United States Patent

Bromell

[15] **3,662,842**

[45] **May 16, 1972**

[54] AUTOMATIC COUPLING SYSTEM

[72] Inventor: **Raymond J. Bromell**, Dallas, Tex.

[73] Assignee: **Automatic Drilling Machines, Inc.**, Dallas, Tex.

[22] Filed: **Apr. 14, 1970**

[21] Appl. No.: **28,344**

[52] **U.S. Cl.** **173/1**, 29/240, 166/77.5, 166/315, 173/15, 173/164

[51] **Int. Cl.** **B23p 19/04**, E21b 19/16

[58] **Field of Search** 81/52.4, 57.11, 57.33, 57.34, 81/57.35; 173/1, 45, 12, 21, 164, 57, 163, 15; 175/27, 52, 57, 85, 170; 166/77.5, 315; 29/240

[56] **References Cited**

UNITED STATES PATENTS

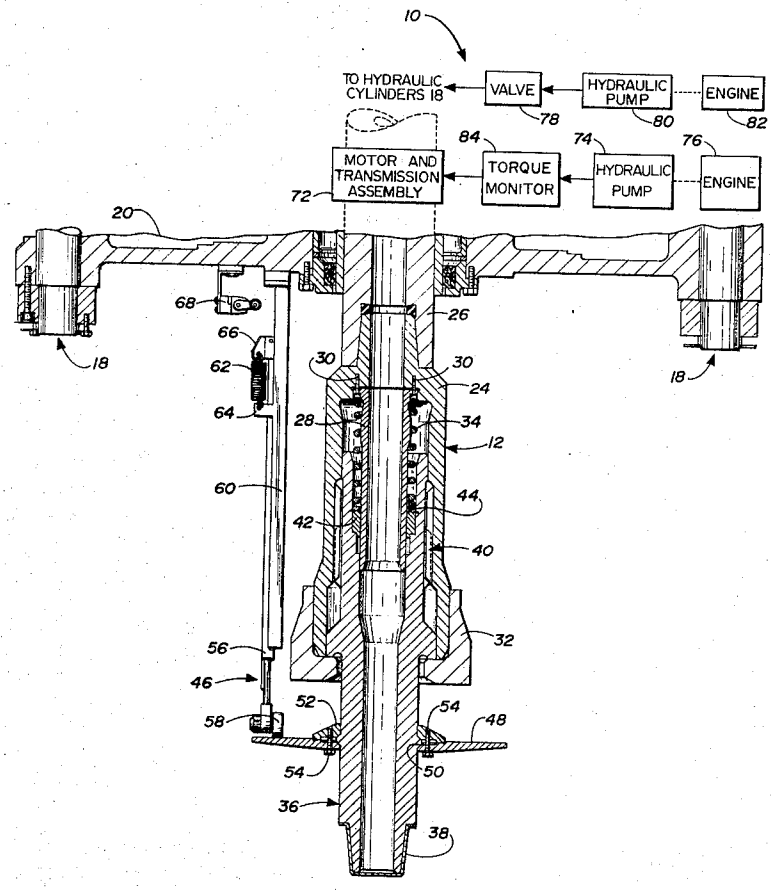
1,377,575	5/1921	Greve	173/57
2,762,403	9/1956	Ferm et al.	81/57.11 X
2,887,920	5/1959	Austin	81/52.4
2,984,000	5/1961	McConnell	81/52.4 X
2,972,388	2/1961	Thornburg	166/77.5 X
3,191,450	6/1965	Wilson	173/1.63 X

Primary Examiner—Ernest R. Purser
Attorney—Richards, Harris & Hubbard

[57] **ABSTRACT**

In an automatic coupling system, a threaded quill is connected to a rotating and advancing mechanism by a slip coupling and is biased toward a drill pipe by a spring. In the use of the system, the quill is advanced toward the drill pipe and is simultaneously rotated with respect to the pipe. When the quill engages the pipe, it slips relative to the advancing and rotating mechanism against the action of the spring until a quill advance terminating switch is closed. The rotation of the quill is continued until the torque on the quill reaches a predetermined limit.

18 Claims, 5 Drawing Figures



PATENTED MAY 16 1972

3,662,842

SHEET 1 OF 2

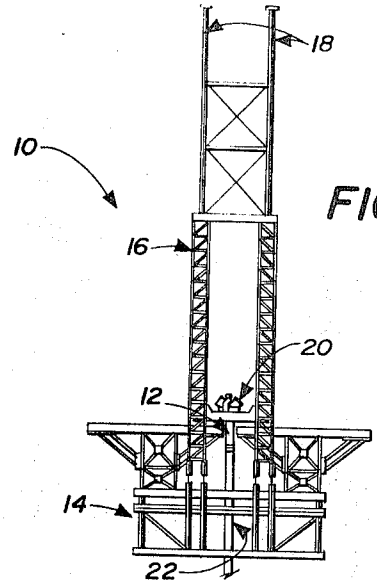


FIG. 1

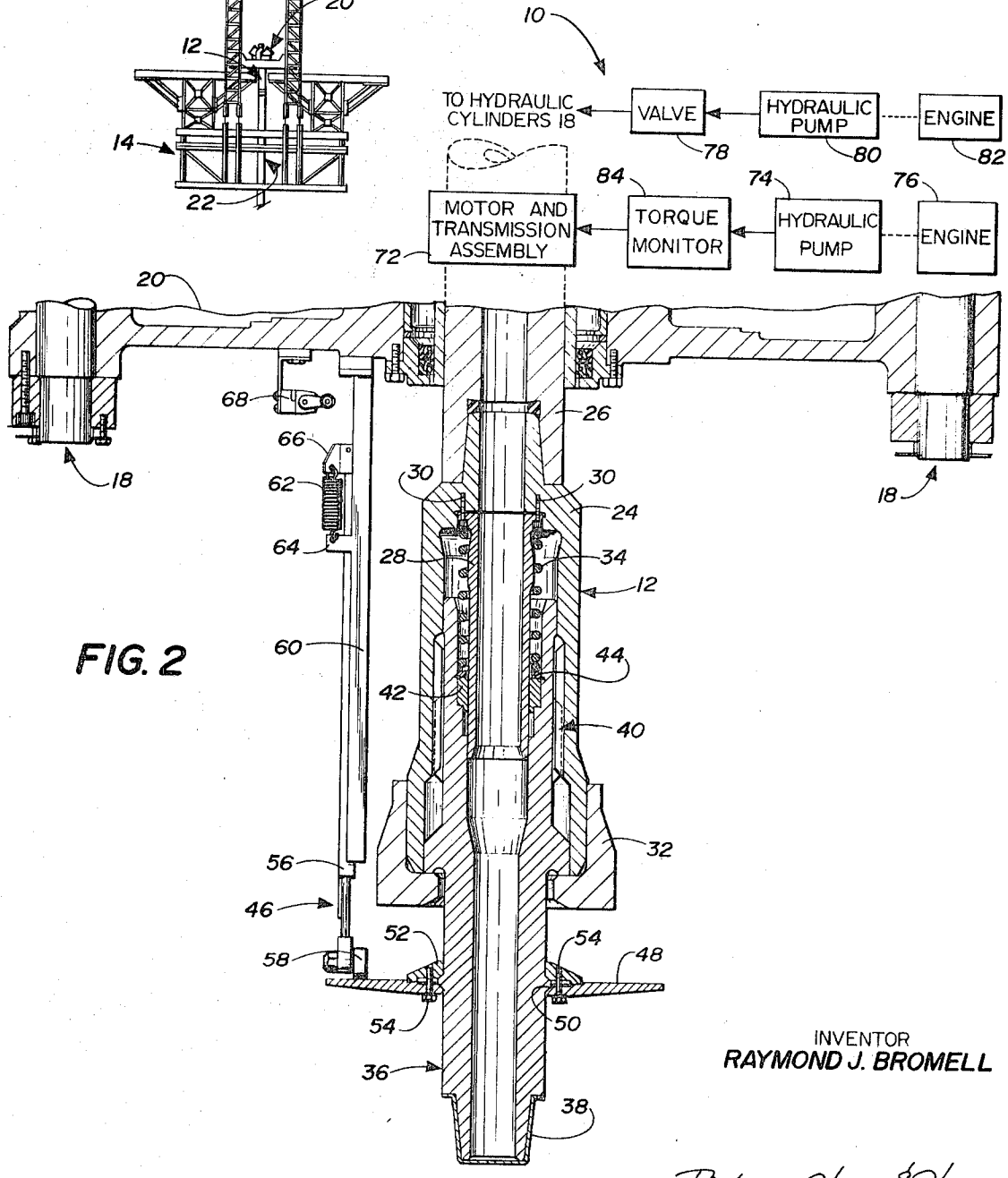


FIG. 2

INVENTOR
RAYMOND J. BROMELL

Richards, Harris & Hubbard
ATTORNEYS

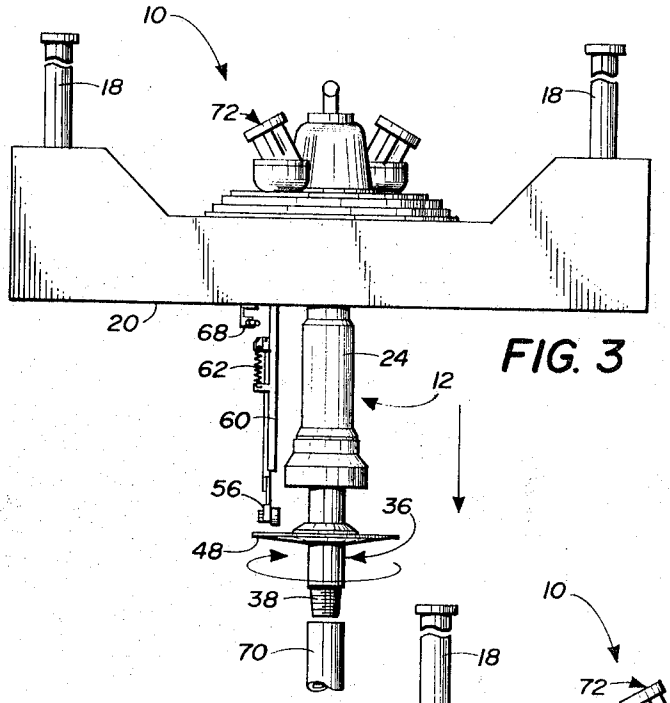


FIG. 3

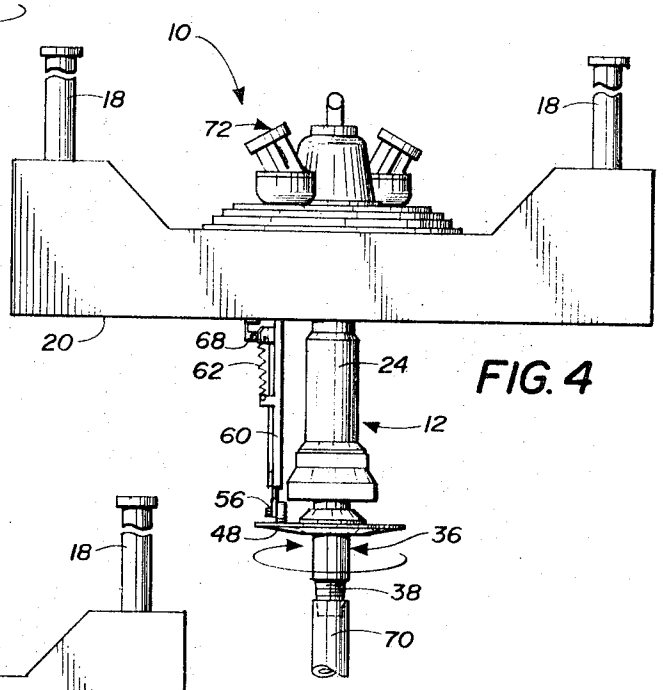


FIG. 4

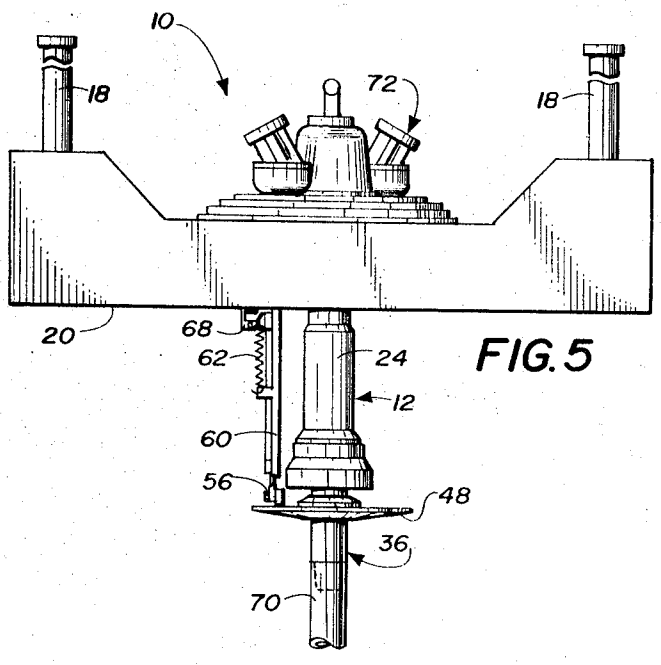


FIG. 5

INVENTOR
RAYMOND J. BROMELL

Richard, Harris & Hubbard
ATTORNEYS

AUTOMATIC COUPLING SYSTEM

BACKGROUND OF THE INVENTION

In the drilling industry, drilling machines or rigs are employed to form oil wells and similar deep boreholes. As opposed to conventional rigs, automatic drilling machines perform the various steps involved in forming a borehole without human intervention. Typically, this is accomplished by means of a drill head mounted in a drilling tower for vertical movement by hydraulic cylinders connected to the top of the tower.

In the use of an automatic drilling machine, the drill head is connected to a drill bit through a string of drill pipe. The drill head rotates the drill string and the drill bit and thereby forms a borehole. As the depth of the borehole increases, new sections of drill pipe are added to the drill string. This is accomplished by disconnecting the drill head from the drill string, operating the hydraulic cylinders to raise the drill head to the top of the tower, connecting a new section of pipe to the drill head, and then connecting the new section to the drill string.

Heretofore, the connection of the drill head to a new section of drill pipe has been a relatively slow operation, even in an automatic drilling machine. This is because the drill head is connected to the pipe through a quill that is threadably engaged with the upper portion of the pipe. In order to threadably interengage the quill and the pipe, it has heretofore been necessary to rotate and advance the quill in accordance with the lead of the threaded connection.

This invention relates to a method and apparatus whereby the drill head of an automatic drilling machine is attached to a section of drill pipe in a rapid and efficient manner. The use of the invention permits the automatic connection of the drill head to a section of drill pipe without danger of jamming or mutilating the threads of either the pipe or the quill, and without the necessity of accurately positioning the pipe. Furthermore, the use of the invention eliminates the application of excessive torque loads to the threaded connection between the quill and the pipe, and thereby facilitates the subsequent removal of the quill from the pipe.

SUMMARY OF THE INVENTION

In accordance with the preferred embodiment of the invention, an automatic coupling system includes a threaded member that is simultaneously advanced and rotated. The advance of the threaded member continues until the threaded member contacts another threaded member. Rotation continues until a threaded connection is formed. Preferably, the threaded member is spring biased and is rotated until a predetermined torque is applied between the threaded members.

DESCRIPTION OF THE DRAWINGS

A more complete understanding of the invention may be had by referring to the following detailed description when taken in conjunction with the drawings, wherein:

FIG. 1 is an illustration of an automatic drilling machine including an automatic coupling system employing the present invention;

FIG. 2 is an enlarged sectional view illustrating the automatic coupling system of the automatic drilling machine shown in FIG. 1, and

FIGS. 3, 4 and 5 are illustrations of various steps in the operation of the automatic coupling system.

DETAILED DESCRIPTION

Referring now to the drawings, and particularly to FIG. 1 thereof, there is shown an automatic drilling machine **10** including an automatic coupling system **12** employing the present invention. The automatic drilling machine **10** includes a platform **14** having a tower or mast **16** mounted on it. The tower **16** extends upwardly from the platform **14** and supports a plurality of hydraulic cylinders **18**. The tower **16** also supports a drill head **20** which is mounted for reciprocation in the tower **16** upon operation of the hydraulic cylinders **18**.

In the use of the automatic drilling machine **10**, the drill head **20** is connected to a drill string **22** which extends to a drill bit (not shown). The drill head **20** rotates the drill string and the drill bit and thereby forms a borehole. As the formation of the borehole progresses, the drill head **20** moves downwardly relative to the tower **16** of the automatic drilling machine **10**.

When the drill head **20** reaches the position shown in FIG. **1**, it is disconnected from the drill string **22** and is raised relative to the tower **16** by the hydraulic cylinders **18**. When the drill head **20** is at the top of the tower **16**, a new section of drill pipe is positioned under the drill head **20** and the automatic coupling mechanism **12** of the present invention couples the drill head **20** to the new section of drill pipe. The new section of pipe is then connected to the drill string **22**, and the drill head **20** is again operated to rotate the drill string **22** and the drill bit.

Referring now to FIG. **2**, the automatic coupling system **12** of the automatic drilling machine **10** is shown in detail. The system **12** includes an outer sleeve **24** which is coupled to a drive tube **26** that extends downwardly from the drill head **20**. An inner sleeve **28** is secured to the outer sleeve **24** by a plurality of screws **30**, and a retaining collar **32** is threadably engaged with the distal end of the outer sleeve **24**. A compression spring **34** is mounted between the inner sleeve **28** and the outer sleeve **24**.

In addition to the sleeves **24** and **28** and the spring **34**, the automatic coupling system **12** comprises a quill **36** having a threaded distal end **38**. The quill **36** is mounted for sliding movement axially of the outer sleeve **24**, but is prevented from rotational movement relative to the outer sleeve **24** by a spline connection **40**. A packing nut **42** is secured between the quill **36** and the inner sleeve **28** by a retaining ring **44**. The compression spring **34** extends into engagement with the retaining ring **44** and normally urges the threaded quill **36** into engagement with the retaining collar **32**.

The automatic coupling system **12** further includes a quill advance terminating subsystem **46**. The subsystem **46** includes a switch actuating plate **48** which is secured to the quill **36** by the cooperation of an annular projection **50** on the quill **36**, a retaining ring **52** and a plurality of screws **54**. A slider **56** is mounted adjacent the switch actuating plate **48** and includes a plate engaging roller **58**. The slider **56** is mounted in a guide **60** that extends from the drill head **20** and is urged toward the position shown in FIG. **2** by a tension spring **62** connected between a tab **64** on the guide **60** and a tab **66** on the slider **56**. A limit switch **68** is mounted on the drill head **20** for actuation by the slider **56** upon relative movement between the quill **36** and the drill head **20**.

The operation of automatic coupling system **12** is illustrated in FIGS. **2**, **3**, **4** and **5**. Referring first to FIGS. **2** and **3**, a new section of drill pipe **70** is mounted beneath the drill head **20** of the automatic drilling machine **10** and is secured with respect thereto by a suitable chuck (not shown). Thereafter, the hydraulic cylinders **18** are operated to advance the automatic coupling system **12** toward the new section of pipe **70** and a motor and transmission assembly **72** is simultaneously actuated to rotate the quill **36** of the system **12** relative to the new section of pipe.

Referring specifically to FIG. **2**, the motor and transmission assembly **72** is mounted on the drill head **20** and is coupled directly to the drive tube **26** thereof. The assembly **72** includes hydraulic motors that are driven by hydraulic fluid supplied by a pump **74** which is in turn driven by an engine **76**. Preferably, the pump **74** and the engine **76** are mounted on a platform (not shown) positioned adjacent the drilling machine **10** and are connected to the motor and transmission assembly **72** by hydraulic piping. Hydraulic fluid for the hydraulic cylinder **18** of the automatic drilling machine **10** is supplied through a solenoid operated valve **78** by a pump **80** that is driven by an engine **82**.

Referring now to FIGS. **3** and **4**, the quill **36** of the automatic coupling system **12** is advanced toward the new section of pipe **70** and is simultaneously rotated with respect thereto

until the threaded end **38** of the quill **36** engages the new section of pipe. Interengagement of the quill **36** and the new section of pipe **70** prevents further advance of the quill **36**, but does not prevent further advance of the drill head **20** and the outer sleeve **24** connected thereto. Therefore, upon engagement with the new section of pipe, the quill **36** moves relative to the drill head **20** against the action of the spring **34**.

As the quill **36** moves into the outer sleeve **24**, the plate **48** engages the roller **58** of the slider **56** and thereafter moves the slider **56** upwardly in the guide **60** against the action of the spring **62**. This action continues until the slider **56** engages the switch **68**. Actuation of the switch **68** operates the valve **78** to terminate operation of the hydraulic cylinders **18**. Thus, actuation of the switch **68** interrupts the advance of the drill head **20** and thereby terminates movement of the quill **36** relative to the drill head **20**.

Actuation of the switch **68** does not terminate the rotation of the quill **36** under the action of the motor and transmission assembly **72**. Rather, the rotation of the quill **36** is continued so that the threaded end **38** of the quill threadably engages the new section of pipe **70** under the combined actions of the motor and transmission assembly **72**, which rotates the quill **36**, and the spring **34**, which urges the quill **36** toward the new section of pipe **70**. Rotation of the quill **36** continues until a threaded connection is formed between the quill **36** and the new section of pipe **70** as determined by a torque monitor **84**. The monitor **84** comprises a pressure sensitive switch that monitors the pressure in the line between the pump **74** and the hydraulic motors of the motor and transmission assembly **72** and that terminates the flow of hydraulic fluid to the motors when the load on the motors reaches a predetermined limit.

It will be understood that as the quill **36** is rotated into threaded interengagement with the new section of pipe **70**, the quill **36** moves away from the drill head **20** under the action of the spring **34**. In some instances, this action may move the slider **56** out of engagement with the limit switch **68**. In such a case, the hydraulic cylinders **18** of the automatic drilling machine **10** are again actuated to advance the drill head **20** toward the new section of pipe **70**. This action is terminated as soon as the slider **56** reengages the switch **68**.

After the quill **36** is connected to the new section of pipe, the chucks that were engaged with the new section are released. Then the new section is connected to the drill string and the drill head is employed to rotate the drill string and drill bit. This action increases the depth of the borehole and is continued until the depth has increased about 30 feet whereupon the quill **36** is unthreaded from the drill string, and a new section of pipe is connected between the drill string and the drill head.

The automatic coupling system **12** of the automatic drilling machine **10** also plays an important role in the unthreading of the quill **36**. Because of the spline connection **40** between the quill **36** and the drill head **20**, it is not necessary to correlate the rotary and linear movement of the quill with the lead of the threaded connection. Rather, the quill **36** is simply rotated at high speed relative to the drill string. As the quill unthreads, it moves upwardly relative to the drill head against the action of the spring **34**.

The use of an automatic coupling system employing the present invention in an automatic drilling machine results in several advantages over the prior art. First, when the present invention is employed, it is not necessary to accurately position a section of drill pipe relative to the drill head. That is, since the drill head is advanced until the quill engages the pipe, the pipe can be positioned virtually anywhere when the limits of travel of the drill head without consequence as to the operation of the automatic coupling system.

Second, the use of the present invention eliminates the necessity of correlating the advance and the rotation of the quill with the lead of the threaded connection. Instead, the advance and the rotation of the quill are completely independent and can be carried out at any desired speed. Usually, the quill is advanced much more rapidly than would otherwise be the case, and a threaded connection between the quill and a section of pipe is therefore formed much more quickly.

Third, when the present invention is utilized, the application of excessive torque loads between the quill and a section of pipe is prevented. This eliminates jamming and mutilation of threads. Also, the subsequent unthreading of the quill is facilitated when the initial torque on the threaded connection between the quill and a pipe section is held to a controlled limit.

Fourth, the automatic coupling system shown in the drawings facilitates the disconnection of the quill of an automatic drilling machine in that it eliminates the necessity of correlating the rotary and linear motions of the quill with the lead of the threaded connection during the unthreading of the quill. Thus, the use of the present invention increases the speed of both the coupling and the uncoupling of the quill.

Although only one embodiment of the invention is shown in the drawings and described herein, it will be understood that the invention is not limited to the embodiment disclosed, but is capable of rearrangement, modification and substitution of parts and elements without departing from the spirit of the invention.

What is claimed is:

1. An automatic coupling apparatus comprising:
- a threaded member;
- means for supporting and rotating the threaded member;
- means for advancing the threaded member, and
- means responsive to contact between the threaded member and another threaded member for automatically terminating the operation of the advancing means.

2. The automatic coupling apparatus according to claim **1** wherein the terminating means comprises:
- means for moving the threaded member relative to the supporting and rotating means upon contact between the threaded member and another threaded member, and
- means responsive to the predetermined amount of relative movement between the threaded member and the supporting and rotating means for terminating the advance of the threaded member.

3. The automatic coupling apparatus according to claim **2** wherein the means for moving the threaded member relative to the supporting and rotating means includes a slip coupling between the threaded member and the supporting and rotating means and means for biasing the threaded member into engagement with another threaded member.

4. The automatic coupling apparatus according to claim **1** wherein the supporting and rotating means supports the threaded member for movement between an extended position and a retracted position and means for biasing the threaded member toward the extended position.

5. The automatic coupling apparatus according to claim **4** wherein the terminating means includes means responsive to movement of the threaded member toward the retracted position against the action of the biasing means for terminating the advance of the threaded member.

6. The automatic coupling apparatus according to claim **1** further including means for terminating the rotation of the threaded member upon threaded interengagement between the threaded member and another threaded member.

7. The automatic coupling apparatus according to claim **6** wherein the rotation terminating means is responsive to the torque imposed on the threaded member by the supporting and rotating means.

8. An automatic coupling apparatus comprising:
- a threaded quill;
- means for positioning a drill pipe for threaded connection to the quill;
- means for moving the quill into engagement with the drill pipe and for thereafter biasing the quill toward the drill pipe; and
- means for rotating the quill relative to the drill pipe and thereby forming a threaded connection between the drill pipe and the quill.

9. The automatic coupling apparatus according to claim 8 further including means for terminating the rotation of the quill after the threaded connection is formed.

10. The automatic coupling apparatus according to claim 8 wherein the quill and the rotating means are mounted on a drill head and wherein the moving and biasing means moves the drill head toward the drill pipe.

11. The automatic coupling apparatus according to claim 10 further characterized by a spline coupling between the quill and the rotating means for permitting relative sliding motion therebetween while preventing relative rotation.

12. The automatic coupling apparatus according to claim 10 wherein the quill is mounted on the drill head for sliding movement with respect thereto and wherein the biasing portion of the moving biasing means comprises a spring mounted between the drill head and the quill for urging the quill into engagement with the drill pipe.

13. The automatic coupling apparatus according to claim 12 further including means for terminating the movement of the drill head toward the drill pipe in response to sliding movement of the quill relative to the drill head.

14. The automatic coupling apparatus according to claim 13 wherein the movement terminating means includes switch means mounted for actuation upon relative movement between the quill and the drill head.

15. A method of automatically coupling a threaded quill to a drill pipe comprising:

advancing a spring loaded threaded quill toward a drill pipe and simultaneously rotating the quill relative to the pipe;

engaging the quill with the drill pipe to compress the spring;

actuating sensing means to terminate the advance of the quill after a predetermined amount of compression of the spring, and

actuating sensing means to terminate the rotation of the quill relative to the drill pipe when the torque on the quill exceeds a predetermined level.

16. The method according to claim 15 wherein the advancing and rotating step includes the steps of:

positioning a drill pipe at a predetermined location, and

moving a quill rotating mechanism toward the predetermined location.

17. The method according to claim 16 wherein the terminating step includes the step of sensing relative movement between the quill and the rotating mechanism upon engagement of the quill with the drill pipe.

18. The method according to claim 17 wherein the rotation terminating step includes the steps of:

sensing the torque that is applied to the quill by the rotating mechanism, and

terminating the operation of the rotating mechanism when the torque applied to the quill exceeds the predetermined level.

* * * * *