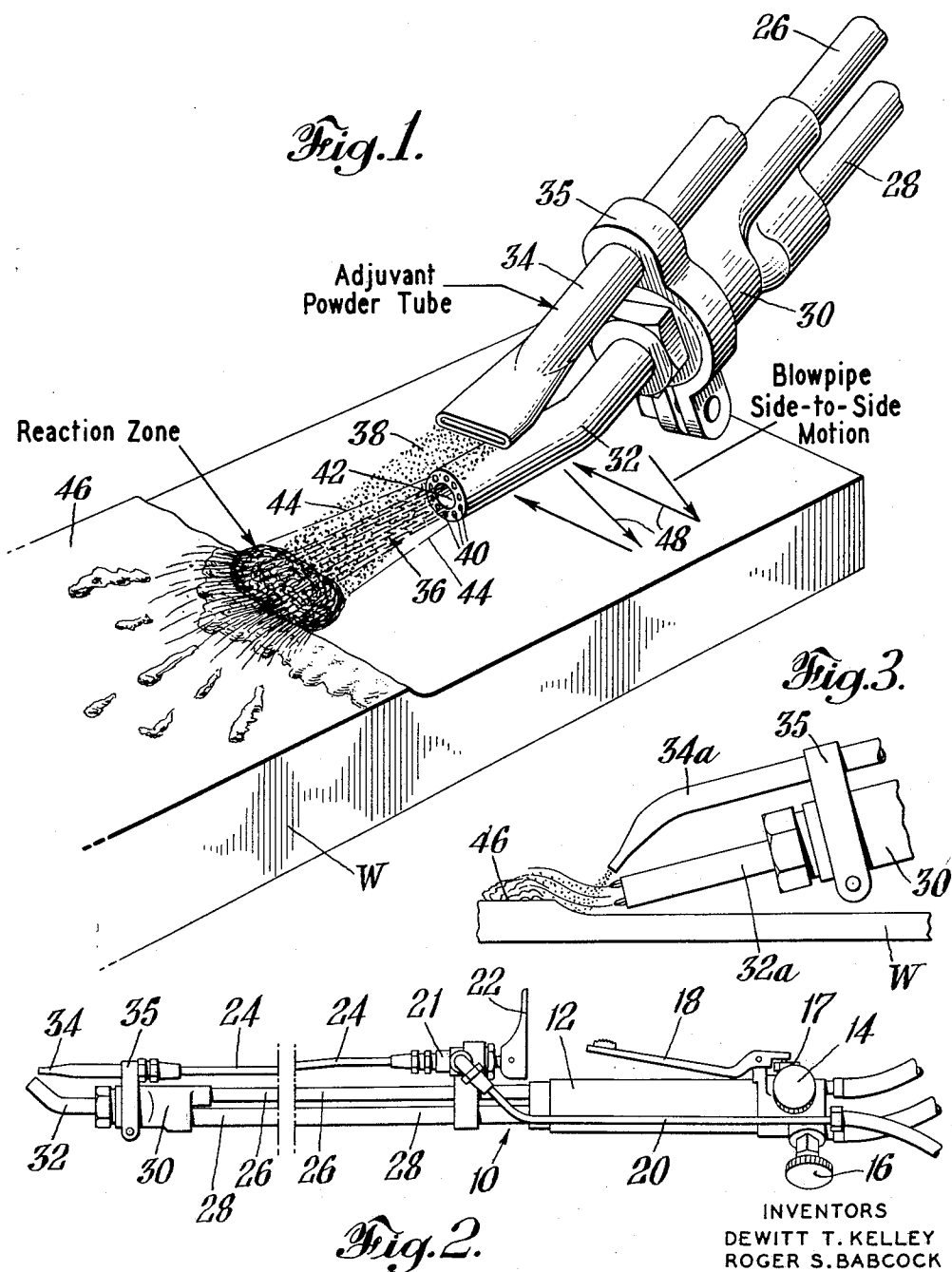


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POWDER WASHING APPARATUS
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POWDER WASHING APPARATUS

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This invention relates to powder washing, and more particularly to apparatus for the thermochemical removal of metal, or refractory substances of the sand type from metal bodies or structures, especially castings.

After a casting has been removed from the mold, loosely adherent sand is usually dislodged by mechanical shakers. Molding sand which sticks in pockets or crevices is later loosened with a pneumatic tool. The exact sequence of the cleaning procedure may vary; however, the next step usually is to remove risers with a conventional oxygen cutting blowpipe. The casting may then be shotblasted to remove additional sand.

The riser cutting operation leaves a riser pad which itself must be removed. The method selected to remove the riser pad depends upon its size and location. Typical prior methods for removing riser pads are: grinding, chipping, machining, and oxygen scarfing.

Several types of grinders are in use. They can be classed as either portable grinders or swing grinders. General foundry practice requires the casting to be transported by overhead cranes to the grinders.

Pneumatic chipping is a method for removing fins, chaplets, chill nails, sand incrustations, and penetrations. As in the case of grinding, the castings are moved from the cutting floor to an area where the chippers are located. All of such methods are time consuming and expensive. The foundrymen have had no relief from continually rising labor and overhead costs and have, therefore, looked searchingly for ways of accomplishing casting cleaning by quicker and less expensive methods.

Three types of oxygen working have been intermittently applied, with little success, to the casting cleaning problem, namely: oxygen scarfing with or without powder; oxygen gouging; and conventional oxygen cutting with or without powder.

Oxygen scarfing, also called deseaming, involves a relatively large volume stream of oxygen of relatively high velocity. The operation proceeds at a relatively high speed—40 feet per minute is an average rate. A continuous, straight-line pass is made, followed by successive adjacent passes to remove a thickness of $\frac{1}{16}$ -inch or more from the body being processed. Such scarfing is best adapted to removing defective surfaces from billets or similar pieces which have a symmetrical cross-section and are of reasonable length. The included angle of incidence of the nozzle axis to the surface plane is seldom greater than 35 degrees. The scarfing process with or without powder has been used on castings, but it is not well suited to this type work, because of the relatively small area of the riser pads, etc. Another reason is that it is impossible to change direction because of the speed of the operation. This speed is a function of the cutting oxygen stream velocity which is in the neighborhood of 900 feet per second. A further reason is that the scarfed surface is left with ridges between passes.

Oxygen gouging has also been applied to casting cleaning with little success. Oxygen gouging is best differentiated from scarfing by its slower progressive speed and better directional control. Representative gouging speed is about 2 to 4 feet per minute as compared to 40 feet per minute for scarfing. Although gouging has not been very useful for casting cleaning, it has found much favor in foundries for cleaning out cracks for subsequent welding

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repair. In an operation of this nature defective material of variable depth and width must be removed. On the other hand, control of the cut is reduced when a very light cut is to be made. Gouging provides good flexibility in making cuts of varying depth and for following irregular contours. This control is made possible by the low-velocity gouging oxygen stream which results from a restriction or spud placed near the exit end of the gouging oxygen passage in the nozzle. As in the case of scarfing, the line of gouging action is straight, except in those cases where reasonable deviation from a straight line is necessary. The included angle of incidence of the gouging oxygen stream to the plane of work surface is appreciably less than in the case of scarfing.

Conventional oxygen cutting with or without adjuvant powder is most obviously unsuited to metal washing operations. This is due to the small cross section and relatively high velocity of the cutting oxygen stream. An oxygen jet of this type is designed specifically for severing operations. Here, the included angle of incidence of the cutting oxygen jet to the plane of workpiece surface is seldom less than 45 degrees. It is usually normal to the surface and the nozzle is moved manually or mechanically in any desired direction over the workpiece. In some cases, a trimming cut is made after the riser is removed and during the trimming cut the nozzle is frequently parallel to the casting surface which remains after riser removal.

Thus, prior to the present invention the problem of quickly and economically cleaning castings remained, to a large extent, unsolved.

The main object of this invention, therefore, is to provide means for thermochemically cleaning and conditioning the surfaces of ferrous metal castings with substantial savings of time, labor and material compared to the prior art. Another object is to provide novel apparatus for thermochemically washing metal castings that is effective, not only for removing defects such as sand trapped or cast in the surfaces but, at the same time, is also suitable for removing metal projections, or imperfections, from the castings. A further object is to provide a powder washing blowpipe that is efficient in operation and easy to manipulate. Other objects will appear from the following description.

According to the invention there is provided means for the thermochemical removal of metal and sand or the like from steel bodies wherein a relatively flat stream of finely divided powder, preferably iron conveyed by air at a velocity of 50–250 feet per second is superimposed on a relatively low velocity (200–500 feet per second) round stream of oxygen, so that the exothermic burning of the iron powder aids the oxidation of the base material and acts to flux the resultant oxides and sand away from the casting. Such streams are moved with a novel side-to-side motion of the streams across the width of the area to be treated, and gradually forwardly of the length of the area. As a result, slag does not accumulate on the adjacent areas, and the process is faster, more economical, and uses less powder than prior oxygen processes; it is faster and more economical than grinding; and provides, in some cases, the only way of reclaiming castings which have extensive penetrations, thereby saving expensive castings which otherwise would have to be scrapped.

The apparatus of the invention includes a portable blowpipe which comprises the combination of a tubular nozzle having a relatively large central passage for discharging a substantially round stream of oxygen, and a plurality of relatively small passages for discharging combustible gas jets around such stream, with a separate relatively flat nozzle having a passage for discharging a sub-

stantially flat stream of air-borne adjuvant powder, and means connecting said nozzles in spaced relation so that the extended longitudinal axes thereof form an acute included angle in front of the nozzles, with the major transverse axis of the flat nozzle lying in a plane which is substantially at right angles to a plane containing such longitudinal axis. The ratio of the width of the flat powder discharge nozzle in the direction of such major transverse axis to the diameter of the round oxygen discharge nozzle should be kept within the limit of 1-3 to 1 for best results.

The blowpipe of the invention is highly suitable for all powder washing operations such as removal of gate stubs, shifts or offsets, chill rods and bars, reinforcing nails, "burned-in" sand, and penetrations (sand in matrix of steel). It is particularly adaptable to medium size castings which require an appreciable amount of metal removal.

The invention includes the following general advantages:

(1) When applied to other than light fins, powder washing greatly reduces fin chipping and grinding—a very real advantage in view of great scarcity of trained chippers in foundries. (On light fins, powder washing time is about the same as chipping time.)

(2) Powder washing either eliminates or minimizes pad grinding time.

(3) When applied to sand removal, powder washing reduces hours of chipping to a matter of minutes.

(4) Because of the versatility of our powder-washing equipment, powder washing can often be used on surfaces which are relatively inaccessible to other methods of metal removal.

(5) With practice, powder washing frequently produces surfaces which are as smooth as the casting surface itself.

In the drawing:

FIG. 1 is a perspective view of powder washing blowpipe apparatus, illustrating the invention, in use;

FIG. 2 is a view in side elevation of a preferred powder washing blowpipe embodying the invention; and

FIG. 3 is a similar (fragmentary) view of a modification.

As shown in the drawing, blowpipe 10 comprises a handle 12 at the back of which are located an oxygen throttle valve 14 and an acetylene, or fuel gas, throttle valve 16, as well as a cutting oxygen valve 17 having a lever 18 extending forwardly over such handle. A powder inlet tube 20 extends alongside the handle 12 and leads to a powder valve 21 having an upwardly extending finger-piece 22 located in front of the lever 18. Pipes 24, 26 and 28 conduct the air-borne powder, cutting oxygen, and oxy-acetylene mixture, respectively, forwardly to the head 30 of the blowpipe, which head is provided with a tubular nozzle 32 and a separate flat nozzle 34 having a divergent section as illustrated in FIG. 1. Such nozzles are connected by a clamp 35.

The tubular nozzle 32 is bent toward the flat nozzle 34, as shown, and has a central passage from which a round stream of oxygen 36, FIG. 1, is discharged when the lever 18 is moved toward the handle 12. Likewise, a flat stream of air-borne powder 38 is discharged from the nozzle 34 when the finger-piece 22 is operated. The nozzle 32 is also provided with an annular series of passages 40, surrounding the central passage 42, for discharging a plurality of jets of oxy-acetylene (or oxy-fuel gas) flames 44 in the same general direction as the oxygen stream 36. In use the blowpipe 10 is held in the manner of an automatic rifle or billiard cue.

As shown in FIG. 1, the process comprises applying at an acute included angle against the surface 46 to be washed a round, gouging-velocity stream 36 of commercially pure oxygen which is surrounded by flames 44 extending in the same general direction as such oxygen stream, simultaneously applying against such surface 46 at a somewhat greater acute included angle a flat stream of air-borne powder 38 composed mainly of iron, and

manually swinging the blowpipe head 30 from side-to-side and forwardly, thereby moving such streams and flames transversely back and forth across such surface while advancing them along the surface in the general direction of such streams, as shown by the arrows 48. The resulting thermochemical reaction with the material of the work W, cleans the surface by removing incrustations and other foreign matter therefrom as a result of the combined melting and planing action of such flames and oxygen and air-borne powder streams.

The oxygen gouging nozzle 32a may be straight and the powder nozzle 34a may be bent as shown in FIG. 3; or both nozzles may be bent, as desired, without departing from the invention.

The process of the invention is especially recommended for the following:

(1) Fin washing where foundries must remove fin-like projections from large surface area steel castings. (Sand may or may not adhere to fins in fillet at junction with casting.)

(2) Pad washing which consists of removing stumps which remain on castings after gates and risers have been cut away.

(3) Removal of defects in steel casings attributed to mold (including core) sand—for example, removal of sand blisters, sand inclusions, or sand penetrations. Defects and their causes are considered in detail immediately below under separate heading. (The core is that portion of a mold which produces hollow interiors within castings).

(4) Contour washing where it is necessary to smooth down the surface of castings and remove adhering particles of sand and scale.

(5) Washing of repair welds when necessary to remove excess weld metal.

Prior to the present invention the uses of adjuvant powder for scarfing or cutting carbon or alloy steels and cast iron were well established. Also, the application of low-velocity oxygen cutting as applied to rivet washing or gouging operations were likewise common to industry. The problem therefore was one of combining the use of adjuvant powder with the low-velocity gouging process. An unexpected result was that the addition of powder solved the problem of making very shallow cuts with the gouging process. Powder also added greatly to the control for sudden changes of direction. Another result was that the heated slag and its fluxing action washed out more effectively troublesome sand incrustations and penetrations.

The next step was to determine how the powder should be introduced. Experimentation with internally-fed powder, that is powder suspended in and borne by the cutting oxygen, was found to be inefficient because dilution by the powder bearing air interfered with the cutting oxygen efficiency. The powder quickly eroded the cutting oxygen passage, and contributed greatly to sintering difficulties on the inside surfaces of the cutting oxygen passage near the nozzle exit.

At this point it should be noted that a somewhat parallel problem existed in powder scarfing wherein the solution was the superimposition of the powder stream on the scarfing oxygen stream. It was concluded from past experience, however, that the combination of a slotted powder nozzle and a slotted scarfing nozzle could not be well adapted to controlled operation in all positions and in varying directions. Powder scarfing is done in the down-hand position. It was therefore decided that a powder nozzle of circular cross section should be used with a conventional low-velocity gouging nozzle.

The results were encouraging but, because of an uneven reaction zone, a scalloped effect was produced on the finished surface. It was also found that sintering occurred in the gouging oxygen passage because of the close proximity of the powder and oxygen discharge points which was necessary to obtain optimum conditions. It was further observed that there was too high a concentra-

tion of powder in the center of the reaction zone; this uneven distribution tended to cause erratic operation. Nevertheless, there was indication that the apparatus could be operated in all positions as would be necessary in the cleaning of a casting. At this point, we discovered that the usual continuous, straight-line progression of the cutting action could be improved on with a side-to-side motion. Such side-to-side weaving action relieved the slag overlay problem and contributed to the efficiency of metal removal.

In order to distribute the powder more evenly over the top of the oxygen stream, and to deposit an overlap of powder on each side to facilitate the weaving motion, one of the circular powder tubes was formed into a crescent shape. The profile of this powder slot therefore conformed to that of the top half of the oxygen stream.

A very pronounced improvement in flatness of scarf and efficiency over that obtained with the round powder stream on round oxygen stream resulted. It next occurred to us that a crescent shaped powder tube would be relatively expensive to manufacture. As a result, we tried a flat, slotted powder tube with even better results.

We have determined that the cutting oxygen flow should be 400 to 500 c.f.h., the preheat acetylene and preheat oxygen flow should be approximately 100-125 c.f.h. each, and the powder flow should be 15-20 lbs. per hour. The ferrous base powder should be free flowing and should pass through 100 mesh screen. Best results are obtained where iron powders, whose total iron content is 94-99 percent, are used. The width of the slotted discharge passage in the direction of the major transverse axis thereof should be no less than the diameter of the round oxygen discharge passage, and no more than three times such diameter. Below such limits a side-to-side washing motion is difficult to maintain without a loss of the reaction. Above such limits powder is wasted with resultant excessive usage.

Powder washing, using the apparatus described herein, is faster, more economical, and uses less powder than other methods. It is faster and more economical than grinding, and makes possible the reclamation of castings which have extensive penetrations and otherwise would have to be scrapped.

This application is a continuation-in-part of our application Serial No. 398,553, filed December 16, 1953, now abandoned which is in turn a division of our application Serial No. 266,388, filed January 14, 1952 now Patent No. 2,735,796.

We claim:

1. Portable blowpipe apparatus for manually thermochemically washing ferrous metal castings with a side-to-side motion across the width of the area to be washed, comprising the combination of a tubular nozzle having a round central passage for discharging a round stream of oxygen, and a plurality of relatively small passages for discharging combustible gas jets around such stream, with a separate nozzle having a single flat passage provided with a divergent section for discharging a flat stream of evenly distributed gas-borne powder composed essentially of iron, means connecting said nozzles in spaced relation so that the extended longitudinal axes thereof form an acute included angle in front of the nozzles, with the major transverse axis of the powder nozzle lying in a plane which is substantially at right angles to a plane containing such longitudinal axes, and means for supplying oxygen at 400-500 c.f.h. to said central passage and powder at 15-20 pounds/hour to said powder nozzle, the width of said flat powder discharge passage in the direction of the major transverse axis thereof being no less than the diameter of said round oxygen discharge passage and no more than three times such diameter.

2. Blowpipe apparatus as defined by claim 1, in which at least one of the nozzles is bent.

3. A manual powder washing blowpipe comprising the combination with an oxy-acetylene gouging nozzle having an orifice adapted to discharge a round stream of oxygen, and means for supplying oxygen thereto at a flow rate of 400-500 c.f.h. of an adjuvant powder nozzle mounted adjacent thereto and having a single flat passage provided with a divergent section adapted to discharge a flat stream of uniformly distributed gas-borne powder at an acute included angle toward such oxygen stream, and means for supplying powder thereto at a flow rate of 15-20 pounds per hour, the width of said flat powder discharge passage in the direction of the major transverse axis thereof being no less than the diameter of said round oxygen discharge passage and no more than three times such diameter.

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