text{H}$, dichloromethyl sulphonic acid, $\text{CH}_2\text{ClSO}_3\text{H}$, monochloromethyl sulphonic acid, $\text{CH}_3\text{SO}_3\text{H}$ (p.146).

30 *Dibromomethane Diethyl Sulphone*, $\text{CBr}_2(\text{SO}_2\text{C}_2\text{H}_5)_2$, m.p. 131°, and *diethyl-sulphone diiodomethane*, $\text{CI}_2(\text{SO}_2\text{C}_2\text{H}_5)_2$, m.p. 176°, are formed when bromine acts on the potassium salt of methane, diethylsulphone, and iodine in potassium iodide, or iodine alone (B.130,487).

Potassium Di-iodomethane Disulphonate, $\text{CI}_2(\text{SO}_3\text{K})_2$, and *Potassium Iodomethane Disulphonate*, $\text{CHI}(\text{SO}_3\text{K})_2$, are produced when potassium diaromethane disulphonate is decomposed with iodine and with hydrogen iodide. Sodium amalgam reduces both bodies to methylene disulphonic acid (p. 210).

40 *Potassium Methanol Trisulphonate*, $\text{HO.C}(\text{SO}_3\text{K})_3, \text{H}_2\text{O}$, results when the

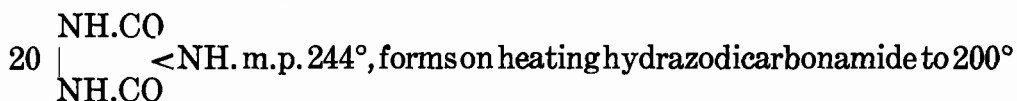
Exhibit—P-88.

Exhibit pages numbered 448 and 449

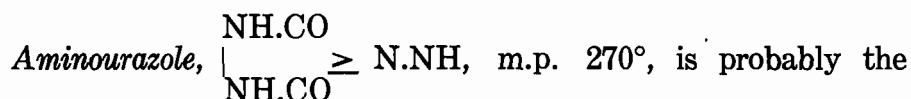
ORGANIC CHEMISTRY

it forms spear-like, very volatile crystals, of a penetrating and stupefying odour, recalling that of phosgene (p. 430) and hydrazoic acid. It is explosive. The aqueous solution decomposes into CO_2 and N_3H (B 27, 2684; J. pr. Ch. [2] 52,482).

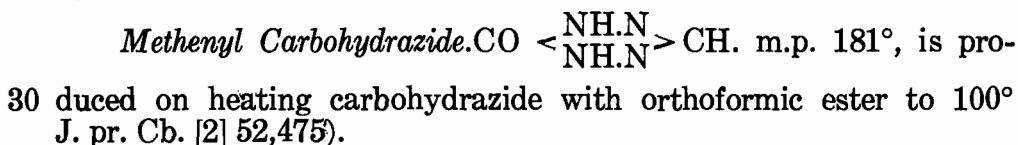
CYCLIC HYDRAZINE DERIVATIVES OF UREA.—URAZOLE. *Hydrazodicarbonimide*,



A. 283.16), or from urea and hydrazine sulphate heated to 120° (B. is a strong, monobasic acid. For its alkylation, see C. 1898, 1. 38.



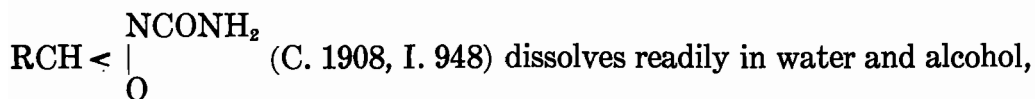
same as *diurea* or *bis-hydrasinocarboxyl*, which is obtained from hydrazo-dicarboxylic ester and hydrazine hydrate at 100° (B. 46. 2094).



HYDROXYLAMINE DERIVATIVES OF CARBONIC ACID.—HYDROXYURETHANE, $\text{HO.NH-CO}_2\text{C}_2\text{H}_5$, or $\text{HON:C } < \begin{array}{c} \text{OC}_2\text{H}_5 \\ \text{OH} \end{array}$ is a colourless

liquid. It is produced when an hydroxylamine solution acts on chlorocarbonic ester (B. 27,1254).

Hydroxyl Urea, Carbamide Oxime, $\text{NH}_2\text{CONH.OH.}$, m.p. 128° , is obtained from hydroxylamine nitrate and potassium isocyanate, together with a (? stereo-) isomeric body *Isohydroxyurea*, m.p. $70-72^\circ$ with decomposition, and when heated in alcoholic solution it changes into the ordinary hydroxyurea. *Methyl Hydroxyl Urea*, $\text{CH}_3\text{NHCO.NHOH}$, m.p. 127° with decomposition, and *Ethyl Hydroxyl Urea*, m.p. 129° with decomposition, are formed from methyl and ethyl isocyanate and hydroxylamine (C. 1902, I. 31). *Dimethyl-nitroso-hydroxy-urea*, $(\text{CH}_3)_2\text{NCO.N(NO)OH}$ (B 30, 2356). *Aldehyde-derivative of carbamide oxime*,

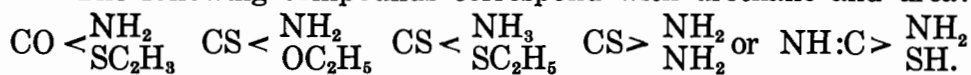


10 but with difficulty in ether.

Exhibit—P-88.

SULPHUR-CONTAINING DERIVATIVES OF CARBAMIC ACID AND OF UREA

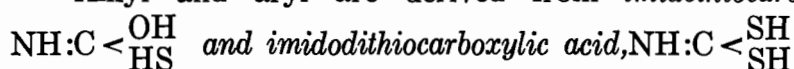
The following compounds correspond with urethane and urea:



Thiocarbamic Sulphocarbamic Dithiocarbamic Sulphourea or
Ester Ester Ester Thiourea.

Many reactions of sulphourea indicate that its constitution is probably best expressed by a formula analogous to one of the non-existing pseudo forms of urea (p. 446).

20 Alkyl and aryl are derived from *imidothiocarboxylic acid*:



Thiolcarbamic Acid, Carbamine-thiolic Acid, $\text{CO} < \begin{array}{c} \text{NH}_2 \\ \text{SH} \end{array}$ is not

known in the free state. Its *ammonium salt*, $\text{CO} < \begin{array}{c} \text{NH}_2 \\ \text{SNH}_4 \end{array}$ is prepared by leading COS into alcoholic ammonia (A. 285,173). It is a colourless, crystalline mass, which is unstable on exposure to the air. When heated to 130° it breaks up into hydrogen sulphide and urea.

30 Alkylamines and COS yield alkyl ammonium salts of alkyl carbamine-thiolic acids, such as *ethyl carbamine-thiolic acid*, $\text{C}_2\text{H}_5\text{NH}.\text{CO}.\text{SH}$, and *isobutyl-carbamine-thiolic acid*, $\text{C}_4\text{H}_9\text{NH}.\text{CO}.\text{SH}$. The mercury salts of these two acids decompose when heated into isocyanic esters and dialkyl ureas (comp. p. 462) (A. 359,202).

Thiol-carbamic Methyl Ester, $\text{NH}_2\text{COSCH}_2$ or $\text{NH}:\text{C} < \begin{array}{c} \text{OH} \\ \text{SCH}_2 \end{array}$

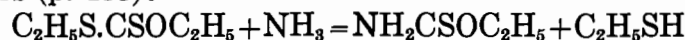
m.p. 95°, and *ethyl ester*, m.p. 108°, both result from the action of ammonia (1) on *dithio-carbonic ester* (p. 431), (2) on chlorocarbonic thiolic ester; (3) by the passage of HCl: into a solution of potassium or alkyl thiocyanate (B. 14,1083) in alcohol, when sulphocarbamic ester is also formed (J. pr. Ch. [2] 16,358).

These are crystalline compounds which dissolve with difficulty in water.

Thiol-carbethylamine Ethyl Ester, $\text{C}_2\text{H}_5\text{NH}.\text{COSC}_2\text{H}_5$, b.p. 204–208°. It results from the union of ethyl isocyanate with ethyl mercaptan.

SULPHOCARBAMIC ACID, *Xanthogenamic Acid, Thiocarbamic Acid*, NH_2CSOH . is known in its alkyl compounds.

10 The ESTERS of *sulphocarbamic acid—thiourethanes*, the *xanthogenamides*—are formed when alcoholic ammonia acts on the xanthic esters (p. 433):

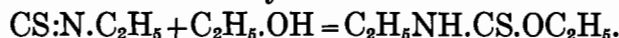


The *ethyl ester* of sulphocarbamic acid m.p. 38°, as well as the *methyl ester*, m.p. 43°, are both slightly soluble in water. Both esters

Exhibit—P-88.

decompose into mercaptans, cyanic acid and cyanuric acid when heated. Alcoholic alkalis decompose them into alcoholic and thiocyanates.

The *alkyl thiocarbamic esters* are obtained when the mustard oils are heated to 110° with anhydrous alcohols:



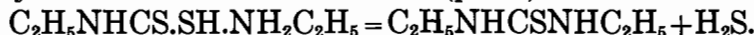
- 20 They are liquids with an odour like that of leeks, boil without decomposition and break up into alcohols, CO₂, H₂S, and alkylamines, and can easily be transformed by halogen alkyls into the isomeric thiolcarbamic esters (above) (C. 1899), 11, 618). *Ethyl Thiocarbamic Ethyl Ester*, C₂H₅NHCSOC₂H₅, m.p. 46°, b.p.206°; *Allyl Thiocarbamic Ethyl Ester* C₂H₅NHCSOC₂H₅, is prepared from allyl mustard oil. *Acetyl Thiocarbamic Methyl Ester*, CH₃CONHCS(OCH₃), m.p.80°, is prepared from thiocarbamic ester and acetic anhydride; or from lead thiocyanate, acetyl chloride, and methyl alcohol. It is converted by iodomethane into the isomeric *Methyl Acetyl Thiolarbamate*,
 30 CH₃CO.NHCOSCH₃, m.p. 146 (C. 1900, 11.853).

DITHIOCARBAMIC ACID, NH₂CSSH or NH=C:(SH)₂, is obtained as a red oil upon decomposing its ammonium salt with dilute sulphuric acid. It readily breaks down into thiocyanic acid HS.NC, and hydrogen sulphide. Water decomposes it into cyanic acid and H₂S. Its *ammonium salt*, NH₂CSSNH₄, is formed when alcoholic ammonia acts on carbon disulphide. It consists of yellow needles or prisms.

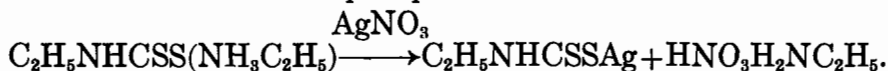
- ALKYL DITHIOCARBAMIC ACIDS. *Dithiocarbalkylaminic Acids*
 The amino-salts of these compounds are formed by heating together carbon disulphide and primary or secondary amines in alcoholic
 40 solution:



When the amine salts of ethyl dithiocarbamic acid are heated to 110° dialkylated thio ureas are formed (p.433):



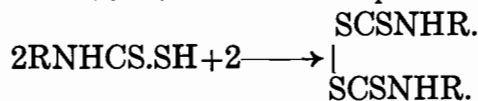
If the salts formed with primary amines are heated in aqueous solution with metallic salts such as AgNO₃, FeCl₃, or HgCl₂, salts of ethyl dithiocarbamic acid are precipitated:



which, when boiled with water, yield *mustard oil* or *isothiocyanic ester* (p. 469).

The *secondary amine* salts of *dithiocarbamic acid* give no mustard oil (B. 8, 107).

- 10 Oxidation with iodine changes the mono- and di-alkyl dithiocarbamic acids into *thiuram disulphide*:



RESULTS OF FLOTATION TESTS MADE AT NORANDA, QUE., Aug. 29—SEPT. 2, 1944 BY R. L. BENNETT

Exhibit D-59

Not a copy of original

1	2	3	4	5	6	7	8	9	10
Test No.	Collecting Reagent	Lbs. of Collecting Reagent / ton of ore	Product	Wt. of Product in gms.	Wt. of Product as % of heads	% Copper by Assay	Units of Copper (Col. 6 x Col. 7)	% Copper Recovered in Conc.	Alkalinity as lbs. of Na ₂ CO ₃ per ton of tailing solution
12	Sodium Cellulose Xanthate (Crude)	0.84	Conc. Tail	36 2915	1.22 98.78	13.62 1.85	16.6 182.7	8.3	0.95
			Head	2951	100.00	1.99	199.3		
13	Sodium Cellulose Xanthate (Crude)	1.68	Conc. Tail	16 2980	0.53 99.47	6.10 2.00	3.2 198.9	1.6	0.98
			Head	2996	100.00	2.02	202.1		
14	Nil	.....	Conc. Tail	264 2700	8.91 91.09	15.91 0.65	141.8 59.2	70.5	0.84
			Head	2964	100.00	2.01	201.0		
15	Sodium Cellulose Xanthate (Purified)	0.10	Conc. Tail	26 2971	0.87 99.13	10.31 1.90	9.0 188.3	4.6	0.97
			Head	2997	100.00	1.97	197.3		
16	Sodium Cellulose Xanthate (Purified)	0.20	Conc. Tail	19 2960	0.64 99.36	5.27 2.01	3.4 199.7	1.7	0.97
			Head	2979	100.00	2.03	203.1		
17	Sodium Ethyl Xanthate	0.08	Conc. Tail	1307 1686	43.67 56.33	4.33 0.10	189.1 5.6	97.1	0.81
			Head	2993	100.00	1.95	194.7		
18	Product of Paragraph 7 of Keller Patent	0.50	Conc. Tail	305 2680	10.22 89.78	13.35 0.69	136.4 61.9	68.8	0.89
			Head	2985	100.00	1.98	198.3		
19	Product of Paragraph 7 of Keller Patent	0.50	Conc. Tail	310 2695	10.32 89.68	13.21 0.92	136.3 82.5	62.3	0.86
			Head	3005	100.00	2.19	218.8		
20	Nil	.....	Conc. Tail	233 2773	7.75 92.25	16.19 0.84	125.5 77.5	61.8	0.72
			Head	3006	100.00	2.03	203.0		

RESULTS OF FLOTATION TESTS MADE AT NORANDA, QUE., AUG. 29-SEPT. 2, 1944 BY R. L. BENNETT

1	2	3	3a	4	5	6	7	8	9	10
Test No.	Collecting Reagent	Lbs. of Collecting Reagent / ton of ore	Eqv. Lbs. of Sod. Ethyl Xan. / ton of ore	Product	Wt. or Product in gms.	Wt. or Product as % of heads	% Copper by Assay	Units of Copper (Col. 6 x)	% Copper Recovered in Concept	Alkalinity as lbs. of Na ₂ CO ₃ per ton of tailing solution.
21	Stanol D (No external heating)	.45	.08	Conc. Tail Head	1214 1742 2956	41.07 58.93 100.00	3.91 0.08 1.65	160.6 4.7 165.3	97.2	0.92
22	Stanol D (Boiled)	.45	.08	Conc. Tail Head	1217 1742 2959	41.13 58.87 100.00	4.00 0.08 1.69	164.5 4.7 169.2	97.2	0.86
23	Sodium Ethyl Xanthate	.08	...	Conc. Tail Head	1329 1637 2966	44.81 55.19 100.00	3.67 0.07 1.68	164.4 3.9 168.3	97.7	0.80
24	Nil	....	...	Conc. Tail Head	318 2651 2969	10.71 89.29 100.00	13.89 0.23 1.69	148.8 20.5 169.3	87.9	0.84
25	Stanol D (No external heating)	.79	.14	Conc. Tail Head	1447 1522 2969	48.74 51.26 100.00	3.38 0.07 1.68	164.7 3.6 168.3	97.9	0.86
26	Stanol D (Boiled)	.79	.14	Conc. Tail Head	1505 1471 2976	50.57 49.43 100.00	3.24 0.08 1.68	163.8 3.9 167.7	97.7	0.81
27	Sodium Ethyl Xanthate	.14	...	Conc. Tail Head	1561 1406 2967	52.61 47.39 100.00	3.18 0.10 1.72	167.3 4.7 172.0	97.3	0.76
28	Stanol D (No external heating)	1.13	.20	Conc. Tail Head	1594 1385 2979	53.51 46.49 100.00	3.12 0.08 1.71	167.0 3.7 170.7	97.8	0.80
29	Stanol D (Boiled)	1.13	.20	Conc. Tail Head	1619 1354 2973	54.46 45.54 100.00	3.01 0.08 1.68	163.9 3.6 167.5	97.9	0.75
30	Sodium Ethyl Xanthate	.20	...	Conc. Tail Head	1645 1327 2972	55.35 44.65 100.00	2.99 0.08 1.69	165.5 3.6 169.1	97.9	0.73
31	Nil	....	...	Conc. Tail Head	342 2627 2969	11.52 88.48 100.00	12.63 0.26 1.69	145.5 23.0 168.5	86.4	0.75

Handwritten notes and signatures:
 515
 [Signature]
 [Signature]

Exhibit—D-89a.

EXHIBIT D—89A.

LEDOUX & COMPANY
(Inc.)

ENGINEERS, CHEMISTS AND ASSAYERS

155 Sixth Avenue.

New York

REPORT OF ASSAY

No. 565878

New York 13, N.Y., Oct. 13, 1944

Our assay of the sample of TAILINGS

Umpire

From Noranda Mines, Ltd.

10 Marked Lot T 12/T 31 incl.

No Seals.

and submitted to us, shows:

After Drying:

	Lot No.	COPPER %
	12	1.85
	13	2.00
	14	0.65
	15	1.90
	16	2.01
	17	0.10
20	18	0.69
	19	0.92
	20	0.84
	21	0.08
	22	0.08
	23	0.07
	24	0.23
	25	0.07
	26	0.08
	27	0.10
30	28	0.08
	29	0.08
	30	0.08
	31	0.26

To Noranda Mines, Ltd.

LEDOUX & COMPANY, Inc.
(signature illegible)

Exhibit—D-89b.

EXHIBIT D—89B.

LEDOUX & COMPANY
(Inc.)

ENGINEERS, CHEMISTS AND ASSAYERS

155 Sixth Avenue.
MM

New York

REPORT OF ASSAY

No. 565879

New York 13, N.Y., October 17, 1944

Our assay of the sample of CONCENTRATES

10 From Noranda Mines Ltd.

Marked as below

Umpire

No seals

and submitted to us, shows:

After Drying

	Lot No.	COPPER %
	C 12	13.62
	C 13	6.10
	C 14	15.91
	C 15	10.31
20	C 16	5.27
	C 17	4.33
	C 18	13.35
	C 19	13.21
	C 20	16.19
	C 21	3.91
	C 22	4.00
	C 23	3.67
	C 24	13.89
30	C 25	3.38
	C 26	3.24
	C 27	3.18
	C 28	3.12
	C 29	3.01
	C 30	2.99
	C 31	12.63

To Noranda Mines, Ltd.

LEDOUX & COMPANY, Inc.
(signature illegible)

EXHIBIT D-61

MR
Nov. 16/44

AGREEMENT AS TO LIST OF XANTHATES

- (1) The list constitutes all the references to xanthate prior to 1923 which could be found by the defendant in the scientific literature.
- (2) None of the references are to metallurgical publications; all are in the chemical field.
- 10 (3) All of the references are to laboratory experiments (with the exception of cellulose xanthate in rayon); and all are reports either of success in preparing the type of xanthate disclosed, or of laboratory exploration of one of more of its properties. None of the references are to preparation or use outside the laboratory.

2540
HM
15/11/44

20 XANTHATES MENTIONED OR DESCRIBED IN PRINTED PUBLICATIONS UP TO 1924

1. *Allyl Xanthates* (organic radical: Allyl)

Cobalt.....1909-1
Lead.....1909-1
Nickel.....1909-1
Potassium.....1909-1
Silver.....1909-1
Sodium.....1909-1
Zinc.....1909-1

2. *Amyl Xanthates* (organic radical: Isoamyl)

30 Ammonium.....1852-1, 1916-2
Cobalt.....1920-1, 1921-2
Copper.....1910-1
Lead.....1852-1
Nickel.....1920-1, 1921-2
Potassium.....1844-2-3-4-5, 1916-2, 1921-2
Sodium.....1910-1, 1916-2

Exhibit—D-61.

3. *Benzyl Xanthates* (organic radical: benzyl)

Copper.....1910-1
 Cobalt.....1920-1, 1921-2
 Nickel.....1921-2
 Potassium.....1906-2, 1918-2, 1921-2
 Sodium.....1906-2, 1910-1

4. *Bornyl Xanthates* (organic radical: bornyl)

10 Cobalt.....1921-2
 Copper.....1890-2
 Nickel.....1921-2
 Sodium.....1890-2
 Potassium.....1921-2

5. *Butyl Xanthates* (organic radical: isobutyl)

A Cobalt.....1920-1, 1921-1
 Copper.....1910-1, 1917-1
 Nickel.....1920-1, 1921-2
 Potassium.....1872-1, 1878-1, 1917-1, 1921-2
 Sodium.....1878-1, 1910-1

(organic radical: normal butyl)

20 Cobalt.....1920-1
 Nickel.....1920-1

(organic radical: secondary butyl)

Cobalt.....1920-1
 Nickel.....1920-1

6. *Cellulose Xanthate* (organic radical: cellulose residue)

Sodium.....1893-1-2, 1901-1

7. *Cetyl Xanthates* (organic radical: cetyl)

A 30 ✓ Barium.....1842-1-2
 Cobalt.....1921-2
 Nickel.....1921-2
 Potassium.....1842-1-2, 1921-2

8. *Cyclohexyl Xanthates* (organic radical: cyclohexyl)

Nickel.....1921-2
 Potassium.....1921-2

Exhibit—D-61.

9. *Ethyl Xanthates* (organic radical: ethyl)
- Ammonium1835-1, 1837-1, 1849-1
 Antimony.....1862-1
 Arsenic.....1862-1, 1912-1
 ✓ Barium.....1835-1, 1837-1, 1911-3, 1916-1
 Bismuth.....1862-1, 1916-1
 ✓ Cadmium.....1923-1
 ✓ Calcium.....1835-1, 1837-1
 ● Chromium.....1862-1, 1914-1
 10 Cobalt.....1862-1, 1877-2, 1904-1, 1911-3, 1914-1,
 1920-1, 1921-1
 Copper.....1822-2, 1824-1, 1835-1, 1837-1, 1849-1,
 1853-1, 1877-1-2, 1880-1, 1883-1,
 1884-1, 1902-1-2, 1906-1, 1907-1,
 1908-2-3, 1910-1, 1911-3, 1916-1,
 1921-1
 Iron.....1862-1, 1911-3, 1914-1
 Lead.....1822-2, 1835-1, 1836-1-2, 1837-1, 1849-1
 1911-3, 1916-1
 20 Mercury.....1822-2, 1862-1, 1911-3, 1916-1
 Molybdenum...1919-1
 Nickel.....1862-1, 1877-2, 1904-1, 1911-3, 1916-1,
 1920-1, 1921-1
 Platinum.....1906-3, 1913-1
 Potassium.....1822-1-2, 1824-1, 1835-1, 1837-1, 1844-1,
 1845-1, 1877-1, 1878-1, 1880-1,
 1881-2, 1906-2, 1909-4, 1911-3.
 Silver.....1911-3
 Sodium.....1835-1, 1862-1, 1881-1, 1906-2, 1910-1,
 1918-2.
 30 Trimethyl phenyl
 ammonium...1918-1
 Tetramethyl
 ammonium...1918-1
 Tin.....1862-1, 1911-2
 Zinc.....1822-2, 1877-2, 1911-3, 1916-1, 1923-1
10. *Glycerol Xanthates* (organic radical: glyceryl)
 Copper.....1881-1
 Sodium.....1881-1, 1910-1
11. *Guaiyl Xanthates* (organic radical: guaiyl)
 40 Potassium.....1908-1
12. *Menthyl Xanthates* (organic radical: menthyl)
 Copper.....1890-2
 Sodium.....1890-2

Exhibit—D-61.

13. *Methyl Xanthates* (organic radical: methyl)

	Bismuth.....	1916-1
	Chromium.....	1916-1
	Cobalt.....	1916-1, 1920-1
	Copper.....	1910-1, 1916-1
	Iron.....	1916-1
	Lead.....	1847-2, 1916-1
	Mercury.....	1916-1
	Nickel.....	1916-1
10	Potassium.....	1840-1, 1847-1-2, 1878-1, 1906-2, 1916-1
	Sodium.....	1906-2, 1910-1, 1918-2
	Zinc.....	1916-1, 1923-1

14. *Propyl Xanthates* (organic radical: normal propyl)

	Cobalt.....	1920-1
	Copper.....	1910-1
	Nickel.....	1920-1, 1921-2
	Potassium.....	1873-1, 1887-1, 1906-2, 1921-2
	Sodium.....	1906-2, 1910-1
20	Trimethyl phenyl ammonium...	1918-1
	Tetramethyl ammonium...	1918-1
	(organic radical: secondary (or iso-) propyl)	
	Cobalt.....	1920-1
	Zinc.....	1923-1

15. *Starch Xanthates* (organic radical: starch residue)

Sodium.....1911-2

16. *Tetrahydronaphthol Xanthates* (organic radical: B-hydronaphthol)

30	Copper.....	1890-1
	Sodium.....	1890-1

Exhibit—D-56.

EXHIBIT D-56

TEST No. 9

Feed: 500 grams.

	Reagents	Lbs. per ton
Pb. Conc.	(1) Pine Oil	0.13
	Beechwood Creosote	0.13

FLOTATION RESULTS:

10 Assay No.	Product	Wt.	% Wt.	Pb.	Zn.	Pb. Rec.	Zn. Rec.
	Feed	498.2	100.00	9.07	21.42	100.00	100.00
10-10-44-17	Conc.	104.6	21.00	28.11	36.35	65.05	35.62
-18	Tail	393.6	79.00	4.01	17.45	34.95	64.38

NOTES:

- (1) Both mixed 1 minute; turn on air; inspect froth; float 2 minutes and 25 seconds to produce Pb. Conc.

IN THE EXCHEQUER COURT OF CANADA

BETWEEN;

MINERALS SEPARATION NORTH AMERICAN
CORPORATION,*Plaintiff;*

— AND —

NORANDA MINES, LIMITED,

Defendant.

REASONS FOR JUDGMENT — THORSON, P.

10 This is an action for the infringement of letters patent 247,576, dated March 10, 1925, issued by the Commissioner of Patents to the plaintiff. The petition for the grant was made by Cornelius H. Keller, who assigned all his right, title and interest in and to his invention to the plaintiff.

The invention relates to "froth flotation concentration of ores" and is an improvement in the existing process. This requires description.

20 Ore, as extracted from the ground, is a mixture of minerals, some being valuable as containing the metals sought to be recovered and others being worthless material, such as silica or rock or as containing metals whose recovery is not desired. The worthless material is known as gangue and the purpose of any concentration of ores process is to separate the valuable minerals from the gangue. The ore is a physical mixture of minerals rather than a chemical compound, which means that the minerals can be separated by physical means and not by chemical reaction.

30 The valuable metals in the ore could be recovered at a smelter, but there was always waste expense in transporting and treating worthless gangue. Efforts were continuously made to eliminate or lessen such expense by finding some process whereby the separation of the valuable minerals from the gangue could be done at the mine and only the valuable minerals sent to the smelter. Prior to the invention of the froth flotation process there were two ways in which this could be done. In some cases, where the ore was rich, the valuable minerals could be picked out by hand. The other method was the use of the gravity concentration process. This was based on the difference in the specific gravities of the valuable minerals and the gangue. The ore was crushed and the crushed ore put in a tray and shaken in water either up or down or from side
40 to side causing the valuable minerals, being heavier, to fall to the bottom leaving the gangue at the top. There were, however, many ores which did not lend themselves to picking the valuable minerals out by hand or to be gravity concentration process.

A great advance took place when the froth flotation process was invented in 1905. In this process the ore was first crushed to a certain size. The crushed ore then went into a series of mills in which it was ground to the desired degree of fineness; some ores had to be ground more finely than others. The final grinding was invariably carried on in the presence of water. The finely ground ore included particles of the consistency of sand, called the sands, and also some very fine substances of the consistency of powder or fine mud, known as the slimes. When the final grinding was completed, the mixture of the sands, the slimes and the water was known as ore pulp. This was placed in a vat and more water was added to the mixture so that it flowed freely, about four parts of water to one of finely ground ore. There was added either to the ore in its final grinding stage or to the freely flowing ore pulp a substance known as a mineral frothing agent or reagent, the terms agent or reagent each being used, and the whole mixture was then violently agitated with air introduced into it. The purpose of the agitation was to mix the ingredients thoroughly and also to promote the formation of air bubbles with their resulting froth.

The secret of the success of the process lay in finding that some frothing agents, when added to the ore pulp, had the remarkable properties, when the mixture was violently agitated and air introduced into it, not only of creating air bubbles in the mixture which rose to the top in the form of a froth, but also of causing the valuable minerals in the mixture to attach themselves to the bubbles and float to the top of the mixture in the froth that formed there. Such frothing agents were known as mineral frothing agents. The particles of gangue did not attach themselves to the bubbles but sank to the bottom of the mixture when the agitation had ceased. The froth into which the valuable minerals had been concentrated by the rising bubbles then overflowed or was otherwise removed from the top of the mixture. This froth with its valuable minerals was known as the concentrate. What was left in the mixture after the froth was removed was called the tailings. The tailings included the worthless gangue but also some valuable minerals which had not risen with the froth. The tailings were then run through a series of further processes of the same kind with a view to concentrating in the fresh froth such valuable minerals as had not floated to the top in the previous process until it was no longer economical to do so. When no more valuable minerals could be economically recovered the remaining tailings, consisting mostly of gangue but still containing some valuable minerals, were run off to a dump.

The success of the froth flotation process depended upon the use of an effective mineral frothing agent. Many different kinds were referred to during the course of the trial, a very good one being steam distilled pine oil. The mineral frothing agents varied in effectiveness with different types of ores, and metallurgists and

others engaged in the process used the kind of mineral frothing agent that gave the best results when applied to the particular type of ore with which they were working; sometimes a combination of mineral frothing agents was required.

Ore pulps might be acid, alkaline or neutral, and it was found that with some mineral frothing agents and some kinds of ores the froth flotation worked best in an acid pulp or circuit. If that was so, sulphuric acid was added to the pulp to make it acid. Sulphuric acid by itself was not a mineral frothing agent. Sometimes, on the other hand, the best results were obtainable in an alkaline pulp or circuit in which case an alkali, such as caustic soda, was added to the pulp to make it alkaline. Similarly, if a neutral pulp produced the best results the necessary steps were taken to make it such.

Just as there were some valuable minerals left with the gangue that was run out with the final tailings, so there was some gangue in the concentrate. Where the concentrate was of insufficient grade to send to a smelter because of too much gangue it was run through another flotation to eliminate the gangue as far as possible. The tailings from the concentrate were called middlings, and these were also run through flotation processes to recover the valuable minerals in them until it was no longer economical to do so. Sometimes, further grinding of the minerals in the concentrate was needed.

The concentrate always had to be cleaned and dried before it could be sent to the smelter and filtration of it was always necessary. Some of the water could be siphoned off, but the thick pulp had to be run through a filter and the water squeezed out by suction, leaving a cake almost dry.

The froth flotation process did not entirely supersede the gravity one, for at some mines both processes were used. The gravity process was used to the extent that was possible, and then the tailings from the gravity concentrator went to the flotation plant for further treatment by the froth flotation process.

An improvement was made in the froth flotation process about 1910 when it was found that certain minerals could be selected from the others by froth flotation. This was known as selective froth flotation and was most usually applied to lead zinc ores. By the use of certain mineral frothing agents the leads bearing minerals could first be floated off, the resulting froth being a concentration of the lead and some other metals, such as silver, which tended to go with it. The lead concentrate thus formed went separately to the smelter. The tailings left after the lead concentrate was removed, containing the gangue and the zinc and other metals, were then treated with some other suitable mineral frothing agent that would float off the zinc separately.

When the concentrate was cleaned and dried it was sent to the smelter which completed the work of recovering the valuable metals

in it. Even with the selective flotation process it was not yet possible to take out of the lead concentrate such metals as gold and silver as might be combined with the lead or which tended to go into the concentrate with it. The necessary separation had to be done at the smelter. The same was true with regard to the metals that might be combined with the zinc in the zinc concentrate or which tended to go into the concentrate with it.

10 While the froth flotation process was a remarkable one and made possible the development of mines with low grade ore bodies, it did not produce complete recoveries of the valuable minerals in the ore, for some still remained in the tailings and, on the other hand, there was still room for improvement in the grade of the concentrate which was measured by the ratio of the valuable metals in it to its total volume. To the extent that there was worthless material in the concentrate there was still a waste of transportation and smelter charges, since they were applicable to the volume of the concentrate and the smelter paid only for the valuable metals contained in it.

20 Moreover, although great success attended the froth flotation process in respect of the kind of ores on which it would work, it did not work at all on oxide ores and, indeed, on oxidized ores it did not work unless the oxidized ores were first sulphidized.

This was the state of the art known as froth flotation concentration of ores prior to the improvement proposed by Keller. Keller was an assayer on the staff of the plaintiff working at San Francisco, and it appears that he was seeking a sulphidizing agent that would enable the valuable minerals in oxide ores to be concentrated by the froth flotation process, when he hit upon an improvement in the froth flotation process itself late in 1922. His proposals were
30 embodied in the specification of an application for a United States patent filed October 23, 1923. The patent issued as No. 1,554,216 and was dated September 22, 1925. The patent in suit corresponds exactly with the United States patent.

The essence of the Keller invention, which may be called the Keller process, was that he proposed the use of certain new agents, which were not themselves frothing agents, in addition to the mineral frothing agents already in use. The basic new agents whose additional use in the froth flotation process was proposed were certain defined substances known as xanthates. Analogous substances were
40 also found to be useful under specified circumstances. Claims were not made to any xanthates or analogous substances as new substances, but only to their use along with mineral frothing agents.

So far as the Keller process relates to the use of potassium or sodium xanthates it has proved very useful. The efficiency of the former froth flotation process has been substantially increased. In some cases the improved process makes better recoveries of the

desired valuable minerals; in others it makes the same recoveries with less quantities of mineral frothing agent; sometimes the increased efficiency is seen in reducing the time required for agitation; the time required for filtration of the concentrate has been reduced by as much as one-half; and the selective froth flotation is made more effective. When the Keller process was adopted at the big Anaconda mine after a competitive test it created a great stir. It has been very extensively used all over the world and many millions of tons of ore have been treated by it. Many of the biggest mining
 10 companies in Canada have licenses under the patent and use the process at their mines, for example, International Nickel Company, Consolidated Mining and Smelting Company, Hudson Bay Mining and Smelting Company, Britannia Mining and Smelting Company and others (Exhibit G14). The invention made by Keller was, in my opinion, a very meritorious one.

The defendant is one of twenty Canadian mining companies that have refused to take out licenses under the patent and this action is brought to enforce the plaintiff's rights. The defence consists of attacks on the validity of the patent.

20 Consideration of these attacks will involve examination of the terms of the specification. The paragraphs have been numbered for convenience of reference. Paragraphs 1 to 8, around which controversy revolves, read as follows:—

30 "1. BE IT KNOWN, that I, CORNELIUS H. KELLER, a citizen of the United States of America, and a resident of San Francisco, County of San Francisco, State of California, Chemist, have invented certain new and useful improvements in FROTH FLOTATION CONCENTRATION OF ORES and do declare that the following is a clear, full, and exact description of the same.

2. This invention relates to the froth-flotation concentration of ores, and is herein described as applied to the concentration of certain ores with mineral-frothing agents in the presence of certain organic compounds containing sulphur.

3. It has been found that certain sulphur derivatives of carbonic acid greatly increase the efficiency of the froth-flotation process when used in connection with mineral-frothing agents. The increased efficiency shows itself sometimes in markedly better recoveries, sometimes in effecting the usual recoveries
 40 mineral-frothing agents, and sometimes in greatly reducing the time needed for agitation to produce the desired recoveries.

4. The invention is herein disclosed in some detail as carried out with salts of the sulphur derivatives of carbonic acid containing an organic radical, such as an alkyl radical and known as xanthates, as the new substance. These form anions and cations in solution. Excellent results were also obtained

by agitating ore pulps with the complex mixture produced when 33 $\frac{1}{3}$ % of pine oil was incorporated with an alcoholic solution of potassium hydrate, and axnthates or analogous substances were produced by adding carbon disulphide to this mixture.

5 The galena-bearing froth obtained with xanthates or analogous substances used at the rate of 0.2 pounds per ton of ore had a characteristic bright sheen, like a plumbago-bearing froth, and seemed to make a more coherent froth than when other materials were used on the same ore.

10 6. In general the substances referred to are not mineral-frothing agents,—producing only a slight scum, and some evanescent frothy bubbles, when subjected to agitation which would produce mineral-bearing froth on an ore pulp in the presence of a mineral-frothing agent. The substances are effective in enabling a selective flotation of lead and zinc; and cause uncombined silver, if present, to tend to go into the lead concentrate rather than with the zinc, where these are separated in separate concentrates. Usually pre-agitation is unnecessary, the brightening and other effects seeming to be practically
20 instantaneous. The pulps may be either acid, alkaline or neutral according to circumstances.

7. Two sticks of caustic potash weighing perhaps 15 grams were partly immersed in about 80 cc. of commercial carbon disulphide and kept for about ten days in a closed bottle containing some air in the warm region of the laboratory where were the hot plates used for drying. These eventually yielded a yellow or orange salt which was used with pine oil at the rate of approximately half a pound to a ton of ore in concentrating Hibernia ore from Timber Butte Mining Company. The test
30 was with a neutral pulp, and the concentrates were seen to be clean with brightened lead sulphide particules.

8. For laboratory purposes potassium xanthate was prepared as follows:

198.4 grams of 88.5% caustic potash was dissolved in 524 grams ethyl alcohol (denatured No. 5 formula) at a temperature of 124°F., in a reflux condenser. The solution was cooled to 58°F. It contained a large excess of alcohol over the theoretical amount needed for the subsequent reactions. To this was added, while stirring, and in a cooling bath, the theoretical
40 amount of carbon disulphide. The reaction was substantially instantaneous, producing a thick pulp of potassium xanthate. The pulp was cooled and centrifuged in a laboratory machine, yielding crystals containing about 20% moisture. The yield thus obtained was 74.7%. Another 17.5% was obtained by evaporation of the mother liquor. Both the centrifuged crystals and the residue from the mother liquor gave excellent

results in flotation. It was found in cases where sulphuric acid was used that the centrifuged material yielded better results than the uncentrifuged.”

Then follow paragraphs 9 to 19 which describe experiments and tests, several of them on a large scale, made on various types of ores, with their results. These need not, I think, be set out. There are 11 claims in the patent, but the only ones in suit are claims 6, 7, 8 and 9, which read as follows:

10 “6. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and an alkaline xanthate adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.

7. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of a xanthate.

20 8. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of potassium xanthate.

9. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of a xanthate and a frothing agent.”

30 The main attacks upon the validity of the patent are directed against the specification, both in respect of the disclosures and against the claims in suit. The attacks upon the disclosures consists of a main general attack and four specific charges; those against the claims are of a specific nature. In view of the final conclusion I have reached, it will be necessary for me to deal with each of the attacks made. There are so many of them that these reasons for judgment, if they are to deal properly with the issues raised, some of which involve questions of considerable difficulty, cannot be otherwise than lengthy.

40 The requirements of a valid patent specification have in Canada been reduced to statutory form. Section 14 of The Patent Act, Statutes of Canada, 1923, chap. 23, which governs the interpretation of the present specification, provides in part as follows:—

“14. (1) The specification shall correctly and fully describe the invention and its operation or use as contemplated by the inventor. It shall set forth clearly the various steps in a process, or the method of constructing, making or compounding, a machine, manufacture, or composition of matter. It

shall end with a claim or claims stating distinctly the things or combinations which the applicant regards as new and in which he claims an exclusive property and privilege.”

The Act speaks of the specification as ending with a claim or claims, which indicates that it has two parts, the first dealing with what leads up to the claims, which may be called the disclosures, and the claims themselves. At the same time it should be borne in mind, in considering the cases, that the term specification in
10 Canada includes both the disclosures and the claims.

The requirements of a specification generally were well stated by the former President of this Court in *De Forest Phonofilm of Canada Limited v. Famous Players Canadian Corporation, Limited*,¹ but he did not attempt to separate the requirements into those that relate only to the disclosures and those that relate only to the claims. This is not easy to do for some requirements, such as freedom from avoidable obscurity or ambiguity, are applicable to both; nevertheless, the requirements relating to the disclosures are not the same as those relating to the claims; and both sets of requirements must
20 be complied with. In view of the attacks upon the disclosure it is, I think, desirable to set out, with more particularity than section 14(1) of the Act does, the duties of disclosure required of an inventor in consideration of the grant of a valid monopoly in respect of his invention.

Two things must be described in the disclosures of a specification, one being the invention, and the other the operation or use of the invention as contemplated by the inventor, and with respect to each the description must be correct and full. The purpose underlying this requirement is that when the period of monopoly has expired
30 the public will be able, having only the specification, to make the same successful use of the invention as the inventor could at the time of his application. The description must be correct; this means that it must be both clear and accurate. It must be free from avoidable obscurity or ambiguity and be as simple and distinct as the difficulty of description permits. It must not contain erroneous or misleading statements calculated to deceive or mislead the persons to whom the specification is addressed and render it difficult for them without trial and experiment to comprehend in what manner the invention is to be performed. It must not, for
40 example, direct the use of alternative methods of putting it into effect if only one is practicable, even if persons skilled in the art would be likely to choose the practicable method. The description of the invention must also be full; this means that its ambit must be defined, for nothing that has not been described may be validly claimed. The description must also give all information that is necessary for successful operation or use of the invention, without

¹ (1931) Ex. C.R. 27 at 42

leaving such result to the chance of successful experiment, and if warnings are required in order to avert failure such warnings must be given. Moreover, the inventor must act *uberrima fide* and give all information known to him that will enable the invention to be carried out to its best effects as contemplated by him. This statement of the extent to which the disclosures must go in describing the invention and its operation or use as contemplated by the inventor, if the patent is not to fail for either the ambiguity or insufficiency of such description, is abstracted from a number of cases cited by counsel for the defendant: *Smith Incubator Co. v. Seiling*¹; *French's Complex Ore Reduction Co. v. Electrolytic Zinc Process Co.*² *The British Ore Concentration Syndicate Limited v. Minerals Separation Limited*³; *Simpson v. Holliday*⁴; *Natural Colour Kinematograph Co. Ltd. v. Bioschemes Ltd. (re G. A. Smith's Patent)*⁵; *Badische Anilin und Soda Fabrik v. La Societe Chimique des Usines du Rhone and Wilson*⁶; *Gold Ore Treatment Company of Western Australia Ltd. v. Golden Horseshoe Estates Co. Ltd.*⁷; *Vidal Dyes Syndicate Ltd. v. Levinstein Ltd.*⁸; *The Franc-Strohmenger and Cowan Inc. v. Peter Robinson Ltd.*⁹. Section 14(1) does not, in my opinion, alter the requirements of the law, as laid down in the cases; it merely puts them into statutory form. If they are not complied with, then the patent fails, not for ambiguity or insufficiency of description, as the cases put it, for the Act does not refer to these terms, but for non-compliance with statutory conditions. The result is the same.

When it is said that a specification should be so written that after the period of monopoly has expired the public will be able, with only the specification, to put the invention to the same successful use as the inventor himself could do, it must be remembered that the public means persons skilled in the art to which the invention relates, for a patent specification is addressed to such persons. In the present case, the specification is addressed to such persons as skilled metallurgists and chemists engaged in the art of froth flotation concentration of ores. It should, therefore, be looked at through their eyes and read in the light of the common knowledge which they should possess. But it is important to note that such common knowledge must be limited to that which existed at the date of the specification.

The main general attack on the disclosures was that it fails to describe the invention at all. The words of each paragraph were minutely scrutinized. It was contended that paragraph 2 indicated that the invention was really wider than "herein described" and might be applied to something altogether different from the concentration of ores, and that the references to "certain ores" and

¹ (1937) S.C.R. 251

² (1930) S.C.R. 462

³ (1909) 26 R.P.C. 33 at 47

⁴ (1866) 1 E.&I. App. 315

⁵ (1915) 32 R.P.C. 256

⁶ (1897) 14 R.P.C. 875 at 888

⁷ (1919) 36 R.P.C. 95 at 132

⁸ (1912) 29 R.P.C. 245 at 269, 273

⁹ (1930) 47 R.P.C. 493 at 501

“certain organic compounds” left the reader in the dark as to the kind of ores and the kind of organic compounds; that paragraph 3 did not advance the definition since it did not indicate which sulphur derivatives of carbonic acid were meant: that in the first part of paragraph 4 the words “herein disclosed in some detail as carried out with “the salts mentioned showed that the inventor was careful not to say that the invention consisted in the use of such salts leaving him free to say that such use was not restrictive but merely a particular example of his invention, that the words “an organic radical”

10 meant “any organic radical”, that the phrase “such as an alkyl radical” meant “for example, an alkyl radical”, that two possible interpretations could be given to the word “alkyl”, that the word “also” in the third paragraph indicated that something that was not “xanthates” was meant, that the first and second sentences added nothing to what the invention was and the third presented a problem in construction and that up to the end of this paragraph the boundaries of the class of sulphur derivatives recommended for use remained undefined; that paragraph 5 and 6 gave no help; that paragraph 7 lead into new territory and dealt with a compound

20 that was not xanthates and had no organic radical in it and thus was a considerable extension of the scope of the invention; that there is a description of certain reagents which are recommended, that the invention as described is an invention of the use of certain sulphur derivatives of carbonic acid in the most general terms; that paragraph 8 is confined to a description of how potassium xanthate is made “for laboratory purposes” only, that the term “theoretical” is another indication of the carelessness and vagueness and unsatisfactory character of the specification, which might have been made clear, simple and definite; that the inventor approached the

30 question of describing the invention but was careful to sheer off so that he could, according to the circumstances, contend that his invention was a narrow or broad one; that nobody can tell what sulphur derivatives are recommended but that all that can be gathered is that there are certain sulphur derivatives of carbonic acid which, with certain ores, the inventor thinks will be useful.

There is no doubt that the specification is not well drawn, but there is a vital difference between imperfection of draughtsmanship and non-compliance with Statutory requirements. There may be faults of expression that do not affect the validity of the patent. A patent

40 specification is not an exercise in composition, and the Court should not concern itself with faults of language that do not amount to breach of the statutory conditions for the grant of the patent. The proper attitude of mind of the Court in construing a specification was well described by Sir George Jessell, M.R. in *Hink & Son v. Safety Lighting Co.*¹ when he said that it should be construed “fairly, with a judicial anxiety to support a really useful invention if it can

¹ (1876) 4 Ch. D. 607 at 612

be supported on a reasonable construction of the patent". This statement has received full acceptance. The need for fair construction was stated by Lord Parmoor in the House of Lords in the *Natural Colour v. Bioschemes* case (*supra*), at page 270. The Supreme Court of Canada has also shown the same attitude. In *French's Complex Ore Reduction Co. v. Electrolytic Zinc Process Co.*¹ Rinfret J., as he then was, in delivering the judgment of the Court, approved Sir George Jessell's statement and said that the specification "should not be construed astutely". And in *Baldwin International Radio Co. of Canada Ltd. v. Western Electric Co. Inc. et al*² Rinfret J., again speaking for the Court, said that the respondents were entitled to have the claims interpreted "by a mind willing to understand, not by a mind desirous of misunderstanding", thus approving the remarks of Chitty J. in *Lister v. Norton Brothers and Co.*³ And in *Western Electric Co. v. Baldwin International Radio of Canada*⁴ Duff C.J., giving the judgment of the Court, pointed out that where the Courts have been satisfied that there was a meritorious invention they have resorted to the maxim *ut res magis valeat quam pereat*, and said:

20 ✓ "And, where the language of the specification, upon a reasonable view of it, can be so read as to afford the inventor protection for that which he has actually in good faith invented, the Court, as a rule, will endeavour to give effect to that construction."

The test of whether a specification complies with the requirements of the first sentence in section 14,¹ is whether persons skilled in the art, on reading the specification in the light of the common knowledge existing at its date and being willing to understand it, would be unerringly led to the invention and be enabled to put it to full use.

30 The first criticism in the attack on the disclosures for failure to describe the invention, namely, that paragraph 2 indicates that the invention may be applicable to something quite different from the concentration of ores may be dismissed off hand as hypercritical; paragraph 1 makes it clear that the invention is one of new and useful improvements in froth flotation concentration of ores; nothing else is contemplated or could reasonably be inferred. The next comment is that the definition of an invention need not appear in a single sentence or paragraph, so long as it appears in the disclosures as a whole. This is particularly true in the case of inventions that
40 are difficult of description. Descriptions of inventions involving the use of chemical substances are frequently difficult by reason of the nomenclatures of chemistry and the limits of their application. The description of the invention under review is of such a nature. All that need be said further with regard to paragraph 2 is that the

¹ (1930) S.C.R. 462 at 470

² (1934) S.C.R. 94 at 106

³ (1886) 3 R.P.C. 199 at 203

⁴ (1934) S.C.R. 570 at 574

terms "certain ores" and "certain organic compounds containing sulphur" are not yet defined. The description of the invention is advanced in the first sentence of paragraph 3 by the reference to "certain sulphur derivatives of carbonic acid". There is no statement yet as to which of these are meant, but the class of "organic compounds containing sulphur" referred to in paragraph 2 has been limited to those that are sulphur derivatives of carbonic acid.

10 The suggestion of counsel for the defendant that the description of the invention stops at the end of paragraph 3 is without merit and should be rejected, for it is clear, notwithstanding the clumsiness of the phraseology used, that the class of sulphur derivatives of carbonic acid whose use in froth flotation is proposed is limited by paragraph 4 to the salts of such derivatives that come within the definition contained in the first two sentences of the paragraph and the specific xanthates or analogous substances referred to in the third sentence. Paragraph 4 is, in my opinion, a vital part of the description of the invention. The first sentence refers to certain defined salts of the sulphur derivatives of carbonic acid as the new substance. To come within the class of such defined salts, the
20 salts must satisfy two conditions, namely they must contain and organic radical, such as an alkyl radical, and they must be known as xanthates. This definition of the salts is, conversely, a definition of the xanthates whose use is proposed. The inventor does not propose the use of all or any xanthates, but only that of those that contain a radical of the alkyl type. Moreover, the second sentence in the paragraph must be read with the first, for the statement "these form anions and cations in solution" is clearly restrictive of the xanthates referred to in the first sentence and is part of their definition. Thus, when the two sentences are read together it is,
30 I think, clear that so far as the invention relates to the use of xanthates as a new substance in froth flotation, the only xanthates whose use is contemplated by the inventor are those that come within the class defined as "containing an organic radical, such as an alkyl radical", and also comply with the requirement that "they form anions and cations in solution."

Most of the expert evidence at the trial related to the meaning and extent of the chemistry terms in this definition. They require most careful attention for it is upon their interpretation that the issue largely depends. The experts called by the parties, Mr. A.
40 H. Higgins for the plaintiff, and Dr. C. B. Purves and Mr. R. L. Bennett for the defendant, were all men of standing and experience, and the Court has had the benefit of their explanations and opinions as to the meaning of the chemistry terms used in the specification and the extent of their application. Mr. Higgins has been retained by the plaintiff as its chief consulting metallurgist since 1925 and is outstanding in his experience and knowledge of the froth flotation art. Dr. Purves is a professor of industrial and cellulose chemistry

at McGill University and has carried out extensive research on the chemistry of carbohydrates and cellulose. Mr. Bennett has been employed by the defendant as a metallurgist on froth flotation since 1942, and before that had varied practical experience including that of an assayer and chemist.

The basic compound to be considered is carbonic acid. It is represented by the formula H_2CO_3 which means that each molecule of it consists of two atoms of hydrogen, one of carbon and three of oxygen. The central atom is carbon. It has four bonds or affinities, each equivalent in its properties, by which it can be linked with another carbon atom or an atom of another element. Each oxygen atom has two bonds, but each hydrogen atom has only one. The bonds are in the nature of arms or hooks to grasp or unite with other atoms. It is essential to the stability of a compound that all the bonds of all the atoms in it should be mutually satisfied or, to put it in descriptive terms, that all the arms of all the atoms in it should be full. The links between the atoms need not necessarily be single, except, of course, in the case of single bond atoms. A description of the structural formation of carbonic acid will illustrate what is meant. The central carbon atom is bonded on one side with an oxygen atom by double links, and on the other to two separate groups of atoms, known as hydroxyl groups, in each case by a single link. Each hydroxyl group consists of an atom of oxygen and one of hydrogen, the hydrogen atom in each case being bonded with the oxygen atom by a single link. Thus all the bonds of all the atoms in the molecule are mutually satisfied; or, in other words, all the arms of all the atoms in it are full.

The next thing to be considered is what is meant by "sulphur derivatives of carbonic acid". Theoretically, and only by indirect means, the atoms of oxygen in carbonic acid may be replaced by atoms of sulphur. If only one oxygen atom is replaced by a sulphur atom the resulting compound is known as monothiocarbonic acid of which there are two forms; in one the sulphur, which has two bonds like the oxygen, is substituted for the oxygen that is bonded with the carbon by the double links, in which case it may be called sulphocarbonic acid, and in the other the sulphur is substituted for the oxygen in one of the hydroxyl groups bonded with the carbon by a single link. If two oxygen atoms are replaced by two sulphur atoms the result is dithiocarbonic acid, which likewise may take two forms; in one case a sulphur atom is substituted for the oxygen atom bonded with the carbon by the double links and another sulphur atom is substituted for the oxygen in one or other of the hydroxyl groups bonded with the carbon by a single link, in which case it may be called sulphothiocarbonic acid, and in the other case a sulphur atom is substituted for the oxygen atom in each of the singly linked hydroxyl groups. This indicates sulphur and the prefix sulpho indicates the substitution by sulphur of the doubly

linked oxygen. Finally, where all three oxygen atoms are replaced by sulphur atoms, the result is trithiocarbonic acid, of which there can be only one form. There are thus five, and only five, acids that are sulphur derivatives of carbonic acid, where the only change made is the substitution of sulphur for oxygen, the other elements in the compound remaining the same. These acids are known generally as thiocarbonic acids. There is also a form of dithiocarbonic acid, of the kind called sulphothiocarbonic, where the hydrogen in the hydroxyl group in which sulphur has not been substituted for the oxygen, is replaced by an ethyl or other alkyl radical. The acid thus derived is known as xanthic acid. These sulphur derivatives all appear on the chart, Exhibit P 54, prepared by Mr. Higgis, which shows both their formulae and their structural formation.

The term "salts of the sulphur derivatives of carbonic acid" is next to be considered. Salts are the result of the union of an acid and a metal. Since the acids that are sulphur derivatives of carbonic acid are the thiocarbonic acids, including xanthic acid, above referred to, the salts resulting from a union between them and a metal are known generally as thiocarbonates. There will, therefore, to correspond with the acids, be as many forms of thiocarbonates as there are of thiocarbonic acid, namely, two forms of monothiocarbonate, two of dithiocarbonate and one of trithiocarbonate. These substances may all be called analogous, since the acids from which they result are analogous. Since xanthic acid is a form of dithiocarbonic acid, as already shown, its resulting salt, which is known as xanthate, is a form of dithiocarbonate. It was part of the scheme of the general attack upon the disclosures to show, if possible, that the limits of the classes of substances referred to in the specification were undefined, and counsel for the defendant contended that this was so in respect of the compounds referred to as sulphur derivatives of carbonic acid. He relied upon the opinion expressed by Dr. Purves, who considered that the class should be extended to include compounds, in which in addition to the substitution of sulphur for oxygen, other elements or groups in the compound are replaced by elements or groups other than sulphur and not containing sulphur. These are shown on the chart, Exhibit D 57, with its explanatory notes, prepared by Dr. Purves. He adopts as being sulphur derivatives of carbonic acid the thiocarbonic acids, including xanthic acid, together with the salts resulting from them, including xanthates, and then proceeds to add to the list. In respect of one of the monothio derivatives, where sulphur has been substituted for the oxygen in one of the hydroxyl groups, he adds two other compounds in which nitrogen or chlorine has been substituted for the other hydroxyl group; and in respect of the other monothio derivative, where sulphur has been substituted for the doubly-linked oxygen, he adds four other compounds in two of which nitrogen replaces either one or both of the singly-linked

hydroxyl groups and in the other two the replacement is by chlorine. Similarly, in respect of the dithio derivatives, he adds two compounds in which nitrogen or chlorine has been substituted for the hydroxyl group in which sulphur has not been substituted for the oxygen. He cannot, of course, make any similar addition to the trithio derivatives. There is also added to his chart a note to the effect that the list might be extended to include four additional compounds in which the chlorine was replaced by bromine and four more in which it was replaced by iodine. Dr. Purves went even farther. He said
10 that he could have included more substances on his chart but had stopped at an arbitrary point. He went so far as to say that if one of the oxygen atoms were replaced by sulphur, the other oxygen atoms could be replaced by other elements and the resulting compounds would all be sulphur derivatives of carbonic acid, but he was unable to say what elements other than nitrogen, chlorine, bromine or iodine might be substituted.

Mr. Higgins thought that the expression "sulphur derivatives" was properly applicable only to derivatives in which sulphur was the only substitution for oxygen; that it was not proper to include the
20 compounds referred to by Dr. Purves in which the oxygen atoms were replaced by sulphur and some other element such as nitrogen or chlorine; and that such a compound should be described, not as a sulphur derivative, but as a sulphur nitrogen or sulphur chlorine derivative. I agree with Mr. Higgins. The inclusion of the compounds in dispute could be justified only by reading the word "sulphur" in the expression "sulphur derivatives" as though it meant "sulphur containing". but such an extension of meaning, is not permissible. Dr. Purves freely admitted that he could not be dogmatic as to what can be included under the head of sulphur
30 derivatives of carbonic acid and that the additional compounds shown on his chart can be described accurately as sulphur nitrogen or sulphur chlorine derivatives of carbonic acid. He said that he had included them because they are closely related to carbonic acid and thiocarbonic acids and contended that everything on his chart was included in Richter's chapter on derivatives of carbonic acid. The reference is to Richter's treatise on Organic Chemistry recognized as the best text book on the subject in English (Exhibit P 88). In my opinion, Richter supports the position taken by Mr. Higgins rather than that of Dr. Purves. On page 431, he shows only the
40 five acids referred to by Mr. Higgins as the acid sulphur derivatives of carbonic acid and then states that "the free acids are not known, or are very unstable, but numerous derivatives such as salts, esters, and amides are known" and, on page 434, he refers to the chlorides of the sulphocarbonic acids. This indicates, I think, that Richter regards the compounds, which Dr. Purves added to his chart, as derivatives of the thiocarbonic or sulphocarbonic acids he referred to as free acids. My conclusion is that the nitrogen

or chlorine containing compounds referred to by Dr. Purves ought to be described either as sulphur nitrogen or sulphur chlorine derivatives of carbonic acid or, alternatively, as nitrogen or chlorine derivatives of thiocarbonic acid and that the expression sulphur derivatives of carbonic acid should be restricted to compounds in which the only substitution for oxygen is by sulphur. The reference by Dr. Purves to Watts' Dictionary of Chemistry further confirms my opinion. This leaves the limits of the class of substances that can be described as sulphur derivatives of carbonic acid clearly and
 10 precisely defined. They are the thiocarbonic acids shown on Exhibit P 54, including xanthic acid, and the thiocarbonates resulting from them, including xanthates. The extent of the class of xanthates depends upon what is meant by an alkyl radical and what metal may be used in their production.

The term "alkyl radical" in the first sentence of paragraph 4 is of vital importance and much of the defendant's attack was concentrated on it. Its meaning and significance in the specification must, therefore, be precisely ascertained. Mr. Higgins defined a radical as part of a chemical compound and Dr. Purves explained
 20 that in chemistry it was found convenient to assume that certain groupings of atoms pass through chemical changes without altering their relative position. Such a grouping is a radical; it is not a complete molecule but a grouping of atoms. Radicals may be organic or inorganic depending on whether they contain atoms of carbon or not. We are here concerned only with organic radicals and only those that are alkyl radicals. Counsel for the defendant, in line with the general scheme of attack sought to construe the words "containing an organic radical, such as an alkyl radical" as expansive. In support of such construction he referred to the
 30 amendment made in the United States patent office prior to the issue of the United States patent. Originally the first sentence of paragraph 4 read:

"The invention is herein disclosed in some detail as carried out with salts of the alkyl sulphur derivatives of carbonic acid known as xanthates, as the new substance."

By the amendment the word "alkyl" before the word sulphur was struck out and after the word acid the expression "containing an organic radical, such as an alkyl radical and" was inserted. Counsel for the defendant contended that by the amendment there was a
 40 deliberate extension of the class of salts whose use was proposed; that the term "organic radical" meant "any organic radical" and that the expression "such as an alkyl radical" was in no sense restrictive but merely illustrative. It was argued that the whole expression "an organic radical, such as an alkyl radical" meant "any organic radical, for example, an alkyl radical." This would have been a convenient construction for the defendant; indeed, it would have ended the plaintiff's case for there are certain

kinds of organic radicals, such as aryl radicals, with which xanthates cannot be made at all, and there are some xanthates containing certain other organic radicals, such as the cellulose radical, that are useless in froth flotation. The expression cannot have the meaning suggested. The amendment was clearly corrective of an erroneous placing of the word alkyl and at the same time restrictive and definitive of the substances referred to. If the term "an organic radical" meant "any organic radical" there would be no need at all for the expression that follows. The expression "such as an alkyl radical" is a ~~qualifying~~ one and has a clear and precise meaning; it is referable to the term "an organic radical" which precedes it and is clearly restrictive and definitive of it. I have carefully consulted the New English Dictionary and Webster's New International Dictionary. Both make it perfectly clear that the expression "such as", referring back as it does to "an organic radical", means an organic radical of the kind or type that is subsequently stated. The whole expression means, therefore, that the only organic radical that is to be considered is an organic radical of the kind or type known as alkyl. The expression is an integral part of the definition of the class of salts, or xanthates, whose use in froth flotation is proposed. No xanthate which does not contain an alkyl radical is contemplated by the inventor, for it would fall outside the defined meaning of xanthates inserted in the specification.

Mr. Higgins defined an alkyl radical as the residue of a saturated hydrocarbon. The first in the series of saturated hydrocarbons is called methane CH_4 , consisting of a carbon atom with each of its four bonds or affinities satisfied with a hydrogen atom, that is, each of its four arms has grasped a hydrogen atom so that all its arms are full. The residue of this saturated hydrocarbon, that is, the grouping of atoms that would remain if one of the hydrogen atoms were removed, is an alkyl radical called methyl CH_3 . This is the first in the series of alkyl radicals. Methyl is what would be left of methane if one of its hydrogen atoms were removed. The hydrogen atom is only theoretically removable since the remaining compound would be unstable, so that methyl cannot exist by itself. It has been isolated but only in a very transitory way. It can, however, enter into chemical composition or reaction in various ways. Since one of the bonds of the carbon atom in methyl is unsatisfied, that is, one of its arms is not full, it is said to have a free valence, that is, one bond or arm free to unite with or grasp another or group of atoms. Valence is the extent to which an atom can combine with another atom or group of atoms. Where an atom has only one free valence it is called monovalent. If there are two or three free valences it is said to be divalent or trivalent. And if it were possible to have an isolated carbon atom it would have four free valences and be called tetravalent. If all the bonds are satisfied there are no free valences and the atom is nonvalent. In this sense methyl

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is a monovalent radical. The next hydrocarbon is called ethane C_2H_6 , consisting of two carbon atoms, each having three of its bonds satisfied with hydrogen atoms and the remaining fourth bond satisfied by being linked with the other carbon atom by a single link. It is of the essence of a saturated hydrocarbon containing more carbon atoms than one that such atoms should be bonded with one another by a single link. Ethane is, therefore, a saturated hydrocarbon and its radical, called ethyl C_2H_5 , being the residue of a saturated hydrocarbon, that is, the grouping of atoms that would remain if one hydrogen atom were removed, is an alkyl radical. Having only one free valence it is monovalent. The addition of each carbon atom to a hydrocarbon requires the addition of two hydrogen atoms to complete its saturation, and in each case, when one hydrogen atom is removed, the residue or grouping of atoms that remains is an alkyl radical. The alkyl radicals are shown on Mr. Higgins' chart, Exhibit P54, as methyl CH_3 , ethyl C_2H_5 , both already dealt with, propyl C_3H_7 , butyl C_4H_9 , amyl C_5H_{11} and hexyl C_6H_{13} . This does not exhaust the list of alkyl radicals for it continues as the number of carbon atoms in the hydrocarbons of the saturated hydrocarbon series increases. It will be seen that in every alkyl radical there are twice as many plus one hydrogen atoms as there are carbon atoms, so that the general formula for all alkyl radicals may be stated as C_nH_{2n+1} . It follows that if the formula for any particular radical does not fall within this general one, such radical is not an alkyl radical. Every alkyl radical is the residue of a saturated hydrocarbon and answers to the same formula C_nH_{2n+1} and every such radical is monovalent in the sense that, regardless of the number of carbon atoms in it, it has only one bond or arm free to unite with or grasp another atom or group of atoms. The definition of the particular class of organic radicals, known as alkyl radicals, given by Mr. Higgins is thus shown to be a clear and precise one.

The precision of this definition did not suit the defendant. It was necessary to attempt to enlarge its scope in order to include xanthates that would not work in froth flotation or to show that the term "alkyl" was ambiguous. Counsel for the defendant relied upon evidence given by Dr. Purves. He explained that the great division of organic radicals was into aryl and aliphatic radicals. The aryl radicals are those derived from compounds of the benzene class. The formula for benzene is C_6H_6 , that is, six carbon atoms and six hydrogen atoms. Its structural formation is distinctive. The carbon atoms are not joined in a chain but in a symmetrical ring with each carbon atom bonded to a carbon atom on one side by a single link and to a carbon atom on the other by a double link. This satisfies three of the bonds of each atom, the remaining bond

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being satisfied by a hydrogen atom, so that there are six hydrogen atoms in a circle each attached to a carbon atom in the central ring, which is called a benzene ring. If one hydrogen atom is removed, the residue or group of atoms that remains is the radical called phenyl C_6H_5 . It is the simplest in the series of aryl radicals. All the aryl radicals are derived by the removal of a hydrogen atom directly from a benzene ring. They differ in chemical behavior from other radicals, one aspect of such behavior being that they cannot be used in making xanthates. All organic radicals, whatever
10 their kind or type, that are not aryl radicals, are called aliphatic radicals. The term aliphatic is thus one of the broadest terms in organic chemistry. Dr. Purves then divided the aliphatic radicals into those that are monovalent and those that are not. The importance of this subdivision lies in the fact that only monovalent aliphatic radicals can be used in making xanthates. Dr. Purves defined a monovalent aliphatic radical as one in which there is only one bond per carbon atom free to unite with another atom or group. This is not the same monovalency as that of the alkyl radical as defined by Mr. Higgins which has only one free valence, not per
20 carbon atom, but in the whole radical, regardless of the number of carbon atoms in it.

Dr. Purves said that, according to Mr. Higgins' definition, alkyl radicals form a precise subsection of aliphatic radicals. He did not challenge the accuracy of the definition and agreed that it was a good, clear cut definition and the most precise one used in the text-books and that it was widely and commonly used. But he also said that in chemistry the term alkyl radical was sometimes used in a wider sense and sometimes in a different one. There was,
30 however, one limit to the territory it takes in, namely, that it never covers a wider territory than that of aliphatic radicals. In its narrowest sense, he said, the term has the meaning given by Mr. Higgins, which is its most precise meaning; in its widest sense it is used in contrast with aryl radical; but it never includes an aryl radical.

While Dr. Purves said that in books of reference the term alkyl had a different meaning from that given by Mr. Higgins, the only chemistry reference book he mentioned was Watts' Dictionary of Chemistry in which, he said, alkyl was defined simply as an alcoholic radical. By these statements and the reference to Watt's the
40 suggestion was left with the Court that in organic chemistry the terms "alkyl radical" and "alcoholic radical" are used synonymously. Such a suggestion is, in my opinion, unwarranted. Dr. Purves explained that the term "alcoholic radical" means that the radical must be such as to give an alcohol where a hydroxyl group has been added to its free valence. According to this explanation, alcohol has two radicals, one the "alcohol radical" and the other the hydroxyl group. When a hydroxyl group is added to an aryl radical the

resulting compound is a phenol which, according to Dr. Purves, is not an alcohol. It is obvious, with this explanation of its meaning, that the term "alcoholic radical" is as wide in extent as the term "alcohol" itself, which, according to Watts', was originally limited to one substance, namely, spirit of wine, but is now applied to a large number of compounds which in their external characteristics show little or no resemblance to common alcohol. It is easy to see how the terms alkyl and aryl may be used in contrast to one another, for the simplest alcohol is produced from an hydroxyl group attached to the simplest alkyl radical, methyl CH_3 , making methyl alcohol CH_3OH , and the simplest phenol is produced from an hydroxyl group attached to the simplest aryl radical phenyl C_6H_5 , making the phenol $\text{C}_6\text{H}_5\text{OH}$ known as carbolic acid. Nor can there be any quarrel with the description of an alkyl radical as an alcoholic radical so far as the substances commonly called alcohol are concerned for they are all derived from saturated hydrocarbons $\text{C}_n\text{H}_{2n+2}$ by the substitution of an hydroxyl group for one of the hydrogen atoms so that such alcohols consist of the radical $\text{C}_n\text{H}_{2n+1}$ and a hydroxyl group, and in respect of such alcohols the terms "alkyl" and "alcoholic" as applied to their radicals would have exactly the same meaning and there would be no confusion with regard to them. But when it comes to alcohols in the wide sense of the term, meaning for the scientific chemist a range of compounds that extends from potable liquids to substances used for making rayon silk, with the radicals for each class or series of such compounds conforming to a specific formula, it becomes obvious, I think, that the statement that each radical of such compounds, meaning thereby the residue or group of atoms remaining after the removal of one or more hydroxyl groups, is an alcoholic radical, no matter what the formula for it may be, is a descriptive statement and not a chemical definition. A study of Watt's supports this view.

It is interesting to note that in the 1882 edition of Watts' the term "alkyl" does not appear. In the 1888 edition, reprinted 1911, it appears simply as follows: "Alkyl. An alcohol radical". Under the article "Alcohols" Watts', after describing the composition of alcohols and their derivation from hydrocarbons containing even numbers of hydrogen atoms by the substitution of one or more hydroxyl groups for an equal number of hydrogen atoms, classifies alcohols as monohydric, dihydric, trihydric, etc., according to the number of hydroxyl groups they contain. He then divides the monohydric alcohols into five series. Each series is described by a formula to which all the alcohols in that series answer. If a hydroxyl group is subtracted from the general formula of the series the general formula of the radical of such alcohols appears. For example, the first series is described as series $\text{C}_n\text{H}_{2n+2}\text{O}$ or $\text{C}_n\text{H}_{2n+1}\text{OH}$, the latter description being written to show the alcoholic radical and the hydroxyl group in that series. Each alcohol in this series

is derived from the paraffin C_nH_{2n+2} by the substitution of a hydroxyl group for a hydrogen atom and the alcohols in the series are described as methyl alcohol, ethyl alcohol, propyl alcohol, butyl alcohol, amyl alcohol, hexyl alcohol, etc. Paraffin is merely another word for saturated hydrocarbon, being derived from *parum* and *affinis* indicating paucity of affinity, namely, saturation. The alcoholic radical in this series is identical with the alkyl radical as defined by Mr. Higgins. The only other series that need be mentioned is the fourth. It is interesting because of Dr. Purves' statement that the term "alkyl radical" is never broad enough to include an aryl radical. Watts' describes this series of monohydric alcohols by the formula $C_nH_{2n-6}O$, which equals $C_nH_{2n-7}OH$, and says that these alcohols are derived from the aromatic hydrocarbons C_nH_{2n-6} in the same manner as the fatty alcohols from the paraffins (or saturated hydrocarbons) C_nH_{2n+2} . The lowest member of this series is phenol C_6H_6O or C_6H_5OH , the radical of which C_6H_5 is described by Dr. Purves on his chart of organic radicals (Exhibit D 86) as phenyl, an aryl radical. The inclusion of phenols in the series of monohydric alcohols implies also the inclusion in the term "alcohol radical" of the radicals of such phenols, all of which, according to Dr. Purves, are aryl radicals. If Watts' is relied upon as authority for the suggestion that an "alkyl radical" means the same thing as an "alcohol radical", it must follow, according to Watts', that the term "alkyl radical" includes such aryl radicals as phenyl. Yet Dr. Purves was quite emphatic in saying that the term "alkyl radical" could never include an aryl radical. Dr. Purves might have pointed out that Watts' classification of monohydric alcohols as including phenols is broader than is now accepted, from which it follows that if the statement in Watt's that "alkyl" is "an alcohol radical" is to be taken as meaning that "alkyl radical" and "alcohol radical" are synonymous terms, as Dr. Purves suggests, then it must, on Dr. Purves' own evidence, be considered as being now erroneous. Dr. Purves should have made this clear. The fact is that when the statement was made in Watts' the term "alkyl" was a comparatively new term in chemistry, the precise limits of which had not been defined. I have already mentioned that it does not appear at all in the 1882 edition. It is also significant that it does not appear in the first volume of the New English Dictionary published in 1888. If the statement in Watts' is to be taken as a definition it must be rejected as taking in too much territory according to modern classifications of radicals. It must be remembered that the classification of radicals had not proceeded as far in 1888 as at the time of the Keller specification. This is shown by the fact that the 1888 edition of Watts' does not give any definition for either aryl or aliphatic radicals, although Dr. Purves said that this was the broad classification of radicals and that aliphatic was one of the broadest terms in organic chemistry. It was, therefore,

- in my opinion, unfair of Dr. Purves to refer to Watts' as an authority showing that in organic chemistry the term alkyl was used in a different sense from that in which Mr. Higgins used it. The only chemistry reference given by him showing a different use was Watts'—No up to date reference book was cited. In Webster's New International Dictionary "alkyl" is defined as meaning "any radical of the methane series, such as methyl, ethyl, propyl, etc." This is the same meaning as that given by Mr. Higgins. It is defined in the same way in the Century Dictionary and Encyclopedia—
- 10 A generic name applied to any alcohol radical, such as methyl (CH_3), ethyl (C_2H_5), propyl (C_3H_7), etc." Other reference books are to the same effect, for example, Kingzett, Chemical Encyclopaedia (1928)—"Alkyl (Radicals)—The monovalent groupings ($\text{C}_n\text{H}_{2n+1}$), such as methyl and ethyl, which form the radicals of the monovalent alcohols", and Hutchinson's Technical and Scientific Encyclopaedia—"Alkyl (Chem.)—A name given to the group remaining when one atom of hydrogen is removed from the molecule of a hydrocarbon of the paraffin series. The names of the individual alkyls are obtained from those of the hydrocarbons by changing
- 20 —ane to—yl. E.g. Methane CH_4 methyl CH_3 etc." and Hackh, Chemical Dictionary (1930)—"Alkyl—Alphyl, Aphyll. A monovalent radical derived from an aliphatic hydrocarbon by removal of one hydrogen atom, as methyl—ethyl or propyl. Their general formula is $\text{C}_n\text{H}_{2n+1}$." and Bennett's Standard Chemical and Technical Dictionary (1939)—"Alkyl. Denoting a non-cyclic saturated hydrocarbon radical of general formula $\text{C}_n\text{H}_{2n+1}$." There can be no doubt as to the generality of the definition given by Mr. Higgins, and there is no room in my opinion for the suggestion of ambiguity or wider meaning left by Dr. Purves. There was another suggestion
- 30 left by Dr. Purves which, in my opinion, was also unfair. When asked whether metallurgists would know the varieties of definitions he had referred to he replied that he could only speculate on that question, that it would depend on where the metallurgist got his training and the work of reference he looked up and said "if he looked up Watts' under Alkyl to see what alkyl meant, he would see it meant an alcohol radical". There is suggested in this reply that a metallurgist engaged in froth flotation on seeing the term "alkyl radical" in paragraph 4 might on looking up Watts' conclude that the term alkyl radical covered as wide a territory as the term
- 40 "an alcohol radicle". It must be remembered that the specification is addressed to persons skilled in the art, metallurgists and chemists working on froth flotation, having the knowledge of the art as of the date of the specification and not of 1888. Such a person would not be confused by looking up Watts'. He would see the description of alkyl as "an alcohol radicle" and would conclude that this was a description rather than a definition of the term. On looking up "alcohols" he would be confirmed in this view, for he would see the

wide range of substances covered. He would see that the monohydric alcohols were classified in series according to given formulae from which he could find the formula of the radical they contained. He would see that there were included together such extremes as the radicals of the paraffin series and the aryl radicals of the phenol series. He would know, as Dr. Purves did, that "alkyl" could not include "aryl" and this would lead him elsewhere than to Watts' for an accurate definition of "alkyl". Indeed, it is altogether inconceivable that a person skilled in the art of froth flotation as of the date of the specification who wished to ascertain the limits of the meaning of such a comparatively new term in organic chemistry as "alkyl radical" would confine his enquiries to Watts', for he would know that since 1888 there had been a great advance in the knowledge of radicals and an increased clarification in their classification and definition. He would, therefore, without question consult more recent text books than Watts'. If he did so he would see the generality of the use of the term alkyl in the sense given by Mr. Higgins. In my opinion, the term "alkyl radical" has the exact, precise meaning that was given to it by Mr. Higgins and I do not think that any skilled metallurgist or chemist engaged in froth flotation could have failed to understand the term according to such meaning or would have been misled into thinking it had the wider meaning suggested as possible by Dr. Purves.

But if there is any doubt in the matter, which I for my part do not see, the doubt should be resolved in favour of the patentee. In his definition, which is a difficult one, the inventor has chosen a term which has a precise and exact meaning which, if applied, will hold his invention. He should not lose it merely because someone has been astute enough to find another possible meaning which, if applied, will destroy the patent. In such circumstances, there has been no avoidable obscurity or ambiguity on the part of the inventor and, no lack of good faith being shown on his part and the definition being a difficult one, that meaning should be adopted which will support the patent. That principle is supported by the decision of the House of Lords in *Natural Colour v. Bioschemes (supra)*, to which further reference will be made when the claims are considered.

The xanthates referred to in paragraph 4 are the result of the union of xanthic acid and a metal. If the alkyl radical is ethyl and the metal is potassium the resulting xanthate is potassium ethyl xanthate. Xanthic acid has already been described as a form of dithiocarbonic acid, called sulphothiocarbonic, consisting of a central carbon atom bonded on the one side with a sulphur atom by double links and on the other side with a sulphur hydrogen group by a single link and a group consisting of oxygen and an alkyl radical, in this case ethyl, also by a single link. Potassium ethyl xanthate results when the hydrogen in the sulphur hydrogen group is replaced by

- potassium K. The resulting formula is $SCSKOC_2H_5$ showing the structural arrangement already described. Any alkyl radical may replace ethyl and any metal permitted by the definition may replace potassium, so that if M is used to designate the metal and R the radical the general formula becomes MCS_2RO , the metal, carbon disulphide, the radical and oxygen. When it is known what M and R respectively represent, the calculation of the quantities of the elements required for the formation of the xanthate is fixed by inflexible chemical laws based upon the atomic weights of the atoms.
- 10 Exhibit P 55 shows the way in which two of the commonest xanthates, namely, potassium xanthate and sodium xanthate are made. In the case of potassium xanthate the ingredients are caustic potash, which is potassium hydroxide KOH, ethyl alcohol C_2H_5OH , and carbon disulphide CS_2 , each having the molecular weight that is the total of the atomic weights of the atoms in it. The formula for this mixture with all the elements included is $KCS_2C_2H_5O$, which represents potassium ethyl xanthate, plus H_2O , which is water. The significant fact is that in the production of potassium ethyl xanthate with the ingredients mentioned some water is always
- 20 also formed because of the hydroxyl groups in both the caustic potash and the ethyl alcohol. When the water is removed, pure potassium xanthate results. The theoretic amount of any ingredient required for the production of a given quantity of potassium xanthate is a matter of chemical certainty. Exhibit P 55 shows that to produce 160 grams of potassium ethyl xanthate there will be required 56 grams of potassium hydroxide, 46 of alcohol and 76 of carbon disulphide, which in addition to the desired quantity of xanthate will also produce 18 grams of water. The result will be
- 30 89.9% potassium ethyl xanthate and 10.1% water. It is useless to vary the proportions of the ingredients or to increase the quantities of any of them, but frequently an excess of alcohol over the theoretic amount required is used to enable easier control of the reaction and the excess may then be driven off with the water in various ways. The figures given above are the theoretic ones and are based upon the use of pure ethyl alcohol, but if 10% water is used less xanthate would result, for reasons that will be amplified later, but there would not be enough to stop the reaction.

- 40 A brief reference may be made to the list of xanthates filed by the defendant (Exhibit D 61). An attempt was made to show the number of xanthates to be enormously large. Indeed, it was suggested by counsel for the defendant that it might run into hundreds of thousands. Yet the number included in the list was only 91, classified in 16 groups according to the radical contained. The list was filed subject to an agreement between the parties that it constitutes all the references to xanthate prior to 1923 which could be found by the defendant in the scientific literature; that none of

the references are to metallurgical publications but all are in the chemical field; that all the references are to laboratory experiments (with the exception of cellulose xanthate in rayon) and are reports either of success in preparing the type of xanthate disclosed, or of laboratory exploration of one or more of its properties; and that none of the references are to preparation or use outside the laboratory. Of the 16 groups listed, 10 are excluded from the definition of xanthates in paragraph 4 by the requirement of the first sentence that the radical contained must be of the alkyl type. Which of 10 the xanthates in the remaining 6 groups may be included depends upon the metals used in their production. There are fifty metallic elements but xanthates made with some metals are excluded from the inventor's definition by the requirement of the second sentence that the xanthates must "form anions and cations in solution". This sentence was brought into the paragraph by way of amendment at the same time as the amendments to the first sentence and its restrictive effect was properly admitted. Only such xanthates as form anions and cations in solution are contemplated by the inventor. When a salt is dissolved in water a physical splitting of the molecules takes place through the fact that they carry a charge of electricity and can be separated by the influence of an electric current, the anion from the acid side to the anode and the cation from the metal side to the cathode. For the purposes of the definition the word "solution" in the sentence is the important one, for if a xanthate is to be capable of forming anions and cations in solution it must first of all be soluble. The solubility of a substance is related to the solvent that is to be used and the term "solubility" or "solution" must always be considered according to its context. Its meaning is relative to the circumstances under which it is used. When a 20 substance is stated to be soluble without mention of the solvent, it is generally implied that it is soluble in water. This means that it is all capable of being dissolved in water. I understood Dr. Purves to say that for practical operating reasons in organic chemistry a substance could be regarded as soluble in water if it took 500 parts of water or less to dissolve it completely. A very much smaller degree of solubility is required to enable a substance to form anions and cations for that takes the word soluble out of the working range of the practical organic chemist into that of the physicist. To a physicist, for example, even glass might be soluble, but its order of 30 solubility is so low that it would not be considered soluble by an organic chemist. On the other hand, a much higher degree of solubility would be expected by the chemist or metallurgist engaged in froth flotation for he would think of solubility in relation to the quantity of water used in froth flotation, and if a large amount of water, judged by such a standard, is required to dissolve a substance it would be regarded by him as substantially insoluble. This becomes of importance when the classification of xanthates according 40

to whether they are made with heavy or light metals is considered. Mr. Higgins classified among the heavy metals lead, zinc, copper, mercury, tin, nickel, cobalt and so forth, and described as light metals the alkali group of metals, and also magnesium and aluminum. Mr. Higgins stated, and there was no contradiction of his evidence on this point, that xanthates formed with the heavy metals were not soluble in the sense in which a metallurgist would use them. Copper xanthate, for instance, is one of the most insoluble compounds known to the chemist and some of the other xanthates might give
10 a very slight solution but certainly not enough for them to be of any use in the flotation process. All the xanthates shown on Exhibit D 61 which are formed with heavy metals are, therefore, excluded from the definition of the class of xanthates whose use in froth flotation is proposed, on the ground that they are not soluble in water in the sense in which a chemist or metallurgist engaged in froth flotation would regard that term. This leaves the xanthates formed with the light metals including mainly the alkali metals of which the main ones are potassium and sodium. The xanthates formed from such metals are readily soluble in water.
20 The other metals in the alkali group are caesium, lithium and rubidium. The number of xanthates contemplated by the inventor, instead of running into the hundreds of thousands, is thus shown to be comparatively small.

This concludes the analysis of the description of the invention so far as it relates to the use of xanthates. I have come to the conclusion that it is precise and as reasonably clear from avoidable obscurity or ambiguity as the difficulty of the description permits. A person skilled in the froth flotation art would, in my opinion, have no doubt as to the class of xanthates whose use was proposed by
30 the inventor.

The description of the invention does not, however, stop with the definition of the class of xanthates although it might well have done so, since the use of such xanthates could in itself be the subject matter of a patent. The inventor goes on to describe the rest of his invention. In the third sentence of paragraph 4 he discloses that excellent results were also obtained by agitating ore pulps with a certain complex mixture the nature of which he then describes. The sentence is a clumsy one but its meaning is clear to any one desirous of understanding it. The complex mixture with which
40 the ore pulps are agitated is produced as follows; the pine oil is incorporated with an alcoholic solution of potassium hydrate and carbon disulphide is added to the mixture. There will be potassium xanthate in the mixture, but there will also be other substance that are analogous to it, because of the water in the alcohol. The inventor thus covers substances analogous to xanthates. These are the various thiocarbonates already described. The thiocarbonates are salts, just as xanthate is, resulting from the union of a metal

with the thiocarbonic acid from which they are derived. Xanthate is itself a dithiocarbonate derived from xanthic acid as already explained. If the same metal, for example, potassium, is used in the thiocarbonates as in the xanthate the resulting salts are analogous substances, the only difference being that the thiocarbonates are monothiocarbonates, dithiocarbonates or trithiocarbonates depending upon whether one, two or three atoms of oxygen have been replaced by sulphur in the thiocarbonic acid from which they are derived, and that xanthate is the only one that contains an alkyl
10 radical. The class of analogous substances is as defined as the class of xanthates.

In paragraph 5 the inventor refers to the galena-bearing froth obtained with xanthates or analogous substances, which is merely a reference to their beneficial effect on a lead zinc ore.

In paragraph 6 the inventor discloses that the substances referred to, whether xanthates or analogous substances, are not mineral frothing agents but when used in the presence of a mineral frothing agent are effective in enabling a selective flotation of lead and zinc and cause uncombined silver to tend to go into
20 the lead concentrate rather than with the zinc. There is no attack on this paragraph, except with regard to the last sentence, which will be dealt with separately.

Then paragraph 7, which was inserted by way of amendment, discloses that the invention goes further than already described and covers the use of the substance described in the paragraph to the extent mentioned in it. This substance is neither a xanthate nor exclusively an analogous substance. The salt described as yellow or orange results from the union of caustic potash and carbon disulphide. The evidence is that this substance was a mixture of
30 which about two-thirds was potassium trithiocarbonate, the remainder being potassium carbonate. Potassium trithiocarbonate is a substance analogous to potassium xanthate, but potassium carbonate is not. To this extent, therefore, the invention extends to a substance which is neither a xanthate nor an analogous substance. Potassium trithiocarbonate is derived from trithiocarbonic acid by the substitution of an atom of potassium for the atom of hydrogen in each of the sulphur hydrogen groups. It differs from potassium xanthate in having all three atoms of oxygen substituted by sulphur instead of two and in not having an alkyl radical, its place being
40 taken by another potassium atom. Both are sulphur derivatives of carbonic acid. Potassium carbonate is not a sulphur derivative of carbonic acid but a direct derivative, the hydrogen atom in each of the hydroxyl groups in carbonic acid being replaced by an atom of potassium. The test with this substance was carried out with Hibernia ore, a lead zinc ore, with a neutral pulp.

Then paragraph 8 describes how the inventor made potassium xanthate for laboratory purposes, which he need not have done since no claim is made to xanthate as a new substance.

The remainder of the disclosures deals with experiments and tests made by the inventor on various types of ores and may be regarded as part of the description of the operation and use of the invention as contemplated by the inventor. The description of the invention itself is contained in the first eight paragraphs. It has been described by the inventor in respect of its various aspects in the manner indicated. He has disclosed that his primary and best invention is the use of certain xanthates and has defined the class of such xanthates in the first two sentences of paragraph 4; he has also disclosed that the complex mixture referred to in the third sentence of paragraph 4, consisting of xanthates or analogous substances, produced excellent results; then in paragraphs 5 and 6 he has disclosed that in dealing with lead zinc ores he found good results with xanthates or analogous substances; and, finally, in paragraph 7 he discloses that, on a particular type of ore and with a neutral circuit, he found useful results with the particular substance described in the paragraph. He could, I think, have applied for one patent in respect of the use of xanthates and another in respect of the use of the other substances and it may well be that under The Patent Act, 1935, Statutes of Canada, 1935, chap. 32, his application would be divided, but it is also clear from section 37(1) of such Act that his patent is not invalid by reason only that more than one invention is included. In my opinion, the inventor has correctly and fully described his invention in its various aspects so that any person skilled in the froth flotation art would know precisely what the inventor has found to be new and useful, primarily as his best invention the use of the xanthates he defined, and also, on the ores specified and within the limits stated, the use of the other substances specified. He put into the specification everything that he found useful and has, I think, in this respect fully complied with the requirement of the Act.

In addition to the main general attack on the specification for failure to describe the invention, which fails for the reasons give, four specific charges were made, two of which related to statements that were said to be misleading.

The first of such statements is the implied one that useful results can be obtained with a compound prepared in accordance with paragraph 7. Counsel contended at first that this is positively misleading in that the compound does not lead to the useful results promised, and later that it is inferentially misleading in that it recommends the use of useless material. He argued that the paragraph misleads the person who is trying to put the invention into operation, puts him off the track and directs him away from obtaining successful results. The argument has no merit. The inventor does not propose the use of the substance referred to in paragraph 7 as an alternative to the use of xanthate, nor does he suggest anywhere that it is equal in value to xanthate. The dis-

closures show that potassium or sodium xanthate is the best substance to use, and many proofs of its value are given. Then in paragraph 7, the inventor also shows that on a particular kind of ore, namely, a lead-zinc ore, and with a particular kind of pulp, namely, a neutral one, useful results were accomplished with the substance referred to, namely, that the concentrates were seen to be clear with brightened lead sulphide particles. There is nothing more in the paragraph. The inventor does not hold out the substance as having special value, but merely states what he found

10 when he was working out his invention, namely that this was one of the substances he found useful in its special and limited sphere. There is no statement in the paragraph, either express or implied, that can be considered misleading. As for the contention that the substance is useless, the evidence proves the contrary. It was tested at Noranda by Mr. Bennett, the defendant's metallurgist, who said that the tests indicated that it was substantially inert as a flotation collecting agent. He could not say that it was useless for the tests showed a higher percentage of copper recovery than was possible without it, although the grades in the concentrates

20 were somewhat lower. The value of this evidence is lost by the fact that the tests were with a copper ore in which there was no lead or zinc and with a very alkaline pulp, whereas paragraph 7 shows useful results in a test made with a neutral pulp on Hibernia ore, which was a lead-zinc ore. On the other hand, Mr. Higgins gave evidence that he had made an experiment similar to that set out in paragraph 7 and that it was successful, that while the concentrate was not as good as with potassium xanthate it showed a distinct selection of lead from zinc. He made his experiment with

30 a lead-zinc ore called Orphan Girl, which was the nearest in kind to Hibernia ore which he could find, the Hibernia mine having closed down. In my opinion the evidence of Mr. Higgins proves that the substance referred to, far from being useless, is useful on a lead zinc ore like Hibernia ore with a neutral pulp. This attack on the disclosures fails.

The second statement said to be misleading is the final sentence in paragraph 6, namely, "The pulps may be either acid, alkaline or neutral according to circumstances". As it stands, it is merely a statement of fact, for all three kinds of circuits were in use "according to circumstances", depending upon the type of ore and

40 the kind of mineral frothing agent that was used. Some ores and some mineral frothing agents worked best in an acid circuit, others in an alkaline one and others in a neutral one. Although the trend was away from the use of acid circuits, a few large mines, including Anaconda, still used an acid circuit. Counsel for the defendant did not quarrel with the statement as a statement of fact but read a misleading implication into it. He contended that its inclusion in the specification is meaningless unless the inference is drawn

that it means that the invention is of equal value and operates in the same way whether the circuit used is acid, alkaline or neutral, and that with such an inference the statement is misleading, since there were differences in behavior of the reagents, known to the inventor, which he did not disclose. This attack is not well founded. So far as the use of xanthate is concerned there is no evidence that it does not work successfully in all kinds of circuits. As for the other substances the specification indicates that there are differences and points them out. The evidence showed that in the large scale
10 tests at Anaconda in which an acid circuit was used pure xanthate worked better than xanthate mixed with other substances. This fact was known to the inventor and was, no doubt, the reason for the last sentence in paragraph 8 that "it was found in cases where sulphuric acid was used that the centrifuged material yielded better results than the uncentrifuged." This is a warning to any person reading the specification that if he is dealing with an acid circuit he should use xanthate by itself rather than xanthate mixed with analogous or other substances. As to the use of xanthates or analogous substances in alkaline or neutral circuits there is no evidence
20 of any difference in effect. As to the use of the substance referred to in paragraph 7 the only statement as to its effect is that on Hibernia ore, a lead-zinc ore, useful results were obtained in a test made with a neutral pulp. There is no statement or suggestion that the same result would follow with a different ore or with a different circuit. I find nothing misleading in the last sentence of paragraph 6.

The next charge is that the inventor knew that his proposed reagents did not work on oxide ores but had failed to disclose this necessary information. Ores are sulphide or oxide depending upon
30 whether the metalliferous minerals they contain are mainly sulphide or mainly oxide. The metalliferous minerals referred to are those that are chemical combinations of metals and other elements. If the combination contains sulphur it is sulphide, but if it contains oxygen it is oxide. Sulphide ores tend to reaction by oxygen when exposed to the air and are then said to be oxidized. There was controversy during the trial as to the position of oxide ores with regard to froth flotation. Mr. Bennett gave evidence that froth flotation worked particularly well only on sulphide ores. He knew that oxide ores were difficult to treat but was not able to say whether
40 they could be treated at all. When counsel for the plaintiff called Mr. Higgins to give evidence in rebuttal on this question objection was taken by counsel for the defendant on the ground that Keller on his commission evidence had testified that certain oxides were relatively easily floated and others were floated with more difficulty and that another witness, Wilkinson, also giving evidence on commission, showed that oxide ores were the subject of flotation, and that counsel for the plaintiff could not give evidence to contradict

his own witnesses. I allowed Mr. Higgins to be examined on the question reserving consideration of the objection. While there is some support for the objection, it is not clear whether oxide ores could be treated in froth flotation without some sulphidizing agent. In view of this, and also in view of Mr. Bennett's uncertainty, I think that Mr. Higgins could properly be asked what the situation was. His evidence settled the matter beyond dispute. He stated categorically that in 1923 it was not possible to separate oxide ores by the froth flotation process without first subjecting them to the
10 action of a sulphidizing agent, and that this was a matter of common knowledge in 1923 to persons skilled in the art. This evidence, which I accept, is in accord with the general tenor of Keller's evidence. He was really searching for a sulphidizing agent to treat oxide ores so that they could be separated by froth flotation when he fell upon the use of xanthate. He discovered that it worked well with sulphide ores but did not work at all with oxide ores, from which he concluded that xanthate was not a sulphidizing agent. If the use of xanthate had enabled the flotation of oxide ores Keller should have said so, for that would have been a new and startling development in froth flotation,
20 ion, but he was under no duty to say that it did not work with such ores, since it was already known in the art that the froth flotation process did not work at all with oxide ores so long as they remained oxide and the particles were not covered by a sulphide film. This attack on the disclosures was, in my opinion, an unreasonable one.

One other attack on the disclosures was made. It was contended that in the course of the tests at Anaconda, in which an acid circuit was used, the inventor had learned a better method of preparing xanthate for use in an acid circuit than that described in paragraph 8 but had failed to disclose this useful knowledge. This
30 contention requires careful consideration by reason of the chemistry questions involved, but there are, I think, two answers to it. The first is that the inventor did not have to describe any method of preparing xanthate at all, since xanthate itself as a new substance is not the subject of his invention. The second answer is that there was no real chemical difference, having regard to the ingredients used, between the method described in paragraph 8 and that used in the successful test at Anaconda. This requires a clear statement of what happened at Anaconda and a careful analysis of the various methods of preparing the xanthate. The method described in paragraph 8 may be called the Keller method. There
40 were several distinct steps in it. First, the caustic potash was dissolved in the alcohol at a given temperature in a reflux condenser to retain what might otherwise be lost through the mixture being volatile, and the solution was then cooled. The second step was that while this solution was stirring in a cooling bath the carbon disulphide was added, the resulting reaction being substantially instantaneous and producing the potassium xanthate. A third step

was then taken; the thick pulp was cooled and centrifuged, that is, the solid substance was thrown out from the liquid, yielding xanthate crystal containing about 20% moisture. Then there was a fourth step; the liquid remaining after the solid substance was thrown out by the centrifuging, called the mother liquor, also contained some xanthate and this was recovered by evaporation of the liquid. Keller had conceived his invention in September, 1922, and made his first formal demonstration in the plaintiff's San Francisco laboratory in March, 1923. Anaconda ore was a problem and the

10 Anaconda slimes were particularly difficult. In May, 1923, arrangements were made for large scale tests of the Keller process at Anaconda. Two samples of xanthate were taken to Anaconda, one being that used in the laboratory, and the other, consisting of 250 pounds each of potassium xanthate and sodium xanthate having been made by Great Western Electric Chemical Company. The plaintiff's staff went out to supervise the demonstration. The tests took place in June, 1923. Counsel for the defendant refers to them as encouraging but not conclusive, but the evidence is that they were successful and created quite a furore in the Anaconda

20 Mill. This was the first Anaconda test. Then Anaconda arranged for a further test on a full section of the mill, and an order was placed with Great Western Chemical Company for 1000 pounds of potassium xanthate. The second test was run during July and August, 1923. While the results were successful they were disappointing in that they were not as good as anticipated, and the tests were stopped. The xanthate had been prepared by the Company according to the method given by their chemist. Dr. Rosenstein, Keller felt certain that the lack of anticipated results was due to the inferior quality of the xanthate and there were acrimonious

30 discussions with Rosenstein. The method used by Rosenstein, which may be called the Rosenstein method, differed from the Keller one in two important particulars. The first difference was that instead of the caustic potash being dissolved in alcohol, it was dissolved in water because it is more soluble in water than in alcohol, and the alcohol and carbon disulphide were added to such solution. The second major difference was that the resulting mixture was not centrifuged at all, but merely dried by evaporation. A third test at Anaconda was then arranged. This was to be a competitive

40 test between xanthate and another flotation agent called thiocarbonamid. Two sections of the mill were to run side by side, one using xanthate and the other thiocarbonamid. An order for 1500 pounds of xanthate was placed with the Great Western Chemical Company and special instructions were given to prepare it according to what counsel for the defendant called the Nutter method. The steps in this method were as follows. First, the caustic potash was dissolved in an excess alcohol and the mixture allowed to settle; the water in the mixture went to the bottom in what was called

the aqueous layer, leaving the alcohol, called the supernatant liquid, at the top. The next step was to get rid of the water, either by decanting the alcohol solution off the top or draining or siphoning the water layer away from the bottom. Then the carbon disulphide was added to the solution containing the alcohol, which was the only part of the original mixture that was used for the reaction. Finally, the resulting compound was centrifuged and only the centrifuged material was used in the test, the mother liquid being "dumped down the sewer".

10 The only difference between this method and the Keller one was that the water was removed from the first solution before the carbon disulphide was added to produce the reaction and only the centrifuged material was used in the test. The result was that xanthate won the competitive test and Anaconda adopted the Keller process. Counsel for the defendant said that this proved that the Nutter method was the best one and contended that Keller should have disclosed it to the public so that it should be in the same position as he was to make the most effective use of the invention in an acid circuit. The criticism requires consideration of the chemical reaction involved. I have already discussed the manner

20 in which potassium xanthate is produced through the reaction resulting when carbon disulphide is added to a mixture of caustic potash and alcohol, but some reference should be made to the effect of the presence of water in the mixture during the reaction. Its effect is peculiar. Water has hydroxyl groups similar to those in alcohol so that when alcohol and water are present the sets of hydroxyl groups complete against one another mixture thus tends to reduce the yield of xanthate and also to increase that of other salts that are not xanthate. Moreover, impurities form in the reaction if the ingredients used are not pure and these will be in the mixture

30 and in the solution if an excess of alcohol is used. Centrifuging throws the solids out of the solution leaving the mother liquid with whatever it contains. If there are impurities they tend to remain with it rather than to adhere to the solids thrown out by the centrifuging. The centrifuging does not squeeze all the liquid out of the centrifuged material for some remains in the form of moisture. And the mother liquor will have some xanthate still in it which the centrifuging has not been able to throw out, and it will also contain whatever impurities there were in the ingredients and whatever other substances the water in the mother liquor was able to attract

40 in its competition with the alcohol less what went with the solids. The result is that while the centrifuged material still contains some liquid and, therefore, some impurities and substances other than xanthate there is no doubt that it is more nearly a pure xanthate than the product of the mother liquor when evaporated or the product without centrifuging would be. It is, therefore, apparent why there was a different result with the xanthate prepared by the Nutter method from that prepared by the Rosenstein one. The

use of water in the latter method in dissolving the caustic potash would accentuate the formation of substances other than xanthate and the failure to centrifuge would leave all such substances, as well as any impurities in the solids when the mixture was dried by evaporation, so that the resulting product was not pure xanthate but included other substances and impurities as well. The success in the third test proved the superior value of pure xanthate in an acid circuit. But that is all, in my opinion, that it did prove. While the tests at Anaconda did show that the product prepared by the

10 Nutter method was more nearly pure xanthate and worked better than that prepared according to the Rosenstein one, there is no proof that there would not have been the same success with xanthate prepared according to the Keller method if only the centrifuged material had been used. There would be some moisture in the Nutter method xanthate just as there was in the centrifuged material referred to in paragraph 8 and some of it would have been water, with its accompanying impurities and substances other than xanthate, for there would still have been some water in the supernatant liquid even after the aqueous layer had been removed, and there is no

20 evidence that it was more free from impurities and substances other than xanthate than the centrifuged material of the Keller method xanthate was. Mr. Higgins described the Keller method as quite a good one and Dr. Purves agreed that it would give a good yield. He did not like the use of denatured alcohol for this meant that there would be a little methyl alcohol mixed with the ethyl alcohol so that there would be some methyl xanthate mixed with the ethyl xanthate and there would also be some water. He said that the less water there was the greater the yield of xanthate would be, but he agreed that the small amount of methyl and water present

30 in the Keller method would not be a matter of any practical consequence. He also agreed that the Keller method could be applied to commercial production. When Dr. Purves was asked to compare the Keller method with the Nutter one he said that the latter showed the presence of water and that he could not really compare the two methods without knowing how much water there was. This indicates that the quantity of water that is present is important. Dr. Purves' view was that the results of the two methods were substantially the same and that the Nutter method was basically simply a device for using an inexpensive grade of alcohol containing water.

40 He could see no chemical difference between the two methods. The use of pure alcohol would yield more xanthate but would cost more; the use of a cheaper alcohol containing water would yield less xanthate but would cost less. The only difference between the Keller method and the Nutter one was that in the latter after the caustic potash was dissolved in the alcohol the water in the mixture was removed by draining or siphoning it away or by decanting the alcohol before the carbon disulphide was added to the

solution. Dr. Purves' evidence that he could see no chemical difference between the two methods supports the contention of counsel for the plaintiff that the only difference between the two methods was purely a mechanical one made necessary by the fact that a cheap alcohol in which there was more water than was desirable was being used and that it was merely a process of removing the excess water. Even when pure alcohol is used some water is produced in the reaction for, as we have seen, potassium hydrate KOH, ethyl alcohol C_2H_5OH and carbon disulphide CS_2 produce potassium ethyl xanthate $KCS_2C_2H_5O$ plus water H_2O . The small amount of additional water involved in the use of the denatured alcohol referred to in paragraph 8 would make no real difference, either as to the yield or purity of the xanthate produced. These are all facts that a chemist would know and are matters relating to the manufacture of xanthate. Consequently, if instead of using pure alcohol or the denatured alcohol referred to in paragraph 8 the chemist wished to use a cheaper alcohol containing an excessive amount of water, he would know that if he wanted to get the same results as he would get with pure alcohol, he would have to take 20 steps to drive off the excess water, and that it would be desirable to do so before the carbon disulphide was added and the reaction took place. In my opinion the defendant has not been able to prove the grounds upon which his last attack on the disclosures of the specifications was based.

The defendant thus fails in all its attacks upon the disclosures portion of the specification. In my view, any person skilled in the froth flotation art on reading the specification would know what the invention related to and what it was. He could have no doubt as to its ambit or scope. Moreover, he could with the specification and his knowledge of the art put the invention into effect as successfully as the inventor could do himself. He is directed to the use of the best substance without any need for experimentation and can then deal with the other substances found to be useful as he chooses under the conditions mentioned. There are no misleading statements to put him off the track. He has been given the necessary warning if he is dealing with an acid circuit. The inventor has, I think, fulfilled the duty of full disclosure required of him by section 14.(1) of the Act.

Section 14.(1) also requires that the specification shall end with 40 a claim or claims stating distinctly the things or combinations which the applicant regards as new and in which he claims an exclusive property and privilege. By his claims the inventor puts fences around the fields of his monopoly and warns the public against trespassing on his property. His fences must be clearly placed in order to give the necessary warning and he must not fence in any property that is not his own. The terms of a claim must be free from avoidable ambiguity or obscurity and must not be flexible;

they must be clear and precise so that the public will be able to know not only where it must not trespass but also where it may safely go. If a claim does not satisfy these requirements it cannot stand. The need for freedom from avoidable ambiguity or obscurity cannot be better expressed than it was by Lord Loreburn in the House of Lords in *Natural Colour v. Bioschemes* (*supra*)¹ where he said:

10 “It is the duty of a patentee to state clearly and distinctly, either in direct words or by clear and distinct reference, the nature and limits of what he claims. In it he uses language which, when fairly read, is avoidable obscure or ambiguous, the Patent is invalid, whether the defect be due to design, or to carelessness or to want of skill. Where the invention is difficult to explain, due allowance will of course, be made, for any resulting difficulty in the language. But nothing can excuse the use of ambiguous language when simple language can easily be employed, and the only safe way is for the patentee to do his best to be clear and intelligible.”

and in the same case Lord Parker said at Page 269

20 “It is open to the Court to conclude that the terms of a Specification are so ambiguous that its proper construction must always remain a matter of doubt, and in such a case, even if the Specification had been prepared in perfect good faith, the duty of the Court would be to declare the Patent void.”

*Vide also General Railway Signal Co., Ltd. v. Westinghouse*²; *Whatmough v. Morris Motors, Ltd.*³.

The inventor may make his claims as narrow as he pleases within the limits of his invention but he must not make them too broad. He must not claim what he has not invented for thereby he would be fencing off property which does not belong to him. It follows
30 that a claim must fail if, in addition to claiming what is new and useful, it also claims something that is old or something that is useless: *Vidal Dyes v. Levinstein* (*supra*)⁴; *Natural Colour v. Bioschemes* (*supra*)⁵.

The attacks upon the claims may now be considered. Objection was taken to claim 6 on the ground of ambiguity. It reads as follows:

40 “6. The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and an alkaline xanthate adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth.”

¹ (1915) 32 R.P.C. 256 at 266

² (1939) 56 R.P.C. 295 at 382

³ (1940) 57 R.P.C. 177 at 198

⁴ (1912) 29 R.P.C. 245 at 268, 270

⁵ (1915) 32 R.P.C. 256 at 266, 268

Three expressions were said to be ambiguous, namely, "suitable pulp of an ore", "alkaline xanthate" and "adapted to cooperate". "Suitable pulp of an ore" may mean that the suitability is related either to the fineness of the ore and the amount of water required for the pulp or to the nature and kind of the ore and whether it can be treated by froth flotation. This means no more than that the pulp should be suitable for froth flotation; this would be known to a practical metallurgist or chemist. I see no objection to the expression. Nor was the expression "adapted to cooperate" seriously
 10 challenged, although it was said to be ambiguous. The strongest exception was taken to the term "alkaline xanthate". Xanthate is a neutral salt and the term alkaline xanthate appears as a contradiction. By itself it does not make sense. Mr Higgins considered it a slip of the tongue but did not think any metallurgist would misunderstand it. He regarded it as synonymous with alkali xanthate or alkali metal xanthate. Dr. Purves stated that the expression did not make sense to a chemist since xanthates are neutral substances. It struck him as a conundrum. His first
 20 impression was that it meant a xanthate in an alkaline solution, but it might mean a xanthate made with an alkali or an alkali metal. Mr. Bennett thought the expression a contradiction in terms, but considered that it was possible to regard alkaline as meaning alkali metal and that such a meaning was a reasonable one. The inventor made several clarifying and important amendments during the course of prosecuting his patent application but this term remained untouched. He could have avoided ambiguity if he had used more care. As the expression stands it is either contradictory or incomplete. Counsel for the plaintiff contended
 30 that if it meant alkali xanthate to a metallurgist or chemist the claim should be upheld, but this means interpretation of the claim by experts. The construction of a specification is for the Court and not for the experts. Moreover, to read the word "alkaline" which has a well known meaning as if it were "alkali metal" is not construction of the claim but amendment of it, which is not the function of the Court or within its powers. I find obscurity and ambiguity, which the inventor could have avoided. Claim 6 must, therefore, fail.

Of the remaining claims in suit claim 9 is the significant one. It reads as follows:

40 "9. The improvement in the concentrating of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of a xanthate and a frothing agent".

Two attacks upon this claim were made; one that it extends to some xanthates that will not work in froth flotation and that it is bad because it claims something that is useless, and the other, that there is nothing in the disclosures to warrant confining the claim to a non-acid circuit.

As to the first objection it is said that the claim covers all xanthates and that there are two classes of xanthate that will not work in froth flotation, one being cellulose xanthate and the other copper, cobalt and calcium xanthates. The main attack on claim 9 centered on cellulose xanthate. The evidence that it will not work successfully in froth flotation is conclusive. Mr. Bennett prepared it in accordance with instructions from Dr. Purves and tested it at Noranda. The tests proved that the recoveries made with it were very low, that the purer the xanthate was and the more
10 of it that was used the worse the results were. Far from having any use in froth flotation, it had a positively depressing effect on copper minerals and seemed to prevent them from coming into the froth. Counsel for the defendant contended that notwithstanding the fact that the inventor had tried it and discarded its use he had included its use in claim 9 and that the claim was accordingly bad. A great deal of evidence was given at the trial on this subject and much argument was devoted to it.

Cellulose xanthate was originated as early as 1893. Its discovery was the foundation for the viscose industry and the rayon
20 silk industry and in 1923 it was known chiefly for its value in the latter connection.

The cellulose xanthate was prepared for the tests as follows. The first ingredient was cellulose to which was added a caustic soda solution, that is, caustic soda dissolved in water. This was agitated and stirred for two hours. The compound was then filtered, the excess solution discarded and the residue pressed between blotters. The resulting swollen gelatinous mass was shredded with scissors to get it into small particles or crumbs. These were aged or ripened
30 for 46 hours and then carbon disulphide was added. This mixture was agitated and stirred for 3 hours and any excess carbon disulphide was removed. What was left was a highly swollen, yellow, somewhat crumbly material. This was crude cellulose xanthate, really a mixture of cellulose xanthate with some caustic soda in it. This compound was known as viscose. The obtaining of pure cellulose xanthate required further processes. To the yellow crumbly material a caustic soda solution and water were added until all the crumbs were dissolved, forming a viscous clear solution. While this was being stirred methyl alcohol was added causing the cellulose xanthate to coagulate. All excess alcohol was decanted and the
40 coagulated material was further treated with alcohol to wash out all excess caustic soda, leaving only the pure cellulose xanthate.

The essential chemical difference between sodium cellulose xanthate and sodium ethyl xanthate is that in the former sodium is mixed with cellulose, whereas in the latter it is mixed with ethyl alcohol. The cellulose takes the place of the ethyl alcohol, with the result that the cellulose xanthate contains the cellulose radical whereas the sodium ethyl xanthate contains the ethyl radical. There

are other differences which are perhaps of a physical rather than a chemical nature. The ethyl xanthate is a crystalline substance, the cellulose xanthate a fibrous one. The ethyl xanthate dissolves easily in water, whereas the cellulose xanthate to the extent that it does dissolve forms only what is called a colloidal solution.

The evidence shows a number of practical differences between sodium cellulose xanthate and sodium or potassium ethyl xanthate. Cellulose xanthate is more difficult and takes longer to make; more care has to be taken of temperatures and times. Cellulose xanthate
10 is not readily purchasable on the market for in the rayon industry the material that is used is viscose; the xanthate itself is not a commercial product. Consequently, if xanthate were to be purchased it would be in the form of viscose, which does not lend itself to shipment or storage except for very short periods, for the xanthate in it quickly decomposes. Sodium or potassium ethyl xanthate, on the other hand, is easily and quickly made, the ingredients for its production are readily procured, the xanthate is sold on the market, is easily shipped and can be stored in large quantities at the mine. Moreover, the cost of cellulose xanthate was greater
20 than that of ethyl xanthate. So far as froth flotation was concerned there were obvious disadvantages in using cellulose xanthate as compared with ethyl xanthate, even if their use was equally efficacious.

Counsel for the plaintiff had several replies to the defendant's criticism that claim 9 was invalid because it covered cellulose xanthate which was useless in froth flotation. Mr. Bennett admitted that as a practical metallurgist and chemist he would, after reading the specification, first try potassium or sodium xanthate. I think any person skilled in the art would do the same thing. He would
30 be led immediately and directly to that kind of xanthate, and no other, as the best substance to use and he would be able to achieve the same best success as the inventor could without any experimentation on his part. The situation is quite different from that in the *Natural Colours. v. Bioschemes* case (*supra*), on which the defendant relied, for there the reader of the specification was given no indication as to which red and green he would have to use to succeed and his success with the invention depended on his finding the right colours himself by his own experiments. Mr. Bennett also admitted that in view of the disadvantages in the use of cel-
40 lulose xanthate, as compared with potassium or sodium xanthate, he would not, as a practical man, use it in froth flotation even if it did work. Under the circumstances, counsel for the plaintiff contended that the claim should not be held invalid. His argument was that cellulose xanthate was a different kind of xanthate from the kind whose use was proposed in the specification; that no practical metallurgist or chemist engaged in froth flotation, having been directed by the specification to use potassium or sodium xanthate

would think of using cellulose xanthate; that it was not necessary to consider whether the word xanthate was wide enough to include cellulose xanthate or not, since no practical person skilled in the art would think that the claim extended to it; and that if there was any doubt whether the word did or did not include cellulose xanthate it should be resolved in favor of the patentee since no person would be led to use it. Counsel relied on *Thermit Ltd. v. Weldite Ltd.*¹. In that case the proposal in the specification was to combine powdered aluminium and the powdered oxide of a metal with the idea
10 that the aluminium would join with the oxygen in the metal and leave the metal. The purpose was to get a metal free from oxygen for welding purposes. Aluminium has a particular affinity for oxygen. It was stated in the specification that all metals or their alloys could be gained in this way. The patent was attacked on the ground that in the case of some metals this process did not work—that the aluminium would not combine with the oxygen in the metal. It was held that since it was known to chemists that there were certain metals with which aluminium would not react at all, that the statement in the specification that all metals or their
20 alloys could be gained by the process should be read as referring only to those metallic compounds which are capable of reduction by aluminium under the conditions described in the specification. It was contended that a similar principle should be applied in the present case, and that the claim should be read as referring only to a xanthate of the kind which a person skilled in the art would regard as practical and adequately described in the specification. This suggested construction of a claim in the light of the knowledge of practical persons skilled in the art is an interesting one, but the weakness of the contention that it should be applied in the present
30 case lies in the fact that at the time of the specification there was no knowledge in the art of the use or efficacy of any xanthate in the froth flotation process. It was the discovery of the value of the use of certain xanthates of a defined class as a new substance in froth flotation that was the very subject matter of the invention. The situation is not similar to that existing in the *Thermit* case (*supra*), where there was chemical knowledge as to what metals would react with aluminium, and it cannot be considered applicable, even if otherwise acceptable as an authority.

The plaintiff has, however, a complete answer to the defendant's
40 contention. It is clear from the correspondence that the inventor was not concerned with cellulose xanthate and was not afraid of infringement through its use. He was anxious, however, about trithiocarbonate. It was for these reasons that the amendments were made. Paragraph 4 was amended, as already noted, to make sure that only such xanthates were included as contained an organic radical of the alkyl type and formed anions and cations in

¹ (1907) 24 R.P.C. 441

solution; and all other xanthates were excluded from consideration. Then by the inclusion of paragraph 7 the inventor protected himself from infringement from the trithiocarbonate side. By his definition of the kind of xanthate whose use he proposed and his exclusion of other xanthates thereby the inventor was entitled to have the word xanthate, which was not a common word, interpreted to mean what he intended it to mean, namely, only the kind of xanthate he had specifically defined in the first two sentences of paragraph 4. The word xanthate is thus used with the meaning
 10 which the inventor has given to it. If it is so read, then cellulose xanthate must be excluded from its ambit on two grounds, as will be shown later.

The construction of a specification, both as to the disclosures and as to the claims, is a matter of law for the Court, and it is well established that there are cases in which the terms in a claim may, and should, be interpreted in the sense in which the inventor has used them in the specification. In such cases, the specification is the dictionary of the claims and serves a purpose similar to that of the definition section of a statute. The basic case for the state-
 20 ment of this principle is *Needham and Kite v. Johnson and Co.*¹. In that case there were two possible constructions of the word "conduit" in one of the claims, but the Court adopted that which would validate the patent, and Lindley, L. J., at page 58, laid down the following rule:

30 "The expression 'conduit' requires explanation, and one must look for it, and see what it does mean. Of course it does mean that which the patentees have said it means. You are not to look into the dictionary to see what 'conduit' means, but you are to look at the specification in order to see the sense in which the patentees have used it."

The same principle was stated by the House of Lords in *British Thomson - Houston Company Ltd. v. Corona Lamp Works Ltd.*². There one of the claims was for an incandescent electric lamp having a filament "of large diameter", and one of the attacks on the patent was that the ambit of the claim had not been sufficiently defined. Sargant J. gave effect to this objection, and the Court of Appeal affirmed his judgment, but it was unanimously reversed by the House of Lords. At page 67, Viscount Haldane, after stating that the specification must be read as a whole, said:

40 "The Claiming Clauses, for example, are not to be taken as standing in complete isolation. For if the Patentee has used in these clauses expressions which he has already adequately interpreted in the body of his specification, he is entitled to refer to the specification as a dictionary in which the meaning of the words he uses has been defined."

¹ (1884) 1 R.P.C. 49

² (1922) 39 R.P.C. 49

The principle has also been recognized in Canada, the leading authority being the decision of the Supreme Court of Canada in *Western Electric Co. v. Baldwin International Radio of Canada*.¹ Duff, C. J., speaking for the Court, there applied the principle “that the specification itself provides the dictionary by which the scope and effect of the terms in the claims is to be ascertained” to one of the claims before the Court. The claim related to the use of a combination of sound amplifiers. It was disclosed in the specification that the combination would work “without transformers” and that the absence of transformers was a characteristic and essential feature of the invention, but there was no statement in the claim that the combination should be “without transformers”. The judgment contains a number of illuminating statements. At page 580, Duff, C. J., agreed with the holding of the president of this Court that the language of this claim must be construed by reference to the disclosure of the nature of the invention in the body of the specification, and also said:

20 “This is especially one of those cases in which it is the document itself which affords the most valuable assistance possible for ascertaining the scope and signification of the phrases employed to limit the claim.”

Later, he found it impossible to separate the claim from a passage in the specification in which it was clear that the discovery was of a combination that would operate “without transformers” and said, at page 583:

30 “I have no doubt whatever that, on a proper construction of the specification as a whole, the combination mentioned in the second claim is the combination described in the passage just quoted; or that the “thermionic” repeaters mentioned in the claim must be taken to be thermionic repeaters having the characteristics ascribed by definition to those which the inventor has succeeded in securing the results which he says are secured by his invention”.

In the result, the claim was held to be limited to a combination that worked “without transformers” even although no such limitation was expressed in the claim itself. The two cases last cited were further referred to by the Supreme Court of Canada in *Smith Incubator Co. v. Seiling*.² There Duff, C. J. said, at page 256:

40 “Lord Haldane’s judgment in *British Thomson-Houston Co. Ltd. v. Corono Lamp Works Ltd.* (*supra*) at page 67, affords an illustration of the manner in which expressions used in the claim may be interpreted by reference to the body of the specification. *Western Electric Co. Inc. v. Baldwin International Radio of Canada* (*supra*) is another case in which the description in the body of the specification of the invention provided a lexicon interpreting the phrases in the claim.”

¹ (1934) S.C.R. 570

² (1937) S.C.R. 251

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and Rinfret J. (all other members of the Court concurring) said, at page 259:

“the rule is that the claims must be regarded as definitely determining the scope of the monopoly having regard to the due and proper construction of the expressions they contain.”

and, at page 260:

10 “the claims must be construed in the light of the rest of the specification; and that is to say, that the specification must be considered in order to assist in comprehending and construing ing—and possibly the special meaning—in which the words or the expressions in the claims are used.”

These authorities were relied upon by counsel for the plaintiff in support of his submission that the word xanthate in claim 9 should be read as meaning only the kind of xanthate which the inventor had defined in paragraph 4 of the specification.

Counsel for the defendant, however, contended that the meaning of the word could not be limited by importing any qualification from the specification and relied upon two cases in support of his contention. The first was the judgment of Davis, J., speaking
20 for the Supreme Court of Canada, in *B.V.D. Company Ltd. v. Canadian Celanese Ltd.*¹. There the validity of claims in a patent in respect of fabrics containing a thermoplastic derivative of cellulose was under attack. They could be saved from invalidity on the ground of anticipation by previous patents only if they could be limited to the use of the cellulose derivative in the form of yarns, filaments and fibres and such limitation appeared in the disclosures of the specification. Yet Davis, J. held that the claims could not be so limited. At page 237, he said:

30 “We are invited to read through the lengthy specification and import into the wide and general language of the claims that which is said to be the real inventive step disclosed. But the claims are unequivocal and complete upon their face. It is not necessary to resort to the context and as a matter of construction the claims to not import the context. In no proper sense can it be said that though the essential feature of the invention is not mentioned in the claims the process defined in the claims necessarily possesses that essential feature. The Court cannot limit the claims by simply saying that the inventor must have meant that which he has described.
40 The claims in fact go far beyond the invention. Upon that ground the patent is invalid.”

It is difficult to read the judgment in this case without feeling that the Court was to some extent influenced by the fact that the inventor had limited his claim in his British and United States patent applications but had omitted any limitation in his Canadian one. The

¹ (1937) S.C.R. 221

other case relied upon was that of the English Court of Appeal in *Molins* and *Molins Machine Co. Ltd. v. Industrial Machinery Co. Ltd.*¹ There a claim was made to a “cigarette making machine of the continuous rod type”. It was contended that the claim ought to be read as being limited to high speed machines in order to give effect to the object of the invention but this contention was rejected. Greene, M. R., as he then was, said, at page 39:

10 “It is sufficient for me to say that in my opinion there is no justification whatever for importing into the claim, drawn as it is in simple and direct language, a limitation extracted either from the language of the body of the specification or from the purpose at which the invention is aiming. It has been laid down over and over again that this method of construing a patent specification is inadmissible.”

These cases do not deny the principle that the specification is the dictionary by which the scope and effect of the terms in the claims is to be ascertained but merely indicate that it is not of general application and ought not to be applied in cases where a claim is expressed in simple and direct language or in wide or general terms
20 whose meaning is plain and unequivocal. Some of the authorities cited by Davis, J. in the *B.V.D. Company* case (*supra*) make this clear, for example, in *Terrell on Patents*, 8th Edition, at page 134 it is said:

“If the words of the claim are plain and unambiguous, it will not be possible to expand or limit their scope by reference to the body of the specification”.

And in *Ingersoll Sergeant Drill Company v. Consolidated Pneumatic Tool Company Ltd.*² Lore Loreburn said:

30 “The idea of allowing a patentee to use perfectly general language in the claim, and subsequently to restrict, or expand, or qualify what is therein expressed by borrowing this or that gloss from other parts of the specification, is wholly inadmissible.”

And in *British Hartford-Fairmont Syndicate, Ltd. v. Jackson Bros. (Knottingley), Ltd.*³ Romer, L. J., said:

40 “But where the construction of a claim when read by itself is plain, it is not in my opinion legitimate to diminish the ambit of the monopoly claimed merely because in the body of the specification the patentee has described his invention in more restricted terms than in the claim itself.”

In my opinion, this case is quite a different kind of case from those relied upon for the defendant. Xanthate is not a common word at all, not is it a word whose meaning is so plain and unequivocal that it necessarily includes cellulose xanthate, for authority

¹ (1938) 55 R.P.C. 31
² (1908) 25 R.P.C. 61 at 83

³ (1943) 49 R.P.C. 495 at 556

can be found in the dictionaries for two meanings of the word, the commonest one of which completely excludes cellulose xanthate and the other only possibly includes it. The New English Dictionary (1928) defines xanthate as "A salt of xanthic (sulphocarbethylic) acid" and xanthic acid as "a complex acid containing sulphur and carbon, also called sulphocarbethylic or ethyldisulphocarbonic acid ($C_2H_5OS_2$), many of whose salts (*xanthates*) are yellow." When this formula is rewritten to show the structural formation of the acid it is $SCSHOC_2H_5$, being that form of dithiocarbonic acid in which the alkyl radical, ethyl, has replaced the hydrogen in the hydroxyl group in which sulphur has not been substituted for the oxygen. This definition is exactly the same as that contained in the first sentence of paragraph 4. If this meaning is given to the word "xanthate" in claim 9, it cannot include cellulose xanthate, for its radical is quite different from the ethyl one. The definition of xanthate in Watts' Dictionary of Chemistry is the same. All that would be found there would be "Xanthates". The salts $RS.CS.OE$ where R is a metal; v. Ethyl Dithiocarbonate" and "xanthic acid v. Ethyl Dithiocarbonate". Then Mono-ethyl Dithiocarbonate is given as "EtO.CS.SH. Xanthogenic acid. Xanthic Xanthic acid". Et is the symbol for ethyl C_2H_5 . This definition would not fit cellulose xanthate. It should be noted, however, that this definition antedates the discovery of cellulose xanthate.

The most recent dictionary meaning is to be found in Webster's New International Dictionary (Second Edition) (1942). It defines xanthate as "a salt or ester of xanthic acid" and one of the meanings of xanthic as "Pertaining to or designating any of a series of thio acids having the general formula $ROCSSH$, obtained in their salts (*xanthates*) by treating alcoholates with carbon disulphide; specif., ethyl-xanthic acid, C_2H_5OCSSH , a colorless unstable oil. Alkali-metal xanthates form yellow precipitates with copper salts". The specific illustration in this definition would also exclude cellulose xanthate but the general formula might include it if R is read as being broad enough to include the cellulose radical and if the word alcoholates is read as including a solution of a metal hydroxide, water and cellulose. The definition might convey such a meaning to a scientific chemist of Dr. Purves' standing who might classify cellulose as an alcohol. It is interesting to note that in the earlier edition of this dictionary, published in 1910, a less extensive meaning of xanthic acid is given, with the same formula as that in the New English Dictionary. Of the chemical dictionaries to which reference was made for the meaning of the word "alkyl", the only one that mentions cellulose xanthate is Hutchinson's Technical and Scientific Encyclopaedia. The others all give a meaning to xanthate which would exclude cellulose xanthate. For example, Hack's Chemical Dictionary (1930) gives the following, namely "xanthate. Xanthogenate. A salt of xanthic acid of the general type, $MO.CS.SEt$,

or MO.CSSR, where M is a metal and R an alkyl radical". This is the same definition as that in the first sentence of paragraph 4 and excludes cellulose xanthate. On the evidence of the experts a wider meaning than the common dictionary one was given which did include cellulose xanthate. The list of xanthates (Exhibit D 61) shows 16 groups of substances called xanthates in 10 of which the radical is not of the alkyl type, one of these being cellulose xanthate. Dr. Purves explained that, while the nomenclatures of chemistry accurately describe compounds according to their constituent elements, they are not as accurate and precise in the matter of description of classifications of substances. The classifications are being revised from time to time as knowledge grows. Indeed, when substances such as potassium ethyl xanthate and cellulose xanthate, which differ so greatly both in chemical composition and in behavior, are classified under the same term, it would not be strange if one were to question the correctness of the classification or the aptness of the term. It should also be remembered that none of the references to the xanthates listed in Exhibit D 61 were to publications in the metallurgical field. And counsel for the defendant strongly urged that there was no common knowledge of xanthates in the froth flotation art at the time of the invention by which the meaning of the word xanthate could be ascertained. Certainly, to borrow an expression from Duff, C. J. in *Western v. Baldwin* (*supra*), at page 582, the word xanthate was not a term of art having "a generally understood signification in the art at the date of the patent". The term is a technical chemistry term, the meaning of which might not be known to the persons to whom the specification is addressed. Under the circumstances, it seems to me that it would be proper and reasonable for a reader unfamiliar with the term to look at the specification to see whether the inventor has used it with a defined special meaning. If he did so he would find a definition of xanthates in paragraph 4 that is in accord with the common dictionary meaning but is more restricted by reason of the requirement of the second sentence in it. In my opinion, this case falls fairly within the proper application of the principle stated by Duff C. J. in *Western v. Baldwin* (*supra*) that "the specification itself provides the dictionary by which the scope and effect of the terms in the claims is to be ascertained". The word xanthate in claim 9 should, therefore, be read in the light of the inventor's definition in paragraph 4 of the kind of xanthate whose use in froth flotation he found useful. That is the only kind of xanthate he had in mind.

Counsel for the defendant is under the onus not only to prove that cellulose xanthate is useless in froth flotation but also to show that it comes within the definition given in paragraph 4. The first part of the onus is discharged, but the second is not. There are two grounds for holding that he has not succeeded in bringing cellulose xanthate within the definition. In the first place, the

evidence as to whether cellulose xanthate can form anions and cations in solution is not free from doubt. Dr. Purves stated that it would form anions and cations if it were soluble, but he was not at all sure whether it was soluble in water. He had no definite knowledge about the matter but admitted that its solubility was not very large. Dr. Purves is an outstanding expert on cellulose and his doubt on the subject is important. Mr. Bennett stated that he had added 1 gram of carefully purified potassium cellulose xanthate to 100 grams of distilled water and that substantially all of the gram was dissolved, from which he concluded that it was soluble in water to the extent of approximately one per cent. Solubility must in this case be looked at from the point of view of the froth flotation process and it is far from clear that this degree of solubility is enough. Moreover, Mr. Bennett admitted that the solution was a colloidal solution and Mr. Higgins stated that in 1923 colloids were not used in froth flotation but were avoided like poison. On cross-examination it was brought out that in some cases sodium silicate was used in froth flotation and that it would form a colloid if used in an acid, but Mr. Higgins said that he did not know a single case where it was used except in an alkaline circuit. I conclude that cellulose xanthate was not soluble in the sense in which a froth flotation metallurgist or chemist would use the term. There is a second ground upon which the defendant completely fails. Cellulose xanthate is a different kind of xanthate from the xanthates whose use in proposed is the specification. The cellulose radical is not an alkyl radical. It is a radical of a carbohydrate, which means that it has oxygen in it, the formula of the radical being $C_6H_7O_2$ taken X times, whereas an alkyl radical is a radical of a saturated hydrocarbon and has no oxygen in it, the formula being C_nH_{2n+1} . Dr. Purves admitted that the cellulose radical was not like methyl or ethyl etc. If the term alkyl radical is to receive the precise meaning given by Mr. Higgins and in the dictionaries referred to, as I think it should, then it is clear beyond any possible dispute that the radical in cellulose xanthate is not an alkyl radical. The result is that cellulose xanthate is completely excluded from the definition of xanthates given in paragraph 4 and consequently from the word xanthate in claim 9.

Moreover, since the onus is on the defendant to bring cellulose xanthate within the ambit of claim 9, I am of the view that if there is any doubt in the matter it should, under the circumstances of the case, be resolved in favour of the patentee. There is support for this opinion in *Natural Colour v. Bioschemes (supra)*. In that case, there is an illuminating discussion on the subject of ambiguity in a specification, and how it should be dealt with in its various aspects. I have already quoted the language of Lord Loreburn and Lord Parker, in connection with the attack on claim 6. In the same case Lord Parmoor points out that the word ambiguity is itself ambiguous and may denote several things. In the first

place, it may denote that the language used is not sufficiently explicit in describing the nature and ambit of the invention to ensure to the public the benefit of the discovery. Secondly, it may denote language that is designedly capable of alternative constructions; this is a studied and affected ambiguity that is inconsistent with the good faith required of a patentee. There is a third sense which is quite different. At page 272, Lord Parmoor says:

10 “In a third sense there is ambiguity which arises from the difficulty of accuracy in expression, there being no suspicion of the want of good faith, and where the language used, if capable of being construed in the sense claimed, would give a sufficient description of a new and useful invention. I apprehend that in this case the same principles apply to the construction of a Patent grant as to other documents which determine public rights or obligations, as distinct from documents which define the contractual relationship between the contracting parties, and that, if, applying these principles, the grant is fairly capable of being construed in the sense claimed, it is a valid grant and supports the claims of the inventor to his
20 monopoly right.

The principle involved in this statement is properly applicable in the present case. The inventor has taken care in the specification to define the kind of xanthate whose use in froth flotation he proposes. It is part of the definition that the xanthate must contain an organic radical of the alkyl type. In the most precise sense of that term, which is consistent with its use in modern chemistry reference books, cellulose xanthate would be excluded from the definition because its radical is not of the alkyl type. It is only by importing into the word alkyl a meaning as wide as that of aliphatic that
30 cellulose xanthate could possibly be included in the inventor's definition. Then, with regard to the meaning of the word xanthate in the claim itself we find that the common dictionary meaning of the word is similar to that which the inventor has used in his definition and will by itself exclude cellulose xanthate and that it is only by giving an extended meaning to the term that cellulose xanthate could be included. Moreover, while the word xanthate cannot be interpreted according to any common knowledge in the art, for the reason that it was a new term in the art, the specification itself is full of references to the kind of xanthate the inventor contemplated.
40 Under the circumstances, I think it would be erroneous to construe the word xanthate in claim 9 as including a useless xanthate, such as cellulose xanthate, and declaring the claim invalid on that account, when the word is fairly capable of another meaning which will exclude cellulose xanthate and support the patent, particularly when such meaning is in accord with the common dictionary meaning of the word and clearly the meaning with which the inventor himself has used the term in the specification. It is,

I think, sound in principle and consistent with authority under the circumstances to resort to the maxim *ut res magis valeat quam pereat* and give effect to the construction that will validate the patent. This, in my opinion, would be fair construction and consistent with a "reasonable and judicial anxiety to support a really useful invention". I, therefore, come to the conclusion that the word xanthate in claim 9 was not intended to include and does not include cellulose xanthate.

Neither does the claim include calcium, copper or cobalt xanthate. There is no evidence that xanthates made with these substances, if they can be made at all, will not work. All that the defendant has to rely on is a statement in Keller's notebook (Exhibit K 12, page 70) to the effect that he had told Mr. Nutter that copper xanthate, cobalt xanthate and calcium xanthate were not useful "as they are insoluble". If these xanthates are insoluble they are excluded from the definition. Mr. Higgins spoke of copper xanthate as one of the most insoluble compounds in chemistry. Cobalt is also one of the heavy metals whose use in making xanthates is excluded. Calcium is an alkaline earth rather than a metal and while there is no evidence that calcium xanthate is insoluble, except the statement by Keller in his notebook, Mr. Higgins says that calcium hydrate is only very slightly soluble in water and it would follow, I think, that the same is true of the xanthate.

There was also some controversy as to ammonium xanthate. In the first place, the evidence is quite clear that xanthate cannot be made with ammonium directly but must be made indirectly by making sodium or potassium xanthate first, then acidifying such xanthate and then neutralizing it with ammonia. Tri-methyl-phenyl ammonium and tetra-methyl-ammonium will make xanthates but these are not the same substances as ammonium. As I read the evidence relating to ammonium I think it quite irrelevant in considering claim 9 because there is no evidence that ammonium xanthate will not work. The defendant relies upon a statement by Keller to Mr. Nutter on August 2, 1923, (Exhibit K 38) that he had made ammonium xanthate and that the substance was not very stable. He gave the formula he used which showed that he tried to make it directly, substituting only NH_4 (ammonia), which is really a radical, for either sodium or potassium. Dr. Purves says that with this substitution the inventor would wind up with the ammonium salt of thiocarbamic acid which is not a xanthate at all. If this substance is not a xanthate there is not a tittle of evidence that ammonium xanthate, which can be made only indirectly, is useless in froth flotation. And even if the substance referred to by Keller is ammonium xanthate, there is proof that it has usefulness for Keller says that it gives a good selection between lead and zinc, although its action on copper is not as favourable as potassium or sodium xanthate. Whichever way it is regarded there is no evidence of its uselessness.

One other objection to claim 9 remains for consideration. It will be remembered that the claim is limited to a non-acid pulp. It was contended by counsel for the defendant that no foundation for such a limitation was laid in the disclosures in view of the statement in paragraph 6 that the pulp may be either acid, alkaline or neutral according to circumstances. It was also contended that in confining his claim to a non-acid pulp, Keller was claiming an invention that really belonged to Lewis who had been allowed to take out a patent for the use of xanthate in an alkaline circuit. We are
10 not concerned with why Lewis was allowed to do this or with the Lewis patent. Moreover, it seems to me that the last sentence in paragraph 6 provides a sufficient basis for enabling the inventor to make a claim in respect of any kind of a circuit. That being so, I see no reason why he should not restrict his claim to a non-acid circuit if he desired to do so. I find no substance in this objection. I find, therefore, that claim 9 in the patent is valid.

Under the circumstances, I find it unnecessary to pass on the validity of claims 7 and 8, or to deal with the contention that if claim 8 is valid then sodium xanthate is the chemical equivalent
20 of potassium xanthate.

In addition to the attacks upon the disclosures and the claims, the validity of the patent was challenged on a number of other grounds. The contention that it was a selection patent and was invalid because it did not satisfy the requirements of such a patent may be dealt with briefly. Terrell on Patents, 8th Edition, refers to selection patents at pp. 81-82. In the case of chemical patents the invention may reside in the selection of a particular substance or group of substances out of a class for a particular purpose. The general principles governing the validity of selection patents were
30 stated in *In re I. G. Farbenindustrie A. G.'s Patents*¹ by Maugham J.

“First, a selection patent to be valid must be based on some substantial advantage to be secured by the use of the selected members. (The phrase will be understood to include the case of a substantial disadvantage to be thereby avoided.) Secondly, the whole of the selected members must possess the advantage in question. Thirdly, the selection must be in respect of a quality of a special character which can fairly be said to be peculiar to the selected group.”

A selection patent appears to presuppose an originating patent.
40 In this case the originating patent was said to be the Perkins United States Patent No. 1,364,304, dated January 4, 1921, said to cover the invention of the use in froth flotation of “certain non-oleaginous solid organic compounds, which themselves have substantially no frothing properties, but which have valuable properties as collecting agents for the mineral”. It was contended that this general des-

¹ (1930) 47 R.P.C. 289 at 322

- cription covered xanthates and the other substances referred to in the patent in suit, such as trithiocarbonate and monothiocarbonates, and that this made the patent in suit stand in relation to the Perkins patent as a selection patent. Then it was contended that the second requirement for the validity of a selection patent, namely, that all the selected members must possess the advantages claimed for them, could not be complied with since xanthates and the other two substances, trithiocarbonate and monothiocarbonates, were of unequal advantage and that, in consequence, the whole patent was invalid.
- 10 In my view, the plain answer is that the patent in suit is not a selection patent in relation to the Perkin's one. A study of the Perkin's patent shows that it would be quite unreasonable to regard the substances referred to in the patent in suit as selected members of the class of substances dealt with in the Perkin's patent. They are not so at all. For example it is said in the Perkin's patent that the collecting agents are substantially insoluble, and are commonly referred to as insoluble, but are soluble to a very small degree, whereas it is of the essence of the xanthates covered by the patent in suit that they should be soluble. Furthermore, the specific compounds referred to in the Perkin's patent, for example, diazo-amino-
- 20 benzene, are not of the same class as the substances covered by the patent in suit. Under the circumstances, it cannot, in my opinion, properly be said that the patent in suit is a selection patent covering the use of members of the class of substances, if there is any, whose use is covered by the Perkin's patent. This contention as to the invalidity of the patent is quite untenable.

- The next attack on the patent was that it was void because there was no authority in the Commissioner of Patents to issue it. The facts on which this argument is based are as follows. On Oc-
- 30 tober 23, 1924, a letter was sent by Messrs. Caron & Caron on behalf of the inventor to the Commissioner of Patents enclosing a petition, oath and specification together with the fee of \$15. The letter also stated that a new specification, which might be amended to correspond with the case filed in the United States, would be substituted as soon as completed. The specification indicated that the invention related to a method for which the inventor had applied for a patent in the United States of America under serial number 670,242 on October 23, 1923. It was, to say the least, a very informal specification and was obviously filed with the intention of getting the
- 40 benefit of a convention filing date. Then, on the following day, October 24, 1924, Messrs. Caron & Caron filed a new petition signed by the inventor and an oath, as well as the specification in duplicate and a third copy of the claims, "to be substituted for those filed yesterday." An assignment from the inventor to the plaintiff and an assignment fee of \$2 was also enclosed, but no further fee of \$15 was paid. The specification filed on October 24, 1924, is the one included in the patent subsequently issued on March 10, 1925.

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Counsel for the defendant took the position that the two applications were in respect of different inventions; that the \$15 fee had been paid and received in respect of the application of October 23; that no fee had been paid in respect of the application of October 24; and that since the statutory requirement of payment of the proper fees had not been complied with, the Commissioner had no jurisdiction to receive or deal with the application or to issue a patent based upon it and that the patent was, therefore, void. The section relied upon is section 43 of the 1923 Act which provides:

10 “43. (1)The following fees shall be payable before an application for any of the purposes herein mentioned shall be received by the Commissioner, that is to say:—

On filing an application for patent \$15.00”

It would be strange if a person could justify what would otherwise be an infringement by such a defence as this. There are two answers. The argument disappears altogether if there were not two different applications. There was certainly no intent to make two applications: the letters from Caron and Caron make this clear. Moreover, the file wrapper (Exhibit D 83) shows that the Commissioner dealt with the matter as though only one application were involved, under one serial number and with one filing date. In my opinion, he did so correctly, for all that happened was that on October 24th, a new set of documents relating to the application made on October 23rd, was filed. The most that can happen, if the papers filed on October 23rd are not complete, is that the plaintiff is not entitled to October 23rd as its filing date, but should have it only as of October 24th. That still leaves one application. As it is, nothing turns on the date and I see no reason for disturbing it. The next answer to the defence is *Fada Radio Limited v. Canadian General Electric Company Limited*¹. There the defendant sought to attack the validity of a re-issued patent because of the absence of an affidavit. There was some questions as to whether it was required, but in any event, Anglin C. J., delivering the judgment of the Supreme Court of Canada, said; at page 523:

40 “we are satisfied that any insufficiency in the material on which the Commissioner acts, the entire absence of an affidavit or any defect in the form or substance of that which is put forward as an affidavit in support of the claim, cannot, in the absence of fraud, . . . avail an alleged infringer as a ground of attack on a new patent issued under s. 24.”
And, at page 524:

“The recital of the patent that the applicant. . . . has complied with the requirements of the *Patent Act*” is conclusive against the appellant in the absence of fraud.”

¹ (1927) S.C.R. 520

And then a number of United States cases are referred to. This statement of principle is applicable in the present case. The patent in suit contains a recital that the petitioner has complied with the requirements of The Patent Act, and it is not open to the defendant in an infringement action to deny the validity of the patent on the ground that the fees payable on the application for it have not been paid, even if such has been the case.

Finally, the defence of anticipation of the invention was set up. Counsel for the defendant contended that there was nothing
 10 in the way of information contained in the specification of the patent in suit which was not contained in a document eight years earlier and made available to the public at that time. The document relied upon is called Bulletin No. 2 (Exhibit G-3), dated August 15, 1915, and compiled by one R. B. Martin under the circumstances hereinafter set forth. It is headed "Preparation of Flotation Reagents" and deals with a number of substances called Kotrix, Mimola, Cinol, Grabanol, Stanol. We are concerned only with that portion which deals with Stanol, reading as follows:

STANOL

20

PREPARATION OF STANOL

Measure out 100 c c of Denatured alcohol

Measure out 10 c c of Carbon sulphides

Weigh out 1 gram of Caustic soda

Shake until dissolved and digest under a reflux condenser until the caustic soda disappeared.

Several Stanols have been made up varying the proportion of carbon disulphides and caustic soda to meet the condition of the ore under treatment. The following proportion will serve as a guidance:"

30	A Stanol	Denatured Alcohol	100 c c
		Carbon Disulphide	10 cc
		Caustic Soda (NaOH)	1 gram
	B Stanol,	Denatured Alcohol	90 c c
		Carbon Disulphide	20 c c
		Caustic Soda (NaOH)	1 gram
	C	Denatured Alcohol	80
		Carbon Disulphide	30
		Caustic Soda	1 gram
40	D	Denatured Alcohol	100 c c
		Carbon Disulphide	10 c c
		Caustic Soda	5 grams

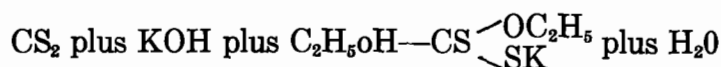
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E	Denatured Alcohol	90 c c
	Carbon Disulphide	20 c c
	Caustic Soda	5 grams
F	Denatured Alcohol	100 c c
	Carbon Disulphide	10 c c
	Resin	10 grams
	Caustic Soda	1 gram
10	Denatured Alcohol	90 c c
	Carbon Disulphide	20 c c
	Caustic Soda	5 grams
	Resin	20 grams

Boil under reflux condenser until the resin is saponified. Dilute with 500 c c of water.

These formulas illustrate that in preparing Stanol variation can be practiced by the addition of resin, the alcohol can be diminished and the caustic soda should always be governed as to only have present sufficient quantity to produce the reaction sought for. With some ores an excess of caustic soda to neutralize the acidity seems to impart specific results over the neutral Stanol.

20 The theory of forming flotation compounds from alcoholic caustic Potash and carbon disulphide may be expressed as follows:



Potassium Ethyl—Xanthate

The equation illustrates that if we digest under reflux condenser

Carbon Disulphide	57.6%
Caustic Potash	26.8
Denatured Alcohol	15.6

30

100.0

we should upon the completion of the reaction obtained crystalline Potassium xanthate which, however, is soluble in alcohol and can be employed at any strength to effect flotation of copper salts.

Potassium Xanthate is not a frothing agent and therefore it must be mixed with some appropriate agents that will give a voluminous froth. Alcohol, Resin and pine oil seem to be the most suitable agents for this purpose.

40 It might be conjectured that some arrangements of combining Potassium xanthate with alcohol and Resin and then mixing this compound with mineral oil, would be the initial step of using such a commercial mixture for the flotation of copper carbonates.

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A substituted product may be formed by using caustic soda.

Carbon Disulphide	70.8%
Caustic Soda	10.0
Denatured Alcohol	19.2
	100.0

The soda compound does not seem to produce the correspondent good results as is produced with the potassium xanthate. The high cost of potassium salt will prevent this compound from entering
 10 as a competitor of the much cheaper sodium salt.

All the experiments conducted so far have been by the use of sodium hydrate and denatured alcohol.

A very good compound is made up for alkali ores by using 20% sodium Ethyl xanthate and 80% Denatured Alcohol." At the time of Bulletin No. 2 Martin was in the employment of Minerals Separation American Syndicate (1913) Limited, the predecessor of the plaintiff, as a metallurgist and engineer under an employment agreement dated March 6, 1915, one of the terms of which was
 20 made by him during his employment relating to the treatment of ores or tailings, flotation concentration or reagents. On the same date Martin also entered into an option agreement with Minerals Separation, Limited, a British Company related to the plaintiff's predecessor, whereby he agreed to disclose all inventions theretofore made by him relating to the treatment of ores or tailings or flotation concentration or reagents to such company for its benefit and to Mr. H. D. Williams for patent application purposes, and to give the company an exclusive option to purchase such inventions for \$5,000. The agreement also provided that if in the company's
 30 opinion any of his reagents could be successfully and profitably manufactured as a patented flotation oil or reagent the Company would do its best to exploit its manufacture and pay him 25% of the net profits therefrom. Bulletin No. 2 was one of a number of reports made by Martin both in the course of his employment and pursuant to the option agreement.

Counsel's attack on the patent based on Bulletin No. 2 is a twofold one, namely, that before Keller made the invention for which the patent in suit was issued it was known by Martin in 1915, and that the Bulletin was a publication that anticipated the invention in that it had been disclosed or used in such a manner that
 40 it had become available to the public. He argued that he was not barred from this defence by anything contained in section 61. (1) (a) of The Patent Act, 1935, which provides as follows:

"61. (1) No patent or claim in a patent shall be declared invalid or void on the ground that, before the invention therein defined was made by the inventor by whom the patent

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was applied for it had already been known or used by some other inventor, unless it is established either that,

- (a) before the date of the application for the patent such other inventor had disclosed or used the invention in such manner that it had become available to the public;” or that

This was introduced as section 37A of the Patent Act, R.S.C. 1927, chap. 150 by An Act to amend the Patent Act, Statutes of Canada, 1932, chap. 21, section 4. Counsel argued that section 61. (1) (a) could not be retroactive in effect and that, in any event, there had
 10 been a disclosure of the invention such as to meet the conditions of the section. It was agreed that a disclosure made to persons under a duty of confidence is not a disclosure at all, but it was argued that when Martin delivered the bulletin to his employer and to the British Company he made a disclosure to persons who were under no obligation of confidence and that such disclosure made the contents of the bulletin available to the public. Counsel contended that this put these companies in the dilemma of being
 20 in one or other of two relations so far as Martin was concerned, namely, either they were in the same position as the inventor or they were in the position of being the public. Consequently, when the Keller invention was used at Anaconda in 1923, the plaintiff, as the successor of Martin’s employer, could not say that such use was that of an invention made only in 1923 by Keller, when they knew of it as an invention made by Martin in 1915. Accordingly, so the involved argument goes, either Martin made his invention available to the public in 1915 when he disclosed Bulletin No. 2 to his employer and the British Company or, alternatively, the
 30 plaintiff made it available to the public in 1923 by its use at Anaconda. It is clear that counsel, although relying only on Bulletin No. 2 and its disclosure to the persons receiving it, does not abandon the defence alleged in the statement of defence that Martin was a prior inventor, for the defence of anticipation based on Bulletin No. 2 depends upon the assumption that when Martin compiled it in 1915 he knew the invention covered by the patent in suit. Whether he did so cannot be determined by a consideration of Bulletin No. 2 by itself. It is a matter of inference to be drawn not only from the document but also from the facts and circumstances leading up to and surrounding its compilation. The onus of proof of the fact
 40 of Martin’s prior knowledge of the invention lies on the defendant.

The evidence of Mr. Higgins is important. He first met Martin late in February or early in March, 1915, at the office of the British Company in New York. He was its chief metallurgist and had instructions to examine Martin’s inventions to see whether they had any value. Soon afterwards he and Mr. H. D. Williams, the patent attorney for the British Company and the plaintiff’s predecessor, had a further meeting with Martin at which Martin dis-

closed all the inventions later referred to in Bulletin No. 2 except grabanol. At that time the substance later named stanol was called natrola or nitrola. Both Mr. Williams and Mr. Higgins took notes of the disclosures made. It was important that Martin should demonstrate his inventions. In order that he should be able to do so the British Company made a laboratory available to him and supplied him with the apparatus and chemicals he requested. In the laboratory there were the necessary testing machines for flotation tests and in the basement the necessary apparatus to crush

10 ore. Martin also had chemistry reference books at his disposal. Subsequently, early in June 1915, Mr. Higgins discussed with Martin certain draft specifications for certain substances, including stanol, which Martin had prepared for patent application purposes. Martin had been making tests with his various substances including stanol. Mr. Higgins and his assistant, Mr. Waling, supervised the making of these tests. Mr. Higgins saw how Martin made stanol. This was about the end of July or the middle of August. Moreover, he saw Martin make tests with stanol and he made some tests himself. When asked what was the result of these tests Mr. Higgins' reply was "They were perfectly negative. Neither Martin nor

20 Waling nor I found the least use in stanol." Some use was found in kotrix, which was a sulphidizing agent, and in reconstructed oil, called mimola, which was a mineral frothing agent. Bulletin No. 2 was received directly from Martin by Mr. Higgins on September 14, 1915. Mr. Higgins stated that there were so many formulae in the Bulletin that he requested Martin to put the best of each one into a book; this was subsequently done and the book handed to Mr. Higgins on October 21, 1915. On September 28, 1915, Mr. Higgins received from Martin Bulletin No. 3 in which no mention

30 of stanol was made. He then instructed Martin to furnish a further report and to make a test on Anaconda Copper Company's ore. Then he received Bulletin No. 4 from Martin in which Martin stated that stanol was not satisfactory for the Anaconda ore. This was the last Mr. Higgins heard of stanol until sometime in 1923, for although Martin compiled 88 bulletins altogether the last one in which he mentioned stanol was Bulletin No. 4. Patent applications were filed for kotrix and re-constructed oils, but not for stanol. Mr. Higgins stated that patents were secured for everything which Martin and he regarded as of any value. Stanol was never patented.

40 The evidence given by Mr. Higgins, together with the documents, including Bulletin No. 2, prepared by Martin is, I think, quite relevant to the issue whether Martin on August 15, 1915, knew the invention covered by the patent in suit, and is, in my judgment, against the contention that he did so. The very first disclosure by Martin to Mr. Higgins and Mr. Williams of the substance called natrola or nitrola, which was the same as stanol, showed that he was thinking of something different from the use of xanthate.

He was looking for new flotation reagents that would be patentable and entitle him to the chance of a share of the profits from their exploitation, which would not happen in the case of a known substance such as xanthate which would not be patentable. Then we come to the draft specifications to which Mr. Higgins referred. These were sent with a covering letter, dated March 19, 1915, to Dr. S. Gregory, the managing director of both the plaintiff's predecessor and the British company and referred to Mr. Higgins. The reference is as follows

10 “*Stanol*, an alkaline organic sulphide containing a great many complex organic compounds produced from organic sulphides and an alkali. This solution should be of vital importance to the flotation industry, especially so should your Company decide to manufacture it as a patent flotation agent.”

This was a description of something other than xanthate, for xanthate is not a complex compound at all and being already known could not be patented as a flotation agent. The draft specifications were discussed with Martin by Mr. Higgins and carry the latter's notes made at the time. The specification relating to stanol is quite
20 inconsistent with the suggestion that Martin had the use of xanthate in mind. Of this fact there are many indications. Martin describes stanol as an “organic alkali sulphide salt”. Mr. Higgins' note of the formula after his discussion with Martin is “ $(C_2H_5)_2S$ ”, which is ethyl sulphide a substance not related to xanthate and Mr. Higgins was not sure that it was a compound. Then reference is made to the substance

30 “obtained by the action of an alkali upon the numerous organic compounds, such as the hydrocarbon and carbohydrates, including the more specific groups of alcohols, carbon disulphide, carbon tetrachloride, and other carbon compounds, such as methanes, carbon monoxide, etc. in the presence of an organic sulphide, or an alkali sulphide.”

Xanthate cannot be made with such substances as carbon tetrachloride, methanes, or carbon monoxide. Later Martin says that
“variation may be practiced in the process of manufacturing the alkali organic sulphide by varying and selecting the raw organic material.”

That is not true of xanthate whose composition is fixed by nonvariable chemical laws. Then there is another very significant statement,
40 namely,

“The presence of water and other impurities are essential in promoting the formation of the desired compound. The reaction that takes place is complicated and many compounds that may be classed as impurities are formed, of which the mercaptans, alkynes, and esters, are hereby classed as beneficial to the reaction and necessary in the application of compound-

ing the alkali organic sulphide and the ultimate employment of this agent in promoting flotation.”

This statement is proof that Martin did not know the use of xanthate as Keller did. Xanthate is not a complex compound but the result of a very simple chemical reaction. And, far from being essential in the formation of xanthate, the presence of water and other impurities is quite the reverse. The Martin went on to say,

10 “In preparing the alkali organic sulphide, I prefer the employment of sodium hydrate, as the alkali, and alcohol and water as the organic base, and carbon disulphide as the organic sulphide, though in practice it is feasible to employ other analygeous combination to effect the same results.”

The most that can be said for this statement is tnat some of the ingredients of stanol also enter into the composition of xanthate, but this does not mean that stanol was xanthate and there is no suggestion that Martin knew the value of the use of xanthate as such. The claims in the draft specification also suggest something other than the use of xanthate for some of them assert that stanol replaces oil in flotations or is used in preference to oil. That
20 could not be said of xanthate. Mr. Higgins stated that he could not be said of xanthate. Mr. Higgins stated that he could not understand most of the specification and suggested to Martin that it did not disclose what he had to sell and that he had better make some and show how the substance worked. Mr. Higgins said that after that he saw Martin work in the laboratory up to about the end of July or the middle of August. He described the way in which Martin made stanol as follows: first he put in the alcohol and then the carbon disulphide and shook them up; then he put in the caustic soda and water; this was all in a flask that was put on a wire gauze
30 over a bunsen burner; the flask was fitted with a reflux condenser and the substance was thoroughly boiled, sometimes for as long a period as three days. The mixture was then brown muddy liquid. If Martin had known the use of xanthate he would not have made it in such a manner, for he would have known not only that water should not be added but also that prolonged heating would cause decomposition. Whatever may be the cause one thing is certain, namely, that neither Martin nor Mr. Higgins nor his assistant Waling found the least use in stanol. There is no contradiction of this evidence. It seems to me that up to the date of Bulletin No. 2
40 the evidence is conclusive against the defendant's contention that Martin knew the value of the use of xanthate in froth flotation.

Then came Bulletin No. 2, which counsel for the appellant relies upon as proof that Martin knew the invention covered by the patent in suit. The document as a whole is inconsistent with any such contention and its contents require comment. The first formula would be a very strange one if Martin were thinking of xanthate

as his active reagent for the ingredients used would produce very little xanthate. This is Stanol A which could produce only 3.9% xanthate, the balance being mostly alcohol and some carbon disulphide. Then the instructions are given "shake until dissolved and digest under a reflux condenser until the caustic soda has disappeared" These are indefinite, but there is nothing to indicate that Martin had a different method in mind from that which he used in the manner described by Mr. Higgins. Then the statement is made that "several stanols have been made up varying the

10 proportion of carbon disulphides and caustic soda to meet the condition of the ore under treatment." Martin could not have been thinking of xanthate, for the proportion of the ingredients entering into its composition is not variable. Then 7 different formulae for stanol are given with varying compositions, Stanol D being the one that will produce the most xanthate, approximately 19%. These are all called stanol which is not xanthate; nowhere is there any indication that xanthate is the product being sought. Then Martin suggests that the stanols should be diluted with water, which is quite inconsistent with his really knowing the value of the

20 use of xanthate. Then come the references to potassium ethyl xanthate in the bulletin. Counsel argues that these show that Martin really proposes the use of xanthate as his active reagent. This is quite inaccurate. He does no such thing. Nowhere in Bulletin No. 2 does Martin propose the use of xanthate. The only reagent whose use he proposes is stanol, compounded in different proportions of ingredients and then he expresses the theory of forming his compounds from alcoholic caustic potash and carbon disulphide in terms of a chemical formula which represents potassium ethyl xanthate, and the, after setting out certain proportions, he

30 states that "we should upon the completion of the reaction obtained crystalline Potassium xanthate which, however, is soluble in alcohol and can be employed at any strength to effect flotation of copper salts". I think it is clear that Martin is here travelling in the field of conjecture. He expresses a theory in terms of a chemistry formula which means potassium ethyl xanthate together with an expectation of potassium ethyl xanthate being effective in flotation for which there is no foundation of experimentation or knowledge at all, but is founded solely on speculation and conjecture. No crystalline potassium xanthate was ever obtained. Indeed, there is an ad-

40 mission that there were no experiments at all with caustic potash. And there is no evidence of any tests or experiments with any xanthate. The reference to the effectiveness of potassium xanthate is pure speculation. So far as any tests with stanol go they are failures. Moreover, the formula of the ingredients is wrong. The correct formula as per exhibit P 55, is carbon disulphide 42.7% instead of 57.6%, caustic potash 31.5% instead of 26.8% and denatured alcohol 25.8% instead of 15.6%. This is, I think, evidence

that Martin was not thinking of xanthate. The proportion suggested where caustic soda is used instead of caustic potash is even more out of line. Then with regard to the soda compound he says that it “does not seem to produce the corresponding good results as is produced with the potassium xanthate.” How could he know whether this is so since no experiments were conducted with the latter? Nowhere in the document is there any statement or suggestion that xanthate is his reagent or any direction that xanthate should be used. Martin is thinking of stanol and the most that
 10 can be said for Bulletin No. 2 is that it contains a statement that in theory there is some xanthate in stanol and a speculation that it should be effective in flotations. But speculation and conjecture are not knowledge. I can find no justification in Bulletin No. 2 for saying that Martin knew the invention that Keller later made.

Furthermore, what happened subsequently bears out that Keller was not thinking of xanthate and had no knowledge of its value in froth flotation. Mr. Higgins, knowing that stanol was a failure and seeing so many formulae in Bulletin No. 2, instructed Martin to put the best of them in a book. This Martin did and in
 20 Exhibit G 4 the following entry is made under the heading Stanol: “Denatured alcohol 100 c c., Carbon Disulphide 100 c c., Caustic Soda (NaOH) 100 grs. Digest under reflux condenser”. This is further proof that Martin had no thought of xanthate, for these are not the proper proportions; not only is there an excess of alcohol, but there is also a great excess of caustic soda, which would tend to cause the decomposition of any xanthate produced. Moreover, the heating of the mixture would also hasten the decomposition. If Martin had known the value of xanthate, it is inconceivable that he would have put this down as the best of his formulae. Coupled
 30 with this fact is his further statement in Bulletin No. 4 that stanol was not satisfactory with the Anaconda ore. This was the very kind of ore with which Keller made such a success with xanthate as to create a furore at Anaconda. Then after the admission of this failure in Bulletin No. 4 there is no further record of stanol and no suggestion that Martin was thinking of xanthate was made until after Keller discovered its value in 1923. It is established beyond dispute that Keller knew nothing of Martin’s work or of
 40 Bulletin No. 2 when in 1923 he was looking for a sulphidizing agent for oxidized ores and fell upon his important invention of the use of xanthate. Even if it could be said that Martin had made experiments and had failed and that he had abandoned his experiment, it has been long settled that unsuccessful experimentation is not prior invention. In *Calloway v. Bleaden*¹ Tindal C. J. said:

“a mere experiment, or a mere course of experiments, for the purpose of producing a result which is not brought to its completion, but begins and ends in uncertain experiments

¹ (1839) 1 Webster’s P.C. 520 at 525

—that is not such an invention as should prevent another person, who is more successful, or pursues with greater industry the claim in the line that has been laid out for him by the preceding inventor, from availing himself of it, and having the benefit of it;”

And even if it could be said that Martin had some idea of the use of xanthate in froth flotation that would not be enough to make him a prior inventor, for it was said in *The Permutit Company v. Borrowman*¹ by Viscount Cave, L. C.:

10 “It is not enough for a man to say that an idea floated through his brain; he must at least have reduced it to a definite and practical shape before he can be said to have invented a process.”

On the evidence before me I have no hesitation in finding that the defendant has failed to discharge the onus of proving that when Martin compiled Bulletin No. 2 he knew the invention covered by the patent in suit.

And I find no assistance for the defendant in the tests carried on by Mr. Bennett at Noranda in 1944. He used Stanol D prepared in two ways, namely, one by simply mixing the ingredients
20 shown in Bulletin No. 2 and the other by boiling them for only 15 minutes. He then ran tests with sodium ethyl xanthate and Stanol D. The amounts used are significant. Of sodium ethyl xanthate he used only .08 pounds per ton of pulp, but of Stanol D he used .45 pounds. It is clear that he worked from the amount of xanthate that was necessary to success and then used the necessary amount of Stanol D that would produce the same amount of xanthate. Stanol D would yield 18.74% of xanthate while Stanol A would yield only 3.91%. It follows that if Mr. Bennett had used Stanol A he would
30 have had to use 2.25 pounds per ton. He, therefore, used the Stanol that had the largest potential xanthate content. Under these circumstances his evidence was that Stanol D gives as good results in flotation as sodium ethyl xanthate. But this must be considered also in the light of the fact that to accomplish equal results almost 6 times as much Stanol D would be required as would be needed in the case of sodium ethyl xanthate. This is an important cost factor and is important in respect of an invention of an improvement in a process by the reduction of cost. At first sight it seems strange that Stanol D worked in the tests as made by Mr. Bennett, in 1944
40 but failed to show any usefulness in the tests made by Martin in 1915. The answer is plain. The tests were made under different circumstances. Mr. Bennett did not have only Bulletin No. 2 to work with. He had the 1944 knowledge of the use of xanthate derived from the Keller specification. He knew how much xanthate was required for success and worked from that as a starting point,

¹ (1926) 43 R.P.C. 356 at 359

using whatever quantity of Stanol D was necessary to give him the same amount of xanthate. It may be assumed, I think, that if he had used less than .45 pounds of Stanol D per ton the results would not have been as satisfactory. Without the knowledge of the use of xanthate he could not have known from Bulletin No. 2 what amount of stanol was necessary for success for it gave no information on the subject. If Martin had had the same knowledge of the use of xanthate in 1915 as Mr. Bennett had in 1944 he would not have failed in his tests with stanol. The fact that he did fail
10 and that Mr. Bennett succeeded is, in my opinion, clear evidence that Martin did not have the knowledge of the use of xanthate that Mr. Bennett had, namely, the use that was the subject matter of the Keller invention. The suggestion implied in the defendant's suggestion that stanol is the same thing as xanthate is absurd.

The finding that when Martin compiled Bulletin No. 2 he did not know the invention covered by the patent in suit really disposes of the defendant's plea of anticipation. Counsel for the defendant relied upon Bulletin No. 2 as having shown that Martin had the same information in 1915 as Keller had in 1923 and that its disclosure to the British Company and the plaintiff's predecessor was a disclosure to the public of as good information as is contained in the specification of the patent in suit. There was also reliance upon an alleged public use of the invention at Anaconda in 1923. There are several answers to the appellant's argument on this branch. Bulletin No. 2 was received by Mr. Higgins directly from Martin at a time when Mr. Higgins was acting for the British Company to see whether Martin had any inventions worth purchasing. If there was any invention the disclosure to Mr. Higgins was in confidence and both he and his principal were under a duty of confidence with regard to it and it cannot be considered as a disclosure
20 to the public. Thereafter, there was no disclosure by the alleged inventor. Then when the inventions were paid for in 1917 there was no further disclosure by any one for Bulletin No. 2 was never again referred to. The public use at Anaconda in 1923 can have importance only if Martin made the same invention as Keller did. If, as has been found, Martin was not a prior inventor, then the public use at Anaconda in 1923 was of an invention quite different from Martin's and has no bearing on the present question.

Moreover, even if it were assumed that Martin knew the Keller
40 invention, it does not follow that Bulletin No. 2 can be regarded as anticipation of the Keller invention. The only possible resemblance to anticipation in Bulletin No. 2 consists in the references to xanthate and a resemblance can be seen only if the document is looked at in the light of the knowledge imparted by the Keller patent. That is not anticipation. It might be said that there was a clue to the Keller invention but this is not enough. In order that a document should anticipate an invention, it must give the

same information as the specification in the patent covering the invention. The test of anticipation was carefully discussed by the Judicial Committee of the Privy Council in *Pope Appliance Corporation v. Spanish River Pulp and Paper Mills Ltd.*¹ There Lord Dunedin, at page 54, referred to the statement of Lord Moulton in *British Ore Concentration Syndicate v. Minerals Separation*²;

10 “It cannot be too carefully kept in mind in patent law that, in order to render a document a prior publication of an invention, it must be shown that it publishes to the world the whole invention, i.e., all that is material to instruct the public how to put the invention in practice. It is not enough that there should be suggestions which, taken with suggestions derived from other and independent documents, may be shown to foreshadow the inventions or important steps in it.”

And, at page 52, after referring to the cases he expressed the test of anticipation as follows:

20 “Would a man who was grappling with the problem solved by the Patent attacked, and having no knowledge of that Patent, if he had had the alleged anticipation in his hand, have said, “That gives me what I wish”?”

It is obvious that Bulletin No. 2 does not begin to meet these tests. No one having only Bulletin No. 2 could put the Keller invention of the use of xanthate in froth flotation into practice. It gave no instructions as to the amount of stanol to use and it is obvious from Mr. Bennett's evidence that the amount required would depend upon which stanol was used. Then the instructions as to its preparation namely “shake until dissolved and digest under a reflux condenser until the caustic soda has disappeared” are indefinite. Mr. Bennett found ambiguity in the words “and digest”; then, 30 acting upon the assumption that “digest” meant boil, he boiled the ingredients, but only for fifteen minutes, and not for three days as Martin did. The conclusion is, in my opinion, inescapable that if any one had had only Bulletin No. 2 he would have met with the same failure as Martin did. I have no hesitation in finding that there was no anticipation of the invention in Bulletin No. 2. Counsel for the defendant admitted that it was not a printed publication within the meaning of section 7 of the Act. This means that it could have importance only if it came within section 61 (1) (a), assuming its retroactivity. This it cannot do for the conditions 40 of the section, namely, of prior invention, of disclosure by the inventor, and of disclosure in such manner that the invention had become available to the public, have not been satisfied. Under the circumstances it is not necessary to consider whether section 61 (1) (a) of the 1935 Act is retroactive or not. The defence of anticipation of the invention, in my opinion, fails completely.

¹ (1929) 46 R.P.C. 23

² (1909) 26 R.P.C. at 147

In its statement of defence the defendant alleged that the plaintiff was not entitled to the relief claimed because of its laches and acquiescence in that it postponed the bringing of this action and nineteen other infringement actions until a few days before the expiry of the patent in order to avoid the risk of provoking an attack on its validity and the loss of benefits that would result from a successful attack. The facts may be stated briefly. In August, 1930, the plaintiff requested the defendant to sign a license agreement for the use of amyl xanthate which the defendant had
 10 been using at its mill at Noranda and, subsequently, there was further correspondence between the parties on the subject. Then on February 12, 1936, Mr. J. Y. Murdock, the defendant's president, notified Mr. J. A. Boyd, the plaintiff's representative, to the effect that he had concluded that the defendant was not liable for and should not pay any royalty to the plaintiff. Then there was further correspondence without any change of result. The defendant persisted in its refusal to pay royalty and no steps were taken by the plaintiff to enforce payment until this action was taken some 10 days before the expiry of the patent. Dr. S. Gregory, the plaintiff's
 20 president, on his examination for discovery, explained that he had recommended to the board of directors that no action should be taken until the patent expired or was about to expire and that he had given two reasons for this, namely, that the tonnage the plaintiff would gain by fighting with Mr. Murdock's corporation, the defendant, was a small fraction of what was coming from other directions; and that he thought a fight with the defendant would disturb the relationship with the licensees that were paying royalties. Acting on his advice the plaintiff refrained from taking action. It was this inaction that was relied upon as laches and acquiescence.
 30 But counsel for the defendant admitted that he could not, in this Court, maintain this defence in view of the statement by Fletcher Moulton, L. J. in *Vidal Dyes Syndicate v. Levinstein Ltd.*¹ that it is settled law that a patentee need not attempt to stop an infringement when he first learns of it and that his right of action against an infringer is not affected by the circumstance that he did not take action until just before the expiry of the patent. While counsel admitted that he could not urge the defence of laches and acquiescence in this Court he did not abandon it. I adopt the statement of Fletcher Moulton, L. J. as applicable in the present case. The
 40 plaintiff's delay in bringing action was not laches or acquiescence on its part.

This leaves only the question of infringement. If the plaintiff's patent is valid there is no doubt that it was infringed by the defendant. The process used by the defendant at Noranda is described in Exhibit M 1; there is no difference between it and that disclosed in the Keller specification. Then Exhibit M 2 sets out

¹ (1912) 29 R.P.C. 245 at 259 GJ.

Reasons for Judgment—Thorson, P.

the list of reagents used by the defendant in its four circuits. It shows that during the years for which the plaintiff may claim damages, the defendant used potassium amyl xanthate in its copper circuit, sodium ethyl xanthate in its pyrite flotation circuit, potassium amyl xanthate in its pyrite regrinding circuit, and also during the years 1940, 1941 and 1942 potassium hexyl xanthate in the same circuit, and potassium amyl xanthate in its pyrrhotite retreatment circuit. The type of circuit used by the defendant was an alkaline one.

- 10 Under the circumstances there will be judgment for the plaintiff declaring that claim 9 is valid, that it has been infringed by the defendant and that the plaintiff is entitled to damages in such amount as may be found on an enquiry as to damages by the Registrar if the parties cannot agree as to the amount. The plaintiff is also entitled to costs.

Judgment accordingly,

President.

Ottawa.
May 28, 1947.

FORMAL JUDGMENT

IN THE EXCHEQUER COURT OF CANADA
THE 28TH DAY OF MAY, 1947.

PRESENT: THE HONOURABLE PRESIDENT

THIS ACTION having come on for trial at the City of Ottawa before this Court on the 13th, 14th, 15th, 16th, 17th, 20th, 21st, 22nd, 23rd, 24th, 27th, 28th, 29th, and 30th days of November and the 1st and 2nd days of December, A.D. 1944, in the presence of counsel for the plaintiff and the defendant, upon hearing read the pleadings herein and upon hearing the evidence adduced and
10 what was alleged by counsel aforesaid, this court was pleased to direct that this action should stand over for judgment and the same coming on this day for judgment,

THIS COURT DOTH ORDER AND ADJUDGE that Claim 9 of the Letters Patent Number 247,576, bearing date the 10th of March, 1925, in the pleadings mentioned, is valid and has been infringed by the defendant;

AND THIS COURT DOTH FURTHER DECLARE that the plaintiff is entitled to recover from the defendant the damages sustained by the plaintiff by reason of the infringement of Claim 9
20 of the Letters Patent aforesaid;

AND THIS COURT DOTH ORDER that the defendant do within thirty (30) days after the service of this judgment file with the Registrar of this Court statements duly verified on oath showing statements, records and accounts pertinent and relative to the damages referred to herein;

AND THIS COURT DOTH FURTHER ORDER that enquiry be made by the Registrar of this Court as to the damages sustained by the plaintiffs;

AND THIS COURT DOTH FURTHER ORDER AND
30 ADJUDGE that the defendant do pay to the plaintiff its costs of the action forthwith after taxation thereof.

40

By the Court,

(Sgd.) H. R. L. HENRY,
Registrar.

Consent as to Contents of Case

IN THE EXCHEQUER COURT OF CANADA

BETWEEN:

MINERALS SEPARATION NORTH AMERICAN
CORPORATION,

Plaintiff;

— AND —

NORANDA MINES, LIMITED,

Defendant.

CONSENT AS TO CONTENTS OF CASE

10 THE parties hereto consent that the Case in Appeal from the judgment of the Exchequer Court of Canada, dated May 28th, 1947, should comprise the following documents:—

1. Statement of case in the form attached.
 2. Notice of appeal.
 3. Pleadings:
 - (a) Statement of claim
 - (b) Particulars of breaches
 - (c) Demand for particulars
 - (d) Answer to demand for particulars
 - 20 (e) Statement by plaintiff of date relied on for making patented invention
 - (f) Statement of Defence
 - (g) Particulars of objection as amended.
 4. Transcript of proceedings at the trial (not including the argument).
 5. Evidence on commission taken as read at the trial (to appear immediately after page 238, line 29, of the transcript of proceedings at the trial), followed by para. 2 of letter of March 11, 1944, from R. S. Smart to Ewart, Scott, Kelley, Scott & Howard, and reply of March 18, 1944, from Ewart, Scott, Kelley, Scott & Howard to R. S. Smart.
- 30

Consent as to Contents of Case

6. Exhibits produced and filed at the trial with the exception of the following:
 - Exhibits M1, M3, M5, M6, M7, M8 and M9
 - Exhibits W15, W19, W20, W21, W22 and W22a
 - Exhibits K23, Ka
 - The diagram on Page 17 of Exhibit G4
 - Exhibit K10 apart from the reference therein to the Sayre Flotation Patent.
7. Reasons for judgment of Thorson, P. dated May 28th, 1947.
- 10 8. Formal judgment of the Exchequer Court of Canada dated May 28th, 1947.
9. This consent.
10. Orders with respect to the printing of certain exhibits.
11. Solicitor's certificate.
12. Registrar's certificate.

DATED at Ottawa, Canada, this 23rd day of August, 1948.

EWART, SCOTT, KELLEY & HOWARD,
Solicitors for the Plaintiff.

SMART & BIGGAR,
Solicitors for the Defendant.

Order dispensing with printing

ORDER OF SUPREME COURT DISPENSING
WITH PRINTING

BEFORE: THE REGISTRAR IN CHAMBERS.

FRIDAY, THE 25TH DAY OF JUNE, 1948.

UPON application of counsel for the appellant, upon hearing read the agreement as to the contents of the Case on Appeal signed by the solicitors for the parties hereto, and upon hearing what was alleged by counsel aforesaid;

IT IS ORDERED that the printing of the following exhibits
10 be dispensed with, said exhibits being physical in character and incapable of reproduction, namely:

Exhibits P51, P52 and P53.

IT IS FURTHER ORDERED that the printing of the following exhibits be dispensed with on condition that the appellant provide twelve copies thereof for the use of the Court and of counsel, namely:

Exhibits M2

Exhibits K1, K21, K22, K42, K46, KB, KC

Exhibits P54, P55, P60

20 Exhibits D57, D58, D86, D87.

IT IS FURTHER ORDERED that the printing of the following exhibits consisting of laboratory note-books be dispensed with on condition that the appellant provide twelve copies for the use of Court and of counsel of any pages thereof which were referred to in the proceedings at the trial, or to which it is proposed to refer in the appeal, namely:

Exhibits K12, K14, K15, K16, K19 and K20

Exhibits P103

Exhibits D90.

30 AND IT IS FURTHER ORDERED that the costs of and incidental to this application be costs in the appeal.

PAUL LEDUC,
Registrar.

Order of Supreme Court dispensing with printing of exhibit P104
Solicitor's Certificate

ORDER OF SUPREME COURT DISPENSING
WITH PRINTING OF EXHIBIT P104

BEFORE: THE REGISTRAR IN CHAMBERS.

MONDAY, THE 23RD DAY OF AUGUST, 1948.

UPON application of counsel for the appellant, upon hearing read the agreement as to the contents of the Case on Appeal signed by the solicitors for the parties hereto, upon hearing read the order made by the Registrar dispensing with the printing of certain exhibits dated Friday, the 25th day of June, 1948, and upon
10 hearing what was alleged by counsel aforesaid;

IT IS ORDERED that the printing of Exhibit P104 be dispensed with on condition that the appellant provide twelve copies of each page thereof upon which freehand notes or interlinings appear for the use of Court and of counsel;

AND IT IS FURTHER ORDERED that the costs of and incidental to this application be costs in the appeal.

PAUL LEDUC,
Registrar.

SOLICITOR'S CERTIFICATE

20 I, CHRISTOPHER ROBINSON, of the City of Ottawa, Province of Ontario, Solicitor, hereby certify that I have personally compared the annexed case in appeal to the Supreme Court of Canada, with the originals and that the same is a true and correct reproduction of such originals.

CHRISTOPHER ROBINSON,
A Solicitor for the Appellant.

IN THE SUPREME COURT OF CANADA.

REASONS FOR JUDGMENT—KERWIN, J.

The defendant in this action, Noranda Mines Limited, appeals against a judgment of the Exchequer Court declaring that claim 9 of Canadian Letters Patent of Invention dated March 10, 1925, was valid and had been infringed by the appellant and ordering the usual consequential relief. The letters patent were issued as the result of an application filed October 23, 1934, for an invention of Cornelius H. Keller relating to Froth Flotation
10 Concentrates of Ores. The respondent is the plaintiff Minerals Separation North American Corporation to whom Keller assigned all his right, title and interest in and to the invention, and to whom the letters patent were issued. Claims 6, 7 and 8 were also in suit but the trial judge, the President of the Exchequer Court, decided that the first of these was void for avoidable obscurity and that, in view of his conclusion as to claim 9, it was unnecessary to deal with 7 and 8. The appellant admits infringement of claim 9 and as I have come to the conclusion that it is valid, no opinion is expressed as to the other three.

20 Froth flotation is a method of treating an ore so as to separate the gangue from the values, and which method reduces the bulk of material that has to be subsequently smelted to obtain the desired metal. The operation is accomplished by the addition of a frothing agent to the pulp to which the ore had already been reduced and by such a violent agitation of the pulp that, at the top, a voluminous froth is formed, having the property of tending to cause the values to adhere to the bubbles as they rise through the pulp. The froth is removed and, after the required number of treatments, the minerals contained therein
30 are known as the concentrate.

For my purpose the process may be thus baldly stated because although it was fully developed in the evidence and is set forth in detail in the reasons for the judgment appealed from, there is no dispute between the parties as to its existence in that form at the earliest time of any importance in the litigation, that is March, 1915, which is relied upon by the appellant as being the time when the use of xanthates in froth flotation concentration of ores was known by one R. B. Martin. In fact
40 was in error in holding the contrary. Before proceeding, the other three grounds of alleged error may be stated :—

2. In holding that the specification of the patent in suit described the invention in the manner required by the statute ;

Reasons for Judgment—Kerwin, J.

3. In holding that claim 9 was limited by the disclosure to a certain kind of xanthates ;

4. In holding that the disclosure was limited to a certain kind of xanthates which did not include cellulose xanthate and heavy metal xanthates.

It will be convenient to examine the last three of these allegations before turning to the first but attention should now be directed to subsection 1 of section 7 and subsection 1 of section 14, of the Patent Act, chapter 23 of the 1923 Canadian
 10 Statutes, which was the enactment in force at the time of the application for, and granting of, the patent in suit. These enactments are as follows :—

“ 7. (1) Any person who has invented any new and useful art, process, machine, manufacture or composition of matter, or any new and useful improvements thereof, not known or used by others before his invention thereof and not patented or described in any printed publication in this or any foreign country more than two years prior to his
 20 application and not in public use or on sale in this country for more than two years prior to his application may, on a petition to that effect, presented to the Commissioner, and on compliance with the other requirements of this Act, obtain a patent granting to such person an exclusive property in such invention.

14. (1) The specification shall correctly and fully describe the invention and its operation or use as contemplated by the inventor. It shall set forth clearly the various steps in a process, or the method of constructing, making or
 30 compounding, a machine, manufacture, or composition of matter. It shall end with a claim or claims stating distinctly the things or combinations which the applicant regards as new and in which he claims an exclusive property and privilege.”

It is upon subsection (1) of section 14 that the appellant relies in connection with its last three submissions and I therefore refer immediately to the disclosure. Paragraphs 2 and 7 inclusive thereof read :—

“ 2. The invention relates to the froth-flotation concentration of ores, and is herein described as applied to the
 40 concentration of certain ores with mineral-frothing agents in the presence of certain organic compounds containing sulphur.

3. It has been found that certain sulphur derivatives of carbonic acid greatly increase the efficiency of the froth-flotation process when used in connection with

Reasons for Judgment—Kerwin, J.

mineral-frothing agents. The increased efficiency shows itself sometimes in markedly better recoveries, sometimes in effecting the usual recoveries with greatly reduced quantities of the usual mineral-frothing agents, and sometimes in greatly reducing the time needed for agitation to produce the desired recoveries.

10 4. The invention is herein disclosed in some detail as carried out with salts of the sulphur derivatives of carbonic acid containing an organic radical, such as an alkyl radical and known as xanthates, as the new substance. These form anions and cations in solution. Excellent results were also obtained by agitating ore pulps with the complex mixture produced when $33\frac{1}{3}\%$ of pine oil was incorporated with an alcoholic solution of potassium hydrate, and xanthates or analogous substances were produced by adding carbon disulphide to this mixture.

20 5. The galena-bearing froth obtained with xanthates or analogous substances used at the rate of 0.2 pounds per ton of ore had a characteristic bright sheen, like a plumbago-bearing froth, and seemed to make a more coherent froth than when other materials were used on the same ore.

30 6. In general the substances referred to are not mineral-frothing agents, producing only a slight scum, and some evanescent frothy bubbles, when subjected to agitation which would produce mineral-bearing froth on an ore pulp in the presence of a mineral-frothing agent. The substances are effective in enabling a selective flotation of lead and zinc; and cause uncombined silver, if present, to tend to go into the lead concentrate rather than with the zinc, where these are separated in separate concentrates. Usually pre-agitation is unnecessary, the brightening and other effects seeming to be practically instantaneous. The pulps may be either acid, alkaline or neutral according to circumstances.

40 7. Two sticks of caustic potash weighing perhaps 15 grams were partly immersed in about 80 cc. of commercial carbon disulphide and kept for about ten days in a closed bottle containing some air in the warm region of the laboratory where were the hot plates used for drying. These eventually yielded a yellow or orange salt which was used with pine oil at the rate of approximately half a pound to a ton of ore in concentrating Hibernia ore from Timber Butte Mining Company. The test was with a neutral pulp, and the concentrates were seen to be clean with brightened lead sulphide particles."

Paragraph 8 states that for laboratory purposes potassium xanthate was prepared in the manner described and the subsequent

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paragraphs set forth certain tests, and the specification ends with eleven claims, of which the ninth only need be noticed :—

“ 9. The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of a xanthate and a frothing agent.”

In its attack the appellant has sought to place each of the paragraphs of the disclosure set out above in a straight jacket and by a meticulous examination of every word has endeavoured
 10 to show that Keller never put his finger on what he had discovered. That this is not a proper way to read the specification is made clear by a number of authorities, to one only of which is it necessary to refer. In *Smith Incubator Co. v. Seiling* [1937] S.C.R. 251, Chief Justice Duff states at 255 :—

“ It is now settled law that, for the purpose of ascertaining the meaning of the claims, the language in which they are expressed must be read in light of the specification as a whole, but it is by the effect of the language employed in the claims themselves, interpreted with such aid as may properly
 20 be derived from the other parts of the specification, that the scope of the monopoly is to be determined.”

And at page 260, the present Chief Justice notes :—

“ As often observed, of course, the claims must be construed in the light of the rest of the specification ; and that is to say, that the specification must be considered in order to assist in comprehending and construing the meaning—and possibly the special meaning—in which the words or the expressions contained in the claims are used.”

In accordance with this principle, “ xanthate ” as used in
 30 claim 9, must be read as limited by the definition in the disclosure. This is not inconsistent with the decision of this Court in *B.V.D. Company Limited v. Canadian Celanese* [1937] S.C.R. 221, as xanthate is a technical chemical word for which there is no precise meaning and, therefore, the inventor supplied one in paragraph 4 of the disclosure. I agree that the words “ such as ” mean “ of the type of.” So read, Keller has made it clear to any one versed in the art that his invention consists of a new and useful improvement in froth flotation concentration of ores by
 40 the use of a mineral frothing agent with sulphur derivatives of carbonic acid containing an organic radical of the type of an alkyl radical which forms anions and cations in solution. Without detailing the evidence which appears in the President’s reasons, I may state that I am satisfied that Keller’s disclosure was limited to a certain kind of xanthates, which did not include cellulose xanthates and heavy metal xanthates.

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I now turn to the first argument of the appellant that the use of xanthates in flotation was known in 1915 by Martin and that, therefore, Keller had not, in compliance with subsection 1 of section 7 of the Patent Act, invented any new and useful process not known by others before his invention. Martin was not called as a witness. He had been engaged by the respondent's predecessor in March, 1915, under an employment agreement, and by another agreement of the same date had given an option to a related English company for the purchase, subject to a shop
10 right to Utah Copper Company, of all inventions previously made by him relating to the treatment of ores and to flotation concentrates and reagents. On the same day, Martin disclosed his alleged inventions to Higgins, the chief metallurgist for the respondent's predecessor. Among these was the only one requiring mention, "NATROLA," the name he had used at Utah Copper Company for a composition he later called "STANOL." At the trial, Higgins said Martin had been provided with laboratory accommodation, chemicals and ores, and that he had supervised Martin's work but that STANOL had been found by Higgins,
20 Martin, and a third party to be of no use. Later, at Higgins's suggestion, Martin incorporated in a document dated August 15, 1915, and known as Bulletin 2, descriptions of his flotation reagents, including Stanol. Applications for patents covering other alleged inventions of Martin were prepared and according to the testimony of Mr. Williams, the respondent's patent attorney, they represented all that Martin had succeeded in demonstrating to be of any value of the inventions brought by him to his employer. Bulletin 2 was discussed between Higgins and Martin when the former found that there were so many
30 formulæ in the document that he concluded that they could not all be equally effective and he asked Martin to put the best of each one of them in a book of reference. Some time before October 21, 1915, this book was prepared and handed to Higgins and in it are set out certain notations showing what was most useful in each of the preparations contained in Bulletin 2. This was followed by Bulletin 3 in which STANOL is not mentioned. On October 22, 1915, Bulletin 4 was delivered by Martin to Higgins and on page 9 is mentioned "STANOL" and stated that it was not satisfactory on ore at Anaconda Mine. Bulletin 4 is
40 the last one in which mention is made of STANOL notwithstanding that Martin prepared and delivered eighty-eight bulletins in all. Although applications were prepared for KOTRIX and certain reconstructed oils which had been disclosed by Martin, he and Higgins decided that there was nothing of value in STANOL to patent. It appears that shortly after the issue of the Keller patent in the United States, Martin resigned his position with the respondent and subsequently was instrumental in having

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declared an interference between the Keller United States patent and Martin's own application for a patent. This interference was dissolved without a determination of the question of priority.

Nowhere did Martin claim that STANOL was xanthate. He was thinking of STANOL only and while he theorized as to there being some xanthate in it and that it should be effective in flotations, the evidence all leads to the conclusion that he did not know the value or use of xanthate as such ; that is, he did not know the invention that Keller later made. It should be added
 10 that there is no suggestion that Keller ever saw Martin's bulletins or books. This makes it unnecessary to consider the respondent's argument that even if Martin did know, section 61 (1) (a) of the present Patent Act, 1935, c. 32, although enacted in 1932 by c. 21, section 4 (after the patent in suit was issued), applies so as to render such knowledge unavailing unless Martin had disclosed or used his process in such manner that it had become available to the public.

The appeal should be dismissed with costs.

KELLOCK, J.

20 The specification states that one, Keller, has invented "certain" new and useful improvements in "froth-flotation concentration of ores" and he declares that what follows is a "clear, full and exact description of the same." The next paragraph reads :

"This invention relates to the froth-flotation concentration of ores, and is herein described as applied to the concentration of certain ores with mineral-frothing agents in the presence of certain organic compounds containing sulphur."

30 So far, it would appear that the "invention" with which the paragraph opens, is something different from the "certain organic compounds containing sulphur" with which the paragraph concludes. In paragraph 3, however, the inventor states what he has found in the following language :

"It has been found that certain sulphur derivatives of carbonic acid greatly increase the efficiency of the froth-flotation process when used in connection with mineral-frothing agents."

40 The paragraph then gives particulars of the respects in what this increased efficiency shows itself. Paragraph 4 then follows :

"The invention is herein disclosed in some detail as carried out with salts of the sulphur derivatives of carbonic acid containing an organic radical, such as an alkyl radical and known as xanthates, as the new substance. These form anions and cations in solution. Excellent results were also

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obtained by agitating ore pulps with the complex mixture produced when $33\frac{1}{3}\%$ of pine oil was incorporated with an alcoholic solution of potassium hydrate, and xanthates or analogous substances were produced by adding carbon disulphide to this mixture.”

In paragraph 5 the inventor says :

10 “ The galena-bearing froth obtained with xanthates or analogous substances used at the rate of 0·2 pounds per ton of ore had a characteristic bright sheen, like a plumbago-bearing froth, and seemed to make a more coherent froth than when other materials were used on the same ore.”

In paragraph 6 he says :

“ In general the *substances* referred to are not mineral-frothing agents . . . The substances are effective in enabling a selective flotation of lead and zinc . . . Usually pre-agitation is unnecessary . . . The pulps may be either acid, alkaline or neutral according to circumstances.”

20 In my opinion, taking the view for the moment that “ the invention ” is to be found in paragraph 4, such invention is really twofold—(1) the use of xanthates, and (2) the use of the “ analogous substances ” in flotation. I do not think either can properly be described as primary or secondary. The inventor in paragraph 5 says that either produce the results therein described, and in paragraph 6 he says that “ the substances,” i.e., both the xanthates and the analogous substances, are not mineral-frothing agents and may be used in acid, alkaline or neutral pulps.

30 As the claims here in question relate to xanthates only, I do not consider it necessary to consider further the “ analogous substances ” in view of the conclusion to which I have come with respect to the claims.

40 With respect to xanthates, the respondent contends that paragraph 4 is to be read as saying that “ the invention ” consists of xanthates containing an alkyl radical and a soluble metal. This, in effect, is the view which commended itself to the learned trial judge. Appellant, on the other hand, says that the paragraph does not so state and that “ the invention ” is not defined by the paragraph, but is only described as carried out with certain substances, the ambit of the invention being left vague. Appellant further says that if the paragraph is a definition, the expression “ such as an alkyl radical ” is used in the sense of “ for example ” and the organic radicals mentioned in the paragraph are not limited to alkyl but extend to all organic radicals or, alternatively, if limited by the expression, the radicals are all organic radicals of the type of alkyl. In appellant’s contention these include all aliphatic radicals which react chemically in the same way as alkyl radicals. Appellant further submits that the second

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sentence of the paragraph is not part of the definition but even if it is properly to be so considered cellulose xanthate would be included and cellulose xanthate is not only useless but positively harmful in flotation.

The first question to be considered therefore, is the proper construction of paragraph 4. I deal first with the opening sentence of the paragraph.

According to Murray's English Dictionary, 1919 Edition, "such" is a demonstrative word used to indicate the quality or
 10 quantity of a thing by reference to that of another or with respect to the effect that it produces or is capable of producing. Head 9 deals with uses of the words "such as" marked by special word-order and in sub-paragraph (*d*) which follows upon illustrations of attributive use after a substantive, the authors state that the expression such as "is used to introduce examples of a class: = for example, e.g."

Had the expression used in paragraph 4 read "such an organic radical as an alkyl radical" the situation might have been more in favour of the respondent's contention but the expression
 20 actually used "an organic radical, such as an alkyl radical" points to the construction that the patentee was using the phrase "an alkyl radical" by way of example or illustration only. If "an alkyl radical" and an alkyl radical only had been intended it would have been simple to so state, but in the absence of any context other than that furnished by the first sentence of the paragraph itself, the patentee appears not to be limiting himself to alkyl radicals but is including the larger field.

It is well settled that the specification is to be read as a whole and the claims, of course, are part of the specification. In
 30 *Consolidated Pneumatic Tool Company Ltd. v. Clark*, 23 R.P.C. 666, Warrington, J., as he then was, said:—

" . . . the claims are to be looked at as intended to define the invention, to point out what it is that the inventor regards as new, and for which he claims protection, and the general rule in dealing with claims is to treat what is not claimed as being disclaimed."

In *Jackson v. Wolstenhulmes*, 1 R.P.C. 105, Cotton, L.J., said at 108:—

40 "The object of a claim is this, to restrict and cut down what might be suggested as the claim made by the previous part of the description, so as to show what it does consist of, and to prevent the patent from being defeated in consequence of words being used which might lead to the inference that something which was not *intended to be claimed* was claimed, and thus the patent being defeated by there being included in the previous part of the specification that which was not new but old."

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Perhaps the most authoritative statement is that of Lord Russell of Killowen in *Electric and Musical Industries v. Lissen*, 56 R.P.C., 23 at 39, as follows :—

10 “ The function of the claims is to define clearly and with precision the monopoly claimed, so that others may know the exact boundaries of the area within which they will be trespassers. Their primary object is to *limit* and not to extend the monopoly. What is not claimed is disclaimed. The claims must undoubtedly be read as part of the entire

20 document and not as a separate document ; but the forbidden field must be found in the language of the claims and not elsewhere. It is not permissible, in my opinion, by reference to some language used in the earlier part of the specification to change a claim which by its own language is a claim for one subject-matter into a claim for another and a different subject-matter, which is what you do when you alter the boundaries of the forbidden territory. A patentee who describes an invention in the body of a specification obtains no monopoly unless it is claimed in the claims.”

20 In *Smith v. Seiling* [1937] S.C.R. 251, Duff, C.J.C., said at 256 as follows :—

“ We are asked to construe the claim with reference to the specification, *not in order to understand what the former says*, but to make it say things which in fact it does not say at all.”

The claims then define and limit the ambit of the invention and may be read with the disclosure in the earlier part of the specification “ in order to understand what the former says.”

30 Accordingly, one finds that claim 10 claims the use of “ a sulphur derivative of carbonic acid containing an organic radical,” simpliciter. The same is true of claim 11, the only difference being that it is “ a salt of a sulphur derivative of carbonic acid containing an organic radical ” which is there claimed. One contrasts with this language that which is found in claim 3 where the wording is “ a salt of an *alkyl* sulphur derivative of carbonic acid.” In these circumstances I do not think it open to the patentee to say that when he said in paragraph 4 “ an organic radical, such an alkyl radical ” he used that wording as the equivalent of “ an alkyl radical ” simpliciter. To permit this would enable the patentee to say under claim 10 or 11 as against

40 an infringer using an organic radical in his process but not an alkyl radical, that paragraph 4 extended to all organic radicals and that the phrase “ such as an alkyl radical ” had been used as an illustration only. Alternatively also, it would be open to him to put forward the present argument that paragraph 4 meant “ an alkyl radical ” simpliciter and that claims 10 and 11 were obviously too wide and should not have scared off anyone from using anything except an alkyl radical. There is a well settled

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principle which prevents language being so used by a patentee whose obligation under section 14 of the Patent Act of 1923 is to “correctly and fully describe the invention as contemplated by the inventor” and to “set forth *clearly* the various steps in a process, or the method of constructing, making or compounding a machine, manufacture or composition of matter.” The specification must “end with a claim or claims stating *distinctly* the things or combinations which the applicant regards as new and in which he claims an exclusive property and privilege.”

10 In *Natural Colour Kinematograph Co. Ltd. v. Bioschemes Ltd.*, 32 R.P.C., 256 at 266, Lord Loreburn said :

“Some of those who draft Specifications and Claims are apt to treat this industry as a trial of skill, in which the object is to make the Claim very wide upon one interpretation of it, in order to prevent as many people as possible from competing with the patentee’s business, and then to rely upon carefully prepared sentences in the Specification which, it is hoped, will be just enough to limit the Claim within safe dimensions if it is attacked in Court. This leads to
20 litigation as to the construction of Specifications, which could generally be avoided if at the outset a sincere attempt were made to state exactly what was meant in plain language. The fear of a costly law suit is apt to deter any but wealthy competitors from contesting a Patent. This is all wrong. It is an abuse which a Court can prevent, whether a charge of ambiguity is or is not raised on the Pleadings, because it affects the public by practically enlarging the monopoly, and does so by a kind of pressure which is very objectionable. It is the duty of a patentee to state clearly and distinctly,
30 either in direct words or by clear and distinct reference, the nature and limits of what he claims. If he uses language which, when fairly read, is avoidably obscure or ambiguous, the Patent is invalid, whether the defect be due to design, or to carelessness or to want of skill. Where the invention is difficult to explain, due allowance will, of course, be made for any resulting difficulty in the language. But nothing can excuse the use of ambiguous language when simple language can easily be employed, and the only safe way is for the patentee to do his best to be clear and intelligible.
40 It is necessary to emphasize this warning.”

In the case at bar if the present contention of the respondent as to his meaning is correct, there was no more difficulty at the date of the application than now in so expressing it, but in my view, upon the internal evidence furnished by the specification itself, that is not what the draughtsman had in mind in the preparation of the first sentence of paragraph 4.

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This conclusion is confirmed by a reference to what occurred in connection with the application in the United States, which antedated the application in Canada. In the original application the wording used in paragraph 4 was "the invention is herein disclosed in some detail as carried out with salts of the *alkyl* sulphur derivatives of carbonic acid known as xanthates as the new substance." This was subsequently amended by striking out the word "alkyl" where it appeared before the word "sulphur" and by inserting after the word "acid" the words
10 "containing an organic radical, such as an alkyl radical" so as to produce the form of wording in the Canadian application. As I have already stated, I have reached my conclusion as to the construction of the Canadian patent upon the internal evidence of that patent itself. The American proceedings merely illustrate that the respondent intended the meaning that, in my opinion, the language he adopted in the Canadian patent properly bears. I think therefore that the invention described in the first sentence of paragraph 4 extends to all organic radicals.

Coming to the second sentence, "These form anions and
20 cations in solution" the respondent says that this sentence limits the substances referred to in the first sentence and that these substances must be soluble, as that term would be understood at the date of the patent by a skilled workman in the flotation field. Again it may be pointed out that it would have been a simple matter for the patentee to have spoken in the first sentence of paragraph 4 of "soluble salts of sulphur derivatives of carbonic acid containing an alkyl radical and known as xanthates." Appellant says that he did not do so and that the second sentence forms no part of the description of the xanthates referred to in
30 the first sentence. That is that the second sentence cannot be read as meaning that the only substances referred to by the patentee are those which have some particular degree of solubility. The appellant contends, further, however, that even if the second sentence of the paragraph is part of the definition cellulose xanthate is included.

In 1923 the only xanthate in commercial use according to the evidence was cellulose xanthate which was used in the rayon industry. Keller himself experimented with cellulose xanthate prior to July of that year but did not find it useful and, according
40 to the evidence of the witness, Bennett, cellulose xanthate is not only useless but absolutely harmful for flotation purposes. This is accepted by the respondent and is the subject of an express finding by the learned trial judge.

As to the word "soluble" the evidence is that it would be interpreted in accordance with the use to be made of the information. Dr. Purves said that to a practical organic chemist if a substance is soluble to the extent of a few tenths of one per

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cent. it would satisfy his understanding of the term. There is no contradiction of this or that a metallurgist would have any different view. The witness Bennett, a practical metallurgist, used a one per cent. solution of cellulose xanthate in tests performed by him. In the respondent's factum it is stated that "flotation reagents do not necessarily have to be very soluble : 2 pounds of reagent to one ton of ore, i.e. 4 tons of water are ordinarily used."

Respondent contends, however, that such a solution is not a true solution but a colloidal one and the respondent's witness,
 10 Higgins, said that in 1923 colloids were avoided like poison in flotation. I do not think that this evidence is sufficient to remove cellulose xanthate from the ambit of paragraph 4 of the specification, if it is otherwise included as I think it is. The utility of the use of any xanthate in flotation was entirely new in 1923 and I do not think it can be said that a metallurgist, on reading the specification at that time would, without test, have excluded cellulose xanthate from paragraph 4 merely because it was a colloid. He would have no experience or knowledge of xanthates and therefore the language of paragraph 4 would, in my opinion,
 20 be taken by him as including cellulose xanthate. There are two matters in evidence which confirm this view. The first has already been referred to, namely, that Keller experimented with cellulose xanthate before discarding it. In the second place, in Bennett's view a metallurgist in 1923 would have tested cellulose xanthate before he would know whether it was useful or not. I therefore think that it has been made out that cellulose xanthate comes within the meaning of paragraph 4, even taking the view that the second sentence is part of the description of xanthates covered by the paragraph.

30 It is contended on the part of the respondent, however, that any practical metallurgist, on reading the specification, would first try potassium and sodium xanthate and would go no further and that the difficulty of storing and transporting cellulose xanthate, its cost and other considerations would exclude it in his mind.

In *Norton and Gregory v. Jacobs*, 54 R.P.C., 271, Sir Wilfred Greene, M.R., said at 276 :—

40 "The fact that a skilled chemist desiring to use the invention would reject certain reducing agents as being unsuitable is one thing ; it is quite a different thing to say that a claim must in point of construction be cut down so as to exclude those reducing agents because a skilled chemist would not use them. To adopt the latter proposition would not be to construe the Specification but to amend it . . ."

As pointed out by Lord Normand in *Raleigh v. Miller* [1948] 1 A.E. 308 at 318, the above observation, while directed to the construction of claims, applies with equal force to the disclosure.

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The decision of Warrington, J., in *Thermit v. Weldite*, 24 R.P.C. 441, is distinguishable. See also *Vidal Dyes v. Levinstein*, 29 R.P.C. 245, per Fletcher Moulton, L.J., at page 272. In my opinion therefore the invention described in the specification extends to cellulose xanthate.

Coming then to the claims, those which are in question are 6, 7, 8 and 9. With respect to claim 6, the material words are "alkaline xanthate". According to the respondent, what was intended was "alkali-metal xanthate," and in the opinion of
 10 Mr. Higgins the term used would be so understood by a metallurgist. It is admitted that "alkaline xanthate" is a contradiction in terms, as all xanthates are neutral. According to Dr. Purves, a number of possible constructions could be given to the words. In claim 5 the phrase "alkali-metal salt" is used. It therefore seems that when the draughtsman of the specification intended "alkali-metal" he knew how to so express himself. When he used the word "alkaline" in claim 6 the presumption is that something else was intended. This is left in ambiguity. Even if the contention of the respondent be accepted that
 20 "alkaline" is to be read "alkali-metal" the latter expression would include sodium and potassium cellulose xanthate. From any point of view, therefore, the claim in my opinion is invalid.

Claims 7 and 9 may be considered together. The relevant expression is "a xanthate." The respondent seeks to read these claims as limited to the xanthates described in paragraph 4 of the disclosure. For the reasons already given in considering the proper construction to be placed upon that paragraph, these claims are invalid as extending to cellulose xanthate. Apart from this, my opinion on the authorities is that the expression "a xanthate"
 30 in the above claim is not to be so limited. In my view the case does not come within the principle applied in *Western Electric Co. v. Baldwin* [1934] S.C.R., 570, but rather within that applied in the *B.V.D. Co. v. Canadian Celanese Ltd.* [1937] S.C.R., 221.

In *Baldwin's* case the question related to the construction of claim 2, which read :

"The combination with a plurality of thermionic repeaters connected in tandem, the first repeater of the series having a high-voltage output and the last repeater of the series having a high-current output."

40 It was held that the language of the claim was to be interpreted by the specification as a whole and that the thermionic repeaters mentioned in the claim must be taken to be thermionic repeaters having the characteristics ascribed "by definition" in the specification. It will be sufficient to quote the specification itself, in part :

"It has been discovered that audions of the usual type may be so constructed that, *without the use of transformers,*

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they will step up the input voltage of either direct current or alternating current of any frequency in one step to as much as 30 times its original value, or in two successive steps to as much as 500 times its original value. The voltage amplification thus secured is entirely free from wave distortion whatever may be the initial frequency and wave form. *This type of audion will, for convenience, be hereinafter referred to as the high-voltage output audion.*

10 It has furthermore been discovered that audions may be constructed which will step down the input voltage, for example, to one-third of its original value. This last-mentioned type of audion has a high-current and a low-voltage output. Because of its low output impedance, i.e., the low impedance between its cathode and anode, such type of audion can be worked efficiently into a line of like impedance. *This new type of audion will, for convenience, hereinafter be referred to as the high-current output audion.*"

* * * * *

20 "It has been discovered that a combination of one or more of the *aforementioned* high-voltage output type of audions, working into *one of the high-current output type*, will operate without transformers, from a line of low impedance, for example, 250 ohms, into a like line with a resultant current much greater, fifty or more times greater, than would flow in the second circuit if it were directly connected to the first circuit. The present invention is directed to such combination of two different types of repeaters, preferably audions." In giving the judgment of the court Sir Lyman Duff, C.J., said at page 577 :—

30 "To revert to the definition of the combination to which, as the specification says, 'the invention is directed,' it would be difficult to find any construction, consistent with the grammatical sense of the words, that would exclude the absence of transformers from the essential features of the combination in respect of which protection is claimed. First of all, he defines the 'high-voltage output audion'; and *an element of that definition* is that 'without the use of transformers' it will perform certain operations on the input current. Then, there is a definition of the 'high-current output audion,' which does not explicitly make the absence of transformers *an essential element*, but which, as already indicated, appears very *clearly to do so* when it is read with the specification as a whole properly construed.

40

"Then, after mentioning that the patentee has applied for patents in respect of these types of audions, he proceeds to describe the combination, and the combination, which is the invention for which he desires protection, is of one or

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more of the *aforementioned* high voltage output type of audions (a type which, by *definition*, is of such a construction that it performs the function assigned to it in this circuit arrangement *without the use of transformers*) with one of the high-current output type.”

And at page 583 :

10 “ I have no doubt whatever that, on a proper construction of the specification as a whole, the combination mentioned in the second claim is the combination described in the passage just quoted ; or that the ‘ thermionic ’ repeaters mentioned in the claim must be taken to be thermionic repeaters having the characteristics ascribed by *definition* to those with which the inventor has succeeded in securing the results which he says are secured by his invention. As a matter of construction, the point does not really appear to me to be open to serious argument.”

20 In my opinion the result of the judgment is that the court found that “ a high voltage output ” repeater and a “ high-current output ” repeater, as those expressions were used in claim 2 were to be construed by the definition contained in the disclosure which, as the disclosure itself says, would be the expressions “ hereinafter ” used as meaning the types defined.

30 When one turns to the *Canadian Celanese* case, the distinction between that case and *Baldwin’s* case is obvious. In fact, although three of the members of the court who decided the *Celanese* case had sat on the former appeal, the *Baldwin* case was not mentioned. The disclosure in the patent, which it was claimed by the respondent had been infringed, described the invention as associating a woven, knitted or other fabric, made of *yarns* of a thermoplastic cellulose derivative, with other fabrics. The claim, however, did not mention yarns at all but merely referred to “ a thermoplastic derivative of cellulose.” It was held that the use of the cellulose derivative in the form of yarns, filaments or fibres was of the very essence of the invention but that the claims must be interpreted as they stood. In both the British and United States patents the claims had expressly mentioned yarns, or filaments or fibres. At page 237 Davis, J., giving the judgment of the court, said :

40 “ We are invited to read through the lengthy specification and import into the wide and general language of the claims that which is said to be the real inventive step disclosed. But the claims are unequivocal and complete upon their face. It is not necessary to resort to the context and as a matter of construction the claims do not import the context. In no proper sense can it be said that though the essential feature of the invention is not mentioned in the claims the process defined in the claims necessarily possesses that

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essential feature. The Court cannot limit the claims by simply saying that the inventor must have meant that which he has described. The claims in fact go far beyond the invention. Upon that ground the patent is invalid."

The same result was reached by the Court of Appeal in England in a similar case, *Molins v. Industrial Machinery Co., Ltd.*, 55 R.P.C. 31.

In my opinion, in the case at bar, we "cannot limit the claims by simply saying that the inventor must have meant that
10 which he has described." "A xanthate" is what the patentee claims. This would include at least one xanthate which will not work. The claim is therefore invalid.

With respect to claim number 8, which is limited to "potassium xanthate," the appellant says it has not infringed this claim as it has not used potassium xanthate, although it has used sodium xanthate. The respondent contends however, that sodium xanthate is the chemical equivalent and that the appellant's use constituted an infringement. The question in
20 my opinion resolves itself, first, into the question as to whether the respondent has, upon the true construction of the specification as a whole, excluded from claim 8 everything but the specific substance there mentioned and, in my opinion, it has. There are in all eleven claims in the specification and both potassium and sodium xanthate would be included in the general language used in every one of them with the exception of the particular claim in question, assuming that some meaning can be given to the expression "alkaline xanthate" in claim 6. Further, one finds
30 the general expression "a xanthate" in claims 7 and 9 and, as just mentioned, the expression "alkaline xanthate" in claim 6. I think, therefore, that it is impossible to contend that in using the expression "potassium xanthate" in claim 8, anything else but that substance was intended to be included.

In the result the respondent fails to obtain protection with respect to a very useful invention which became dominant in the art but this result comes about in my opinion from the failure to observe the requirements of the statute calling for clear expression as to the invention and the claims. There was no difficulty in the adoption of reasonably clear language in the present case.

40 I would allow the appeal and dismiss the action both with costs.

The judgment of Rand and Locke, J.J., was delivered by:—

RAND, J. :—

The first objection raised to the validity of the patent is that the inventor, in the specification, has failed to satisfy the requirement of the statute that he describe his invention correctly

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and fully. Both at the trial and before us the defendant pressed the question, what is the invention? And to deal with that initial challenge adequately a statement of the main facts must be given.

The invention is stated to be an improvement in a process known as the froth flotation of minerals, a method of separating them which in its modern form dates from the year 1905. These minerals are chemical compounds containing metals such as gold, silver, copper, lead, etc.; and they are found generally in a
10 mixture with other substances, chiefly silicas, called an ore body. The minerals may be thickly or thinly scattered throughout the ore; but their extraction from the mixture is a preliminary to the direct recovery of the metal from the compound in which it appears.

The flotation process consists, first, of crushing and grinding the ore to varying degrees of fineness: the material is then thoroughly mixed with water into what is called a pulp: an oil or similar substance is added: air is introduced, and the whole well agitated. Masses of bubbles are formed, apparently with an
20 oily film, which, laden with mineral particles, rise to the top in a dark scum called the concentrate. This scum is collected, the froth matter is driven off, and the residue of mineral is then ready for the smelter.

The oil or other substance added is primarily a frothing agent: but it has also more or less a collecting function, that is, it produces an attraction between the air bubbles and the mineral particles which causes the latter to cling to the former. The theory of this attraction seems not to be agreed upon, nor whether the emulsified
30 oil in any degree films the particles. But I infer that it is a real attraction, probably of an electro-magnetic nature, and is not merely a mechanical involvement of the particles in the surface tension of the bubbles. The attraction may also be selective; that is, the copper, say, may be caught up in priority to the lead. Some agents are more effective in producing froth than collecting the mineral while others have a converse action; and a combination of two or even more may be used. So many factors of difference in the minerals and in the ores are found, that each mine tends to work out its own best method; changes in the chemical composition may take place more or less constantly,
40 both slowly and rapidly, and local adaptation may become a factor in good operation. For instance, mineral may oxidize. Now oxide minerals, in which an oxide of the metal sought predominates, cannot directly be recovered in flotation; the bubbles do not collect the particles. In sulphide minerals, on the other hand, they do. Oxides are therefore washed or filmed with a sulphidizing agent and they then are amenable. The choice of agents to be used may thus, by similar and other conditions, be influenced.

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The search then became one for more effective collector agents, including agents for sulphidizing, substances that would, at the cheapest cost, gather to the concentrate the greatest quantity of values, or minerals, and the least of the waste or gangue: and the whole field of organic and inorganic chemistry was opened to the exploration.

In this state of things, the scientists of the respondent took up the hunt. In 1922, September 19, one of them, a chemist named Keller, in search of a sulphidiser, issued a direction to his
10 associate in metallurgy to test a salt known as potassium xanthate for that purpose. In the course of the next year a great many experiments with xanthate and similar substances were carried out in the company's laboratories at San Francisco and New York. It was discovered that certain xanthates, although not sulphidizing agents, did produce a remarkable increase in the flotation efficacy of frothing or collecting agents. They were not capable of producing froth and did not, apparently, react through coating the particles of mineral. Their property of enhancing the process was demonstrated in March, 1923; and after continuing tests
20 and the exploration of peripheral areas throughout the summer and autumn, application for a patent was made in the U.S.A. on October 21, 1923.

Since the discovered salts have neither frothing nor sulphidizing powers, they are not directly effective on oxide ores until first sulphidized, and they must be combined with a frothing agent: their role is to influence favourably the process as it was carried on with oils and other substances at the time of the invention. They are therefore new factors whose effect is made upon the existing process, in which they appear to play a part
30 analogous to that of a catalytic agent.

Now it is obvious that in the field of chemistry family relationship in compounds is likely to be characterized by similar significant reaction results; and that a xanthate has such modifying powers leads at once to the notion of a chemical group which, possessing certain characteristic qualities, may be efficacious in producing the same effects. So it happened with Keller. Having made an important discovery, he set about to distribute the field of such agents not only as a contribution to the operation but also to protect his invention against encroachment. The
40 invention became therefore the discovery of a series of modifiers and the initial question raised is whether there has been a sufficient description of that series. In such a case an inventor cannot be called on to investigate and to name every possible substance individually of the group; he may do that by a description and that description may be of attributes or by classification.

The argument tended to assume that the "correct and full" description required by section 14 of chapter 23 of the Patent Act,

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1923, must be in what has been called the narrative portion of the specification. But the statute makes no such provision; the specification is to end with the claims, but it is in the specification that the description must be given: and to the whole of it we are entitled to look to ascertain what the invention is. The language of Duff, C.J., in *Smith v. Seiling* [1937] S.C.R. at p. 257, in which he speaks of the specification "as a whole," seems to me to have been carefully phrased to avoid the restrictive interpretation suggested.

10 The specification recites that "it has been found that certain sulphur derivatives of carbonic acid" are effective for the purposes of flotation. It then proceeds to reduce this general statement to defined particulars by furnishing examples of derivatives which embody the special property, by indicating certain characteristics and lastly by delimiting, in the claims, the boundaries, within the field of the derivatives, of the group for which the inventor asserts monopoly. The introductory sentence to the claims, "Having described certain embodiments of the invention, what is claimed is," clearly, I think, relates the claims to the description
 20 as well as the delineation of the exclusive field. What the disclosure lacks to a full description is the completion of enumeration; at this point description has become enumeration, and that is furnished by the claims.

I take the disclosure to imply in fact that the invention consists of those sulphur derivatives of carbonic acid which are described or defined in the claims. So far as a claim may include, for instance, a useless or an antagonistic substance, it is, as a definition of the monopoly, defective, but its descriptive function remains. The only question then is whether when the description
 30 contains a substance of no value or use the patent *ipso facto* is invalid as not specifying the invention correctly and fully. The special circumstance here is that the invention is a distributive discovery; (a), (b), (c) and (d) are asserted individually and severally; the first three have in fact been invented and are correctly and fully described; but the inventor has also described as invention (d) which he has not invented. Assuming a claim which does not include (d), it is as if the inventor had declared, I assert I have also invented (d) but I do not claim it. Only if
 40 we treat the invention as being of the group as an entirety, can it be said that the description is not correct; but that is not what the specification here intends. The substances are to be viewed as quasi-independent inventions but by the necessities of the case they can distributively be made the subject of a single patent.

The invention is therefore the use in flotation of those substances taken distributively which are sulphur derivatives and which are of such nature or characteristics, are so combined, and react in such conditions as are expressed in the specification

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as a whole. To require the full detailed description to be given in the so-called narrative would necessitate a virtual repetition of the claims. Taking the specification in its totality, Keller has, I think, met the requirement of the statute: no competent metallurgist would have any difficulty in grasping the discovery in all its essentials.

Against this conception, it is said that the expression "sulphur derivatives of carbonic acid" is ambiguous, on which there would be wide divergencies of opinion in metallurgists or
 10 chemists. But it is agreed by Dr. Purves, for the appellant, that a sulphur derivative is one in which the oxygen of the formula H_2CO_3 is replaced by sulphur. The initial replacements would result in H_2CO_2S , H_2COS_2 and H_2CS_3 , mono-, di-, and tri-thio-carbonates. Dr. Purves, however, in a chart of resultant combinations, in the mono- and di-groups substituted chlorine or an ammonium radical for OH: in doing that he violated, I think, the primary premise of sulphur substitution for the oxygen. In this I accept the opinion of Higgins, the chief metallurgist of the respondent, that "derivative" means exactly what it
 20 says, and that the introduction of Cl and NH_2 , though it does produce a derivative containing sulphur, does not produce a sulphur derivative of carbonic acid; it would properly be called a chlorine or other derivative of a sulphur derivative; but to that the statement of the discovery does not extend.

The invention was one of great value to the mining industry and brought in a group of agents of which there had been no previous knowledge or experience. It was not only natural but legitimate that the inventor should have endeavoured to protect his discovery. Precise description in such an uncharted field
 30 is hedged with difficulty; and although overreaching must draw its penalty, we are not called upon to employ microscopic means of discovering it nor to insist upon a pedantic accuracy to satisfy a formal symmetry.

A great deal of the evidence was taken up with matter arising out of the 4th paragraph of the specification which reads:—

"The invention is herein disclosed in some detail as carried out with salts of the sulphur derivatives of carbonic acid containing an organic radical, such as alkyl radical and known as xanthates, as the new substance. These form
 40 anions and cations in solution. Excellent results were also obtained by agitating ore pulps with the complex mixture produced when $33\frac{1}{3}\%$ of pine oil was incorporated with an alcoholic solution of potassium hydrate, and xanthates or analogous substances were produced by adding carbon disulphide to this mixture."

The respondent took the position that here was an exclusive description of xanthate for the purposes of the specification;

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that the xanthates intended to be denoted by that term were those containing an alkyl radical, which in solution formed anions and cations. These compounds, it may be stated, are salts of xanthic acid. That restrictive definition was considered necessary seemingly to support claim #9 which speaks of "a xanthate", by excluding certain xanthates which admittedly are of no value, such as cellulose and certain of the heavy metal compounds. This reduction of the discovery to special xanthates and "similar substances" mentioned in paragraphs 4 and 7 appears to me to
 10 be incompatible with the plain meaning of the language of the paragraphs as well as of the specification generally. What the narrative does is to furnish the circumstances and results in tests of certain "embodiments" of the invention, or, as one might say, of certain members of the group discovered. The reference may be taken as limited to such xanthates; but they are named only as illustrative examples: they, only, are disclosed in some detail: but that the language is intended to furnish a conventional meaning of xanthate to be carried forward into the claims is a conclusion which I am quite unable to draw.

20 The claims which the defendant is charged with infringing are numbers 6, 7, 8 and 9. The first, #6, is as follows:

"The process of concentrating ores which consists in agitating a suitable pulp of an ore with a mineral-frothing agent and an alkaline xanthate adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore, said agitation being so conducted as to form such a froth, and separating the froth."

It was attacked as ambiguous in the expression "alkaline
 30 xanthate." Admittedly xanthates are neither alkaline nor acid: they are neutral; and the adjective, as every competent metallurgist would know, cannot be taken to indicate such a characteristic of the substance. Nor do I think it can be taken to refer to the condition of the pulp. But, in some sense it does clearly qualify xanthate and I find no difficulty in satisfying myself in what that lies. Throughout the disclosure it appears that xanthates of potassium and sodium were used exclusively in the experiments. These are two alkali metals which in the standard
 40 formula for xanthate replace the hydrogen atom associated with sulphur. The disclosure also describes how these xanthates were made by the inventor, which was by first dissolving the hydrate of the one or the other in ethyl alcohol and then adding carbon disulphide. From these facts and the somewhat free and imprecisely adapted use of adjectival language by chemists, as well as the general knowledge of the chemistry of xanthates, I think it a reasonable inference that the language is intended

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to describe xanthates in which the metal or radical which replaces the hydrogen atom is that which comes from an alkali, those in the making of which an alkali is used. Several alternatives were suggested. The meaning attributed by the respondent was alkali metals, which are those present in alkalies: the appellant suggested, in addition, alkaline earths which are earths, i.e. oxides of chlorine and certain allied elements, and which exhibit properties midway between alkalies and earths: but I am unable to take the word to relate to either of these classes. Claim #5, in
 10 specifying an "alkali metal" salt, seems to conclude the question against the first; and the second falls through its own remoteness.

It was contended by Mr. Robinson that, on the respondent's interpretation, the inclusion of ammonium xanthate invalidated the claim because that substance was of no value in flotation. The evidence relied on is the report of Keller in which he describes the combination of ammonium hydrate with alcohol and carbon disulphide to produce what he took to be xanthate. But both Higgins and Dr. Purves agree that ammonium xanthate cannot be so produced and that Keller was wrong in his chemistry.
 20 Whatever the product his mixture gave him, whether good or bad for his purpose, it was not xanthate; and ammonium xanthate has not been shown to be of no utility.

But it would appear that whether we take the expression to signify alkali or alkali metal, the same objection arises. The evidence discloses that cellulose xanthate is a product from ingredients of which the alkali, sodium hydrate, is one; it is then a xanthate embraced within both meanings; and since admittedly it is harmful to the process, the claim cannot stand.

But with this, the language "with a mineral-frothing agent
 30 and an alkaline xanthate adapted to co-operate with the mineral-frothing agent to produce by the action of both a mineral-bearing froth containing a large proportion of a mineral of the ore" must be considered. At trial, the appellant challenged this language as insufficient in not specifying which xanthates were "adapted" and which not. In this interpretation "adapted" relates to the properties of the xanthate necessary to co-operative action, and its effect would be that it would restrict xanthates to those that could be successfully used. Mr. Gowling, in his factum, states that "it simply means that the purpose of mixing the two
 40 substances is to enable them to co-operate together to give the desired result." I must confess to a difficulty in appreciating the sense intended to be conveyed by this but, in my opinion, in any admissible sense the clause cannot be taken validly to restrict the scope of "alkaline xanthate" to those that will co-operate, and the clause does not, therefore, affect the conclusion otherwise reached.

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The second claim, #7, reads :—

“ The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of a xanthate.”

This is met by the formidable objection that “ a xanthate ” means *any* xanthate including cellulose xanthate. It may be convenient to state here that “ cellulose ” xanthate is a description in terms of the organic radical used ; but xanthates are also
 10 known in terms of their metal or of both the metal and radical. The only answer to this is the special interpretation given paragraph 4 with which I have already dealt. The common knowledge contained in the working chemistry dictionaries in 1923 extended to a great many xanthates besides those of soluble metals or alkyl radicals. They had become in fact known to Keller. For these as well as the reasons already given, I must give the language its ordinary meaning and hold the claim invalid.

A second objection is that the claim extends to the use of xanthate without a frothing agent. If it stood alone, I should be
 20 disposed to interpret “ flotation operation ” as including a frothing function. But the express mention of a “ frothing agent ” in claim #9 in collocation with “ flotation operation ” implies there either some special conjunction with the xanthate or that two frothing agents are contemplated, or that “ flotation operation ” is not intended to embrace frothing. The duty of an inventor is to define intelligibly and consistently the boundaries of his exclusive area, and it would be doing violence to this requirement to accept either of the first two suggested meanings ; I must then take it that where a frothing agent is not mentioned
 30 it is intended to be excluded as a requirement. On this ground, also, the claim fails.

Claim #8 is as follows :—

“ The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of potassium xanthate.”

It raises the same question of frothing agent just considered and for the same reason it is defective.

It was urged that the appellant did not use potassium xanthate
 40 within six years preceding the commencement of action. The respondent's answer was both that Exhibit M2 shows that use and that sodium xanthate is a chemical equivalent. The contradiction arises from the fact that the defendant takes potassium xanthate in the claim to mean potassium ethyl xanthate and the respondent that it covers potassium xanthate with any alkyl radical. Paragraph 8 of the specification sets out the method followed by Keller to make potassium xanthate and the ingredients

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used show that he made potassium ethyl xanthate. But that was for laboratory purposes only and there is no implication that it is the only potassium xanthate or that for the purposes of the specification potassium xanthate means that with the ethyl radical. Both amyl and hexyl radicals are mentioned in Exhibit No. 6 listing the xanthates made before 1923. Notwithstanding the evidence of Higgins, that, in common parlance among metallurgists, in the absence of reference to the radical, ethyl is understood, I think the respondents are right in their
10 interpretation.

This in turn raises the question of potassium cellulose xanthate. The metal used in cellulose xanthate, in the manufacture of rayon, is sodium: but the evidence of Bennett is that potassium xanthate of cellulose has the same effect on flotation as the sodium compound, a conclusion which would follow from the fact, agreed upon, that in these compounds the two metals are interchangeable.

Assuming the expression signifies ethyl xanthate, the contention that sodium is, for this purpose, an equivalent must be
20 considered. Both sodium and potassium xanthates, presumably ethyl, are disclosed as having been made and tested and found beneficial to flotation. Potassium was evidently more fully explored than sodium although the latter would appear to be the cheaper product. Both were thought, no doubt, to be protected under claim #7: and we are entitled to ask, why, then, the special claim for the one and not the other? It may be that potassium xanthate was looked upon as the central and basic discovery which would carry with it any such equivalent. But that is a speculation which I do not feel at liberty to act upon. An
30 equivalent is a known substitute means to a certain end; but here sodium xanthate is known as a modifying agent only as it has been discovered as part of the invention. To select one of two substances so discovered is impliedly to exclude the other: otherwise it would be to patent the invented substance not directly but as an equivalent; but the specification makes it quite clear that these two substances are not being dealt with in that manner.

The claim, then, is too broad and fails.

The last is #9:—

40 “The improvement in the concentration of minerals by flotation which comprises subjecting the mineral in the form of a non-acid pulp to a flotation operation in the presence of a xanthate and a frothing agent.”

This the President held valid. He accepted the contention that paragraph 4 defines and limits xanthates for the purposes of the specification, i.e. those containing an alkyl radical and forming anions and cations in solution. With this I have already dealt.

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It is a matter of interest that on the original application in the United States the words were, "as carried out with salts of the alkyl sulphur derivatives"; to change this to "salts of the sulphur derivates . . . containing an organic radical, such as an alkyl radical," is, in my opinion, to put the actual intention of the draughtsman in the Canadian document beyond controversy; and interpreting the paragraph in the context of the specification as plain and unambiguous language, I find it to carry out that intention.

10 On the plain language of this claim, it is bad: there were known to Keller many xanthates which were of no value to the process. In opening the case, counsel for the respondent, speaking of claim #7, stated that "a xanthate" meant "any xanthate" and that I think is precisely what it means in #9. The reconstruction of paragraph 4 now put forward appears to me as an artificial patchwork which imputes meaning beyond the capacity of the words to bear.

As is seen, the claims fail chiefly because of the inclusion of xanthates which are antagonistic or useless to the flotation.
 20 That of cellulose is most prominent, and in this it is the radical, cellulose, that provides the destructive element. There are at least sixteen organic radicals with which before 1923 xanthate had been made; in the tests of Keller the ethyl radical was used almost exclusively: but cellulose which had become well known through the development of rayon was in fact tested and found hostile. In other xanthates it is the metal that is known to furnish that character.

These conclusions diverge from those of the President on the point of the interpretation of paragraphs 4 and 7; and as the
 30 language of these paragraphs is set against that of the claims, we have a good example of the sort of thing mentioned by Lord Loreburn in *Natural Colour v. Bioschemes* [1915] 32 R.P.C. 256:—"Some of those who draft specifications and claims are apt to treat this industry as a trial of skill, in which the object is to make the claim very wide upon one interpretation of it, in order to prevent as many people as possible from competing with the patentee's business and then to rely upon carefully prepared sentences of the specification which, it is hoped, will be just enough to limit the claim within safe dimensions if it is
 40 attacked in court." As in *B.V.D. v. Canadian Celanese* [1937] S.C.R. 221, the claims are wide and general; and for the reasons there given, they cannot be restricted by the language of the disclosure.

Several other objections were raised, the most important of which was that the invention had already been known by Martin, a chemist employed by the parent company of the respondent;

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but in view of the conclusion reached on the claims, consideration of these grounds becomes unnecessary.

The appeal must, therefore, be allowed and the action dismissed with costs throughout.

ESTEY, J. :

This is an appeal from a judgment in the Exchequer Court awarding damages against the appellant for infringement of respondent's Canadian Letters Patent No. 247,576, dated March 10, 1925. This patent was applied for by Cornelius
 10 H. Keller under date of October 23, 1924, in respect of "improvements in froth flotation concentration of ores." The improvements were effected by the introduction of "xanthates or analogous substances" into the froth flotation process. That such improvements were effective is clearly established and infringement is admitted if the patent is valid.

The appellant's contention is that the specification does not adequately describe the invention nor set forth the claims within the meaning of sec. 14 (1) of the Patent Act, S. of C. 1923, c. 23, and therefore the patent is invalid.

20 "14. (1) The specification shall correctly and fully describe the invention and its operation or use as contemplated by the inventor. It shall set forth clearly the various steps in a process, or the method of constructing, making or compounding, a machine, manufacture, or composition of matter. It shall end with a claim or claims stating distinctly the things or combinations which the applicant regards as new and in which he claims an exclusive property and privilege."

The purpose of this section is set forth in 22 Halsbury,
 30 p. 161, art. 388 :

"In order that the public may have sufficient and certain information respecting what they are prohibited from doing whilst the privilege continues, the patentee must particularly describe and ascertain the nature of his invention. In order that, after the privilege is expired, the public may be able to do what the patentee has invented, he must particularly describe and ascertain the manner in which the same is to be performed."

The appellant's first contention, therefore involves a
 40 construction of the specification. My lord the Chief Justice in commenting upon the construction of the specification in *French's Complex Ore Reduction Co. v. Electrolytic Zinc Process Co.* [1930] S.C.R. 462, stated at p. 470 :

"It should not be construed astutely. The patent should be approached, in the words of Sir George Jessel

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‘ with a judicial anxiety to support a really useful invention ’
(*Hinks & Son v. Safety Lighting Co.* (1876), 4 Ch. D. 607,
at p. 612); but, on the other hand, the consideration for a
valid patent is that the inventor must describe in language
free from ambiguity the nature of his invention, including
the manner in which it is to be performed; and he must
define the precise and exact extent of the exclusive property
and privilege which he claims. Otherwise the specification
is insufficient and the patent is bad.”

10 The respondent’s contention is that the foregoing sec. 14 (1)
is complied with; that the language of paras. 2 and 3 of the
disclosure portion of the specification when read together do
limit the substance used to “certain sulphur derivatives of
carbonic acid,” and that in para. 4 the inventor sets forth his
invention.

20 “4. The invention is herein disclosed in some detail
as carried out with salts of the sulphur derivatives of carbonic
acid containing an organic radical, such as an alkyl radical
and known as xanthates, as the new substance. These form
anions and cations in solution. Excellent results were also
obtained by agitating ore pulps with the complex mixture
produced when $33\frac{1}{3}\%$ of pine oil was incorporated with an
alcoholic solution of potassium hydrate, and xanthates or
analogous substances were produced by adding carbon
di-sulphide to this mixture.”

It will be observed that in the foregoing para. 4, the inventor
speaks of “xanthates or analogous substances.” Inasmuch as
the alleged infringements are restricted to the use of xanthates,
we are here concerned only with xanthates.

30 The “certain sulphur derivatives” in paragraph 3 are in this
paragraph restricted to “salts of the sulphur derivatives of
carbonic acid containing an organic radical, such as an alkyl
radical and known as xanthates, as the new substance.” The
parties did not agree as to the meaning of the phrase “sulphur
derivatives.” However, the evidence is to the effect that the
more accurate construction of this phrase would restrict it to
those derivatives in which the S or S’s alone displace one or more
O’s in carbonic acid (H_2CO_3). The sulphur derivatives thus
obtained are five in number and they are the only sulphur
40 derivatives of carbonic acid.

The displacement of the oxygen by the sulphur may take
place according to five different formulæ and the five resulting
acids are known as thiocarbonic acid (the prefix “thio” meaning
“sulphur”). These five acids are known as mono-thio carbonic
acid (H_2CO_2S), di-thio carbonic acid (H_2COS_2), and tri-thio
carbonic acid (H_2CS_3), each of the former having two formulæ.

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From the di-thio carbonic acid having a central carbon with sulphur bonded by two bonds on the left, one with the SH group and one with the OH group, xanthic acid is formed when the hydrogen of the OH group is replaced by an alkyl radical. Then when the H in the SH group is replaced by a metal the result is a di-thio carbonate, or a salt properly described as a "sulphur derivative of carbonic acid." If the metal used be potassium the result is "potassium xanthate."

- The next requirement of paragraph 4 is that these salts
 10 contain "an organic radical such as an alkyl radical." It is around the construction of this phrase "such as an alkyl radical" that much of the controversy centres. The first contention is with respect to the meaning of the word "alkyl." The parties hereto agree that all organic chemical compounds contain carbon and that a radical is an incomplete fragment of a molecule. The respondent's witness Higgins explained that "organic alkyl radicals" are "the residue of the saturated hydro carbon groups." In these saturated hydro carbon groups if all of the C bonds are taken up the result is a product of which methane (CH₄) is one.
 20 If, however, CH₃ is formed, one C bond remains unattached and you have the methyl radical (CH₃). The ethyl radical is C₂H₅. In every radical there is at least one bond of C unattached. The other radicals of the saturated hydro carbon group are propyl, butyl, amyl and hexyl. Higgins would restrict the "alkyl radicals" to these six.

Appellant contends that Higgins' definition of "alkyl radical" is too narrow and that all "aliphatic radicals" should be included under the word "alkyl" when properly defined.

- By agreement the parties filed a list of ninety-one xanthates,
 30 being the only xanthates that in 1923 could be found referred to in scientific literature and that in all of these the radicals are "aliphatic" (as distinguished from the other classification of "radicals" known as "aryl"). These were grouped under sixteen headings, according to their radicals, and six of these groups were the above-mentioned "alkyl radicals." The appellant contends that all of the ninety-one xanthates should be included in the "alkyl" group. If, however, Higgins' definition is accepted, only six of the groups are classified as having "alkyl radicals." The appellant's experts admitted that the Higgins definition "is
 40 a good definition and it is the strictest, most precise, narrowest definition which is accepted in textbooks," and again, "It is clean-cut and very often quoted and very frequently used." The appellant's experts were able, however, to cite authorities which did use the word in a wider sense than that used by Higgins. The evidence of Dr. Purves is pertinent in this regard. He says that all of the radicals in the ninety-one xanthates are "aliphatic" and "all infringe that strict definition in one respect or another."

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The learned President accepted the respondent's contention that the specification should be construed as not to include all "organic aliphatic radicals" and that "such as" means "of the type of" and in this I am in agreement, and the further discussion is on that basis. It is, however, of some significance that Keller and his associates would know of the different senses or meanings given to the phrase "alkyl radical" by the authorities when they adopted the phrase "such as an alkyl radical," and yet not only made no effort to specifically declare that they adopted the

10 Higgins meaning but, as will immediately appear, actually added to the confusion. That the phrase "such as an alkyl radical" was deliberately chosen is apparent from an examination of the application filed for the United States patent on October 23, 1923, where as originally filed the paragraph corresponding to paragraph 4 under discussion read "with salts of the alkyl sulphur derivatives of carbonic acid known as xanthates," which did definitely limit the xanthate to those having an "alkyl radical." That application, however, was amended by striking out the word "alkyl" and inserting after the word "acid" the words "containing an

20 organic radical such as an alkyl radical" and adding the sentence "These form anions and cations in solution." The language of the amendment was adopted in the Canadian application dated one year later, October 23, 1924. It is no longer "alkyl sulphur derivatives" but "sulphur derivatives containing an organic radical such as an alkyl radical." The deliberate insertion of the words "such as an alkyl radical" under these circumstances cannot be construed other than that the inventor intended to include more than "alkyl radicals," but that he did not intend to include all organic radicals.

30 Throughout the evidence the respondent appears to treat the words "such as" to mean not "of the type of" but rather as meaning "restricted to" or "synonymous" with "alkyl radical." This is emphasized by the evidence of Higgins, specifically referring to para. 4, where he states: "That is a more detailed description of his agent, and this introduces, in addition to the sulphur and the metal, the alkyl radical." Again, when his attention was directed to the formula of a di-thio carbonate here in question, he stated the radical "had to be an alkyl radical" in order that the xanthate here desired might be

40 obtained.

Then again, this para. 4 must be read and construed as part of the entire specification. *French's Complex Ore Reduction Co. v. Electrolytic Zinc Process Co., supra.* The respondent contends that the invention is described in paras. 2, 3 and 4 of the disclosure and that in para. 8 thereof he sets forth how he prepared potassium xanthate in the laboratory. The opening words of the first three of these paragraphs are significant: "2. This invention relates

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to . . . ; 3. It has been found that certain sulphur derivatives . . . ; 4. The invention is herein disclosed in some detail as carried out with salts . . . ” In para. 8 the inventor states: “ For laboratory purposes potassium xanthate was prepared as follows . . . ” This language does not suggest that this was “ the method ” but rather that it was but “ a method.” Then at the conclusion of this disclosure he states: “ Having thus described certain embodiments of the invention, what is claimed is . . . ” All of the foregoing goes far to support the appellant’s
 10 contention that the inventor never does define or describe his invention but contents himself with setting forth his findings in a series of experiments. However, approaching the case as presented by the respondent, the foregoing adds to the ambiguity and confusion and does not, nor does any other part of the specification, assist in determining the meaning of the phrase “ such as an alkyl radical.”

The specification must be construed as a whole, but here nothing is found in the claims portion that defines or clarifies the phrase “ such as an alkyl radical.” Claim No. 3 is limited
 20 to “ a salt of an alkyl sulphur derivative.” This again is the very language and limitation in the United States application before the amendment. Claims 4 and 5 refer to ethyl-sulphur derivatives of carbonic acid. These are the more restricted but in other claims the language is sufficiently wide and comprehensive to include xanthates with radicals other than the “ alkyl.” In Claims 6, 7, 8 and 9 here in issue, being the only claims in which “ xanthates ” are specifically mentioned, one finds in para. 6 the phrase “ an alkaline xanthate.” Xanthates are neutral and this phrase is admittedly contradictory and would be so recognized
 30 by one skilled in the art. It was suggested by the respondent that the phrase “ alkali xanthate ” was intended and the appellant admits such would be a reasonable construction. The phrase “ alkali xanthate ” would include the “ alkali metal xanthates ” which may have “ alkyl ” or one of the other radicals mentioned in the course of this litigation. It would include the “ cellulose xanthate ” which does not contain an “ alkyl radical ” but which forms a colloidal solution and is admittedly harmful in the flotation process. Respondent, however, submitted that it was excluded by the draftsmen inserting the words “ adapted to
 40 co-operate with the mineral-frothing agent,” which in this Claim No. 6 immediately follows the words “ alkaline xanthate.” Then in Claims 7 and 8 the word “ xanthate ” is used without any limitation whatever, and here again it would include xanthates with other than “ alkyl radicals.”

The terms “ potassium xanthate ” and “ sodium xanthate ” are used repeatedly throughout both the disclosure and claims without any word of limitation as to their radical content.

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Likewise, the terms “alkaline xanthate” (construed to mean “alkali xanthate”) and “xanthate” appear in the claims without limitation as to their radical content. These terms were in 1923 well known and understood by chemists and metallurgists, certainly to the extent that every one of these xanthates might have “alkyl” or practically any of the other “aliphatic radicals.” Keller does not discover a new xanthate but what he discovers is a new use of xanthate by his introduction of it into the froth flotation process. Therefore those skilled in the art in reading
 10 this specification would conclude that the xanthates used were not those which had only the “alkyl radical.”

A specification may be so drafted as to indicate a special or limited sense in which the terms may be used but here the inventor, so far from doing that, has first adopted clear and definite language, discarded it, and in lieu thereof has adopted terms which are ambiguous and which ambiguity, under the circumstances that here obtain, must have been then apparent. In this regard the language of Lord Parker in *Natural Colour Kinematograph v. Bioschemes Ltd.* [1915] 32 R.P.C. 256, at
 20 p. 269, is pertinent :—

“Further though it may be true that in construing an instrument *inter partes* the Court is bound to make up its mind as to the true meaning, this is far from being the case with a Specification. It is open to the Court to conclude that the terms of a Specification are so ambiguous that its proper construction must always remain a matter of doubt, and in such a case, even if the Specification had been prepared in perfect good faith, the duty of the Court would be to declare the Patent void.”

30 and also the language of Earl Loreburn, at p. 266 :—

“If he uses language which, when fairly read, is avoidably obscure or ambiguous, the Patent is invalid, whether the defect be due to design, or to carelessness or to want of skill. Where the invention is difficult to explain, due allowance will, of course, be made for any resulting difficulty in the language. But *nothing can excuse the use of ambiguous language when simple language can easily be employed, and the only safe way is for the patentee to do his best to be clear and intelligible.*”

40 And in our own Courts, Mr. Justice Maclean in the Exchequer Court stated :—

“If the specification uses language which when fairly read, is avoidably obscure or ambiguous, the patent is void, whether the defect be due to design, or to carelessness, or to want of skill; nothing can excuse the use of ambiguous language when simple language may easily be employed, due

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allowance of course, being made where the invention is difficult to explain and there is a resulting difficulty in the language.” *De Forest Phonofilm of Canada Ltd. v. Famous Players Can. Corp. Ltd.* [1931] Ex. C.R. 27, at p. 43.

The specification as phrased gives no information as to what is meant or included in the phrase “such as an alkyl radical.” Keller found that xanthates with an “alkyl radical” soluble in water effected a substantial improvement in the froth flotation process and the evidence at the trial would indicate that so far
 10 as xanthates were concerned that constituted his invention. The language of the specification, however, is not so restricted. The language there adopted leads the reader into a field that was unknown to the inventor and which in the specification is not defined. In fact beginning with the phrase “sulphur derivatives” almost every important phrase, as already indicated, is so used that issues such as are here raised were almost inevitable. That in itself is indicative of ambiguity and the absence of that clarity which section 14 (1) of the Patent Act contemplates.

This is not a case where the language is open to one or more
 20 constructions and the Court, in the language of Lindley, L.J., in *Needham and Kite v. Johnson & Co.*, 1 R.P.C. 48, at p. 58: “. . . would put upon it that construction which makes it a valid patent rather than a construction which renders it invalid.” The language here used is so vague and ambiguous that in order to attribute to it that clarity and certainty required by the statute we must erase or eliminate the words “such as” and therefore amend rather than construe the language of the specification and thereby restrict the xanthates used in the improvement to those having an “alkyl radical.”

30 Apart from what has already been said, there is another ambiguity inherent in this phrase, and that is the test to be applied to determine what “alkyl” is “such as an alkyl radical.” Should the radical be composed of the same or similar ingredients, or whether its effect in chemical reactions should be as the “alkyl radical” is left entirely to conjecture. Moreover, the evidence is to the effect that once you go beyond the “alkyl radical” as defined by Higgins, it is impossible to find a point where a line can be drawn until the xanthates containing all of the “organic aliphatic radicals” are included. The respondent in this action
 40 makes no such claim. Even if one adds the limitation in para. 4 that they form anions and cations in solution, the specification does not correctly and fully describe the invention as required by sec. 14 (1) (above quoted) of the Patent Act.

As already indicated, the ambiguity persists throughout both the disclosure and claims portion of the specification, and in the claims 6, 7, 8 and 9 herein in question it is not stated

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“ distinctly the things or combinations which the applicant regards as new and in which he claims an exclusive property and privilege,” within the meaning of sec. 14 (1).

The appeal should be allowed with costs.

Formal Judgment.

FORMAL JUDGMENT

IN THE SUPREME COURT OF CANADA
MONDAY, THE 5TH DAY OF DECEMBER, 1949

PRESENT :

THE HONOURABLE MR. JUSTICE KERWIN
THE HONOURABLE MR. JUSTICE RAND
THE HONOURABLE MR. JUSTICE KELLOCK
THE HONOURABLE MR. JUSTICE ESTEY
THE HONOURABLE MR. JUSTICE LOCKE

10 BETWEEN :

NORANDA MINES, LIMITED

Appellant ;

— AND —

MINERALS SEPARATION NORTH AMERICAN
CORPORATION

Respondent.

The appeal of the above-named appellant from the judgment of the Exchequer Court of Canada, pronounced in the above cause on the 28th day of May, 1947, having come on to be heard
20 before this Court on the 30th and 31st days of March, 1949, and the 1st, 4th, 5th, 6th, 7th, 8th, 11th, and 12th days of April, 1949, in the presence of Counsel as well for the appellant as for the respondent, whereupon and upon hearing what was alleged by Counsel aforesaid, this Court was pleased to direct that the said appeal should stand over for judgment, and the same coming on this day for judgment ;

THIS COURT DID ORDER AND ADJUDGE that the said appeal be and the same was allowed and that the said judgment of the Exchequer Court of Canada be and the same was reversed
30 and set aside ;

AND THIS COURT DID FURTHER ORDER AND ADJUDGE that the respondent should and do pay to the appellant the costs incurred by the appellant as well in the Exchequer Court of Canada as in this Court.

(Signed.) PAUL LEDUC,
Registrar.

In the Privy Council
Order granting Special leave to Appeal

L.S.

AT THE COURT AT BUCKINGHAM PALACE
THE 21ST DAY OF JULY, 1950

PRESENT :

THE KING'S MOST EXCELLENT MAJESTY
LORD PRESIDENT
LORD HENDERSON
LORD MORRISON
MAJOR MILNER
MR. WILSON

10 WHEREAS there was this day read at the Board a Report from the Judicial Committee of the Privy Council dated the 18th day of July, 1950, in the words following, viz. :—

20 “ WHEREAS by virtue of His late Majesty King Edward the Seventh's Order in Council of the 18th day of October 1909 there was referred unto this Committee a humble Petition of Minerals Separation North American Corporation in the matter of an Appeal from the Supreme Court of Canada between the Petitioners (Plaintiffs) and Noranda Mines Limited Respondents (Defendants) setting forth (amongst other matters) : that the Petitioners (a company incorporated under the laws of the State of Maryland United States of America and having its principal place of business at 11 Broadway New York in the State of New York United States of America) desire special leave to appeal from a Judgment of the Supreme Court delivered on the 5th December 1949 which by a majority of four to one (*a*) reversed with costs a Judgment of the President of the Exchequer Court of Canada in so far as he decided that claim 9 of the Petitioners' Letters Patent No. 247576 was valid and infringed

30 by the Respondents (*b*) upheld the decision of the President in so far as he decided that claim 6 of the said Letters Patent was invalid and (*c*) decided that claims 7 and 8 of the said Letters Patent (not dealt with by the President) were invalid and that claim 8 was not in any event infringed : that Letters Patent No. 247576 were granted on the 10th March 1925 to the Petitioners as assignees of Cornelius H. Keller who filed an application for the same in the Canadian Patent Office on the 23rd October 1924 : that on the 1st March 1943

**In the Privy Council
Order granting Special leave to Appeal**

10 the Petitioners commenced an action against the Respondents (a Company incorporated under the laws of the Dominion of Canada and having its head office at 941 Dominion Square Building Montreal in the Province of Quebec) alleging infringement of claims 6, 7, 8 and 9 of the said Letters Patent by the Respondents at their mine continuously during the preceding period of five years and claiming the usual relief : that the said Letters Patent relate to the froth-flotation process used in the concentration of ores : that the Petitioners submit that there should be no doubt as to the principles of construction which must be applied to the claims of Canadian Letters Patent particularly where the Courts have found that the description of the invention in the body of the specification is clear and sufficient : And humbly praying Your Majesty in Council to grant the Petitioners special leave to appeal from the Judgment of the Supreme Court dated the 5th December 1949 and for such further or other Order as to Your Majesty may appear fit :

20 “ THE LORDS OF THE COMMITTEE in obedience to His late Majesty’s said Order in Council have taken the humble Petition into consideration and having heard Counsel in support thereof and in opposition thereto Their Lordships do this day agree humbly to report to Your Majesty as their opinion that leave ought to be granted to the Petitioners to enter and prosecute their Appeal against the Judgment of the Supreme Court of Canada dated the 5th day of December 1949 upon depositing in the Registry of the Privy Council the sum of £400 as security for costs :

30 “ AND THEIR LORDSHIPS do further report to Your Majesty that the authenticated copy under seal of the Record produced by the Petitioners upon the hearing of the Petition ought to be accepted (subject to any objection that may be taken thereto by the Respondents) as the Record proper to be laid before Your Majesty on the hearing of the Appeal.”

HIS MAJESTY having taken the said Report into consideration was pleased by and with the advice of His Privy Council to approve thereof and to order as it is hereby ordered that the same be punctually observed obeyed and carried into execution.

40 Whereof the Governor-General or Officer administering the Government of the Dominion of Canada for the time being and all other persons whom it may concern are to take notice and govern themselves accordingly.

E. C. E. LEADBITTER.

No. 40 of 1950.

In The Privy Council

ON APPEAL FROM THE SUPREME COURT OF CANADA

BETWEEN :

MINERALS SEPARATION NORTH AMERICAN
CORPORATION,

Appellants

—AND—

NORANDA MINES, LIMITED,

Respondents.

RECORD OF PROCEEDINGS

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