A top mount dual bit well drilling mechanism has a rotary driven tubular housing having a top mount body within an upper end portion of the housing to which the upper end of a mud motor is mounted for support within the housing. A reamer bit is connected for rotation by the tubular housing upon rotation by a well drilling string and defines a core removing bit chamber that is recessed within the reamer bit and has communication with the core receiving receptacle. A core removing bit is rotated within the core removal bit chamber by the mud motor and continuously cuts away the upper end of a formation core that enters the receptacle as the reamer bit cuts into the formation.
TOP MOUNT DUAL BIT WELL DRILLING SYSTEM

RELATED PROVISIONAL APPLICATION


RELATED UTILITY APPLICATION

[0002] This application is related to the subject matter of pending non-provisional application Ser. No. 14/085,091, filed on Nov. 20, 2013 by Edwin J. Broussard, Jr. and entitled “Steerable Well Drilling System”.

BACKGROUND OF THE INVENTION

[0003] 1. Field of the Invention
[0004] The present invention relates generally to well drilling systems and particularly to well drilling mechanisms having a reamer bit defining a central opening within which a formation core is permitted to enter as the reamer bit progresses into the formation. The well drilling system of the present invention has a core removal bit that is located within the reamer bit and is independently rotated for continuously cutting away the core of formation material that is not cut away by the rotating cutters of the reamer bit.

[0005] The present invention also concerns dual drill bit well drilling systems having a drilling housing to which is mounted a reamer bit. The housing and the reamer bit are rotated by any suitable rotary power system such as a rotary drill string or a drilling fluid driven rotary motor, also known as a “mud motor”. Within the drilling housing is mounted a core removal bit mud motor that has drilling fluid energized driving relation with the core removal bit and accomplish continuous cutting of the upper end portion of the remaining formation core. The core removal bit is preferably composed of a metal bit body structure, typically composed of steel, to which is adhered a carbide or other hard-facing material that defines cutter elements and having a PDC coating to enhance the durability thereof. If desired, the core removal bit may have a multiplicity of PDC cutter elements affixed thereto or may have any other drill bit form that is suitable for cutting away the remaining formation core that is left by the reamer bit, without departing from the spirit and scope of the present invention. Generally, the terms “cutting elements” or “cutting face”, as employed in this specification, means a range of formation cutting devices including PDC cutting elements, carbide cutting elements, PDC coated carbide or metal bit structure, bits defining hardened metal cutting teeth, and the like as is deemed suitable for efficient cutting of the character of formation material that is being drilled.

[0006] The reamer bit preferably incorporates polycrystalline diamond (PDC) formation cutting elements that are supported by a matrix material that is affixed to a reamer bit body but may also incorporate hardened metal cutting elements or rotary cone cutting elements, if desired. Even further, the present invention concerns a dual bit wellbore drilling system having a reamer bit that has no central cutting elements and therefore leaves a central core of formation material during drilling. The reamer bit therefore defines a downwardly facing central opening that is entered by the central core as the reamer bit progresses into the formation during drilling activity. The smaller, mud motor driven core removal bit is either located concentrically or eccentrically with respect to the reamer bit for efficiently removing the remaining core material from the top of the core simultaneously with formation cutting by the reamer bit.

[0007] 2. Description of the Prior Art
[0008] Dual PDC well drilling systems having an external reamer bit and an interior mud motor driven core removal bit are disclosed by U.S. Pat. No. 7,562,725 of Edwin J. Broussard, Jr. and Herman J. Schellistede. A reamer bit is mounted to and rotated by a rotary drill string that extends from a rotary drilling rig at the surface. The core removal bit is rotated by a mud motor that is located within a drilling unit, the mud motor being driven by the flow of drilling fluid that is pumped through the drill string from the surface. Another somewhat similar drilling system is disclosed by U.S. Pat. No. 8,201,642 of Steven J. Radford, et al. wherein a reamer bit is rotated in one direction by the drill string and a concentric bit is located within the reamer bit and is rotated in a counter rotational direction by a downhole motor such as a positive displacement motor (PDM). It is noted that the smaller centrally located bit is located entirely within the outer reamer bit, with its cutting elements engaging the central portion of the formation within which the wellbore is being drilled. The drill cuttings of the smaller bit will tend to build up on the cutting interface of the smaller bit, thus further interfering with its formation cutting capability. Though these types of drilling systems will function and achieve wellbore drilling, typically no provision is made for controlling the delivery of drilling fluid for reamer drilling, core removal bit drilling, mud motor operation and bearing cooling for the mud motor and other components of the drilling system.

[0009] During well drilling with a conventional PDC bit, it is known that the most central of the PDC cutter members will be rotated against the formation being drilled at a slower speed as compared with the PDC cutter members that are located further from the center portion of the bit. This difference in formation cutting speed is due to the circumferential distance each of the PDC cutter members travel during each revolution of drill bit rotation. The cutter members at the outer periphery of a drill bit travel at a greater formation cutting speed than the cutters near the center of the bit. The slower cutting speed of the more centrally located cutters causes inefficient formation cutting at the central portion of the borehole being drilled, so that the central portion of the drill bit cutting face tends to crush, rather than cut the formation material, and thus retards the overall penetration rate of the bit. It is considered desirable therefore to employ the benefits of PDC cutter members for rotary well drilling without having the well drilling efficiency hampered by inefficient formation cutting at the central portion of a drill bit.

[0010] It has been determined that by relieving the central portion of the cutting face of a drill bit, the formation cutting efficiency and penetration rate of the bit will be significantly enhanced. However, such a drill bit will permit a central formation core to remain. This core must be removed so that it will not interfere with the drilling process. According to U.S. Pat. No. 7,562,725 of Edwin J. Broussard and Herman J. Schellistede, a dual PDC drilling system is provided having an outer reamer bit for cutting away a major part of the formation during drilling and having an inner core removal bit that is independently rotated, such as by means of a mud motor or other rotary power system of the drilling mechanism and which functions to continuously and completely cut away the
remaining central formation core that is not cut away by the reamer bit. U.S. Pat. No. 8,201,642 discloses a dual bit well drilling system having a reamer bit and a small centrally located bit within the reamer bit that is rotated in a direction that is opposite the rotation of the reamer bit. Another well drilling system has been developed which employs a rotary PDC reamer bit for primary drilling and employs a fixed PDC element at the center of the reamer bit to fracture away or crush the formation core material that is not cut away by the reamer bit. [0011] PDC drill bits typically drill an oversize wellbore, and thus allow for lateral movement of the drill bit within the formation while drilling. This lateral drill bit movement is undesirable because it causes the resulting borehole to be oversize or out of gauge and will often cause the PDC cutters to be sheared from the bit. Drill bit manufacturers recognize this potential problem and are known to design the PDC bits to have a somewhat concave cutting face and rounded towards the outer periphery. This bit geometry causes wedging of the drill bit into the borehole and thus minimizes the potential for lateral bit movement during drilling and also minimizes the development of shearing forces on the PDC cutter members. However, these concave PDC bit designs cause the cutter area of the bits to be increased and thus cause the cost of the resulting bit to also be increased. This increased drill bit cost is a commercial disadvantage in the well drilling industry. [0012] The dual PDC drill bit arrangement of the present invention achieves more rapid penetration in most hard subsurface formations because drilling penetration is not resisted by poor drilling capability of the central portion of the bit and by the presence of a formation core that develops between the PDC bit blades and retards penetration movement of the bit. The larger the core diameter is and longer it is, (to a point) will significantly stabilize the bit during its drilling rotation and thus minimize the lateral movement that is typically inherent in causing the drilling of oversize wellbores by PDC drill bits. The faster the rate of penetration, the more properly gauged the resulting wellbore will be and the better the bit will be stabilized during its rotational operation. With these advantageous features of bit design incorporated, a flatter PDC bit could be built, having less surface cutter area, thereby minimizing the number of PDC cutters that are employed in bit designs and minimizing the application of torque force to the drill string.

SUMMARY OF THE INVENTION

[0013] It is a principal feature of the present invention to provide a novel well drilling system that is adapted for threaded mounting to a bit box of a drill string or mud motor for straight drilling.

[0014] It is also another feature of the present invention to provide a novel well drilling system that may incorporate any of a number of different types of formation cutting elements, such as polycrystalline diamond cutting elements, hardened metal cutting elements, rotary cone type rock bits within the spirit and scope of the present invention.

[0015] It is also a feature of the present invention to provide a novel well drilling system having a reamer bit that is rotationally driven by a drill string or by any other rotary drive mechanism and a core removal bit that is located within a tubular housing of the well drilling system and is rotated along or near the longitudinal axis of the reamer bit.

[0016] It is another feature of the present invention to provide a novel well drilling system having fluid flow control features to ensure optimum drilling by a reamer bit and a core removal bit and to further ensure optimum flow of drilling fluid for cooling of mud motor bearings and for mud motor operation.

[0017] It is an even further feature of the present invention to provide a novel well drilling mechanism having a PDC reamer bit that is capable of being rotationally driven by a rotary drill string or a mud motor that is mounted to a rotatable or non-rotary drill string and which defines a central bit opening within which is located a formation core removing rotary bit that is independently driven in the direction of rotation of the reamer bit or in the opposite direction of rotation of the reamer bit.

[0018] It is also a feature of the present invention to provide a novel well drilling mechanism having a core removal mud motor and core removal bit assembly that is supported in eccentric or concentric relation within a drill housing by a top mount section of the tubular drill housing and positions a core removal bit for mud motor driven rotation within a bit chamber for continuous cutting of a formation core that remains as reamer bit drilling occurs.

[0019] Briefly, the various objects and features of the present invention are realized through the provision of a well drilling system having a tubular housing that is connected with a drill string and has core removal bit assembly that is supported within the housing by a top mount within the upper end portion of the tubular housing of the well drilling system. The housing of the top mount well drilling system has an internal mud motor and may be mounted to the lower end of a drill string extending from the drilling rig at the surface and only rotates if the drill string is rotated from above via rotary/kelly or by the top drive of a drilling rig.

[0020] The rotation speed of the inner core removal bit is determined according to the characteristics of the different types of subsurface formations that are encountered. It is expected that the rate of penetration will increase geometrically since the inner core of the formation is continuously and completely cut away from the top down, rather than being chipped or crushed as is typically the case with conventional PDC bits.

[0021] The well drilling mechanism has a housing to which is mounted reamer bit having a small mud motor located within the housing and supported by the top portion of the housing. This small mud motor is arranged to drive a core removal bit at higher rpm's than that of the reamer bit. The rate of penetration of the well drilling system of the present invention, in comparison with conventional PDC drilling systems, increases geometrically. Because the present invention has a combination of a PDC reamer bit with a mud motor driven core removal bit, which has PDC cutters on the reamer bit, whether the core removal bit is centered or offset from the center-line of the larger reamer bit, achieves efficient removal the formation core while drilling more efficiently with the reamer bit.

[0022] The dual bit drilling mechanism of the present invention has an outer reamer bit that has been bored or otherwise prepared for containing a small mud motor having a bearing pack that is provided for wear resisting rotary support of a drill bit drive shaft. A core removal bit is threaded to the drive shaft mechanism of the small mud motor and is positioned within a bit chamber that is defined within a reamer bit body. When the drilling system is designed for left hand rotation of the reamer bit, opposite the typical direction of rotation of the reamer bit by a well drilling system, the
various threaded connections of the mud motor bearing pack components will have left hand threads to resist the left hand reactive torque that is received due to cutting engagement of the core removal bit with the remaining formation core. When the mud motor imparts left hand rotation to the core removal bit, left hand reactive torque of the mud motor will be applied to all connections except the connection of the core removal bit to the bit drive shaft.

[0023] Only a small amount of power is required to rotate a relatively small bit, such as 1/4" core removal bit. Also the mud motor has a smaller bearing pack with a larger power section driving the core removal bit to ensure adequate rotational power. The PDC reamer bit has fluid passages that are noozled to a specific size, creating internal bit pressure that forces drilling fluid through the mud motor power section, rotating the core removal bit below. This feature allows the bearing pack fluid to divert to the lower pressure of the well bore annulus, thereby simultaneously cooling the mud motor bearing pack and the core removal bit, and flushing away drill cuttings from the core removal bit. The entire drilling assembly can be threaded into the bit box of a bottom hole assembly for straight wellbore drilling.

[0024] The dual drill bit mechanism of the present invention has a combination of a PDC reamer with a mud motor driven core removal bit, with PDC cutter elements mounted to the reamer bit by means of cutter retention matrix or by any other suitable means for cutter retention. Whether the core removal bit be centered or in laterally offset relation with the larger reamer, the core removal bit cuts away the formation core more efficiently while drilling. The optimal offset distance of the core removal bit relative to the center or axis of reamer bit rotation will be determined by the well drilling parameters at any point in time.

[0025] The PDC reamer bit has fluid passages that are noozled to a specific size, creating predetermined internal bit pressure, thereby forcing drilling fluid through the mud motor power section, rotating the core removal bit below. The mud motor is supported within the tubular housing of the drilling system by a top mount body or housing section which also serves to isolate the bearing pack fluid bypass opening from the high pressure chamber that is within the housing of the drilling system. This feature allows the flow of bearing pack fluid to be diverted to the pressure of the well bore annulus, thereby simultaneously cooling the mud motor bearing pack and the core removal bit and serving to flush drill cuttings from the core removal bit. A hardened internal wear resistant sleeve is located within the reamer bit to prevent wear to the reamer bit by the core removal bit. The complete drilling assembly is adapted to be threaded into the bit box of the drill string for typical straight hole drilling.

[0026] The PDC cutters near the center of the reamer bit can be designed to slightly overlap the reamer core area, cutting the edge of the core and preventing core contact with the reamer bit. However, it should be borne in mind that the presence of a small formation core can have a stabilizing effect on the PDC reamer bit, by serving to ensure against lateral deviation of the reamer bit from a straight course. Also because of wellbore core removal, minimal bottom hole assembly weight is required to cause the PDC cutters to efficiently penetrate into the formation and drill a straight hole effortlessly. As more weight is added to any drill bit, it will force the drill collars above to flex and lay to one side of the well bore, causing the drill bit to be cocked on a slight angle, thereby drilling off in a selected direction. Thus, the drilling system is capable of directional drilling for correction of wellbore direction as needed. If drilling continues in the selected direction, the angle of the drill bit will continually increase as additional borehole is drilled. There will also be less heat generated by friction due to efficient cutting of formation material, rather than having the PDC cutters at the central portion of a standard PDC bit slide on top of the formation or crush the formation rather than cutting it, thereby extending PDC drill bit life dramatically.

[0027] Significant vibration is typically experienced when the rotor of the mud motor of the core removal bit is spinning within the stator in response to drilling fluid flow. For this reason, resilient stabilizers formed of rubber or rubber-like polymer material are provided within the mud motor to absorb the vibration. This feature prevents damage to the small PDC coated carbide core removal bit as it spins within the core removal bit chamber of the reamer bit. The offset core removal bit will be recessed behind the PDC cutters of the reamer bit and is positioned for efficient removal of the formation core that remains as the reamer bit penetrates into the formation. The optimal recessed distance of the core removal bit is determined by the parameters of the formation being drilled; however, it should be borne in mind that the formation core also serves to stabilize rotation of the reamer bit. With the core removal bit centered within the reamer bit, it can be recessed behind the PDC cutting members on the blades of the reamer bit and protrude out of the reamer bit, provided the core removal bit outer diameter overlaps the PDC cutters in the center of the reamer bit.

[0028] Though the mud motor powered rotary drilling system or head may incorporate a variety of formation cutting or eroding elements, such as polycrystalline diamond (PDC) cutting elements and hardened metal rock cutting or chipping elements, steel, carbide or other metal cutting members, which may include hard-facing material or PDC or other hard coatings, for purposes of simplicity the invention is discussed herein as it concerns formation boring by using PDC cutting elements particularly for the reamer bit. The drilling mechanism has a tubular housing that is connected with a mounting sub that is connected with a drill string extending from a drilling rig the surface. The lower end portion of the tubular housing is provided with a vibration isolation member to dampen any vibration forces that are encountered. A reamer bit is connected with the lower end of the tubular housing below a stabilizer that ensures centering of the drilling system within the wellbore being drilled.

[0029] A mud motor is located within the tubular housing of the well drilling system and includes a rotor having an axis of rotation that can be concentric or eccentric with respect to the longitudinal rotational axis of the tubular housing and reamer. The drilling fluid inlet of the mud motor is in communication with a high pressure fluid chamber that is defined within the tubular housing. An interchangeable orifice flow control nozzle is present within the partition for control of drilling fluid flow past the mud motor for cooling and cleaning of the reamer bit and for cooling and lubricating the bearing pack of the mud motor.

[0030] The bottom hole drilling mechanism incorporates an external reamer bit having a central portion with no cutting elements, thus defining a downward facing central opening that is entered by a central formation core as formation drilling progresses. The formation core that remains as the reamer bit is operated is cut away from top to bottom by a mud motor driven core removal bit that is located for mud motor powered
rotary movement within a core bit chamber within the reamer bit. Preferably, the core removal bit is a carbide bit having core cutting edges or teeth and being formed of carbide material that is preferably coated with PDC material. Alternatively, the core removal bit may have a cutting face that is defined by a multiplicity of PDC cutting elements or teeth; however each of its various forms and materials permits the core removal bit to cut away the remaining formation core from the top down as penetration of the reamer bit progresses into the formation.

[0031] The core removal bit mud motor is mounted within the reamer bit head typically by being threaded into a threaded receptacle of a top mount sub that is provided within the upper end of a drilling housing. The core removal bit is provided with formation cutting elements and is rotated at a different, typically higher rate of rotation as compared with the rate of rotation of the reamer bit. However, if the core removal bit has the same rotary speed as the reamer bit, the rotary speed of the core removal bit will be added to the rotary speed of the reamer bit, causing the core removal bit to rotate at a faster rotary speed than the reamer bit. The reamer and core removal bits work in concert to facilitate a greater overall formation penetration rate as compared with conventional PDC drill bits.

[0032] The fluid flow that operates the mud motor is also employed for cooling and cleaning of the core removal bit. The core removal bit has a plurality of drilling fluid passages that permit the flow of drilling fluid for cleaning of the cutting elements of the core removal bit and for cooling and lubricating the bearing pack of the core removal bit to promote extended service life thereof. Drilling fluid flow through the reamer passages is selectively adjustable by means of replaceable flow control nozzles that are sized according to well drilling parameters, such as well depth, formation character and hardness, fluid pressure at the drill bits, and the like.

[0033] When the core removal or inner bit is rotated about an axis of rotation that is offset from the rotational axis of the reamer bit, the core removing cutting edges of the core removal bit are not centered on the top of the formation core, but rather cut across the top surface of the core to cut it away from the top down. Regardless how big or what the offset of the core removal bit is, the recessed core removal bit will always remove the remaining formation core that is not cut away by the PDC cutter elements of the reamer bit. As the formation core is continuously cut away by the core removal bit, it does not restrict the efficiency of formation penetration by the PDC cutters of the reamer bit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] So that the manner in which the above recited features, advantages and objects of the present invention are attained and can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to the preferred embodiment thereof which is illustrated in the appended drawings, which drawings are incorporated as a part hereof.

[0035] It is to be noted however, that the appended drawings illustrate only a typical embodiment of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

[0036] In the Drawings:

[0037] FIG. 1 is a schematic illustration showing a well drilling rig that is located at the surface of the Earth's surface and extends a drill string or stem into a wellbore that is being drilled and shows a well drilling system embodying the principles of the present invention being connected with the drill string;

[0038] FIG. 2 is a longitudinal sectional view of an upper portion of a dual bit well drilling mechanism embodying the principles of the present invention and showing top mounting of an eccentrically arranged drilling fluid energized rotary motor for operation an core removing drill bit of a dual bit drilling system and showing mounting of the drilling system to a drill string;

[0039] FIG. 3 is a longitudinal sectional view similar to that of FIG. 2 showing an intermediate section of the well drilling system of FIG. 2;

[0040] FIG. 4 is a longitudinal sectional view similar to that of FIGS. 2 and 3 showing a bearing pack section of the well drilling system of FIGS. 2-4;

[0041] FIG. 5 is a longitudinal sectional view showing a dual bit well drilling mechanism having an exterior reamer bit and having an eccentrically arranged internal core removal bit being rotatably driven by the drilling fluid energized rotary motor;

[0042] FIG. 6 is a bottom view of the dual bit well drilling mechanism showing right hand rotation of the exterior reamer bit and left hand rotation of the internal laterally offset core removal bit;

[0043] FIG. 7 is a longitudinal sectional view showing a laterally offset core removal bit having an external reamer bit that is rotated to the right during drilling and an internal core removal bit that also rotated to the right by its drilling fluid energized rotary motor;

[0044] FIG. 8 is a bottom view showing the dual bit mechanism of FIG. 7 and illustrating the overlapping relation of inner portions of the PDC cutter supporting blades of the reamer bit with the cutting face of the internal core removal bit;

[0045] FIG. 9 is a longitudinal sectional view, similar to FIG. 2, showing the upper section of a well drilling housing having an eccentrically arranged drilling fluid energized rotary motor for rotary actuation of an eccentric or laterally offset core removal bit;

[0046] FIG. 10 is a longitudinal sectional view, similar to FIG. 9 showing flow control nozzles being arranged for controlling the flow of drilling fluid through an external annulus, and for controlling the flow of drilling fluid through the drilling fluid energized rotary motor;

[0047] FIG. 11 is a longitudinal sectional view of a dual bit well drilling system having a concentrically arranged drilling fluid energized rotary motor with drilling fluid flow control by flow passage dimensions;

[0048] FIG. 12 is a longitudinal sectional view showing the concentrically arranged drilling fluid energized rotary motor of FIG. 11 and showing flow control nozzle being mounted for controlling the flow of drilling fluid through the drilling fluid energized rotary motor of the dual bit drilling system of the present invention;

[0049] FIG. 13 is a longitudinal sectional view showing a bearing pack section of the dual bit drilling system of FIG. 12;

[0050] FIG. 14 is a longitudinal sectional view of the lower section of the dual bit drilling system of FIGS. 11-13 showing the concentric dual bit mechanism, with the reamer bit
arranged for right hand rotation and the internal core removal bit also arranged for right hand rotation;

[0051] FIG. 15 is a bottom view of the concentric dual bit mechanism of FIG. 14 showing an overlapping relation of the inner portions of the PDC cutter supporting blades of the reamer bit with the cutting face of the internal core removal bit;

[0052] FIG. 16 is a longitudinal sectional view showing the concentrically arranged dual bit drilling mechanism with the external reamer bit arranged for right hand rotation during drilling and the internal core removal bit being arranged for left hand rotation;

[0053] FIG. 17 is a bottom view showing the concentric dual bit well drilling system of FIG. 16 and further showing an overlapping relation of the inner portions of the PDC cutter supporting blades of the reamer bit with the cutting face of the internal core removal bit;

[0054] FIG. 18 is a longitudinal sectional view showing the upper portion of a concentrically arranged drilling fluid energized rotary motor for a concentric dual bit well drilling mechanism and showing a spline arrangement maintaining a non-rotatable relation of the motor mechanism within the tubular housing of the well drilling system;

[0055] FIG. 19 is a longitudinal sectional view showing an upper portion of a concentrically arranged drilling fluid energized rotary motor also showing a spline arrangement maintaining a non-rotatable relation of the motor mechanism within the tubular housing of the well drilling system;

[0056] FIG. 20 is a section view taken along line 20-20 of FIG. 19;

[0057] FIG. 21 is a longitudinal sectional view showing the dual bit well drilling system of the present invention with the mud motor and core removal bit of the dual bit well drilling mechanism being concentrically arranged and having gauge control elements being mounted to ensure formation core controlled stability of the reamer bit against undesired lateral deviation from its intended course during drilling activity;

[0058] FIG. 22 is a longitudinal sectional view showing the dual bit well drilling system of the present invention and showing an eccentrically arranged drilling fluid actuated rotary motor and an eccentric core removal bit positioned within a gauge lined central core receptacle of the reamer bit.

[0059] FIG. 23 is a transverse section view taken along line 23-23 of FIG. 22 and showing flow control nozzles;

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

[0060] While the well drilling system is discussed herein particularly as it concerns PDC drill bits, it is not intended to limit the spirit and scope of the present invention to such, since this invention is adaptable to a variety of drilling systems, including systems for effectively drilling materials other than earth formations. Referring now to the drawings and first to the schematic illustration of FIG. 1, a well drilling rig 10 is shown that is located at the surface “S” of the Earth. The well drilling rig has a rotary turntable 12, rotary top drive or other rotary drive mechanism for rotating a Kelly 14 to which is connected a drill string 16 that is composed of multiple sections of drill pipe, also known as drill stem. The drill stem 16 extends from the drilling rig into a wellbore 18 that is being drilled through various earth formations 20 to one or more production zones that may contain crude oil, natural gas, distillate and other petroleum products. The drill stem or pipe 16 of the drill string is tubular and defines a central flow passage 22 through which drilling fluid, also called drilling mud, is pumped for the purpose of cooling and lubricating the drilling mechanism and flushing away drill cuttings and other debris that is loosened from the formation during drilling. When drilling a straight wellbore, the rotary drive mechanism of a drilling rig continually rotates the drill string and drilling fluid is continuously pumped through the drill pipe while the weight of the drill string is applied to the drill bit to drill straight ahead. When the well drilling system is being used to drill a directional wellbore, drilling fluid is through the drill pipe and with the drill string stationary, a bent housing mud motor is rotationally oriented to the desired direction for wellbore deviation or correction. The well driller will then slide the drill string ahead to correct the course of the wellbore or to change the wellbore direction. After sliding the drill string a desired distance to achieve the well correction or change that is desired, the driller will then begin to rotate the drill string and once again and drill straight ahead.

[0061] A well drilling mechanism 26 is connected with the bit box of the mud motor powered drilling mechanism 24, will be hydraulically powered by pressurized drilling fluid that is pumped through the drill stem to the drill bit or bits 28 of the well drilling mechanism 26. Every mud motor has two sets of threads, internal threads and external threads. With a standard mud motor, the internal and external threads constitute right hand threads because the mud motor is supported at its upper end by the drill string. The left hand reactive torque that occurs during drilling tends to tighten all of the right hand threads of the outer body of the mud motor. All internal threads of the motor constitute right hand threads because the motor rotor drives the drill bit to the right and thus has the effect of tightening all of the threads beneath it. The opposite effect occurs during the practice of the present invention, when the mud motor is arranged to rotate a core removal bit to the left. The mud motor for driving the core removal bit of the present invention is supported at its upper end by a top mount that is located within a tubular drilling body that is in turn supported by a rotary drill string.

[0062] As shown in FIG. 2-5, at the lower or distal end of the drill string 16 is mounted a dual bit well drilling mechanism shown generally at 30, which is typically rotated by a drill string, but can be rotated by a mud motor if desired. The dual bit well drilling mechanism 30 is employed to achieve rotation of a reamer bit, shown generally at 32, and a core removal bit, shown generally at 34, both being shown in FIG. 5. The dual bit well drilling mechanism 30 comprises a tubular housing, shown generally at 36 in FIG. 2, which is comprised of a mounting sub 38 which defines an upwardly projecting externally threaded connection 40 that is received by the internally threaded receptacle 42 of a bit box connector 44. The tubular housing 36 of the drilling fluid energized rotary motor or “mud motor” further includes an upper housing section 46 having an upper internally threaded connection 48 having threaded assembly with an upper externally threaded connection 50. The upper housing section 46 also functions as an outer reamer drive member and has threaded connection at 49 with a lower housing section 51 which is threadedly connected at 47 with a reamer bit body 52. The lower housing section 51 is typically provided with a plurality of external elongate radially spaced centralizer members 53 that centralize the drilling mechanism within a wellbore being drilled. Spaces between the centralizer members define flow passages within the wellbore and externally of the tubular housing for the return flow of drilling fluid and drill cut-
tings after the drilling fluid has been discharged from the drill bit mechanism of the well drilling system.

[0063] The reamer bit body 52 is typically composed of a durable metal composition, such as steel, and defines an external surface 54, as shown in FIG. 6, to which a cutter retention matrix 56 is affixed by bonding, welding or by any other suitable means for attachment. As is evident from the bottom view of FIGS. 5 and 6, the cutter retention matrix 56 is formed to define a plurality of outwardly radiating vanes or blades 58, having leading edge portions 60 that define a multiplicity of cutter receptacles 62 each having a PDC cutter element 64 secured immovably therein. Thus, a plurality of substantially radially oriented arrays of PDC cutter elements 64 are arranged to present cutting edges that engage and cut away a small portion of the formation/reamer bit interface during each rotational revolution of the reamer bit. Collectively, the radiating arrays of PDC cutter elements 64 continuously cut away the major portion of the formation material within which the wellbore is being drilled. Gauge or wear pad members 66, which may be defined by PDC members or by any other hard and wear resistant material, are retained by the cutter retention matrix material 56 and serve to minimize the potential for wear of the cutter retention matrix material as the outer wall of the reamer bit is rotated in contact with the abrasive wall surface of the wellbore.

[0064] When drilling with conventional PDC drill bits the centermost PDC cutter elements tend to crush the central portion of the formation material within the borehole, rather than cut it away, due to the inefficient cutting characteristics of the PDC cutters at the central region of the bit. Even when a PDC bit is provided with a small concentric bit, such as taught by U.S. Pat. No. 8,201,642, for drilling a central portion of a borehole, the center portion of the small concentric bit also tends to crush, rather than cut away the central formation material due to the inefficient formation cutting characteristics of the centrally located formation cutting elements of the small concentric bit. However, as is evident from FIGS. 5-8 of the drawings, the reamer body 52 and the inner portions of the cutter support blades 58 define a downwardly facing central opening 68 which, since the reamer bit has no central cutter elements to retard drill bit penetration, maximizes formation cutting efficiency of the reamer bit. The open central portion of the reamer bit presents virtually no resistance to bit penetration as is typically experienced by conventional PDC drill bits having formation cutter elements at the central portion thereof. However, during drilling activity a central portion of formation material is not cut away and thus defines a formation core 69 that enters the central opening 68 as the reamer bit cuts away the formation material. The core removal bit 34 is positioned to efficiently cut away this central formation core as the reamer bit continues to cut away the formation material.

[0065] The downwardly facing central opening 68 is collectively defined by inner surface sections 71 of the cutter support blade members 58 as shown in FIG. 6. A cylindrical wall surface 76 is defined within the reamer bit body 52 and partially within the matrix material 56 and is eccentric with respect to the center-line C/L₁ of the reamer body, such that its center-line C/L₂ is laterally offset with respect to center-line C/L₁. The cylindrical wall surface 76 defines a bit chamber 77 within which the core removal bit 34 is positioned for core cutting rotation. It should be borne in mind, however, that the core removal bit 34 can be either eccentrically located or concentrically located with respect to the center-line C/L₁ of the tubular housing 36.

[0066] As shown in FIGS. 2-10, the core removal bit 34 is positioned within a core bit chamber 77 for rotation about the center-line C/L₂ and has a core cutting face 70 that is recessed inwardly of the central opening 68 for cutting engagement with the upper end of the formation core, that is shown in broken lines at 72 in FIG. 5, and remains as the reamer bit progresses into the formation during drilling. The outer, generally cylindrical surface of the core removal bit 34 is spaced from the internal cylindrical wall 76 so as to define an annular clearance 75 through which drilling fluid is permitted to flow for cooling and cleaning the core removal bit. The core cutting face 70 of the core removal bit 34 is provided with a plurality of cutting elements 73 that serve to continuously and completely cut away the remaining formation core that is not cut away by the cutting elements 64 of the reamer bit 32. Preferably, however, the core removal bit 34 and its formation cutting elements are composed of a hardened and durable metal composition such as tungsten carbide that may be coated with PDC material to enhance the durability of the cutting face. It should be noted that the reamer bit 32 is typically rotated by a rotating drill string or may be rotated by a drilling fluid energized mud motor that is connected with a drill string. However, the core removal bit 34 is independently rotated by a drilling fluid energized rotary motor or mud motor shown generally at 74 which is located within the tubular housing 36 of the well drilling mechanism 30. The generally cylindrical bore or wall 76 is formed eccentrically with respect to the center-line of the tubular housing 36 and defines a bit chamber 77 within which the core removal bit 34 is independently rotated by the mud motor at a predetermined rotational speed and rotational direction.

[0067] For reamer bit stabilization, to minimize lateral movement of the reamer bit, the matrix material 56 and its PDC cutter supporting blades 58 collectively define a downwardly facing centrally located opening or core receiving receptacle or chamber 68. A bearing support sleeve member 80 is seated within the bore 76 and is sealed to the body 52 of the reamer bit by a plurality of annular seal members 81 that are contained with external seal recesses of the bearing support sleeve member 80. The bearing support sleeve member 80 also serves as an internal wear resisting liner to protect the core removal bit 34 against excessive wear during drilling operations. A bearing set 82 having inner and outer bearing members is located between the bearing support sleeve member 80 and a drive shaft 86 to which the core removal bit 34 has rotary driving connection, thus providing for rotary stabilization of the core removal bit during its rotation.

[0068] It should be noted that the mud motor 74 is supported within the tubular housing 36 of the well drilling system 30 by means of a top mount so that the mud motor and core removing bit as well as the bearing pack of the mud motor are supported by the upper end portion of the tubular housing. As shown in FIGS. 2 and 9, a top-mount body 83 having a drilling fluid flow passage 84 therein is positioned within the tubular body and has a splined connection 85 that permits linear adjustment of the top mount body within the housing section 46 and prevents rotation of the top mount body relative to the housing section. The flow passage 84 is eccentrically located within the top mount body 83 in that it is defined about the laterally offset center-line C/L₂. An externally threaded retainer and adjustment member 87 is received by an internal threaded section 88 of the tubular housing.
section 46 and defines spanner recesses 89 by which the retainer and adjustment member 87 is rotated by a spanner tool for adjusting the position of the top mount body 83 within the tubular housing and securing the top mount body against upward movement within the tubular body. A flow diverting passage 90 within the top mount body 83 communicates the drilling fluid flow from a high pressure chamber 96 into fluid flow passage 84 with an annulus or annular reamer bit supply chamber 91 between the tubular housing 36 and the top mount body 83 to provide for drilling fluid flow within the flow passage 84 of the top mount body and the annulus 91. The top mount body 83 defines an externally threaded connector 92 at the lower end thereof which establishes threaded engagement within an internally threaded connector 93 of a mud motor top sub 94. The top sub 94 has threaded connection with the upper internally threaded connector of a tubular housing 95 of the mud motor 74. Fluid flow through the flow passage 84 and into a motor operation chamber 97 is controlled by a replaceable flow control nozzle 98 to provide for controlled operating speed and power of the mud motor 74.

[0069] The top mount mud motor and dual bit drilling system of FIG. 10 differs from that of FIG. 9 in that the top mount body 83 defines a flow passage 126 that is in communication with the high pressure chamber 96 under the control of a replaceable flow control nozzle 127 so that fluid pressure within the annulus 91 and the motor operation chamber 97 is controlled by the respective flow control nozzles 127 and 98 according to the fluid pressure design of the mud motor and the reamer bit.

[0070] Within the mud motor 74 is provided a stator member 99 which is of tubular form and is composed of rubber or a rubber-like polymer material and defines a generally helical internal profile 100. An elongate rotor member 101, also having an external geometry that is composed of rubber or a rubber-like polymer material, defines a generally helical external profile 102 that cooperates with the internal profile 100 of the stator member 99 so that the flowing drilling fluid passes along the length of the stator and rotor members and causes rotation of the rotor member. The rotor member 101 is provided with a structural core that extends along its length and provides stability and structural integrity for the rotor member. A mud motor positioning and stabilizing member 103 is located in close fitting relation within the tubular housing 36 and defines an opening 104 within which the mud motor housing 95 is received. As the rotor member 101 is rotated within the stator member considerable vibration forces are developed. The mud motor positioning and stabilizing member 103 is composed of a resilient material and functions to minimize transfer of the rotor vibration forces to the mud motor housing and to the tubular housing 36. The lower end of the rotor member 101 defines a non-circular drive member 105 that is engaged within a non-circular receptacle 106 of a rotor driven shaft member 107, which is preferably a flex shaft composed of flexible and durable material, such as beryllium copper, to minimize shock forces that are transmitted by the rotor of the mud motor to the drive shaft and core removal bit of the drilling system.

[0071] As shown in FIG. 4, the rotor driven shaft 107 has a lower end defining cross-over ports 108 and a flow passage 109 and has threaded connection at 110 with the upper end portion 111 of the tubular drive shaft 86 of the core removal bit 34. The drive shaft 86 defines a central flow passage 112 that is in communication with the flow passage 109 and conducts drilling fluid flow to the core removal bit 34 for cooling the bit and for flushing away drill cuttings that occur at the cutting face 70. A bearing pack, shown generally at 113 in FIG. 4 includes sets of radial bearings 114 and thrust bearings 115. Drilling fluid being discharged from the stator and rotor during operation of the mud motor enters an annular flow passage 116, as shown at the lower portion of FIG. 3 and flows downwardly for cooling and lubrication of the bearing pack and for cooling and flushing drill cuttings from the core removal bit 34. An annular fluid flow clearance or passage 117 exists through the bearing pack 113, thereby permitting drilling fluid flow through the bearing pack for cleaning and cooling the bearings and materially enhancing the service life of the core removal bit mud motor and its bearing members. The drilling fluid is discharged from the clearance or flow passage 117 of the bearing pack into the chamber 77 within which the core removal bit 34 is located and then flows through the clearance 75 between the exterior surface of the core removal bit 34 and the surface 76 of the bit chamber within which the core removal bit is also positioned for core cutting rotation.

[0072] As the reamer bit 32 of FIG. 5 is rotated by the drill string and weight is applied a circular region of the subsurface formation is cut away, thereby leaving a formation core 72 that enters the downwardly facing opening 68. As drilling continues the upper end portion of the formation core is contacted by the cutting face 70 of the core removal bit so that continued penetration of the dual bit mechanism causes the core removal bit 34 to continuously cut away the formation core from top to bottom. This activity causes the formation core 72 to have a generally cylindrical external surface that is in close fitting relation with the inner surface segments 71 of the cutter supporting blade members of the reamer bit. A benefit of this close fitting relationship is that the formation core functions as a stabilization gauge to stabilize controlled rotation of the reamer bit and maintains controlled tracking of the course of the wellbore that is being drilled. The formation core thus prevents the reamer bit from wandering or being forced off course during the drilling process. To maintain the close fitting relationship of the formation core and the inner surface segments 71, gauge protector members 118 are inset within the matrix material of the cutter support blades and function to ensure against accelerated wear or erosion of the cylindrical surface of the formation core. Controlled tracking of the dual bit drilling system is also enhanced by the rapid drill bit penetration that occurs due to the absence of any formation crushing activity at the centermost region of the wellbore being drilled. The drive shaft 86 defines an externally threaded lower extremity 119 that is received in threaded engagement within an internally threaded receptacle 120 of the bit body 121 of the core removal bit 34.

[0073] When the reamer bit is rotated to the right by the drill string and the core removal bit 34 is rotated to the left by its mud motor, as in FIGS. 5, 6, 16 and 17, the threads of the mud motor components will be left hand threads to ensure against unthreading of the mud motor components by the reactive torque that is developed as the core removal bit cuts away the formation core. When both the reamer bit and the core removal bit are driven to the right, the thread connections throughout the mud motor and drive shaft will be right hand threads since thread disengagement will not occur. However, in this case the core removal bit should be rotated at a greater rotational speed than the rotational speed of the reamer bit, so that the cutting speed of the core removal bit will be proper for the core cutting capability that is needed.
Drilling fluid distribution passages 122 are defined within the bit body 121 of the core removal bit 34 and serve to conduct fluid flow from the flow passage 112 of the drive shaft 86 to the cutting face of the core removal bit. Replaceable flow control nozzles 123 are located at the outlet openings of the drilling fluid distribution passages 122 and ensure proper drilling fluid flow to the cutting face of the core removal bit. Drilling fluid within the annulus 91 is permitted to flow through fluid distribution passages 124 within the body 52 of the rear end to exit between the cutter supporting blades 58 under the control of replaceable flow control nozzles 125.

The tubular housing of the mud motor 74 is defined in part by a bearing housing section 126 that encapsulates the bearings 114 and 115 and defines an internal annular flange 127 that defines shoulders for bearing support and positioning. A drive shaft enlargement 128 also defines a bearing support and positioning shoulder for the thrust bearings 115. The lower portion of the tubular housing of the mud motor 74 is defined by a housing sub 130 that has threaded connection with the bearing housing section 126 at 132. A downwardly facing generally planar annular surface 134 of the housing sub is seated for positioning and stability on a corresponding upwardly facing annular surface 135 that is defined within the reamer bit body 52. The drive shaft 86 of the core removal bit 34 extends through a central passage 136 of the housing sub 130 with sufficient annular clearance that drilling fluid flows through the clearance and through the bearing set 84 to the bit chamber 77.

With reference to FIGS. 11-21, there is disclosed a concentric dual bit well drilling mechanism is disclosed wherein a reamer bit and a core removal bit rotate about a common longitudinal center-line C/L. As shown in FIGS. 11-14, wherein like reference numerals identify like parts, the dual bit drilling system 30 has a tubular housing 36 that defines a longitudinal center-line C/L about which the center of the flow passage 22 is concentric. A connecting sub 38 of the housing 36 is also concentric with the longitudinal center-line C/L and the centers of the intermediate housing section 46 and the reamer bit body 52 are also concentric with the longitudinal center-line C/L. Like components are identified by like reference numerals.

FIGS. 19 and 20, in addition to showing most of the features of FIG. 18, illustrate a top mount body 130 that is received within the tubular housing section 46 of the housing 36 and has an internally splined section 131 similar to the splined section 85 of FIG. 18. The top mount body 130 has external splines 132 that fit within the internal splined section 85 and thus permit an end movement of the top mount body within the tubular housing section 46 while ensuring that the top mount body is not rotatable within the housing section. The top mount body is linearly adjustable within the housing section 46 by means of an externally threaded adjustment member 87 that is threaded within the housing by a thread connection 88. This threaded adjustment permits the mud motor mechanism, its drive shafts and the core removal bit to be adjustable within the tubular housing. The threaded adjustment member 87 is rotated for linear adjustment by the use of a tool such as a spanner device. The entire mud motor mechanism, including the mud motor housing 95, its bearing pack, drive shaft and the core removal bit are inserted into the mud motor housing as a unit. The adjustment member 87 is then installed and adjusted to ensure against longitudinal movement of the mud motor within the housing 36 of the dual bit drilling system.
The components of the dual bit mechanism are indicated by like reference numerals. The cutting face 70 of the core removal bit may have any suitable configuration and may incorporate a wide range of suitable formation cutting materials without departing from the spirit and scope of the present invention. The core removal bit is shown in Figure and other Figures of the Drawings to have arrays of PDC cutter elements that extend to its center, but it should be borne in mind that the cutting face 70 of the core removal bit may be defined by other formation cutting materials and other drill bit designs. For example, a hard and durable material such as tungsten carbide that is fixed to a metal drill bit body and may have a coating of PDC material affixed thereto is effectively serviceable for use as the core removal bit. Typically, the tungsten carbide or any other suitable hard and durable material is applied as a hard-facing to a bit body that is composed of a durable metal such as steel. The hard-facing material typically defines formation cutting teeth for continuously cutting away the formation core from top to bottom as drilling operations continue.

[0082] The longitudinal section view of FIG. 16 shows a concentric dual bit mechanism having a reamer bit that is rotated to the right for drilling activity and a core removal bit that is concentric within the reamer bit and is rotated to the left during drilling and a core removable bit that is rotated to the left. FIG. 17 is a bottom view of the dual bit mechanism of FIG. 16. The longitudinal section views of FIGS. 18 and 19 and the transverse section view of FIG. 20 also show the concentric version of the dual bit well drilling system of the present invention and differ only in the particular design of the top mount mechanism.

[0083] FIG. 21 is a longitudinal section view showing the concentric dual bit drilling system of the present invention in its entirety, while FIG. 22 shows the eccentric version of the dual bit drilling system of the invention. The transverse section view of FIG. 23 is taken along line 23-23 of FIG. 22 and shows the laterally offset center-line C/1/2 of the embodiment of FIG. 22.

[0084] In view of the foregoing it is evident that the present invention is one well adapted to attain all of the objects and features hereinabove set forth, together with other objects and features which are inherent in the apparatus disclosed herein.

1. A top mount dual bit well drilling mechanism for drilling attachment to a tubular well drilling string extending from a drilling rig located at the Earth’s surface, comprising:
   a tubular housing for connection with a tubular well drilling string;
   a top mount body having an upper end portion mounted in non-rotatable relation within said tubular housing and having a connecting end;
   a drilling fluid energized rotary motor being supported within said tubular housing by said connecting end of said top mount body;
   a reamer bit being connected with said tubular housing and having a plurality of spaced cutter retaining blades each having multiplicity of formation cutter elements mounted thereto and defining a downwardly facing core receiving receptacle, said reamer bit being rotated by said tubular housing upon rotation of said tubular housing by said tubular well drilling string, said reamer bit defining a core removing bit chamber therein in communication with said downwardly facing core receiving receptacle;
   a core removing bit being disposed for rotation within said core removal bit chamber and having a cutting face oriented for engaging and removing a formation core that remains and enters said downwardly facing core receiving receptacle as said formation cutter elements of said reamer bit cut a wellbore into the formation; and
   a bit drive shaft being driven by said drilling fluid energized rotary motor and being connected in rotary driving relation with said core removing bit.

2. The top mount dual bit well drilling mechanism of claim 1, comprising:
   said reamer bit having an axis of rotation;
   said tubular housing of said drilling mechanism having a longitudinal center-line being concentric with said axis of rotation of said reamer bit;
   said drilling fluid energized rotary motor having a longitudinal center-line;
   said top mount body supporting said drilling fluid energized rotary motor with said longitudinal center-line thereof being laterally offset from said longitudinal center-line of said tubular housing of said drilling mechanism; and
   said core removing bit being rotatable about said longitudinal center-line of said drilling fluid energized rotary motor.

3. The top mount dual bit well drilling mechanism of claim 1, comprising:
   said reamer bit having an axis of rotation;
   said tubular housing of said drilling mechanism having a longitudinal center-line being concentric with said axis of rotation of said reamer bit;
   said drilling fluid energized rotary motor having a longitudinal center-line;
   said top mount body supporting said drilling fluid energized rotary motor with said longitudinal center-line thereof in concentric relation with said longitudinal center-line of said tubular housing of said drilling mechanism; and
   said core removing bit being rotatable about said longitudinal center-line of said drilling fluid energized rotary motor.

4. The top mount dual bit well drilling mechanism of claim 1, comprising:
   said reamer bit defining a cutting face;
   said core removing bit defining a cutting face being recessed within said reamer bit and located inwardly of said cutting face of said reamer bit and permitting formation core stabilization of said reamer bit within said downwardly facing core receiving receptacle.

5. The top mount dual bit well drilling mechanism of claim 1, comprising:
   said drilling fluid energized rotary motor having a tubular motor housing;
   a stator member being located within said tubular motor housing;
a rotor member being located within said stator member and being rotated by drilling fluid flow between said stator and rotor members; and
a bit drive shaft being rotationally driven by said rotor member and having driving connection with said core removing bit.
6. The top mount dual bit well drilling mechanism of claim 1, comprising:
said reamer bit having right hand rotation during well drilling; and
said drilling fluid energized rotary motor rotating said core removing bit to the left during well drilling.
7. The top mount dual bit well drilling mechanism of claim 1, comprising:
said reamer bit having right hand rotation during well drilling; and
said drilling fluid energized rotary motor rotating said core removing bit to the right during well drilling.
8. The top mount dual bit well drilling mechanism of claim 1, comprising:
internal splines being defined within said tubular housing; external splines being defined by said top mount body and engaging said internal splines and establishing a non-rotatable relationship of said top mount body within said tubular housing;
a retainer and adjustment member being threaded within said tubular housing and having retaining and adjusting engagement with said top mount body;
said drilling fluid energized rotary motor having a tubular motor housing being connected with and supported by said top mount body and being seated within said reamer bit body; and
a bit drive shaft extending through said tubular housing and into said core removing bit chamber and being in threaded driving connection with said core removing bit.
9. The top mount dual bit well drilling mechanism of claim 1, comprising:
 drilling fluid flow passages being defined within said tubular housing and both internally and externally of said drilling fluid energized rotary motor.
10. The top mount dual bit well drilling mechanism of claim 1, comprising:
a drilling fluid supply chamber being located within said tubular housing and externally of said top mount body and said drilling fluid energized rotary motor;
a substantially centrally located drilling fluid flow passage extending longitudinally through said top mount body and providing a supply of drilling fluid to said fluid energized rotary motor;
a flow diverting passage being defined in said top mount body and being in communication with said substantially centrally located drilling fluid flow passage and diverting a portion of the drilling fluid being supplied by the well drilling string into said drilling fluid supply chamber; and
reamer bit supply passages being defined within said reamer bit and conducting flows of drilling fluid from said drilling fluid supply chamber to spaces between said cutter retaining blades.
11. The top mount dual bit well drilling mechanism of claim 10, comprising:
replaceable flow control nozzles being located within designated drilling fluid flow passages to control the volume of drilling fluid flow for operation of said drilling fluid energized rotary motor, for cooling drilling components and to supply drilling fluid flow for efficient operation of said reamer bit and said core removing bit.
12. A top mount dual bit well drilling mechanism for drilling attachment to a tubular well drilling string extending from a drilling rig located at the Earth's surface, comprising:
a tubular housing having a mounting sub at the upper end thereof for rotary driven connection with a tubular well drilling string;
a top mount body defining a drilling fluid flow passage therethrough and having an upper end portion mounted in non-rotatable relation within said tubular housing and having a connecting end;
a drilling fluid energized rotary motor being supported within said tubular housing by said connecting end of said top mount body and defining a motor operation chamber in communication with said drilling fluid flow passage of said top mount body;
a reamer bit being connected with said tubular housing and having a plurality of spaced cutter retaining blades each having multiplicity of formation cutter elements mounted thereto and defining a reamer bit cutting face, said reamer bit defining a downwardly facing centrally located core receiving receptacle and being rotated by said tubular housing upon rotation of said tubular housing by said tubular well drilling string, said reamer bit defining a core removing bit chamber therein in communication with said downwardly facing core receiving receptacle;
a core removing bit being disposed for rotation within said core removal bit chamber and having a cutting face thereof located inwardly of said cutting face of said reamer bit and oriented for engaging and removing a formation core that remains and enters said downwardly facing core receiving receptacle as said formation cutter elements of said reamer bit cut a wellbore into the formation; and
a bit drive shaft being driven by said drilling fluid energized rotary motor and being connected in rotary driving relation with said core removing bit.
13. The top mount dual bit well drilling mechanism of claim 12, comprising:
said reamer bit having an axis of rotation;
said tubular housing of said drilling mechanism having a longitudinal center-line being concentric with said axis of rotation of said reamer bit;
said drilling fluid energized rotary motor having a longitudinal center-line;
said top mount body supporting said drilling fluid energized rotary motor with said longitudinal center-line thereof being laterally offset from said longitudinal center-line of said tubular housing of said drilling mechanism; and
said core removing bit being rotatable about said longitudinal center-line of said drilling fluid energized rotary motor.
14. The top mount dual bit well drilling mechanism of claim 12, comprising:
said reamer bit having an axis of rotation;
said tubular housing of said well drilling mechanism having a longitudinal center-line being concentric with said axis of rotation of said reamer bit;
said drilling fluid energized rotary motor having a longitudinal center-line;
said top mount body supporting said drilling fluid energized rotary motor with said longitudinal center-line thereof in concentric relation with said longitudinal center-line of said tubular housing of said well drilling mechanism; and
said core removing bit being rotatable about said longitudinal center-line of said drilling fluid energized rotary motor.
15. The top mount dual bit well drilling mechanism of claim 12, comprising:
said drilling fluid energized rotary motor having a tubular motor housing;
a stator member being located within said tubular motor housing;
a rotor member being located within said stator member and being rotated by drilling fluid flow between said stator and rotor members; and
a bit drive shaft being rotationally driven by said rotor member and having driving connection with said core removing bit.
16. The top mount dual bit well drilling mechanism of claim 12, comprising:
internal splines being defined within said tubular housing;
external splines being defined by said top mount body and engaging said internal splines and establishing a non-rotatable relationship of said top mount body within said tubular housing;
a retainer and adjustment member being threaded within said tubular housing and having retaining and adjusting engagement with said top mount body;
said drilling fluid energized rotary motor having a tubular motor housing being connected with and supported by said top mount body and being seated within said runner bit body; and
a bit drive shaft extending through said tubular motor housing and into said core removing bit chamber and being in threaded driving connection with said core removing bit.
17. The top mount dual bit well drilling mechanism of claim 16, comprising:
drilling fluid flow distribution passages being defined within said core removing bit;
said drilling fluid energized rotary motor having a stator within said tubular motor housing and having a rotor with said stator being rotated by drilling fluid flow between said stator and rotor;
said rotor having a non-circular output shaft drive member;
a flex shaft having non-rotatable connection with said non-circular output shaft drive member and cushioning shock forces of said rotor;
a tubular bit drive shaft being connected in driven relation with said flex shaft and being connected in driving relation with said core removing bit and having a drilling fluid flow passage therein in communication with said drilling fluid flow distribution passages of said core removing bit.