plished on turning equipment with a drilling operation, which is a relatively simple, low cost procedure. The saddle engaging surface **44** of the leg and journal assembly **42** can be attached to the saddle bore **40** by electron beam welding techniques as discussed above. Because the saddle bores are formed to position the cutters accurately, only minimal manual alignment of the parts is required, and the leg and journal assembly complete with a cone and cutters can be attached to the bit body in a fully assembled condition.

FIG. **5** illustrates, in side view, a leg and journal assembly **42**, illustrating the relationship between journal **22**, shirttail port **20**, leg extension **18** and saddle engaging surface **44**.

Although the remanufacturing method of this invention has been described and shown with respect to separating the leg extensions and related structures either along a plane perpendicular to the bit axis of rotation or by the generation of saddle bores, other methods of removing the leg extensions which generate surfaces of other geometries may also be employed. For example, the leg extensions may be separated from the bit body by generating a concave or convex conical surface, in which the central axis of the cone is coaxial with the axis of rotation of the bit. In addition, surfaces of other configurations and geometries, such as concave or convex spherical surfaces, could be generated. However, the generation of a surface having any configuration during the separation of the leg extension from the bit body is contemplated to fall within the scope of the present invention.

The method of remanufacturing a rock drill bit discussed in connection with FIGS. **3**, **4** and **5** can also be applied to the original manufacture of new rock drill bits. The bit body **16**, which is formed from a single, integral piece of material can be produced by casting or forging. The bit body thus produced would be drilled and/or machined as required to form the lubrication passages **26**, drilling fluid channel **30**, nozzle housing **35**, threaded connector **14** and saddle bores **40**. Leg and journal assemblies **43** would then be turned and drilled, the cones **12** with teeth **28** formed and secured to assembly **42**, and the complete leg, journal and cone assembly attached to a saddle bore **40** by electron beam welding. An originally manufactured rock drill bit produced as just described costs significantly less to manufacture than the bits of the prior art.

Moreover, use of the saddle bore formation technique both to remanufacture and to originally manufacture a rock drill bit greatly simplifies cone and cutter alignment, thus substantially eliminating drill bit wear problems caused by nonaligned cones. FIGS. **6** and **7** illustrate one type of cone alignment. In FIG. **6** the position of the cones relative to each other is shown diagrammatically. The direction of rotation of the bit is indicated by the arrow **46**, and the center of bit rotation is shown at point **48**. The cones in FIGS. **6** and **7** have two or more basic cone angles, none of which has its apex at point **48**. However, since the cones are forced to rotate about the bit centerline **48**, they slip as they rotate and produce a tearing, gouging action. Cone action can be increased by offsetting the cone centerlines from point **48**, as shown in FIG. **6**. FIG. **7** illustrates three cones in the positions shown diagrammatically in FIG. **6**, and demonstrates the intermeshing of the cutting teeth **28**. If proper cone alignment is not achieved, whether it is the offset type of alignment just discussed or a more centered alignment, breakage or other damage to the cutting teeth could occur and lead to premature bit failure. Consequently, it is critical to achieve proper cone alignment while performing the bit remanufacturing and manufacturing processes of the present invention.

The present remanufacturing process has been discussed with respect to its application to tungsten carbide cutters. The principles described herein may also be applied to recondition other cutters, such as those made of milled steel and having abrasion resistant hard facings. In addition, while the specific journal structure of the remanufactured bit has not been described, it will be apparent to those skilled in the art that the present methods are well suited for reconditioning drill bits having any of the commonly used journal structures. These methods will be equally successful when applied to journals having ball bearings, to journals having annular thrust members and to journals of any other construction. Many other modifications and variations of the present methods within the purview of the following claims will be apparent to those skilled in this art.

INDUSTRIAL APPLICABILITY

The reconditioning and remanufacturing methods will find their primary application in the salvage and reconstruction of rolling cone cutter rock drill bits of the kind employed by the petroleum industry to dig bore holes intended to lead to petroleum deposits. However, any drill bit of similar construction, whatever its end use, can be effectively and inexpensively reconditioned to provide a reliable alternative to discarding a worn bit and replacing it with a completely new one. In addition, the methods described herein can be employed in the original manufacture of a rock drill bit at a lower cost than is currently possible with available original equipment manufacturing methods.

I claim:

1. A method for remanufacturing a used rotary rock drill bit having a bit body with leg extensions supporting journals on which are rotatably mounted at least two cones including cutting elements, including the steps of:

(a) separating all the leg extensions, journals and cones simultaneously from the bit body along a line perpendicular to the central axis of rotation of the drill bit to form a substantially planar bit body attachment surface and discarding said leg extensions, journals and cones;

(b) forming at least two cone support assemblies, including leg extensions, journals and cones, from new materials;

(c) attaching the cutting element-containing cone assemblies to the bit body to form a remanufactured drill bit;

(d) removing the reusable cutting elements from the cones; and

(e) attaching the reusable cutting elements recoverd in step (a) to the cones formed in step (b), adding new cutting elements as required to provide each cone with a full complement of cutting elements.

2. The method for remanufacturing a rock drill bit described in claim **1**, further including the step of machining the bit body attachment surface.

3. The method for remanufacturing a rock drill bit described in claim **2**, wherein the cone support assemblies formed from new material have formed thereon a bit body mating surface corresponding to the bit body attachment surface.