May 16, 1967 L. KRAMER 3,319,723

AXIAL PISTON PULSE GENERATOR

Filed April 1, 1965 5 Sheets-Sheet 1

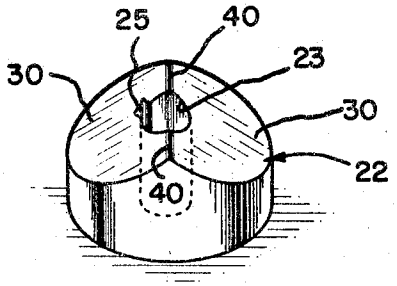


FIG. 2A

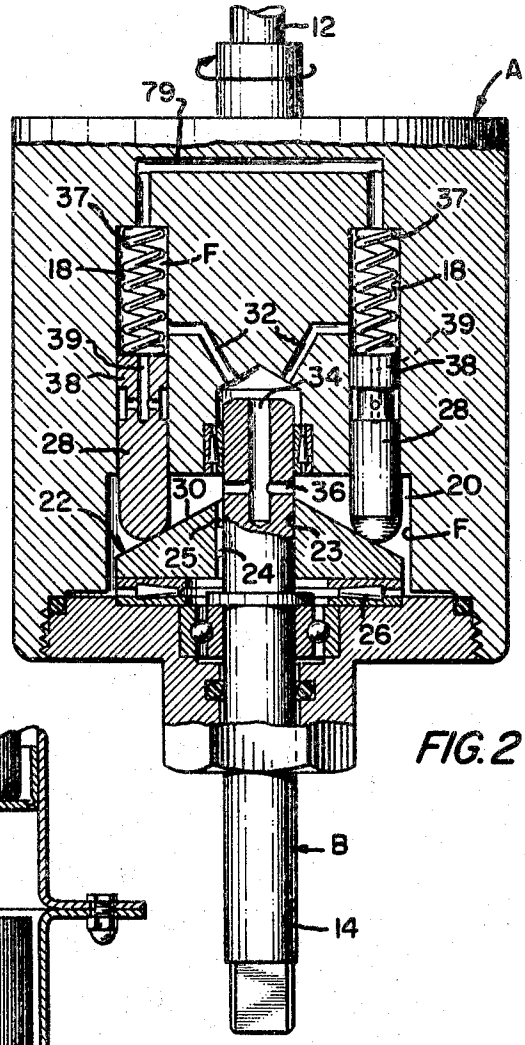


FIG. 2

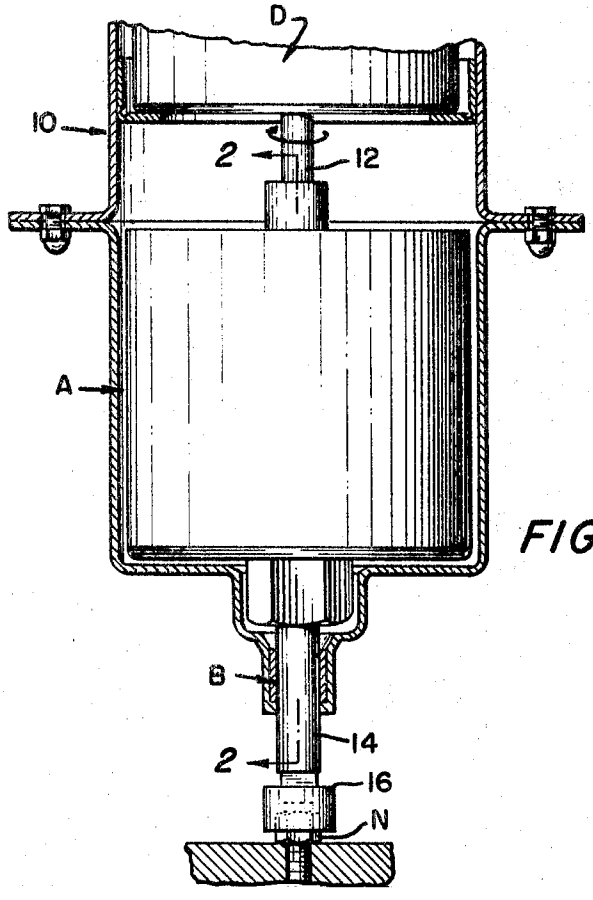


FIG. 1

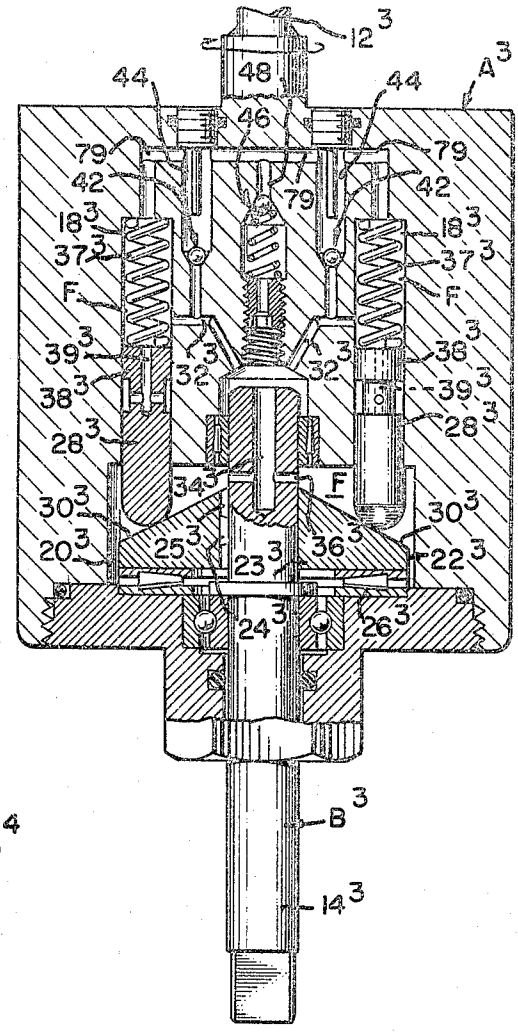
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AXIAL PISTON PULSE GENERATOR

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FIG. 3



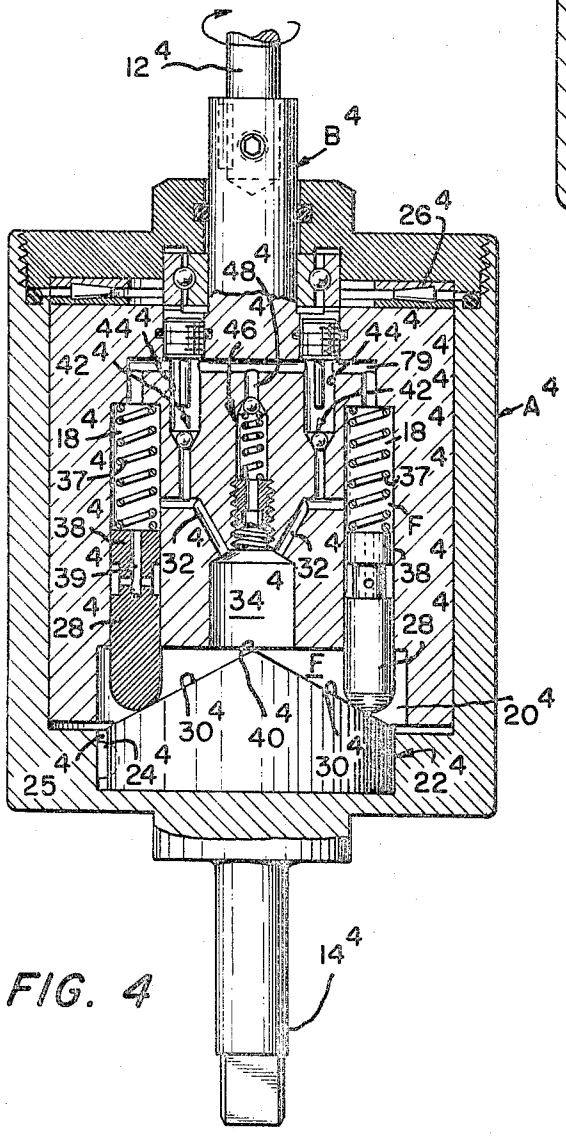


FIG. 4

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AXIAL PISTON PULSE GENERATOR

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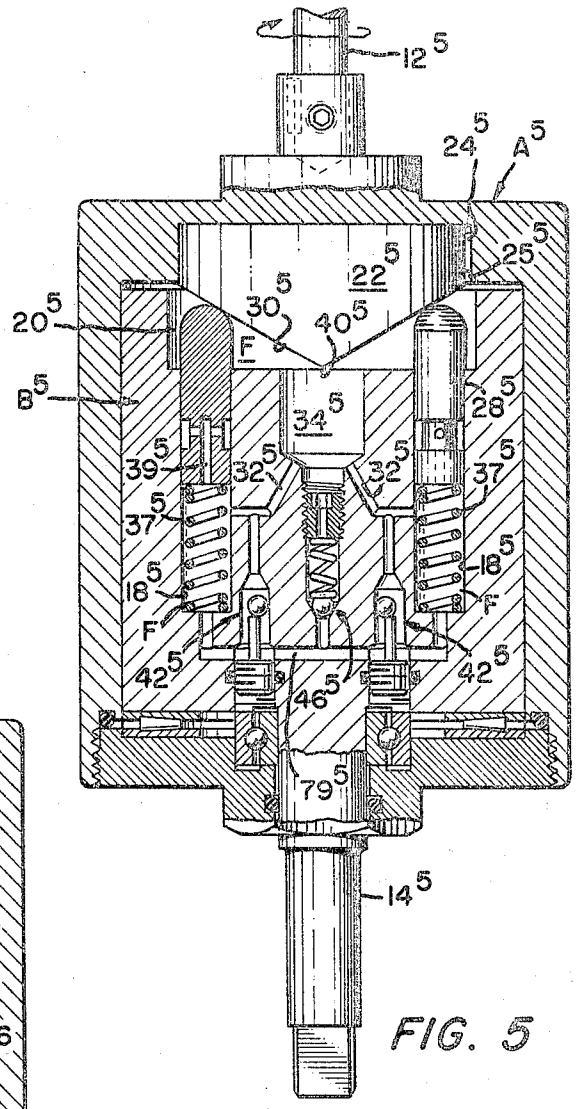


FIG. 5

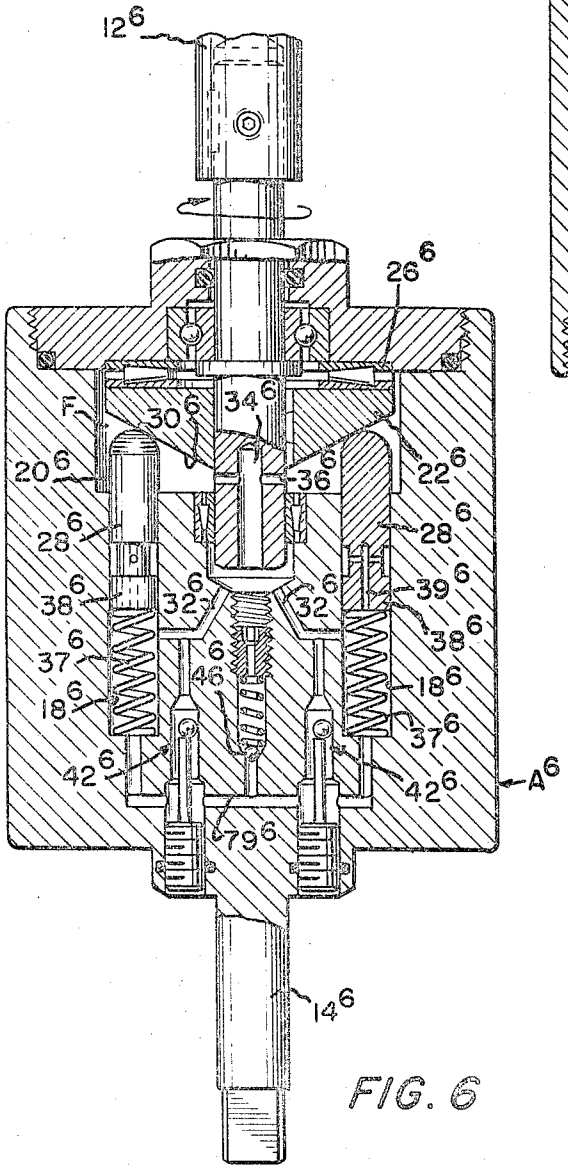


FIG. 6

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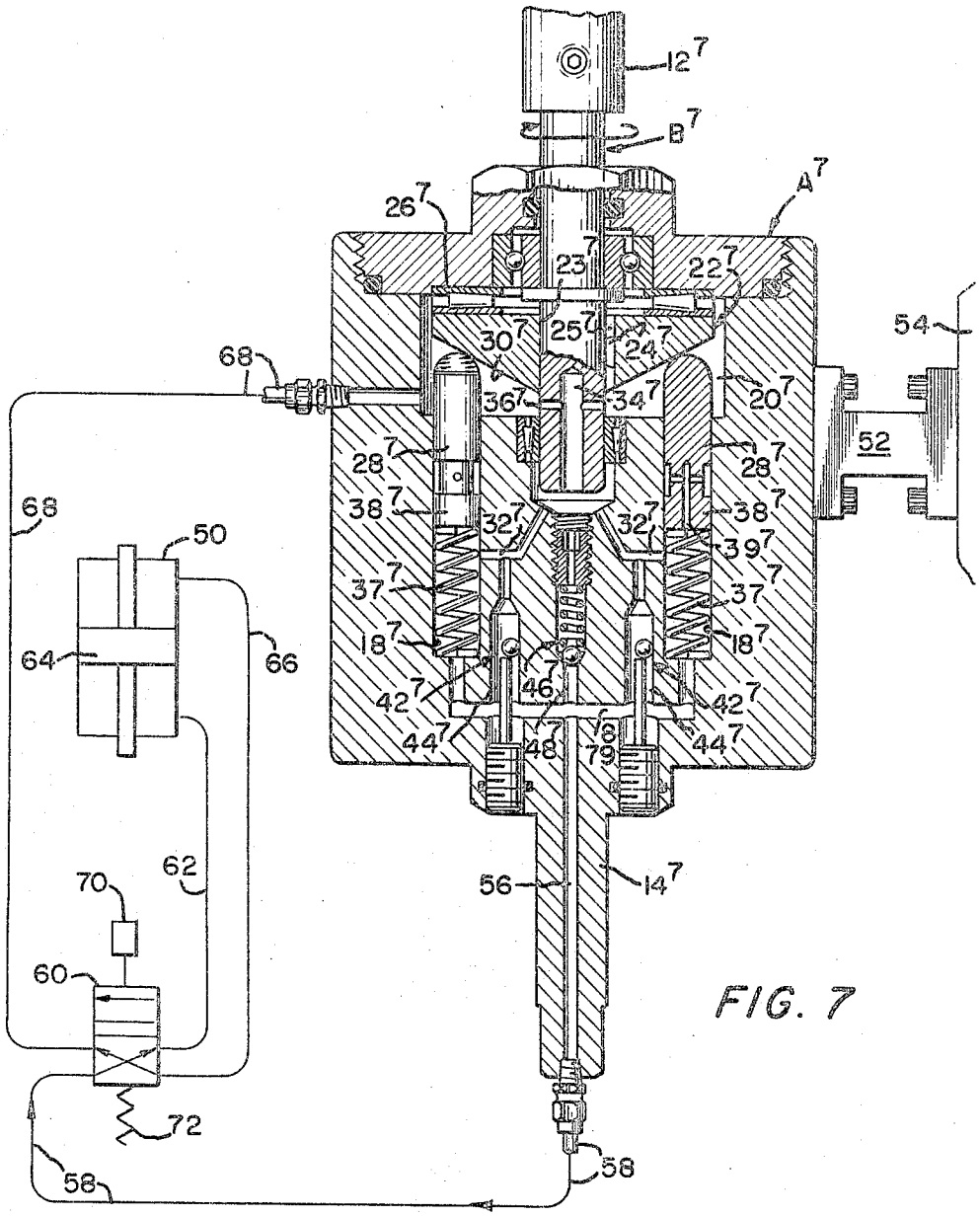


FIG. 7

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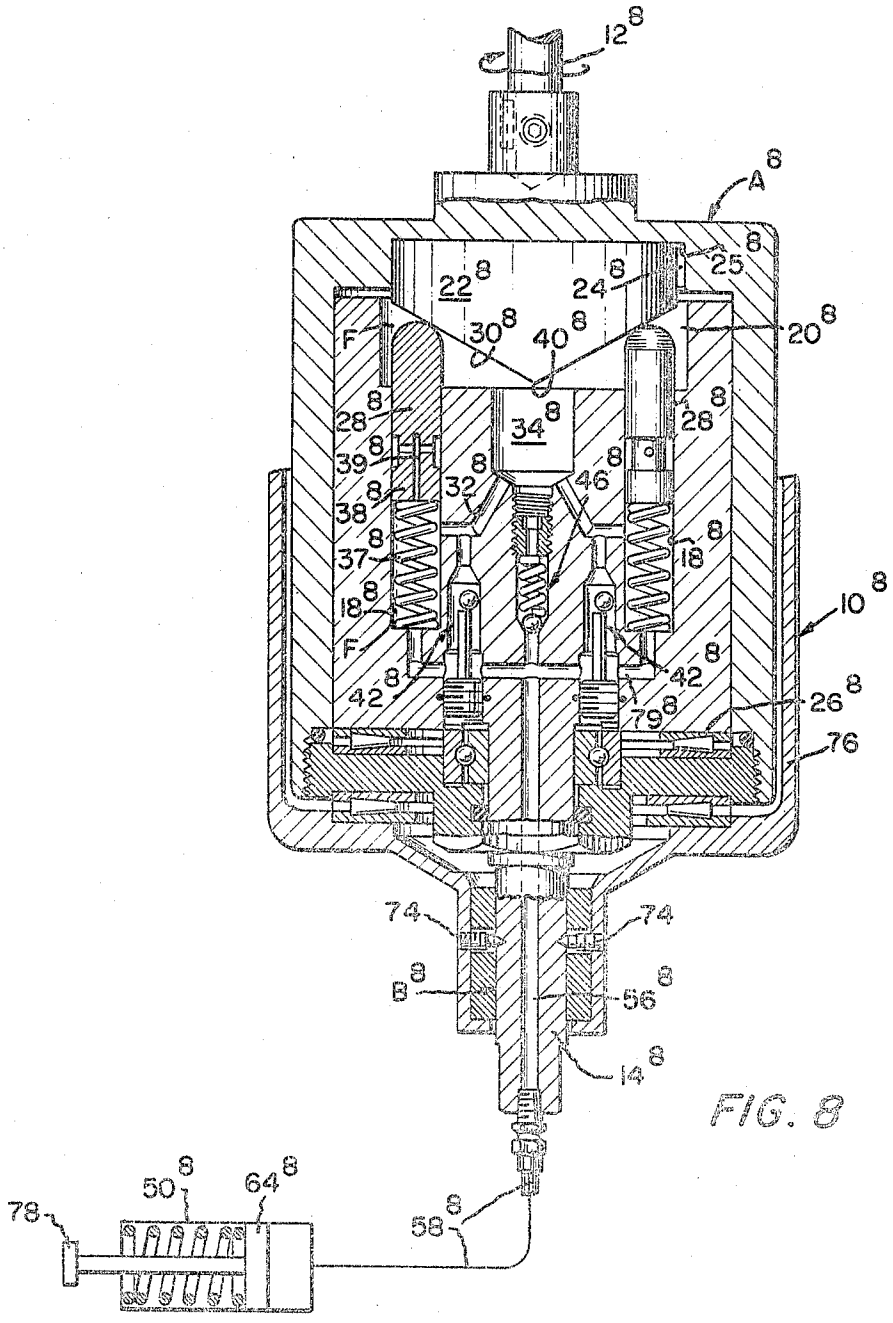


FIG. 8

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United States Patent Office 3,319,723 Patented May 16, 1967

3,319,723

AXIAL PISTON PULSE GENERATOR

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Filed Apr. 1, 1965, Ser. No. 444,657
7 Claims. (Cl. 173—93.6)

ABSTRACT OF THE DISCLOSURE

An impulse tool for driving a fastener including a housing and a spindle relatively movable in the housing, a piston sliding in a piston chamber provided in the housing and engaged with a cam fixed on the spindle and causing the piston to reciprocate in its chamber as the spindle rotates in the housing. The piston chamber contains a hydraulic fluid. A passage is connected to the piston chamber to relieve excess pressure from the piston chamber and is arranged to be blocked by the piston during its pumping stroke whereby the piston begins to compress the fluid in the piston chamber and, as a result, abruptly meets a resisting force causing the housing and spindle to be momentarily locked together to transmit a torque impulse to the fastener. The piston chamber and the fluid passage are arranged so that the housing and spindle are released for further relative rotation very quickly after they are abruptly locked together so that the tool can create a rapid series of torque impulses for application to the fastener.

This invention relates to impulse tools and more particularly to an improved impulse tool of the axial piston type.

Heretofore, impulse tools for applying a torque to an object and/or for use as a source of fluid impulses for operating a tool are disclosed in U.S. Patent No. 3,116,617 issued Jan. 7, 1964, to D. K. Skoog, and in U.S. patent application Ser. No. 285,160 filed Mar. 18, 1963, by D. K. Skoog, now Patent No. 3,263,426.

Other conventional power tools are of the type shown in the following U.S. patents:

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Conventional impulse tools have leakage between the lands of the housing means, the spindle blade and the shank portion of the spindle means thereby requiring close tolerances in the fabrication of these parts.

It is the general object of the present invention to avoid and overcome the foregoing and other difficulties of and objections to prior art practices by the provision of an axial piston type impulse tool which:

(1) Substantially reduces fluid leakage in the impulse tool;

(2) Provides a frictional assist to develop and to transmit torque;

(3) Reduces the number of close tolerance sealing elements within the impulse tool thereby decreasing the manufacturing cost and increasing the life of the impulse tool;

(4) Provides a more rigid impulse tool;

(5) Provides a smaller quantity of fluid under compression and produces higher ultimate torque.

The aforesaid objects of the present invention, and other objects which will become apparent as the description proceeds, are achieved by providing an axial piston type impulse tool having a driven member and a driving member mounted together for relative rotation therebetween. These members cooperate together to form a piston cavity and a spindle cavity. Both the piston cavity and the spindle cavity contain a hydraulic fluid. Cam means is positioned in the spindle cavity and rotationally keyed to one of said members. Piston means is slidably mounted in the piston cavity to engage the cam and to rotate with the other of said members. Relative rotation between the members causes the piston means to ride up on the cam means and to pump the fluid in the piston cavity. Passage means is provided to communicate the piston cavity with the spindle cavity and is located in the piston cavity where it is blocked by the piston means during a later portion of its pumping stroke. Blockage of the passage means causes the piston means to be abruptly and momentarily opposed, part way through its pumping stroke, by the compressed fluid remaining in the piston cavity. An abrupt resistance of the piston by the compressed fluid remaining in the piston cavity results in the members being momentarily locked together to apply a torque impulse to the driving member.

For a better understanding of the present invention reference should be had to the accompanying drawings, wherein like numerals of reference indicate similar parts throughout the several views and wherein:

FIG. 1 is a side elevational view of the improved impulse tool of the present invention and showing the housing means connected to the drive means and the piston means in the housing means;

FIG. 2 is a vertical sectional view taken along the line 2—2 of FIG. 1 in the direction of the arrows;

FIG. 2A is an isometric view of the cam means shown in FIG. 2;

FIG. 3 is a view similar to FIG. 2 of an alternative embodiment utilizing valve means, and showing the hous-

ing means connected to the drive means and the piston means in the housing means;

FIG. 4 is a view similar to FIGS. 2, 3 of an alternative embodiment showing the spindle means connected to the drive means and the piston means in the spindle means;

FIG. 5 is a view similar to FIGS. 2, 3, 4, of an alternative embodiment showing the housing means connected to the drive means and the piston means in the spindle means;

FIG. 6 is a view similar to FIGS. 2, 3, 4, 5 of an alternative embodiment showing the spindle means connected to the drive means and the piston means in the housing means;

FIG. 7 is a view similar to FIGS. 2, 3, 4, 5, 6 of an alternative embodiment showing the impulse tool used as a source of fluid impulses with the spindle means connected to the drive means, piston means in the housing means and the housing means connected to a stationary member;

FIG. 8 is a view similar to FIGS. 2, 3, 4, 5, 6, 7 showing the impulse tool used as a source of fluid impulses with the housing means connected to the drive means, piston means in the spindle means and the spindle means connected to the stationary member.

Although the principles of the present invention are broadly applicable to power tools, the present invention is particularly adapted for use in conjunction with impulse tools and hence it has been so illustrated and will be so described.

With specific reference to the form of the present invention illustrated in the drawings, and referring particularly to FIGS. 1, 2, an axial piston type impulse tool for applying torque to an object, such as the nut N, is indicated generally by the reference numeral **10**.

This axial piston type impulse tool **10** has housing means A and spindle means B in the housing means A. Drive means, such as an air motor or electric motor D is connected through an input shaft **12** (FIGS. 1, 2) to one of the housing means A and the spindle means B (in this case the housing means A) to cause relative rotation therebetween. The other of the housing means A and the piston means B (i.e. the spindle means B) has an output or spindle shaft **14** engageable by a socket **16** with the nut N.

One of the housing means A and the spindle means B (i.e. housing means A in FIG. 2) is provided with a piston cavity **18** and a spindle or low pressure cavity **20**, both cavities **18** and **20** being adapted to contain a fluid, such as oil F.

Cam means, such as the cam **22** (FIGS. 2, 2A) has shaft hole **23** and is slidably keyed at **24, 25** to the output shaft **14**, rotates on thrust bearing **26**, and is disposed in spindle cavity **20**. Piston means, such as the piston **28**, is disposed in the piston cavity **18** and is engageable with the cam face **30** (FIG. 2A) of cam **22**.

The housing means A and spindle means B (in FIG. 2, the housing means A) are provided with passage means, such as return passage **32** in the housing means A, shaft passage **34, 36** in output shaft **14**. If more than one piston **28** is employed, a pressure equalizing passage **79** is employed.

Operation

Briefly the relative rotation between the housing means A and spindle means B causes the piston **28** to ride up the cam face **30** and to close off the return passage **32** and thereby compress the oil F in the piston cavity **18**. The compressed oil F applies a force to the piston **28** thereby imposing a relative torquing between the piston **28** and the cam **22** with attendant rotation of the other of the housing means A and the spindle means B (in FIG. 2, the spindle means B) and resultant application of torque to the nut N.

Referring in greater detail now to FIGS. 1, 2, as the housing means A is rotated by the air motor or electric motor D relative to the cam **22**, the piston **28** moves axially in its piston cavity **18**.

In FIG. 2 the piston **28** is fully extended into the low pressure cavity **20**. At this point, any relative motion between the housing means A and the cam **22** causes the piston **28** to move upward (against action of spring **37**) into the piston cavity **18**. As the piston **28** moves upward (FIG. 2) into its piston cavity **18** it pushes oil F from piston cavity **18** through return passage **32** through shaft passages **34, 36** to low pressure cavity **20**. As the piston **28** continues to move into its cavity **18** it blocks return passage **32** with a subsequent pressure increase in piston cavity **18** as the piston **28** continues to move upward.

As pressure is built up in piston cavity **18** an axial force is applied to piston **28** which piston **28** in turn applies a torque couple to cam **22**. Since cam **22** is fixed to the output shaft **14** via shaft key **24** and cam keyway **25** the cam **22** and output shaft **14** must rotate as one unit.

As the piston **28** continues to move upward into the piston cavity **18** the pressure continues to rise until the piston land **38** passes over return passage **32** thereby communicating piston cavity **18** to low pressure cavity **20** via piston passage **39**, return passage **32** and shaft passages **34, 36** thereby reducing pressure to essentially zero. At this time the piston **28** will be near the end of its upward travel and continued rotation of the housing means A with respect to the cam **22** brings the piston **28** over the maximum rise point **40** (FIG. 2A) of the cam **22** thereby permitting the piston spring **37** to push the piston **28** downwardly (FIG. 2) out of its piston cavity **18** (as rotation continues).

As piston **28** moves downwardly (FIG. 2) out of its cavity **18** oil F must be transferred from low pressure cavity **20** to piston cavity **18**.

It will be understood by those skilled in the art that the housing means A will accelerate freely from the time the pressure in piston cavity **18** is reduced to essentially zero until the piston land **38** again blocks return passage **32**. As the housing means A accelerates freely it develops kinetic energy which can then be converted to pressure pulses in piston cavity **18** and to torque pulses at output shaft **14**.

Alternative embodiments

It will be understood by those skilled in the art that alternatively as shown in FIG. 3 a check valve **42** in line **44** (connecting passage 79^3 and return passage 32^3) is used to permit return of oil F behind the piston 28^3 without cavitation after impulse and when the piston 28^3 is running down (FIG. 3) the cam 22^3. For the purpose of limiting the maximum pressure in the piston cavity 18^3 and hence maximum torque delivered to the nut N, a relief valve **46** in line **48** (connecting passage 79^3 with passage 36^3) is employed.

In FIG. 4 the spindle means B^4 is connected to input shaft 12^4, the pistons 28^4, piston cavities 18^4 etc. are in the spindle means B^4, and the cam 22^4 is carried by the housing means A^4. Passage 34^4 in this case is in the spindle means B^4.

As shown in FIG. 5 the housing means A^5 is connected to the driven shaft 12^5 and carries the cam 22^5. The pistons 28^5 piston cavities 18^5, etc. are in the spindle means B^5. Passage 34^5 in this case is in the spindle means B^5.

From FIG. 6 it will be appreciated that the input shaft 12^6 is connected to the spindle means B^6 which carries the cam 22^6 and the housing means A^6 contains the pistons 28^6, piston cavities 18^6 etc.

Referring to FIG. 7 and the operation of the impulse tool as a source of fluid impulses for operating a tool, such as the cylinder **50**, the housing means A^7 is tied by a plate to a stationary member, such as a table or wall **54**, the spindle means B^7 is connected to input shaft 12^7 and the pistons 28^7, piston cavities 18^7 etc. are in the housing means A^7. Impulses from piston cavities 18^7

are transferred by impulse transfer means (i.e. passage **56** in housing means A^7), line **58**, four way valve **60** and the **62** to one side of piston **64** in cylinder **50**. Line **66** connects the other side of piston **64** to valve **60** and line **68** extends from the valve **60** to spindle cavity 20^7.

When manually actuated valve handle **70** is moved downwardly (as viewed in FIG. 1) against the action of the spring, the flow on each side of the piston **64** is reversed.

In FIG. 8 the spindle means B^8 is connected at **74** to a stationary casing **76** of the tool 10^8 and contains the pistons 28^8, piston cavities 18^8 etc. The housing means A^8 is connected to input shaft 12^8 and carries the cam 22^8. Impulses are transmitted via passage 56^8, line 58^8 to cylinder 50^8, the piston 64^8 of which is connected to a tool, such as a hammer **78**. Passage 34^8 in this case is in the spindle means B^8.

It will be recognized by those skilled in the art that the objects of the present invention have been achieved by providing axial piston type impulse tool which:

(1) Substantially reduces fluid leakage in the impulse tool;

(2) Provides a frictional assist to develop and to transmit torque;

(3) Reduces the number of close tolerance sealing elements within the impulse tool thereby decreasing the manufacturing cost and increasing the life of the impulse tool;

(4) Provides a more rigid impulse tool;

(5) Provides a smaller quantity of fluid under compression and produces higher ultimate torques.

While in accordance with the patent statutes preferred and alternative embodiments of the present invention have been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

I claim:

1. An impulse tool for applying a series of torque impulses to an object, said tool comprising:

a driven member;

a driving member mounted on said driven member for relative rotation therebetween;

drive means connected to said driven member;

said driving member being engageable with said object;

said members cooperating to form a piston cavity and a spindle cavity;

a fluid contained in said portion cavity and said spindle cavity;

cam means in said spindle cavity and rotatively keyed to one of said members;

piston means in said piston cavity engaging said cam means and rotating with the other of said members whereby relative rotation between said members causes said piston means to ride up on said cam means and to pump said fluid in said piston cavity;

passage means communicating said piston cavity with said spindle cavity and located in said piston cavity where it is blocked by said piston means during a portion of its pumping stroke causing said piston means to be abruptly resisted against further movement partway through its pumping stroke, as a result of the compression of the fluid remaining in the piston cavity, resulting in said members being momentarily locked together to apply a torque impulse to said object.

2. The impulse tool recited in claim **1** wherein said driving member is provided with said piston cavity.

3. The impulse tool recited in claim **1** wherein said driving member is provided with said piston cavity.

4. The impulse tool recited in claim **1** wherein said cam means is on said driven member.

5. The impulse tool recited in claim **1** wherein said cam means is on said driving member.

6. The impulse tool recited in claim **1** and having check valve means communicating with said piston cavity and said passage means.

7. The impulse tool recited in claim **1** and having relief valve means communicating with said piston cavity and said passage means.

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