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TAKEO KAGITANI
PORTABLE POWER TOOL

2,923,280

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2 Sheets-Sheet 1

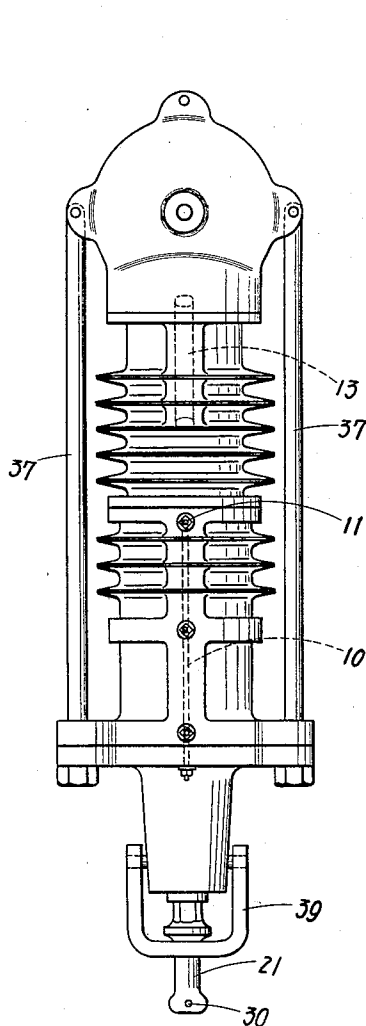


Fig. 1

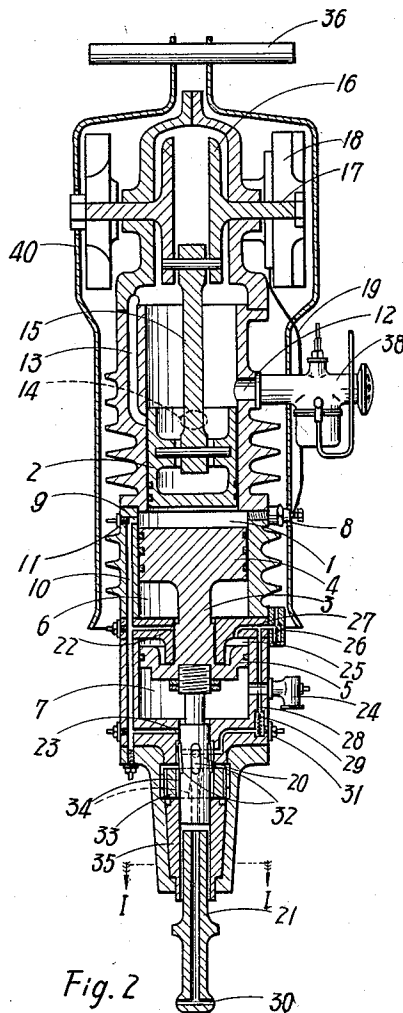


Fig. 2



Fig. 3

TAKEO KAGITANI

INVENTOR.

BY
Wenduth, Lind & Porack
Attys

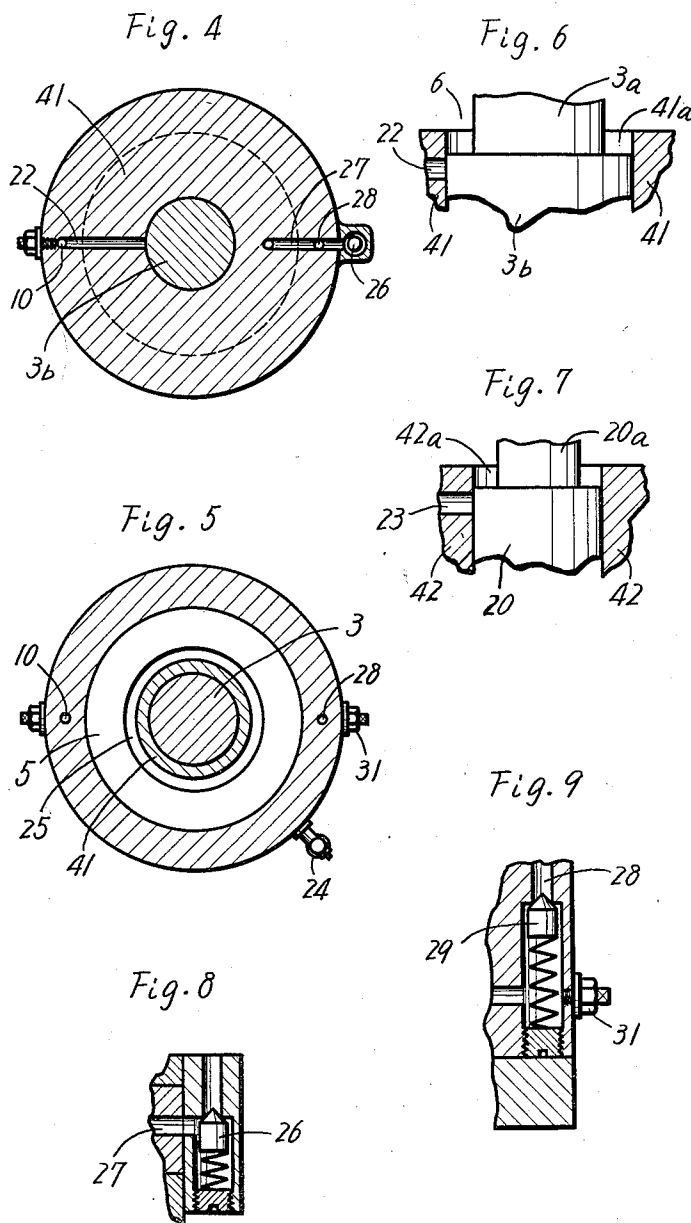
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TAKEO KAGITANI

INVENTOR.

BY *Wendert, Lind & Packer*
ATTORNEYS

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PORTABLE POWER TOOL

Takeo Kagitani, Osaka City, Japan

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2 Claims. (Cl. 123—7)

The present invention relates to improvements in portable power tools driven by a self-contained combustion engine, such tools including portable rock drills, portable rammers and portable cutters; and the objects of the improvement are, first, to employ a portion of the exhaust gas as a shock absorber against movement of the hammer piston on the downward stroke and as a means for facilitating the quick return of the hammer piston; and, second, to use compressed air either as a means for shaking off the dust formed by the drilling operation and/or as an air cushion for reducing the shocks caused by the upward stroke of the hammer piston.

In other words, the portable power tool of the present invention is characterized, on the one hand, by a hammer piston provided with coaxial upper and lower flanges and a hammer cylinder divided into upper and lower chambers for respectively housing said flanges, so that the portion of exhaust gas which is admitted to the respective chambers from the bottom thereof immediately following the explosion of the fuel is allowed to act as an absorber of the mechanical shocks caused by the downward stroke of the hammer piston, and as a means for facilitating the quick return of the hammer piston; and, on the other hand, by a device for taking an adequate volume of outer air into the chamber formed between the hammer piston cylinder partition and the lower hammer piston flange when the hammer piston is on the downward stroke in order to compress and dispel the air under the effect of the action of the upward stroke of the hammer piston out of the tip of the drill rod in order to shake off the dust formed by the drilling operation, and/or to employ the compressed air as an air cushion for reducing the shocks caused by the upward stroke of the hammer piston.

In order that the present invention may be readily and clearly understood, one form of the invention is illustrated in the accompanying drawings, in which:

Figure 1 is a side elevation of the tool according to the invention with the casing, fan and magneto flywheel removed.

Fig. 2 is a vertical section of the tool according to the invention.

Fig. 3 is a section along line III—III of Fig. 2.

Fig. 4 is a section along line IV—IV of Fig. 2.

Fig. 5 is a section along line V—V of Fig. 2.

Fig. 6 is an enlarged detailed view of the hammer piston and the hammer piston cylinder wall separating the flanges of the piston.

Fig. 7 is an enlarged detailed view of the hammer rod and the bottom of the hammer piston cylinder; and

Figs. 8 and 9 are enlarged detailed views of embodiments of the check valve for control of the inlet air and the outlet air.

The example shown in the drawings is a portable rock drill which is provided with a 2-stroke combustion engine coaxial with the hammer piston and the drill too, and

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these members are assembled with the aid of 2 draw bolts.

Referring now to the accompanying drawings, the engine piston 2 faces the hammer piston 3 through the combustion chamber 1. The hammer piston 3 is provided with coaxial upper and lower flanges 4 and 5, and the hammer cylinder is divided by a partition 41 into upper and lower cylinders or chambers 6 and 7 for respectively housing said flanges. The hammer piston flange connecting rods are comprised of different diameters 3a and 3b, enabling the rod of larger diameter to pass slidably through said partition 41 to leave a space 41a opened to the port 22 during the downward stroke of the hammer piston 3. Also the hammer rod 20 connected coaxially at the bottom end of hammer piston 3 by means of a stem 20a of smaller diameter, is slidable in an aperture through the bottom wall 42 of the lower hammer piston cylinder 7 and leaves a space 42a open to the port 23 during the downward stroke of the hammer piston 3. The combustion chamber 1 is connected with upper and lower cylinders or chambers 6 and 7 via the passage 10 built in the side wall of the hammer cylinder, and ports 9, 22 and 23, which are respectively open to the combustion chamber 1, to the upper cylinder 6 via space 41a through the partition 41 and to the lower cylinder 7 via space 42a through the bottom wall 42 of the lower cylinder 7. The combustion engine consists of fuel inlet pipe 12, gas transit pipe 13 and exhaust outlet 14, all suitably connected, and the engine piston 2 is coupled to the crankshaft 16 by means of the piston rod 15. The magneto 18 which is run by the crankshaft rod 17 is connected to carburetor 38 and combustion chamber 1 having a spark plug 8 by means of a wire 19, all suitably arranged. The drill tool 21 is constructed so as to be operated by the action of the downward stroke of the hammer rod 20.

Now the present invention is characterized in the first place, as stated before, by the specific employment of exhaust gas from the internal combustion engine. That is to say, a portion of exhaust gas, immediately following each explosion of fuel in the combustion chamber 1, is allowed to find its way into the lower portion of each of the upper and lower cylinders 6 and 7 via port 9, passage 10, and ports 22 and 23. The volume of the gas to be taken into the cylinders 6 and 7 is adjusted by means of a control plug 11 attached to the port 9, and ports 22 and 23 are so designed as to be opened, that is to pass exhaust gas into said lower portion of each of the upper and lower cylinders 6 and 7, when the engine piston 2 which is started on the power stroke following the explosion in the combustion chamber 1, reaches the position 30 to 50 degrees from the top dead center point of the crank, namely, when the explosive power has reached the highest pressure. Thus the exhaust gas which is taken into the lower portions of the upper and lower cylinders 6 and 7 acts, on the one hand, as an absorber of the shocks caused by the downward stroke of the hammer piston 3, and as a means, on the other hand, for facilitating the quick return of the hammer piston 3, because the reaction area of the hammer piston 3 is made 2 times as large as the working area, and as the hammer piston 3 is provided with double flanges 4 and 5. In addition, the exhaust gas taken into upper and lower cylinders 6 and 7 is led back into the combustion chamber 1 when the hammer piston 3 starts on the return stroke, and the gas is employed again as a shock absorber against the hammer piston 3 on the return stroke, since ports 22 and 23 are closed toward the end of the return stroke of the hammer piston 3 so as to confine the gas within the combustion chamber 1. To prevent excessive pressure of the gas a safety valve 24 is installed in the side wall of the lower cylinder 7.

The present invention is further characterized by the employment of compressed air. An air chamber 25 is provided between the hammer piston cylinder partition 41 and the lower hammer piston flange 5. This air chamber 25 is connected with the outer air by means of inlet valve 26 and inlet port 27, all located in the partition 41 forming the top portion of the lower hammer cylinder 7. Air is taken into the air chamber 25 via inlet valve 26 and inlet port 27 when the hammer piston 3 is on the downward stroke. When the hammer piston 3 starts the upward stroke, however, the inlet valve 26 is closed and the air taken in is compressed within the air chamber 25, thus serving as a shock absorber. The rock drill as illustrated in the accompanying drawings is so formed that the inlet port 27 is connected with opening 30 built in the tip of the hollow drill tool 21 via the said air passage 28, the central portion of hammer rod 20 and drill tool 21. The air in the air chamber 25 is compressed during the upward stroke of the hammer piston 3 and dispersed out of the opening 30, travelling through the air transit port 28 because of the opening of the check valve 29 by the pressure of the compressed air itself. Thus the dust formed in the course of the drilling operation is readily and easily shaken off, and the operation is thereby facilitated to a great extent. In case the power tool of the present invention is employed as a rammer or cutter, the compressed air serves as an air cushion to reduce the mechanical shocks caused by the upward stroke of the hammer piston. The air thus employed, upon the completion of the upward stroke of the hammer piston 3, is let out of the machine into the outer air through the air passage 28 and the outlet plug 31 by leaving it open.

The drill tool 21 is housed within the chuck 35 which is connected with a rack wheel 33. This rack wheel 33 is threaded with a definite number of screw thread grooves 34, and the hammer rod 20 is also threaded with the corresponding number of screw threads 32. These members are all coaxially arranged, with the hammer rod 20 engaging the drill tool 21 via the rack wheel 33 which is in turn connected with the chuck 35. The turning motion, if required as in the case the power tool of the present invention is used as a rock drill as illustrated in the accompanying drawings, is conveyed to the drill tool 21, simultaneously with the downward thrust of the hammer piston 3, by the helical action of the screw threads 32 on the hammer rod 20 and the screw thread grooves 34 in the rack wheel 33, when the hammer rod 20 is given a downward movement and is thrust into the rack wheel 33 following each explosion of the fuel in the combustion chamber 1.

The handle attached to the machine body, 2 draw bolts, and breaking rod holder and the casing are respectively marked 36, 37, 39 and 40.

The convertibility of the power tool of the present invention into a portable rock drill, a portable rammer and a portable cutter is effected by providing the machine with a breaking tool best suited for the purpose of each machine, and it is obvious that various changes may be made in the actual application of the present invention within the spirit and scope thereof, the foregoing description and accompanying drawings being largely confined to a preferred embodiment of the present invention as a portable rock drill. For example, should a cutter or a

tamper be used in place of the drill 21, the rack wheel 33 is replaced by a spacer and the compressed air outlet plug is left open. The compressed air from the space 25 in lower cylinder 7 is thus caused to pass out through the opening left by air outlet plug 31.

What I claim is:

1. In a portable power tool having a self-contained combustion chamber, the combination of a hammer piston having coaxial upper and lower flanges, a hammer piston cylinder having a partition therein dividing said hammer piston cylinder into an upper and a lower cylinder, said hammer piston passing slidably through said partition with said upper flange slidable in said upper cylinder and said lower flange slidable in said lower cylinder, and exhaust gas conduit means connected to the portion of said upper cylinder above said upper flange and to the portion of said upper cylinder between said upper flange and said partition and to the portion of said lower cylinder on the side of said lower flange away from said partition, said hammer piston having cutoff means thereon for closing said exhaust conduit means where it opens into said upper cylinder below said flange and where it opens into said lower cylinder near the upper limit of the stroke of said hammer piston.

2. In a portable power tool having a self-contained combustion chamber, the combination of a hammer piston having coaxial upper and lower flanges, a hammer piston cylinder having a partition therein dividing said hammer piston cylinder into an upper and a lower cylinder, said hammer piston passing slidably through said partition with said upper flange slidable in said upper cylinder and said lower flange slidable in said lower cylinder, exhaust gas conduit means connected to the portion of said upper cylinder above said upper flange and to the portion of said upper cylinder between said upper flange and said partition and to the portion of said lower cylinder on the side of said lower flange away from said partition, said hammer piston having cutoff means thereon for closing said exhaust conduit means where it opens into said upper cylinder below said flange and where it opens into said lower cylinder near the upper limit of the stroke of said hammer piston, air inlet conduit means connected to the portion of said lower cylinder between said partition and said lower flange, compressed air exhaust conduit means connected to said portion of said lower cylinder between said partition and said lower flange, and valve means in said air inlet conduit means and said compressed air exhaust conduit means for permitting intake of air during the downward stroke of said hammer piston and exhaust of compressed air during upward stroke of said hammer piston.

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