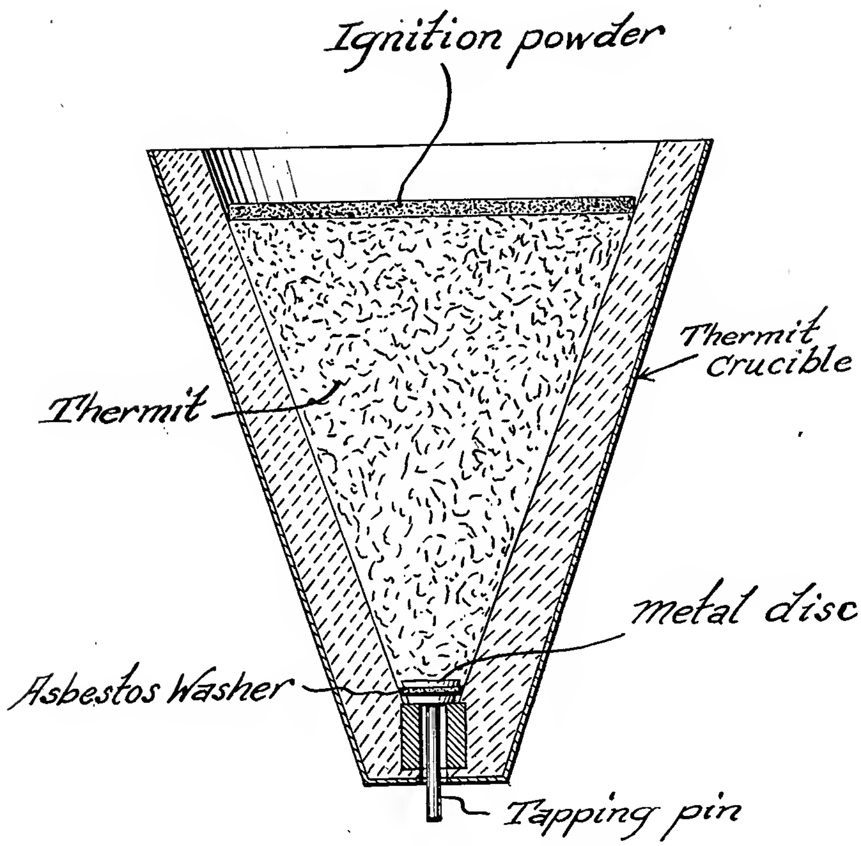
Aug. 19, 1941. F. W. COHEN 2,253,364

IGNITION OF THERMIT MIXTURES

Filed July 27, 1940



Inventor,
F. W. Cohen
By: Henry C. Parker
Attorney.

Patented Aug. 19, 1941 2,253,364

UNITED STATES PATENT OFFICE

2,253,364

IGNITION OF THERMIT MIXTURES

Frederick W. Cohen, Upper Montclair, N. J., assignor to Metal & Thermit Corporation, New York, N. Y., a corporation of New Jersey

Application July 27, 1940, Serial No. 347,965

4 Claims. (Cl. 75—27)

This invention relates to ignition of Thermit mixtures; and it comprises a novel method of igniting Thermit mixtures wherein a mass of Thermit powder is placed in a crucible and ignited across substantially the entire top of the mass, this being usually accomplished with the aid of an easily-combustible ignition powder, whereby a self-propagating horizontal zone of ignition is formed having an area substantially corresponding to the cross section of the crucible, said zone traveling downwardly to the bottom of the crucible at a substantially uniform and controlled rate, thereby producing a highly efficient reaction with reaction products at a maximum, uniform temperature; all as more fully hereinafter set forth and as claimed.

The word "Thermit" is a trade-mark, owned by Metal & Thermit Corporation of New York, used on mechanical mixtures of metal oxides and metals, such as iron oxide and aluminum, the metals employed having a higher affinity for oxygen than the metal of said metal oxide, whereby upon ignition of the mixture the metal originally present reduces or de-oxidizes the metal oxide producing free metal, usually in the molten state, as well as a metal oxide slag derived from the metal originally present.

Probably the most important early contribution to the alumino-thermic art was that which is described in the early U. S. patent to Hans Goldschmidt, No. 578,868. In this patent the patentee acknowledges that the alumino-thermic reaction was well known and had been used previously for producing metals and alloys. He mentions the fact that the reaction, as then conducted, was very violent causing the loss of material from the crucible and waste of fuel used for heating the same. His contribution was the discovery that a cold Thermit powder could be satisfactorily ignited "at one point or place of the mass" preferably by the use of an ignition powder, the reaction proceeding throughout the mass without the explosive violence which marked the former practice of heating the crucible until reaction occurred. This discovery of Hans Goldschmidt marked the beginning of a substantial growth in the use of the alumino-thermic reaction in industrial applications, which growth has continued to the present day.

Since Hans Goldschmidt there has been little if any improvement made in the method of igniting Thermits. The Goldschmidt ignition powders are still used, although some improvements have been made in these powders, and the cold Thermit mass is still ignited at one point, usually in the top of the crucible. For a number of years, however, it has been evident that a closer control of the Thermit reaction is highly desirable if not essential in order to adapt this process to the many uses for which it has been recommended.

While Goldschmidt substantially reduced the explosive character of the Thermit reaction by igniting the mass at one point instead of by heating the crucible until reaction commenced, the ensuing reaction never-the-less has always been violent as well as erratic. The vagarities of the usual Thermit reaction, produced by the ignition at one point of a cold mass of Thermit in a crucible, include a variation in the time as well as the efficiency of the reaction. The slower reactions have the lower efficiencies. And it has been found that the loss of efficiency which accompanies the slow reactions results to at least some extent in a loss of Thermit, which goes into solution in the steel and the slag without reacting. Any iron oxide or aluminum which may dissolve in the steel in this manner is, of course, detrimental. But a more serious result of the erratic nature of the Thermit reaction, as usually conducted, has been the fact that the temperature of the Thermit metal obtained could not be accurately predetermined.

The superheat obtained in the Thermit metal and molten slag is one of the most valuable of the products recovered in the Thermit reaction. This superheat is, of course, what makes Thermit welding possible. But in the welding process it is necessary to preheat the parts to be welded and, unless the temperature of the Thermit metal can be accurately predetermined, it is impossible to determine to what temperature the parts should be preheated. Underheating causes insufficient welding and overheating results in the burning of the metal.

The shorter the time of the Thermit reaction, the hotter the Thermit metal which is obtained. The time required for the Thermit reaction is usually between 25 to 30 seconds, depending to some extent upon the size of the crucible. But as mentioned previously this time varies erratically from one charge to the next when the charge is ignited at one point in a crucible. And the cause for this variation was apparently unknown prior to the present invention.

I have discovered a method of igniting Thermit mixtures in the crucible which results in a reaction of substantially reduced violence in spite of the fact that the reaction time is reduced. While studying the cause for the extreme violence produced at the end of the reaction, when a crucible of Thermit powder is ignited in accordance with the practice first suggested by Hans Goldschmidt, I found that the course of the reaction in the crucible is about as follows: The ignition powder ignites the Thermit at one point forming a mass of Thermit metal. This molten mass of metal, being heavier than the mixture, falls downwardly through the powder and ignites the Thermit with which it comes in contact on its way to the bottom of the crucible and, of course, increasing in size on its downward path. The ignition is also propagated in a horizontal plane by what might be called a progressive or chain reaction, the reaction of particles in the charge causing the liberation of sufficient heat to cause the reaction of the adjacent particles. But this occurs at a rate which is considerably slower than the rate of fall of the mass of molten metal. The result is that a substantial pool of molten metal is formed in the bottom of the crucible before the bulk of the Thermit in the top of the crucible has become ignited. The unreacted Thermit floats on top of this pool of metal. At this point in the reaction, the unreacted Thermit is heated by radiation and conduction from the pool of superheated metal and it soon reaches reaction temperatures en masse, in a manner very similar to that which occurs upon the heating of a Thermit-containing crucible from the outside, as in the method used prior to the invention of Hans Goldschmidt. The unreacted mass of Thermit remaining in the crucible therefore reacts with extreme violence and may even throw some of the molten products out of the crucible.

I have found that any substantial heating of the Thermit mass from below must be avoided, if this type of reaction is to be eliminated. In other words, the zone of ignition should be propagated horizontally or downwardly but not upwardly, which means that the Thermit mixture in the top of the crucible must be substantially reacted before any substantial pool of metal collects in the bottom of the crucible. And I have found that this result can be accomplished in a convenient manner with but little change in the usual technique of igniting the crucible of Thermit.

I have found that, if the entire top surface of the Thermit mixture in the crucible is ignited substantially at one time, this produces a horizontal zone of ignition which travels downwardly through the crucible causing the substantially complete reaction of the Thermit during its progress to the bottom of the crucible. The progressive or chain type of reaction is preserved throughout. The Thermit is uniformly and progressively ignited from the top downwardly and therefore heating from below is avoided. There is no unreacted Thermit mixture to be heated en masse to reaction temperatures and thereby caused to react with the usual violence. A more uniform, albeit a more rapid, reaction results. The time of reaction is reduced from 25 to 40 per cent, depending upon the size and shape of the crucible. And, surprisingly, this time of reaction is accurately reproducible in spite of its shortness. There is no loss of Thermit or slag from the crucible and the composition of the Thermit metal can therefore be predetermined with a degree of accuracy hitherto unobtainable. The Thermit metal obtained is at a higher temperature and the temperature obtained in succeeding reactions is uniform and therefore can be accurately predetermined.

The unexpected results described above can be obtained, as mentioned, by igniting substantially the entire top surface of the Thermit mass at one time. This is, of course, most easily accomplished by the use of an ignition powder which is spread over the top surface of the Thermit in the crucible. But in order to obtain the desired results it is not necessary that the ignition powder cover the entire surface of the Thermit mass but only that it be distributed across this surface in such manner that the top surface is completely ignited before the formation of any substantial pool of Thermit metal in the bottom of the crucible. I have found that this can be accomplished, for example, by placing the ignition powder on top of the Thermit in the shape of a cross, the arms of which extend substantially to the wall of the crucible. It is also possible to secure the desired result by the use of a ring of ignition powder spaced approximately midway between the center and the wall of the crucible.

In conducting the present invention any of the usual ignition powders can be employed. In the Goldschmidt patent it is suggested that suitable ignition powders may be made by mixing powdered aluminum with easily reducible compounds, such as lead oxide and barium peroxide. It is usually advantageous to use the oxidizing agent and aluminum in amounts which are substantially chemically equivalent and improved results are obtained if a little of the Thermit powder to be ignited is incorporated. The ignition powders thus produced have a rate of combustion which is substantially greater than that of the Thermit proper. This ignition powder can be spread loosely on top of the Thermit in the crucible or it may be compressed into the form of briquets of any desired shape. The ignition powder can be ignited by means of a magnesium band, as described in the Goldschmidt patent, or by means of a match, or by touching it with a hot iron rod.

My invention can be described more specifically in connection with the accompanying drawing which shows, more or less diagrammatically, a vertical cross section through a Thermit crucible which is charged with a Thermit and ignition powder, ready to be ignited in accordance with the process of this invention. The figure is provided with descriptive legends which are believed to be self explanatory.

The crucible shown is constructed with the usual magnesia lining and is provided with a tapping pin at the bottom. An asbestos washer is placed above the tapping pin and a metal disc, adapted to be fused by the reaction products, is placed above the washer. The Thermit charge fills the bulk of the crucible and on top of this is shown the ignition powder which, in the embodiment illustrated, is in the form of a layer covering the top of the charge. The crucible is usually provided with a cover which is not shown.

While I have described what I consider to be the best embodiments of my process, it is obvious, of course, that the various specific procedures which have been described can be altered in many particulars without departing from the purview of this invention. My invention can be applied in the case of all of the usual types of Thermits. It is particularly applicable to the ordinary iron Thermit which is widely used in the Thermit welding art.

While I have mentioned that the ignition powder can be distributed entirely across the top of the Thermit or in the form of a cross or a ring, it is possible, of course, to devise additional configurations which will produce the desired results provided that the ignition powder covers at least a large portion of the top surface of the Thermit mass. A series of concentric rings can be used, for example, or the ignition powder may be merely placed in spaced points across the top of the Thermit. As stated previously it is only necessary that the top of the Thermit mass be ignited substantially completely and simultaneously in such manner as to form a horizontal zone of ignition which then travels downwardly to the bottom of the crucible while reacting the Thermit in its path, heating of the Thermit from beneath being thus substantially avoided. In other words, the reaction must be conducted in such a way that the mass of Thermit is substantially reacted before the formation of any substantial pool of molten Thermit metal at the bottom of the crucible. Other modifications which fall within the scope of the following claims will be immediately evident to those skilled in this art.

What I claim is:

1. The process of igniting Thermits which comprises placing a mass of Thermit in a crucible and quickly igniting it across substantially the entire top surface of the mass, whereby a self-propagating, horizontal zone of ignition is formed having an area substantially coinciding with the cross section of the crucible, resulting in a Thermit reaction of substantially uniform intensity and a Thermit metal having a maximum, predetermined temperature.

2. The process of igniting Thermits which comprises placing on the top of a mass of Thermit an ignition powder having a rate of combustion which is substantially greater than that of said Thermit, said ignition powder covering at least a large portion of the top surface of said mass, being in contact with said mass and being distributed in such fashion as to produce, when ignited, a self-propagating, horizontal zone of ignition substantially coinciding with the cross section of said Thermit mass, then igniting said ignition powder, thereby producing a Thermit reaction of substantially uniform intensity and a Thermit metal having a maximum, predetermined temperature.

3. The process of igniting Thermits which comprises placing a mass of Thermit in a crucible, placing on the top surface of the mass an ignition powder having a rate of combustion which is substantially greater than that of said Thermit, said ignition powder being disposed in the form of a cross, the arms of which extend close to the wall of the crucible, and igniting the ignition powder thereby producing a self-propagating, horizontal zone of ignition substantially coinciding with the cross section of the crucible, resulting in the production of a Thermit reaction of substantially uniform intensity and a Thermit metal having a maximum, predetermined temperature.

4. The process of igniting Thermits used in Thermit welding processes which comprises placing a mass of an iron Thermit in a crucible provided with a tap in such manner as to produce a substantially horizontal top surface, distributing an ignition powder across a substantial portion of the top surface of said mass in contact therewith and in such configuration that, upon ignition, the top surface of said Thermit mass will become completely ignited before the formation of any substantial pool of Thermit metal in the bottom of the crucible, and igniting the ignition powder thereby producing a Thermit reaction of substantial uniform intensity and a Thermit metal having a maximum predetermined temperature prior to the tapping of the crucible, said ignition powder being one having a rate of combustion substantially greater than that of said Thermit.

FREDERICK W. COHEN.