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METHOD OF SELECTIVE CARBURIZATION

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This invention relates to the carburizing of gears and other articles having bores, the articles being particularly of steel.

Steel gears for some purposes, as for example for use in transmissions, necessarily must have the diameters of their bores controlled within close limits. Heat treating of the gears, including carburizing, has the effect of producing some distortion and change in diameters of the bores of the gears, and for this reason it has been found desirable to broach out the bores of the gears after they have been hardened by heat treating. In order to do this, however, the bores of the gears must be of some hardness less than that of the outer surfaces of the gears but yet should be harder than the steel in its condition before heat treating. In a gear having internal splines in its final form, the gear is preferably splined by broaching before heat treating, and the gear is finished internally by a final sizing broach after hardening, hence arises the need for a hardness in the bore of the gear materially less than the hardness on the outer surfaces of the gear.

It is therefore an object of the present invention to provide an improved method for carburizing gears or similar objects having bores so that the articles within their bores have a substantial amount of carburizing but yet are carburized to a less extent than the outer surfaces of the articles.

To this end it is an object of the invention to provide an improved method of carburizing in which the amount of carburizing gas admitted within the bores of the gears is controlled so that the inside surfaces of the gears are carburized less than the outer surfaces.

It is therefore a more specific object of the invention to provide an improved method of carburizing gears or similar articles which includes stacking the gears with their bores substantially coinciding and placing separators of asbestos or other material allowing only a predetermined amount of carburizing gas to pass therebetween the gears, prior to placing the gears in a heated carburizing atmosphere.

Other objects, advantages and uses of the invention will become more apparent after reading the following specification and claims and after consideration of the drawings forming a part of the specification, wherein:

Fig. 1 is a schematic sectional view of a carburizing apparatus in which the method of the invention is illustrated as being practiced;

Fig. 2 is a detailed sectional view of a portion of one of the gear holding trays utilized in the method of the invention showing the gears stacked thereon preparatory to carburizing; and

Fig. 3 is a detailed view on an enlarged scale showing one of the washers used between the gears when the gears are stacked as shown in Fig. 2.

Like characters of reference designate like parts in the several views.

In the practice of the invention, I utilize a standard carburizing gas furnace (although any other furnace of any suitable type may be used instead) which may include a combustion chamber 10 formed between a muffle 11 and the outer housing 12 of the furnace. Within the muffle 11 there is maintained an atmosphere 13 of carburizing gas which is circulated by means of a pump 14, being drawn from the forward region of the muffle through a pipe 15 and returned to the rearward region of the muffle through a pipe 16.

The carburizing gas may be a mixture of 20% of carbon monoxide, 1 to 3% of methane, 38 to 40% of hydrogen and 38 to 40% of nitrogen, and there may be traces of other miscellaneous hydrocarbons and moisture. Although carburizing gas of these proportions is satisfactory, it will be understood that carburizing gas of other proportions and constituents instead may be used, this particular gas being mentioned only by way of example.

The respective ends of the muffle 11 are closed by closure members 17 and 18, respectively, which may be the conventional vertical sliding doors adapted to be raised to allow the entrance at one end and the exit from the other end of the trays 19 and the gears 20 stacked thereon. The atmosphere 13 within the muffle is maintained at carburizing temperatures (in the neighborhood of 1700°) by combustion within the chamber 10 of a suitable fuel, preferably hydrocarbon gas, which may be introduced through fuel pipes 21 and 22 leading through the housing 12. In such atmosphere, the steel gears 20 absorb carbon from the carburizing gas, liberating hydrogen which is disposed of by combustion at the mouth of the muffle when the doors 17 and 18 are raised. Fresh carburizing gas may be introduced into the muffle to take the place of that which is consumed, by means of a charging tube 23 communicating with the tube 15 through the medium of a suitable regulating valve 24.

In accordance with the present invention, the bores 25 of the gears 20 are carburized to a less extent than are the outer surfaces of the gears so that the bores will be softer than the outer surfaces of the gears in order to permit subsequent machining of the bores as by broaching. To this end the invention employs separators in the form of washers 26 placed between adjacent gears 20.
as the gears are mounted on the trays 19. The washers 25 are of such a material as to allow only a predetermined amount of the carburizing gas to pass therethrough and into contact with the bores 25. I have found that asbestos is a suitable material for such purpose and it furthermore is capable of withstanding the high temperatures within the carburizing furnace.

In preparing the gears for carburizing they are first threaded on to a rod or pin 27 which is threaded into a base 28 of a tray 19. A washer 26 is put below the first gear 26c threaded on the rod 27 and the other washers 26 are put between adjacent gears 29 as they are threaded on the rod 27. A washer 26 is placed on top of the uppermost gear 26b of the stack, and a nut 29 is secured on to the threaded upper end of the rod 27 for securing the stack of gears together.

After the gears are so stacked together, they are passed through the carburizing atmosphere of the furnace and a predetermined amount of the carburizing gas passes through the asbestos separators and into the chamber formed by the coinciding bores 25 of the gears. The stacked gears are fed through the furnace being admitted at one end and coming out of the furnace at the other end, and during such a course, the external surfaces of the gears 29 are carburized to a much greater extent than are the bores of the gears, due to the inhibiting action of the asbestos separators 25.

In one particular set-up, cited only by means of example, the carburizing of the external surfaces of the gears was such as to produce, after the gears were subsequently heated and quenched according to standard procedure a Rockwell hardness of C58 to C62 with the untreated steel having only a hardness of approximately C13. The inhibiting effect of the asbestos washers 26 was such that a carburizing within the bores 25 of the gears was only such as to produce a hardness of C23 to C35. This latter hardness was substantially above the hardness of the steel in its untreated condition but was substantially less than the hardness of the outer surfaces of the gears.

I have found that as an alternative to using plain asbestos washers 25, good results are obtained also in using such washers which have been previously soaked in solutions containing appropriate salts and subsequently baked in an oven to drive out the acid and moisture. One such salt is copper sulphate and the subsequent baking leaves a residue of metallic copper and copper oxide, and this residue resists the diffusion of the carbonaceous gases through the asbestos to the inner surfaces of the gears. The other salts of copper are also useful for this purpose, and the salts of tin and nickel are useful for this purpose also, but to a less degree. The copper in the copper salts apparently also has the additional function of breaking down the carbonaceous gas to form carbon at least to a greater extent than the salts of other metals mentioned and hence its greater usefulness.

It will be understood that the carburizing just described is preliminary to other steps in a normal hardening process. The work is maintained in the carburizing atmosphere a normal carburizing period which may range from 14 to 16 hours and the work is then discharged and lowered into a quenching bath, whence it is carried through a cleaning bath and a tempering furnace (not shown). After the gears have been so hardened, the bores of the gears are finished as desired. If the gears are desired with splined bores, splines 26c (see Fig. 2) may be cut in the bores 25 preliminary to any hardening operations, and a final sizing broach may be used in the bores of the gears after hardening.

I wish it to be understood that my invention is not to be limited to the specific constructions, arrangements, methods and processes hereinbefore described except only insofar as the claims may be so limited, as it will be understood to those skilled in the art that changes may be made without departing from the principles of the invention. In particular, I wish it to be understood that although I have shown and described a gas carburizing furnace through which the parts to be carburized are passed, my invention is also suitable for use in connection with carburizing agents which may be liquid or solid hydrocarbons as are used at present in conventional casehardening operations.

I claim:

1. A method of carburizing articles of steel having a bore in which the bore is carburized to a substantial extent but less than the outer surfaces of the article, which method includes, stacking the articles together so that their bores substantially coincide with each other to form a chamber, closing said chamber with asbestos which is permeable to some extent to carburizing gas, and placing the articles in a heated carburizing atmosphere.

2. A method of carburizing articles of steel having a bore in which the inside of the bore is carburized to a substantial extent but less than the outer surfaces of the article, which method includes, stacking the articles together so that their bores substantially coincide, placing separators between said articles, said separators being of asbestos which is permeable to some extent to carburizing gas, and placing the articles in a heated carburizing medium.

3. A method of carburizing articles of steel in which portions of the surfaces of the articles are carburized to a less extent than the remaining surfaces of the articles, which method includes, masking the surfaces of the article to be carburized to a less extent with a permeable masking material comprised of asbestos which is impregnated with copper and copper oxide, and placing the article in a carburizing atmosphere.

4. A method of carburizing articles of steel having a bore in which the inside of the bore is carburized to a substantial extent but less than the outer surfaces of the article, which method includes stacking the articles together so that their bores substantially coincide with each other and placing permeable separators between said articles, said separators being impregnated with metallic copper and copper oxide to restrict the permeability thereof, and placing the articles in a carburizing atmosphere.

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