

UNITED STATES PATENT OFFICE.

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METHOD OF UTILIZING AS FUEL THE VOLATILE PORTIONS OF SULFID ORES.

No. 322,713.

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To all whom it may concern:

Be it known that we, RALPH BAGGALEY, of Pittsburg, Allegheny county, Pennsylvania, CHARLES M. ALLEN, of Lo Lo, Missoula county, Montana, and EDWARD WILLIAM LINDQUIST, of Chicago, Cook county, Illinois, have invented a new and useful Method of Utilizing as Fuel the Volatile Portion of Sulfid Ores, of which the following is a full, clear, and exact description.

No drawings are required to illustrate our present invention, because the art may be practiced in various forms of apparatus—such, for instance, as in converters of all the many designs.

The object of our invention is to make it possible to utilize in the arts, and especially as a means of eliminating the use of carbonaceous fuel in the treatment of ores or in greatly reducing the percentages of carbonaceous fuel that it is now found necessary to use in the treatment of many ores the volatile-fuel constituents that are contained in sulfid ores of all kinds, and more particularly in what are called "bisulfid" ores. We accomplish this result by melting such ores or, in other words, by dissolving them while they are submerged in a bath of molten matte, and while the ore is floating on top of the matte, as in our primary converter described in application Serial No. 243,677, filed February 1, 1905, we introduce a light blast of air at or just above the molten bath in sufficient amount to oxidize all of the volatile portion, which can be regulated and determined by the color of the flame at the mouth of the converter.

SO_2 is a colorless gas, while SO_3 in contact with atmospheric air is a voluminous white smoke resembling escaping steam in its color, but having a slight bluish cast. Where sulfurous fumes that have not been fully oxidized come in contact with free air at a temperature at or above 270° centigrade, they burn with a blue flame, as is always noted in present copper-converter practice.

The object of this invention is to utilize such fumes by supplying the air for their combustion at a point within the converter where the heat so produced can be utilized, and the amount of air thus required can be accurately determined by the operator by

simply observing the color of the escaping gases and adding more air as long as there is a blue flame escaping and not increasing the amount of free air materially beyond this point, since to do so would chill the gases and impair the working of the process. To those not fully conversant with the converting of copper mattes it might appear that this same object could be attained by forcing more air into the converter through the tuyers; but this has not been found to be true in practice. On the contrary, the increase of blast produces one of two conditions. It either accomplishes the converting in less time, or it chills the charge, accordingly as it combines with the sulfur and iron or not. Besides, it requires a heavy pressure to force air through the matte, while as we use the air-blast it is only necessary to give it sufficient pressure to overcome the gas-pressure in the converter above the charge, which is very slight and can be governed by the size of the opening used for the gas-escape.

By this method we secure the perfect combustion of all the sulfur that we volatilize, whether the volatilization has been produced by submergence of the ore or by floating it on the surface of molten matte, and we secure this combustion at a point where we can use it to augment the internal heat of the converter or smelting-furnace. We accomplish this in a manner different from any method now in use.

Attention is called to the fact that the iron, copper, and other metals in the matte which is a monosulfid, are already saturated with sulfur. We do not alter this combination; but, instead of allowing the volatile atom from the ore smelted with the matte to escape as sulfur, we cause it to combine with two parts of oxygen and thus to form SO_2 . This combination produces heat, while the mere volatilization of the sulfur, uncombined as an oxid of sulfur, does not produce available heat. Where this atom of sulfur is set free above the fusion zone of the furnace, as is the case in all shaft furnace-work in which an ore-column is used, the volatile atom is not burned; but it is "evaporated," so to speak, because of a lack of sufficient temperature for burning it at the time it is set free. As

the temperature of the sulfur in the form of this gas is steadily decreased in its flight to the stack as it rises and mingles with the evaporating moisture from the ore and finally with the atmospheric air that enters at the charge-doors and as it travels farther and farther from the source of heat, which is the fusion zone of the furnace, it becomes hopelessly lost as fuel. In our process of sub-
 10 mersion this volatile atom is set free at a smelting temperature and at a point where it can most readily combine with the oxygen of the blast, so that its escape uncombined is impossible, because while rising to the sur-
 15 face it must pass through a molten bath, and it is thus compelled to form a union with the oxygen of the blast and to produce heat as the result of such combustion in its transition from sulfur to SO_2 .

20 Carbon produces heat by combining with the oxygen of the air while forming CO_2 or one part of carbon combining with two parts of oxygen. It may be noted that carbon and oxygen will not combine at ordinary temper-
 25 atures, but only after a sufficiently high temperature has been produced to cause them to unite. Afterward the act of this union produces sufficient heat to cause successive addi-
 30 tions of carbon to rise to the temperature where it can unite with the oxygen of the air. In this way fire may be kept going *ad infinitum* with either sulfur or carbon, as described above. It is essential, however,
 35 ignition point of the elements under consideration. Sulfids of the metals fuse at a temperature of from $1,000^\circ$ to $1,500^\circ$ centi-
 40 grade, and the first atom of sulfur in disulfids distils at a temperature far below the degree of heat necessary to produce fusion. Our invention lies in the fact that we by sub-
 45 mersion release the volatile atom beneath or in contact with a molten bath having a temperature above that which is actually re-
 50 quired to effect this combination and introduce above the bath a supplementary blast of air, as stated above. It has been proven in our work that the utilization of the addi-
 55 tional heat from the oxidation of this volatile atom not only enables us to treat more highly silicious ores without the use of carbonaceous fuel, but it also accelerates the smelting action, so that we are able to report from actual test that we have smelted such
 60 charges in a converter under the above-described conditions in much less time than we can by all present methods in which this volatile atom is lost.

In all present forms of pyritic smelting the blast-furnace is resorted to by experimenters. The inevitable result of this is failure to smelt without carbonaceous fuel for many reasons, chief among which may be mentioned the heavy loss of the fuel atoms, through volatil-

ization, in the ores under treatment. Where 65 bisulfid ores are used in what is called "pyritic" smelting, it is a well-known fact that one-half of the sulfur contents of the ores is volatilized, and thus lost for future use, before the zone of actual fusion in the fur-
 70 nace is reached. If the ores under treatment are at all silicious, this renders a hot blast necessary to secure even the present degree of success. Hot blast costs fuel to pre-
 75 heat it before it enters the furnace. If this enormous loss of sulfur contained in the ore is prevented, the smelting process can be successfully conducted without the expense of providing a hot blast, and where this sul-
 80 fur is successfully utilized as fuel, as in our present invention, ores of a much more silicious nature can be successfully smelted, entirely without the use of a hot blast and en-
 85 tirely without carbonaceous fuel. In conducting a series of experiments in this new method of treating ores without carbona-
 90 ceous fuel we have found that we can successfully practice this art, and we can thus quickly and cheaply reduce ores, even of a highly-silicious nature without carbonaceous
 95 fuel. We have found in our experiments that we are enabled to accomplish this result through utilizing a vastly greater percentage of the sulfur fuel in the ores than has ever
 100 been utilized before or than it is possible to utilize by any present method of smelting where the blast-furnace is used. In other
 105 words, we have found as a result of our experiments that we can accomplish results in a converter—such, for instance, as treating
 110 highly silicious ores without carbonaceous fuel—that cannot be successfully accom-
 115 plished in a blast-furnace.

This method of utilizing the volatile-fuel atoms contained in sulfid ores is broadly new, and we claim that it differs widely from any present practice and from any practice that has existed in the past.

We claim—

1. The method of utilizing the volatile-fuel constituent of sulfid ores which consists in feeding the ore into a body of molten matte, blowing air into the matte, and while the ore is floating in the matte introducing a supplementary blast of air into the converter above the molten matte; substantially as described.

2. The method of utilizing the volatile-fuel constituent of sulfid ores which consists in feeding the ore into a body of molten matte, blowing air into the matte, and while the ore is floating in the matte introducing a supplementary blast of air into the converter above the molten matte, and regulating the volume of air to an amount sufficient to oxidize all the escaping sulfur and insufficient to cool injuriously the resulting gases; substantially as described.

3. The method of utilizing the volatile-fuel constituent of sulfid ores which consists in feeding the ore into a body of molten matte, blowing air into the matte, and while the ore is floating in the matte introducing a supplementary blast of air into the converter above the molten matte, and at the place of contact of the floating ore therewith; substantially as described.

In testimony whereof we have hereunto set our hands.

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Witnesses:

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