Aug. 14, 1956 B. E. PREVOST ET AL 2,758,516

JORDAN PLUG AND METHOD OF MAKING THE SAME

Filed May 17, 1954

2 Sheets-Sheet 1

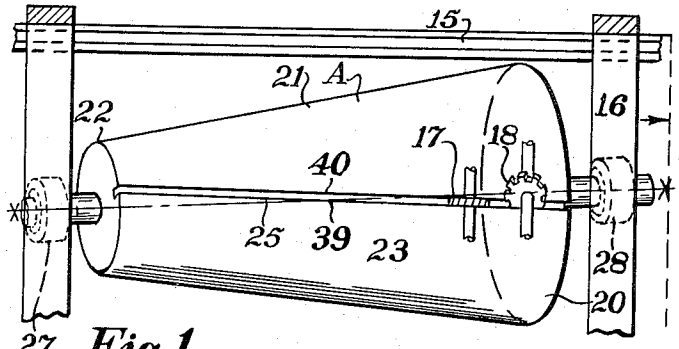


Fig. 1.

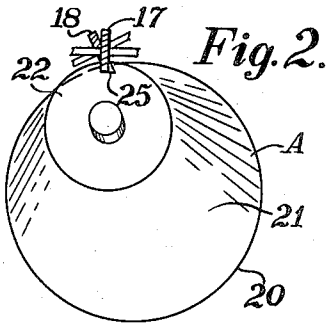


Fig. 2.

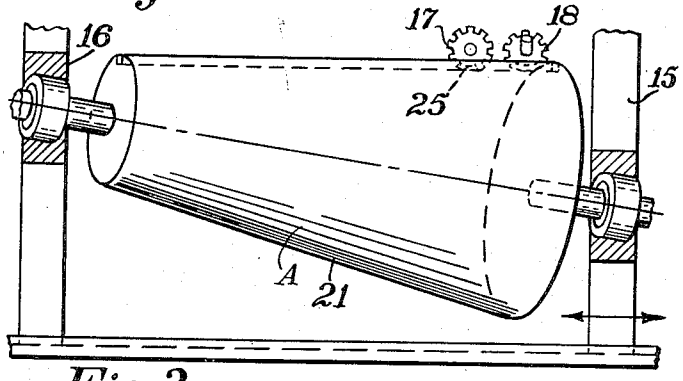


Fig. 3.

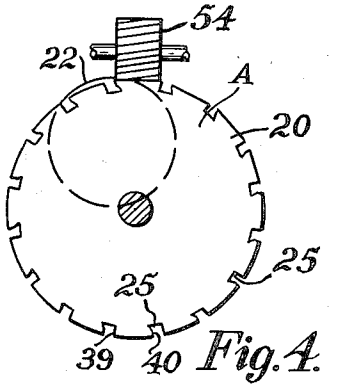


Fig. 4.

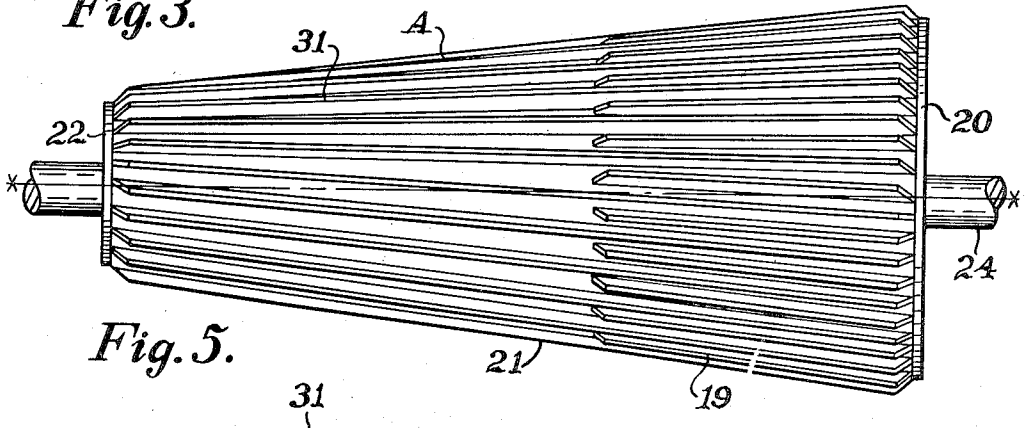


Fig. 5.

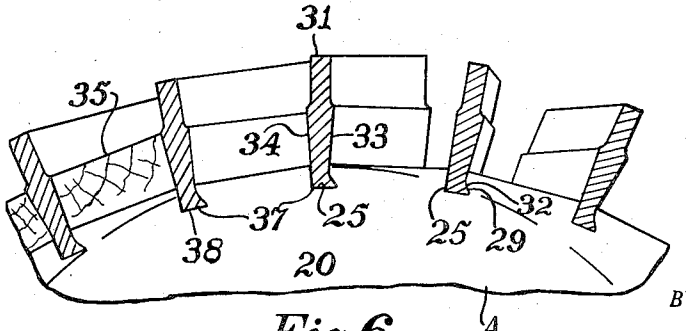


Fig. 6.

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2 Sheets-Sheet 2

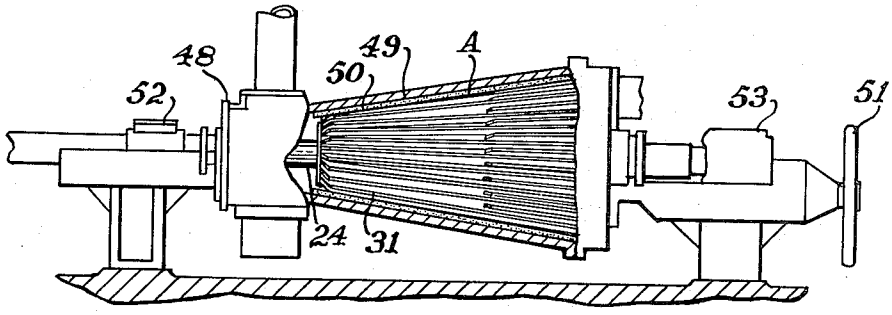


Fig. 7.

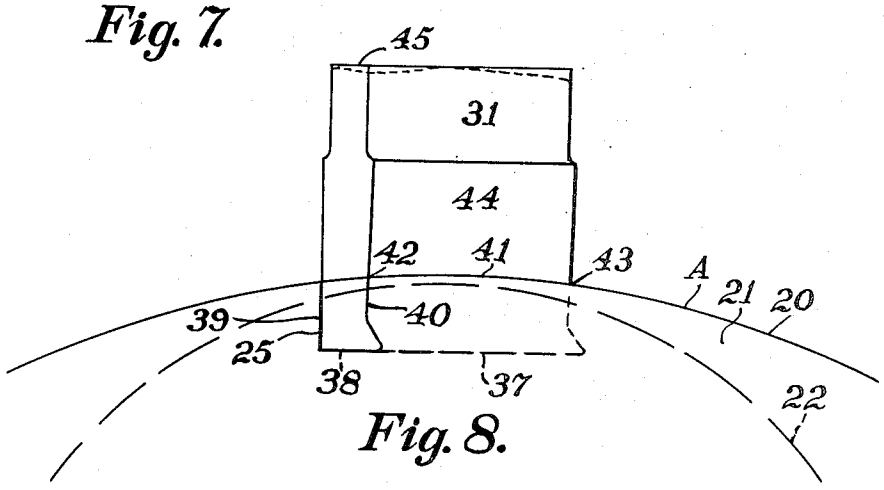


Fig. 8.

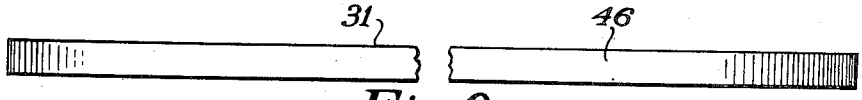


Fig. 9.

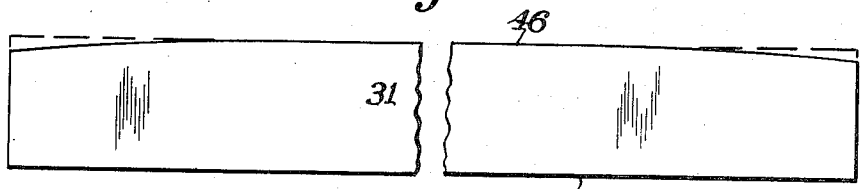


Fig. 10.

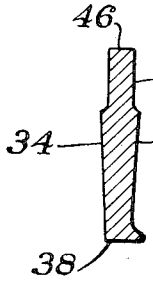


Fig. 11.

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JORDAN PLUG AND METHOD OF MAKING THE SAME

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Application May 17, 1954, Serial No. 430,056

9 Claims. (Cl. 92—27)

This invention relates to the frustro conical plugs of Jordan engines and especially to such plugs having bars or knives angularly offset from the longitudinal centre line thereof.

In a somewhat related art, cylindrical rotors having angularly offset spiraled bars have been proposed as in U. S. Patent No. 63,832 to Beach issued April 16, 1867 and U. S. Patent No. 484,056 to Simonet issued October 11, 1892. Such rotors have been used in pairs for grinding pulp therebetween and the bars have been integral with the rotor body as well as being helically spiraled thereby presenting difficulties in manufacture and replacement. It has also been proposed to provide a frustro conical rotor with angularly offset spiraled bars as in U. S. Patent No. 27,246 to Sweet issued February 21, 1860 and U. S. Patent No. 1,467,207 to Strattman issued September 4, 1923.

The bars of this application however, are not integral with the plug body and are not spiralled around the plug body as in the above mentioned patents.

The bars or knives of this invention are carried by a frustro conical plug and they are straight rather than spiraled but angularly offset from the longitudinal centre line of the plug. They are demountably fixed in straight undercut grooves and are not parallel to each other since they are spaced apart more closely at the small end of the plug than at the large end of the plug.

A plurality of groups of angularly offset straight bars have been provided on frustro conical rotors by previous patentees as in U. S. Patent No. 282,098 to Manning issued July 31, 1883 or U. S. Patent No. 1,184,058 to Watson issued May 23, 1916. While the bars of these patents are straight they are not angularly displaced at the same angle to each other as in this invention. Instead the four or five bars of each group are parallel to each other and of different lengths but the bars of the various groups are angularly displaced from those of other groups.

Frustro conical rotors having straight bars either integral therewith or demountably carried in grooves therein have also been proposed as in U. S. Patent No. 794,187 to Pfeifer issued July 11, 1905 and U. S. Patent No. 1,633,308 to Bolton issued June 21, 1927. The bars of the Bolton patent may have straight side faces extending longitudinally thereof or may be spiralled and they are carried in grooves whereby they are demountable. The bottom wall of the grooves and the bottom faces of the bars or knives in the Bolton patent, however, are curved in order to make each groove of uniform depth through its length while also being angularly offset on the curved surface of the frustro conical plug. The making of a groove of uniform depth in a conical surface, when the groove is angularly offset from the cone axis is difficult and the curving of the bottom face of a bar to conform to the groove is also difficult, time consuming and costly.

So far as I am aware, no one has previously achieved an undercut slotted plug having angularly offset bars whereby the bars and separators may be assembled and disassembled by an endwise sliding movement.

It is the principal object of this invention to provide

a new Jordan plug having angularly offset straight plug bars which bars provide desirable pumping action and are especially firmly held in the plug grooves for the full length of the plug.

Another object of the invention is to provide a Jordan plug with angularly offset bars which can be made with considerable saving in manufacturing cost over previous similar plugs and yet will provide longer wear.

A further object of the invention is to provide a new process of making slotted Jordan plugs with straight angularly offset bars which process eliminates steps formerly used and requiring special costly machinery.

Still another object of the invention is to secure the advantages of angularly offset bars on a Jordan plug while detachably mounting the bars in undercut slots or grooves into which the bars may be slid from one end of the plug.

A still further object of the invention is to provide a Jordan plug with undercut bar slots, straight bars axially insertable in the slots, straight separators axially insertable between the bars and yet with all of the bars angularly offset a like amount.

Other objects and advantages of the invention will be apparent from the following description of the drawings and from the drawings wherein

Fig. 1 is a diagrammatic plan view of a frustro conical Jordan plug showing an angularly disposed groove being formed therein according to this invention.

Fig. 2 is an elevation from the small end of the plug of Fig. 1 showing the step of positioning the plug for the milling of an angularly disposed groove of non uniform depth.

Fig. 3 is a diagrammatic side elevation of the plug shown in Figs. 1 and 2.

Fig. 4 is an elevation from the large end of the plug showing the plug after the step of cutting angularly disposed grooves of non-uniform depth therearound has been completed, and during the step of removing the curved surface between the grooves to accommodate ordinary separators.

Fig. 5 is a side elevation of a plug according to this invention after the step of slideably inserting the bars or knives in the angularly offset grooves has been completed.

Fig. 6 is a fragmentary elevation from the large end of the plug showing the step of inserting separators between the bars, by endwise sliding of the same.

Fig. 7 is a fragmentary side view of a typical Jordan grinding device with parts broken away, showing the step of grinding or otherwise removing the upper edge portion of the plug bars into conformance with the curved inner surface of a Jordan shell.

Fig. 8 is an enlarged diagrammatic view from the large end of the plug showing the depth of the side walls of a groove as greater in the central portion than at either opposite end thereof.

Figs. 9, 10 and 11 are plan, side and end views of a typical plug bar or knife according to the invention.

In the drawings a frustro conical plug body A is shown having a large end 20, an intermediate portion 21 and a small end 22. The body A may be of any well known type so long as there is sufficient material entirely along, or at spaced portions along the curved surface 23 thereof to permit the cutting of undercut grooves therein for receiving and retaining a plurality of longitudinally extendinng, spaced, plug bars or knives. While such plugs are usually called "slotted" plugs, the term "groove" is used herein since the term slot may include an opening or aperture. The slot of this invention always includes a bottom wall and side walls and is therefore not an opening.

Prior use of straight angularly offset plug bars set in grooves have entailed the making of a groove of uni-

form depth obliquely of the curved surface of the plug body sometimes by guiding and supporting the cutting tool on the surface of the curved portion of the plug. Thus as the cutter proceeded longitudinally along the curved surface of the plug body it removed the same depth of material not only from the end portions of the groove but also from the central portion.

To fit and seat a straight bar in such a groove, it was necessary to form a concave lower face on the bottom of the bar because the angular offset of the groove cause it to follow an arcuate path conforming to the curve of the conical plug surface.

While such a bar might be inserted radially into the groove and then anchored as well as possible by welding, or some similar expedient, if the groove was undercut and the bar provided with an anchoring flange or rib to provide a firm anchor against centrifugal force, the bar could not be either inserted radially or slid endwise into the groove. It will be apparent that twisted helical bars also cannot be slid endwise into twisted helical grooves but can only be inserted radially and anchored as well as possible even if the groove has parallel walls rather than one wall undercut. The upper face of the straight bar also had to be similarly convexed in order to follow the curvature of the cone and to enable the finished plug to fit within a similar frustro conical shell of a Jordan engine.

As shown in Figs. 1–4, the straight, angularly offset grooves such as **25** of this invention are preferably formed by a machine **15** having a suitable plug carriage **16** slideable in a straight line past rotary cutters **17** and **18**. The plug body A is rotatably mounted in bearings **27** and **28** of carriage **16** with the curved surface portion to be grooved on a horizontal plane at the level of the cutters. The central longitudinal axis X of plug body A, however, is shifted or angularly offset in a horizontal plane through any desired angle such as 12° relative to the straight line path of carriage **16**. The axis of rotation of cutter **17** is horizontal while that of cutter **18** is inclined from the horizontal to undercut a side wall of the groove **25** formed by cutter **17**.

The first straight line passage of carriage **16** under cutters **17** and **18**, with the angularly offset plug body A contained therein, will cause cutters **17** and **18** to form an undercut groove **25** which is similarly offset from the longitudinal axis of body A. The groove **25** is of non-uniform depth, the side walls thereof being higher in the central portion and lower at the opposite end portions. Without bodily moving the plug body, but by merely rotating it on its axis identical grooves may be formed at equally spaced distances entirely around the plug body A as shown in Fig. 4. All of the grooves such as **25** converge toward each other from the large end **20** toward the small end **22** of plug body A and all grooves are angularly offset an identical amount from the axis X of the plug body. As indicated in Fig. 5, certain grooves may be of less than full length to accommodate bars such as **19** of less than full length, to form plugs of various well known types.

As shown in Fig. 6, the grooves such as **25** are of taper or wedge shape with a cut under portion **29** for holding a bar or knife in place against the effects of centrifugal force. The bars or knives **31** are correspondingly formed with a longitudinal rib or flange portion **32** engageable under portion **29**, the bars preferably having tapered side walls **33** and **34** for retaining separators **35** therebetween, all in a well known manner. All such bars and knives are of generally rectangular cross section although provided with various locking or wedging shapes at the base thereof for retaining the same in the groove or slot of the plug and this invention is obviously usable with bars and grooves having cross sectional shapes other than the one shown in the drawings as an illustration.

In Fig. 8 an enlarged diagrammatic view of a groove and bar of this invention indicates that the bottom wall

37 of each groove **25** is flat and straight and that the bottom face **38** of each bar **31** is also flat and straight. Bottom face **38** thus rests flatwise against and is supported by the bottom wall **37**, preferably throughout its entire length. The straight side walls **39** and **40** of each groove **25** are of gradually increasing height from the ends **20** and **22** of the plug body A toward the intermediate or central portion **21** of the plug body A. The central section **41** of the side walls **39** or **40** thus is of greater depth or height than the opposite end sections **42** or **43** and may be used to provide an increased area of support to the central section **44** of a bar **31** thereby more firmly holding the same against lateral movement.

After formation of a plurality of spaced apart longitudinally extending grooves **25**, each identically angularly offset from the longitudinal centre line of plug body A, a corresponding number of elongated straight bars **31** are each inserted endwise in a groove whereby the upper portions thereof project outwardly from the surface **23**. If desired, at this time, separators may be also inserted endwise between the bars **31**. Both the bottom faces **38** and the top faces **45** of bars **31** are parallel to each other and straight as indicated in Figs. 5, 6 and 8. The bars **31** are fixed in place against endwise movement in the grooves in any convenient manner such as by spot welding, the use of end rings or plates or other well known expedients.

The side walls of the ordinary separator of wood are tapered to fit between the tapered side walls such as **33** or **34** of a pair of adjacent bars such as **31** and when such separators are slid endwise into position from each opposite end in a plug constructed as thus far described, an additional wedging effect is secured along the bottom face of the separator, due to the upward curve encountered. However, instead of removing part of the forward lower face of each separator to conform to the curved surface of the plug body A between offset bars and instead of squeezing the bottom face thereof by the above mentioned wedging action, it is preferred that the metal surface of the plug body A be cut away to accommodate ordinary separators without distortion thereof.

Immediately after the forming of the grooves **25** in the plug body A, the next step is therefore the cutting away of a portion of the surface of the plug body between each adjacent pair of grooves to flatten the surface. A suitable cutter **54** is substituted for cutters **17** and **18** in the machine **15** and the carriage **16** again passed thereunder in a straight line to reduce the height of the walls **39** and **40** along the central portion **41** of each groove entirely around the circumference of plug body A. The separators are then inserted axially.

The next step in the process of manufacture then comprises the removing of identical portions of the top faces **45** of bars **31** to form an arcuate surface curved to conform to the curved surface **23** of plug body A. Where the offset angle of the bars is considerable, it may be desirable to cut down the opposite end portions in a lathe of any well known type but in most cases, grinding is sufficient. The plug body A with its angularly offset grooves **25** and bars **31** is inserted endwise into a special Jordan type engine **48** which may have an inner shell **49** lined with abrasive elements **50** or may have an ordinary inner shell and contain abrasive liquid. The abrasive elements **50** or the ordinary shell, define a frustro conical inside surface exactly of the diameters desired for the outside or top surfaces **45** of the bars **31**. By gradually moving the plug body A, by its shaft **34**, further into the shell **50** the top faces **45** of bars **31** are ground down into arcuate shape shown in Fig. 10. The resulting bars **31** each therefore are of generally rectangular cross section, have straight side walls **33** and **34**, flat straight bottom faces **38** and longitudinally curved arcuate top faces **46** conforming to the longitudinal curve of the frustro conical plug groove when angularly offset therein.

The Jordan 48 is of a well known type and may have a manually operated thrust screw hand wheel 51 for advancing a plug therein while the shaft 24 is revolved in bearings 52 and 53. It will be apparent that instead of pre-forming an arcuate curved top face in each bar prior to assembling the plug, which arcuate faces may be out of line due to slight distortion or inaccuracy in grooving, the method of this invention first firmly embeds the bars in the undercut grooves and subsequently creates curved top faces in the bars of exactly the configuration required by a Jordan engine shell. The increased support for the intermediate portions of the bars, achieved by sliding the bars endwise into undercut grooves is especially useful in supporting the bars laterally against the pumping stresses occurring during the pumping action of the angularly offset bars. The angular offset of the bars also increases the shearing area between the plug bars and the shell knives an appreciable and useful amount whereby added strength the full length of the bar is desirable.

We claim:

1. A frustro conical Jordan engine plug having a frustro conical plug body and a plurality of elongated bars projecting from the curved surface thereof, said bars being identically angularly offset from the longitudinal centre line of the plug and each bar having longitudinally straight side walls, a longitudinally straight bottom wall and a preformed longitudinally curved top wall, said plug body having a plurality of correspondingly offset longitudinally straight grooves in the curved surface thereof for receiving said bars, each said groove having means, forming part of said grooves, for axially slideably receiving and for retaining a bar against radial movement.

2. In a Jordan plug the combination of a frustro conical Jordan plug body; a plurality of identical straight grooves spaced apart around the curved surface of said plug body and converging toward each other from the large end to the small end thereof; said grooves being each angularly offset at an identical angle from the plane of the longitudinal axis of the plug body to extend obliquely along said curved surface, each said groove having a flat straight bottom wall and a pair of spaced apart side walls at least one of which is undercut, and a plurality of straight, non spiraled, preformed plug bars of uniform, generally rectangular cross section, each bar having a straight, flat bottom face resting on and in full length engagement with, the straight flat bottom wall of a groove and having a pair of straight, side faces, the lower portion of which faces are in flatwise engagement with the side walls of a groove and each said bar being of non uniform depth with the side faces thereof progressively increasing in height from each opposite end toward the centre to conform to the curvature of the curved surface of said frustro conical plug body.

3. In a Jordan plug the combination of a substantially frustro conical Jordan plug body; a plurality of straight plug bar grooves extending longitudinally of the longitudinal, exterior surface of said body and angularly offset from the longitudinal centre line of the plug body, each groove have a flat straight bottom wall and straight side walls at least one of which is undercut, and a plurality of straight plug bars each having a flat straight bottom face supported flatwise in full length engagement with the straight flat bottom wall of a groove, each bar having tapered side faces projecting above the plane of the top of its groove and each bar terminating in an arcuate upper face, longitudinally curved to conform to the substantially frustro conical shape of said body.

4. A combination as specified in claim 3 plus a plurality of flat straight plane surfaces forming the longitudinal exterior surface of said plug body, each flat straight plane surface extending longitudinally between an adjacent pair of bars and a plurality of separators each having a flat straight upper face, a flat straight lower face seated flatwise on one of said flat straight plane surfaces and a pair of tapered side faces wedged between the tapered side faces of a pair of adjacent bars.

5. The method of making a Jordan engine plug which comprises the steps of cutting a plurality of spaced apart straight undercut grooves, longitudinally of the curved surface of a frustro conical plug body at identical angles of offset from the longitudinal centre line of said body and to a greater depth below the surface of said body at the groove centre than at the groove ends; then axially sliding straight plug bars, having straight flat bottom and top faces endwise into said grooves with the bottom faces thereof flatwise against the bottom of said grooves, and then removing identical portions of the straight flat top faces of said bars until said top faces are longitudinally curved to conform to the conical shape of said body.

6. A method as specified in claim 5 wherein said cutting step includes the steps of rotatably supporting said plug body with its longitudinal axis angularly offset from a straight cutting path and with a portion of its curved surface in the plane of said cutting path, then advancing and retracting said plug body along said straight cutting path while cutting a straight undercut groove in said curved surface, then successively rotating said plug body on its offset axis to bring other portions of said curved surface into the cutting path and successively advancing and retracting said plug body along said cutting path, after each such rotation to form additional angularly offset grooves in said surface.

7. A method as specified in claim 5 wherein the step of axially sliding the plug bars endwise into the undercut grooves is followed by the step of axially sliding separators endwise between the bars prior to the step of removing portions of the top faces of the bars.

8. A method as specified in claim 5 wherein said removing step includes the steps of first cutting down the major portion of the material of the top face to be removed, and then revolving said plug body and bars within a frustro conical shell of a Jordan engine containing a liquid abrasive to grind off the remaining portion of said top faces into a longitudinally curved configuration conforming to the inside shape of said shell.

9. The method of making a Jordan engine plug which comprises the steps of cutting a plurality of spaced apart, straight, undercut grooves, longitudinally of the curved surface of a frustro conical plug body at identical angles of offset from the longitudinal centre line of said body and to a greater depth below the surface of said body at the plug body centre than at the plug body ends to secure a straight bottom wall in said grooves, then cutting a straight flat surface on said plug body between each adjacent pair of grooves, thereby reducing the height of the grooves at the centre of the plug body to equal the height of the walls at the ends thereof; then axially sliding straight plug bars, each having a projecting rib and tapered side faces endwise into said grooves with the ribs thereof seated under the undercut portion of their respective grooves; then axially driving a wedge shaped separator endwise between each pair of adjacent bars into wedging engagement between the tapered side faces of said bars; then locking the ends of said bars and separators against endwise movement relative to said plug body, and then removing portions of the straight top faces of said plug bars to longitudinally curve the same into the curved configuration of the angularly offset grooved portions of said plug body.

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