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METHODS OF COATING CATALYST CARRIERS

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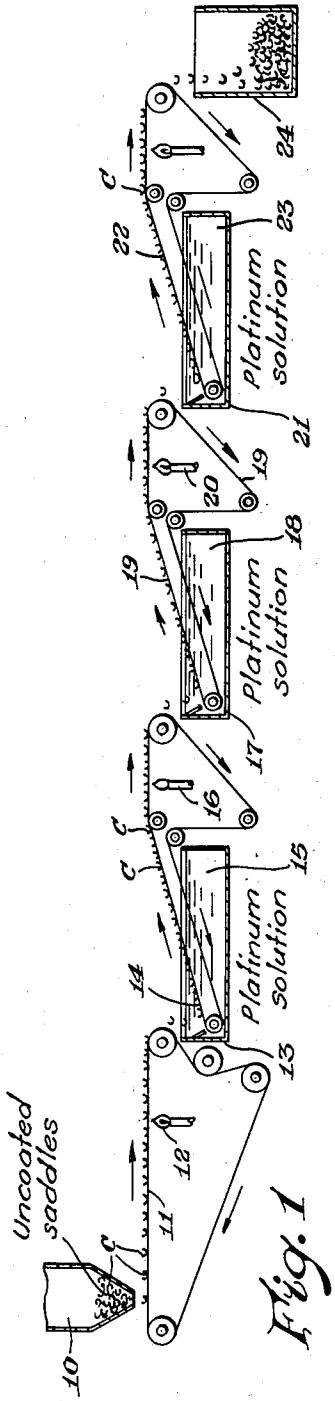



Fig. 1

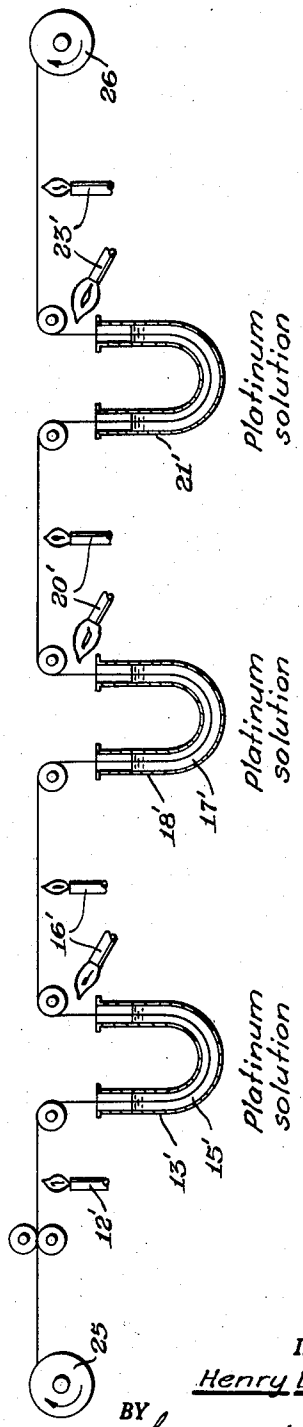



Fig. 2

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# METHODS OF COATING CATALYST CARRIERS

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10 Claims. (Cl. 117—46)

This invention relates to a method of coating catalyst carriers.

Catalyst-coated carriers of the type to which I have reference have just recently been developed for use in household incinerators to burn the odorous off gases of incineration at temperatures far below those normally required for their combustion. My assignee's co-pending applications Serial Nos. 488,888 and 488,889 set forth in detail the construction of the catalyst units which are employed, and describe the carriers for the platinum or palladium coatings which serve as the catalytic agents. Various methods of depositing the catalytic agents in combined or free state have been suggested, however no one has to my knowledge discovered a process as simple and practical as the one to be outlined wherein the catalytic agents themselves are thought to promote their deposition to such an extent that the process can be used to coat carriers of a designated shape in an amazingly rapid and efficient manner with very simple and inexpensive equipment. Obviously, when concerned with the problem of mass producing incinerators containing catalytic units at a price which is well within the range of the average householder and which is competitive with incinerators without catalytic units it is important to develop a process which is as efficient and economical as possible. This is particularly true in view of the relatively high cost of the catalyst metals concerned since any wasting of the metals in the process adds appreciably to the cost of manufacture.

One of the foremost objects of the instant invention is accordingly to provide a coating or metallizing process wherein the steps or stages of treatment in the process can be very rapidly performed in a highly reliable and efficient manner while the carriers are traveling on conveyor means which passes them continuously through the necessary processing apparatus.

Another object of the invention is to provide an improved method of the type outlined which is capable of producing coatings of greater thickness and comprising a greater percentage of free catalytic metal in an uncombined state than has heretofore been possible.

A further object of the invention is to provide an improved method of coating a catalyst on catalyst carriers which securely lodges the metal on the carrier in a manner to provide a surface which has a fine grained texture.

Another object of the invention is to provide a method or process such as described which provides a coating of uniform thickness and density on the entire surface of the carrier and does not leave uncoated areas which have no catalyzing value.

A further object of the invention is to provide a method or process such as described which requires only very simple and inexpensive processing apparatus which can be very readily set up to form a relatively compact production line.

Another object of the invention is to provide a metallizing process which does not require the use of a flux such as would provide the problem of uniformly dispersing the same in a mixture with the metal over the carrier, and



further does not require the use of a stabilizing agent to maintain a metal powder in suspension.

Briefly, the process comprises the steps of cleaning the carrier, applying an aqueous solution of a suitable platinum or palladium compound, to the carrier, firing the carrier in a fuel flame which is surrounded by non-combusted fuel vapors whose burning may be catalyzed, and repeating the steps of applying the solution and firing the carrier until a firmly adhering coating of metal in a practically pure state is deposited on the carrier in the desired thickness.

With the above and other objects in view, the present invention consists in the combination and arrangement of parts hereinafter more fully described, illustrated in the accompanying drawing, and more particularly pointed out in the appended claims, it being understood that equivalent changes may be made in the various elements which comprise the invention without departing from the spirit thereof or the scope of the appended claims.

In the drawings:

Fig. 1 is a schematic view showing apparatus for coating saddle type carrier members.

Fig. 2 is a similar view showing apparatus for coating a carrier strip which can later be cut into ribbons of the desired length.

Referring now more particularly to the accompanying drawing wherein I have shown preferred apparatus for carrying out the process a numeral 10 in Fig. 1 designates a hopper which may be continuously supplied with saddle type berl carriers C. These carriers, which are fully described in the instant assignee's co-pending application, Serial No. 488,888, may be formed of a suitable ceramic or metallic material and I have found Alundum saddles to be particularly well adapted to the process which I will now describe.

The hopper 10 will deposit the saddles preferably one at a time on a perforate or screen conveyor 11 traveling in the direction indicated over a cleaning flame 12 which may be provided by a conventional fuel gas burner. Actually any known means for heating the saddles white hot (850°–950° C.) so that any impurities on the surface of the saddles may be oxidized or burned off, could be employed for this purpose. The conveyor 11 leads from the flame 12 to a tank 13, such as shown, where the saddles fall onto a perforate or mesh conveyor 14 which is partially submerged therein. During passage to the tank 13 on the very slowly moving conveyor the saddles are cooled somewhat so that, while they are still very hot they are not visibly so and will in fact be just below red heat temperature.

The solution 15 in the tank 13 may comprise an aqueous platinum chloride solution whose platinum content is 20 to 25 grams per liter of solution and may be prepared in various ways or purchased in salt form. One method of preparing such a solution which I have found satisfactory is to dissolve a measured weight of scrap platinum in a measured volume of aqua regia solution to produce platinum chloride and platinum nitrate which may then be evaporated to the point where the solids begin to separate out. Distilled water may then be added to form a solution wherein the platinum is in the proportion indicated above. If the platinum chloride solution which is substantially forty percent platinum is provided in salt form, fifty grams of it can be immediately dissolved in a small volume of warm distilled water and thence further distilled water may be added to make up the liter of solution. Such a solution will contain approximately 20 grams by weight of platinum. It should be emphasized that the salt employed need not be platinum chloride, but could be any soluble platinum compound including platinum fluoride, platinum bromide, platinum nitrate or the like. Further, where it is desired to provide

a palladium coating instead of a platinum coating, a suitable palladium salt could be employed. The preparation of the solution might be identical to provide an aqueous solution in which the palladium content was 20 grams per liter. Still a further alternative in providing a catalyst solution might be to provide a mixture of platinum and palladium salts diluted so that their combined metallic content was approximately 20 grams per liter of solution. In the description to follow the solution will be described, for convenience sake only, as a platinum chloride solution containing 20 grams per liter of platinum, however it is to be borne in mind that the solution could well be another soluble platinum compound solution, a soluble palladium compound solution, or a combined platinum compound-palladium compound solution.

From the tank **15** the saddles travel on the partially submerged perforate conveyor over a flame **16** which plays directly on them from below. The burner which produces the flame may be a conventional Mekker or Fisher grid-type fuel gas burner which has air blown in at the bottom thereof. Best results are obtained if the burner is disposed at a slight angle relative to the plane of the conveyor **16**. While it is thought that other gaseous, liquid, or solid hydrocarbon fuels may also be employed with good results, I have found that particularly good results are obtained with a bottled gas fuel whose constituents are propane in the amount of 86 percent and butane in the amount of 14 percent. Such a fuel will produce a normal flame whose heat is in the range 1555° F. to 1730° F. or 846° C. to 940° C. In any event the fuel used must be capable of producing a flame which heats the saddles to a white heat and is enough above the platinum chloride decomposition temperature of 581° C. and platinum oxide decomposition temperature of 555° C. to fix the separated platinum to the saddles, but below the temperature of 1755° C. at which platinum melts.

While it is thought that other gases, artificial or natural, may be employed as the fuel, it has definitely been observed that entirely unexpected results are obtained when the saddles are heated to the desired temperature in an open atmosphere by a flame which plays on the saddles rather than in a muffle furnace or the like. When saddles were fired in a muffle furnace it was discovered that less than half as much platinum was provided on a given carrier and the same was not adherent and was easily rubbed or flaked off. Apparently, the presence of excess air and non-combusted fuel gases which are not primarily combusted, but may be secondarily combusted, are necessary to the process to achieve the startlingly firmly adherent coating of greater thickness which is produced. Under these conditions the catalyst which is initially deposited on the saddles in the primary reduction of the platinum chloride thereon promotes the reaction on its own surface to provide a very rapid reduction of the remaining non-reduced platinum chloride or oxide. This sudden reduction which is of major proportions considering the relatively small percentage of platinum which is primarily deposited makes it possible to move the saddles continuously past the flame, although at a relatively slow rate of travel. It is brought about by the catalytic oxidation of the previously non-combusted gases and continuously issuing fuel gas which raises the flame temperature to between 1100° to 1600° C. and firmly fixes the platinum to the carriers. The fuel gases which are not primarily combusted because they are heavier than air hover around the flame and carrier, and in effect function as a fluxing agent to prevent the formation of an appreciable amount of platinum oxide. Thus, the platinum coating will comprise an almost pure, firmly fused, dense deposition of free platinum. This deposit and succeeding deposits, will in fact be approximately 80% pure platinum with the remainder platinum oxide. It is thought that the fuel gas employed should contain a relatively high percentage of propane or one of its homologs since these fuels will so readily catalytically oxidize in the presence of platinum or palladium to provide the high temperatures which achieve the rapid and complete reduction of the metallic compounds.

After the saddles leave the flame they are carried on the conveyor to a second tank **17** containing a like platinum solution **18**. A conveyor **19** partially submerged therein carries them to a second flame **20** of identical makeup where the fuel gases are again catalytically oxidized and another layer of virtually free platinum is fused to the carriers.

Thereafter the steps are once more repeated, the conveyor **19** carrying the saddles C to a third tank **21** and a conveyor **22** which conveys them over a flame 23, and finally deposits them in a storage bin **24**. In traveling to the bin and thereafter the saddles are air cooled. The platinum coated on will be approximately 1.2 grams per liter of ¾ inch berl saddles.

In Fig. 2 I have shown a process which is identical except that the coating is fired on a continuously moving strip of metal S which is unwound from a reel **25** and passes through various stages in the process to a windup reel **26**. The surface of the metal strip may be roughened prior to commencing the operation by etching it. Means for driving the tape at a relatively slow rate are not shown, however it will be appreciated that such are well known. Similar numerals to the numerals used in Fig. 1 are applied to the tanks and burner flames in Fig. 2 and it should be apparent that the coating process is identical with that previously described. The tanks are, it will be noted, U-shaped rather than rectilinear, and idler rollers must be provided to direct the path of the tape. The coating thus applied to the tape will be so firmly lodged thereon that cutting of the tape into ribbons suitable for use in the catalytic unit described in the previously mentioned application No. 488,889 can be accomplished without chipping the coating or loosening it.

Plainly, either saddle type carriers or ribbons which are prepared in this manner may be very efficiently employed in the catalytic oxidation of the smoke and odorous gases which are normally the by products of garbage incineration and are presently commonly expelled to atmosphere.

Both carriers are provided with roughened surfaces prior to metallizing to enhance the depositing action. The saddles may be formed of a special mix which provides a rough rather than glazed surface or may be sandblasted. The metal ribbon may be etched or sandblasted.

When traveling on the conveyor the approximate speed of a saddle carrier is such that it remains in the flame about two minutes. Two repetitive depositions as shown and described are desirable and the amount deposited is about the same in each deposition.

It is to be understood that the foregoing descriptive matter and drawings are in all cases to be interpreted as merely illustrating the principles of the invention rather than as limiting the scope thereof, and I contemplate that various equivalent substitutions and changes within the scope of the appended claims may be made in the process described to achieve similar results.

I claim:

1. A process for coating a rough surface catalyst carrier with metallic catalyst selected from the group consisting of platinum, palladium, a combination of platinum and palladium, and compounds thereof, said process comprising the steps of applying a flame reducible catalyst compound in solution to the rough surface of the carrier to coat the carrier, and firing the coated carrier in an open flame which contacts the carrier to reduce catalyst compound to free catalytic metal and fix free catalytic metal to the carrier; said flame heating the coated carrier at temperatures above the decomposition temperature of the catalyst compound and below the melting point of the free catalytic metal.

2. The process of claim 1 wherein catalyst compound is applied to the carrier in an aqueous solution and free catalytic metal is fixed to the carrier by fusion.

3. The process of claim 2 wherein the flame is created by the burning of a fuel gas in which propane is the major constituent and the solution includes 20 to 25 grams of catalyst per liter of solution.

4. A process for coating a rough surface catalyst carrier with platinum comprising the steps of applying a flame reducible platinum compound in solution to the rough surface of the carrier to coat the carrier and firing the coated carrier in an open flame to reduce platinum compound to free platinum metal and fix free platinum metal to the carrier; said flame heating the coated carrier at a temperature from 581° C. to 1755° C.

5. The process of claim 4 wherein platinum compound is applied to the carrier in an aqueous solution and free platinum is fixed to the carrier by fusion.

6. The process of claim 5 wherein the carrier is Alundum.

7. The process of claim 6 wherein the solution includes 20 to 25 grams of platinum per liter of solution and the flame is created by the burning of a fuel gas in which propane is the major constituent.

8. The process of claim 7 wherein the steps of applying



the solution to the carrier to coat the carrier and firing the coated carrier are repeated.

9. The process of claim 8 wherein the steps are repeated twice.

10. The process of claim 7 wherein the rough surface carrier is heated white hot before the platinum compound solution is applied to the carrier.

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