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Filed Dec. 14, 1940

Serial No. 370,141

2 Sheets-Sheet 1

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Fig.1

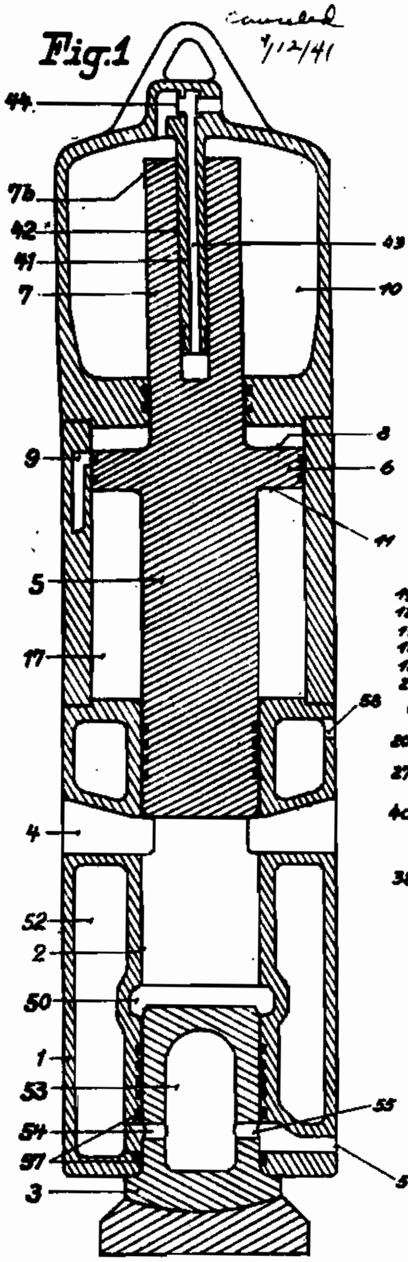
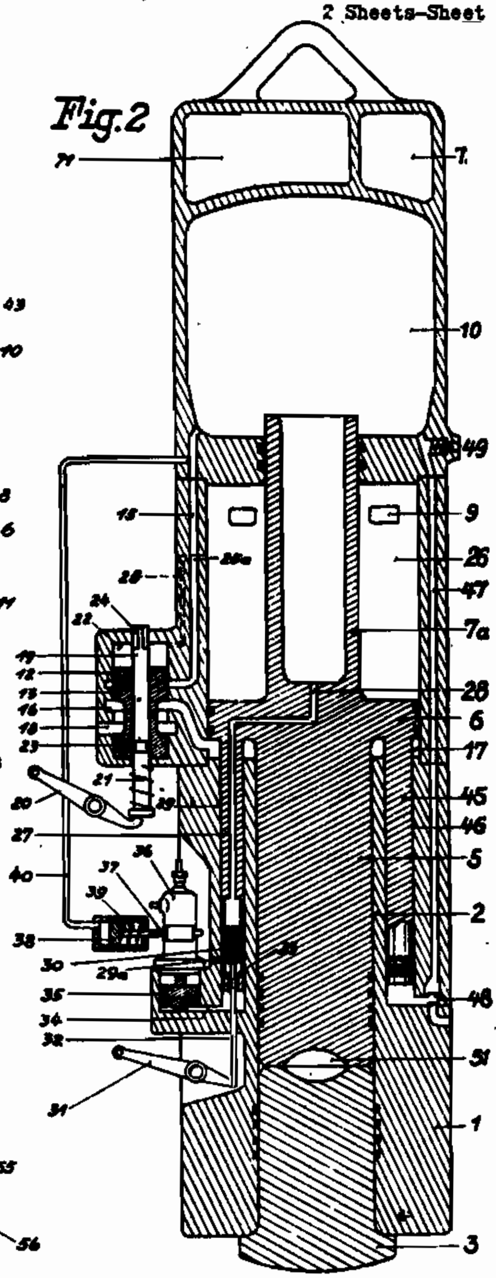


Fig.2



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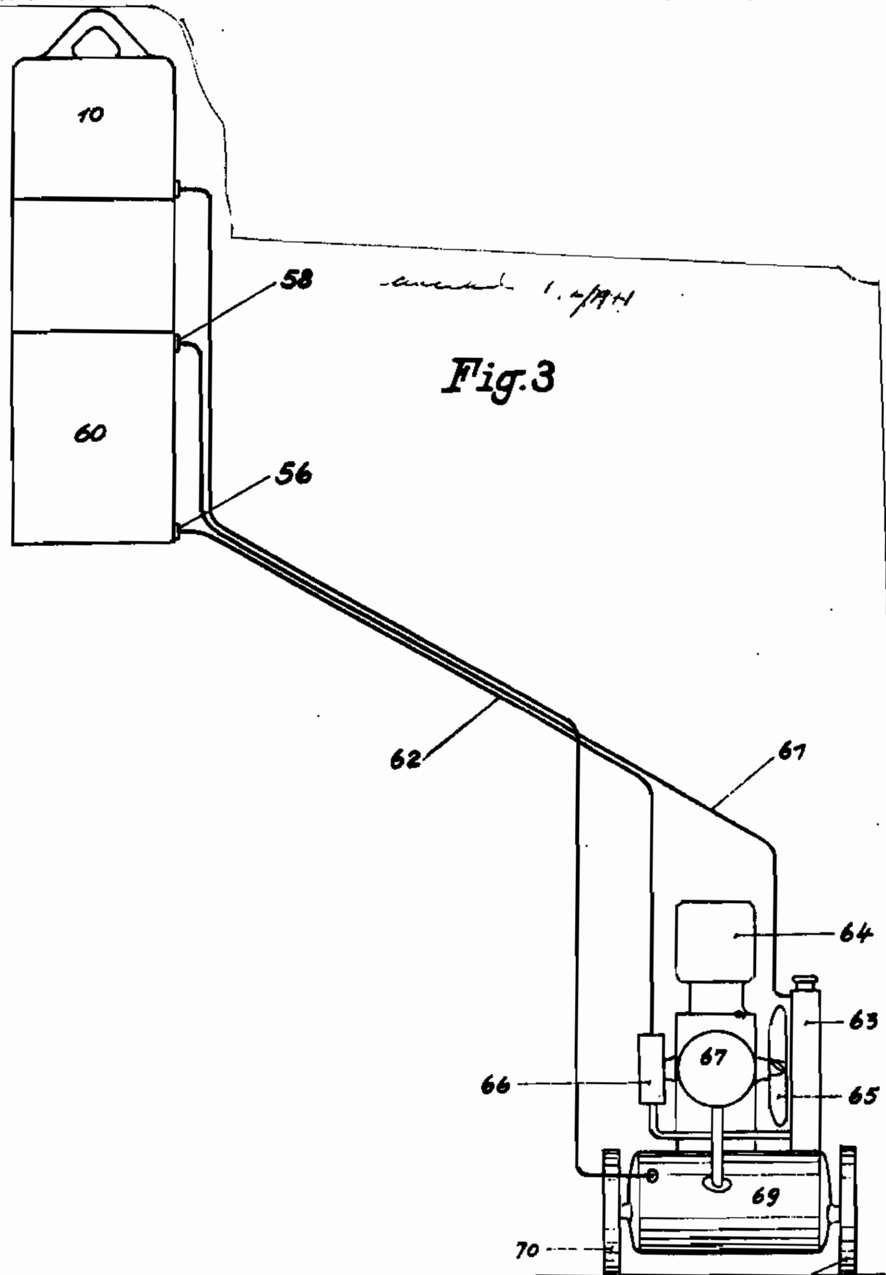

Fig. 3

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PERCUSSIVE TOOLS OPERATED BY AN INTERNAL COMBUSTION ENGINE

Josef Wohlmeyer, Berlin, Germany; vested in the Alien Property Custodian

Application filed December 14, 1940

This invention relates to pile-drivers, pile drawing devices, squarers, rock drills, hammers etc. or—generally spoken—to a percussive tool of any kind which embodies its power supply in the form of an internal combustion engine in the same unit.

The percussive tools of this kind, which have hitherto become known, can only be operated with a relatively small number of strokes per unit of time, as it was necessary to provide long strokes in order to obtain the desired powerful impulses transmitted to the operative tool of the machine. One aimed at increasing the speed of the engine and thereby increasing the efficiency. To this end the engine has been so constructed that during or at the end of each return stroke an air cushion was created which braked the operative member of the tool in its return movement and thereafter accelerated the same in forward direction. The air cushion, however, proved practically ineffectual. The speed of the engine could be somewhat increased, but not to the extent desired. Besides this the air cushion is disadvantageous as the creation of the air cushion causes a sudden increase of the air pressure; in consequence hereof the stationary or non-operative members of the tool must be very heavy in order to avoid jumping thereof.

The mentioned disadvantages exist also in percussive tools equipped with two combustion chambers whereby the forward stroke as well as the return stroke of the operative tool member is caused by internal combustion. The invention is based on the calculation, that practically the efficiency of a percussive tool can only be improved by increasing the speed of the engine; by increasing the weight of the operative member of the tool the spread decreases so that practically increasing of the efficiency cannot be expected. At a definite weight of the operative member of the tool the speed of the engine can only be increased by shortening the stroke.

The invention particularly relates to percussive tools of any kind, whereby, however, the return stroke of the operative member is caused by internal combustion, while the forward stroke is exclusively or essentially caused by an elastic pressure means; it is of no importance, whether the cylinder or the piston of the tool is used as operative member, and whether the fuel is injected into the combustion space or introduced in a gasified state; finally, the invention is not tied to a special arrangement and construction of the combustion chamber and also not to a special kind of scavenging.

In connection with percussive tools mentioned above the invention consists therein that the tension of the means acting upon the operative tool member in the direction of the forward stroke is continuously maintained. It is of special advantage if the said pressure is regulable. The pressure means may consist of a spring or of a gaseous pressure medium. In case of a gaseous pressure medium it is recommended to provide a space which is several times larger than the volume about which it is made smaller by the operative tool member during the return stroke. If the disposable volume is too small the pressure medium space of the tool may be connected to a separate pressure medium chamber outside of the tool.

The charging of the pressure medium space may be effected by introducing compressed air or any other gas under pressure. It is also possible to charge the space by introducing a combustible liquid or substance which produces gases when ignited.

Supplemental charges which may become necessary due to leakiness can be performed in the same manner as the main charge. It will, however, be more advantageous to provide a separate compressor or to combine with the tool an automatic pump the cylinder of which is arranged in or on the stationary respectively non-operative part and he piston of which is arranged in or on the operative member of the tool or vice versa.

The supplemental charge by means of a compressor or pump is recommendable, as—without deranging the operation of the tool—the pressure medium contained in the pressure medium space can be used for starting the tool in a principally new manner. In a corresponding manner the pressure medium can be used for operating the fuel injecting pump or the igniting device and, if desired, auxiliary devices as f. i. the lubricating pumps, the water circulation pump etc.

The utilization of the pressure medium for starting the tool may be realized thereby that the operative tool member is provided with a circular face to which pressure medium is admitted in the direction of the return stroke and which is of larger area than the face loaded with the pressure of the gaseous medium. The mentioned circular face may preferably consist of the under face of the scavenging piston.

The pneumatically operated auxiliary apparatuses, as f. i. the injecting pump, the igniting device, the lubricating pump etc., are preferably connected to an intermediate chamber of the non-operative part of the tool, which chamber is alternately ventilated and filled with pressure medium in accordance with the working rhythm of the tool. The advantage of the pneumatical operation compared with the mechanical operation hitherto provided consists therein that the operative mechanism and the operated devices are not affected by percussive strains.

The invention also comprises the possibility of starting the tool by means of any other disposable gaseous pressure medium provided that it can be admitted in a regulable quantity.

Further features of the invention will be apparent from the description given hereafter.

The accompanying drawings illustrate two modes of carrying out the invention.

Fig. 1 and Fig. 2 are longitudinal sections, of two pile-drivers, whereby the inventive features are shown partly in connection with Fig. 1 and partly in connection with Fig. 2.

Fig. 3 is a schematical side elevation of a complete pile-driver plant.

In carrying my invention into effect in one convenient manner as, for example, in its application to a pile-driver and as illustrated in Fig. 1 and Fig. 2 I combine the tool with an internal combustion engine of suitable form and construction and operating upon the two-stroke cycle principle and of a power capacity suited to the nature of the work which the tool is required to perform.

The housing 1 of the pile-driver is provided with a bore 2 serving as combustion space whereby the conventional cylinder head is replaced by a cylindrical extension co-axial with the bore 2 and adapted to take a piston 3 serving as anvil. At the upper and of the combustion space exhaust openings 4 are provided. The operative member of the tool is constructed as piston of differential diameters; it comprises the percussive piston 5, the scavenging piston 6 and a piston 7. The several pistons may be hollow as f. i. the piston 7a in Fig. 2.

The scavenging piston works with its upper face 8 as scavenging pump, which introduces the gaseous scavenging medium (air or combustible mixture delivered by a carburetter) through openings or channels 9 into the combustion space 2.

The piston 7 extends into a chamber 10, in which a certain gas pressure is maintained during the whole period of operation. The height of this pressure and the weight of operative tool member are decisive for the percussive power of the tool. Hence the percussive power can be regulated by increasing or lowering the gas pressure.

The lower face 11 of the piston 6 is used as means for starting the tool. This face is larger than the face 7b of the piston 7 and 7a respectively so that a differential power in the direction of the return stroke is created if the same pressure fluid—namely the pressure gas in the chamber 10—is admitted to both faces. The admittance of the gas to the face 11 is controlled by a device comprising a cylinder 12 and a piston 13 provided with a circumferential channel. The cylinder 12 is connected through the channel 15 to the chamber 10, through the channel 16 to the circular space 17 below the face 11, and through the channel 18 to the atmosphere. The piston 13 is longitudinally bored, this bore being adapted to take the piston rod 19 which extends through both covers of the cylinder 12. The piston 13 can be raised against the action of the spring 21 by means of a lever 20. The piston rod 19 is provided at its upper end with indentations 24 through which in the lower position of the piston rod (as shown in Fig. 2) the space 22 above the piston 12 has open connection with the atmosphere. In a radial bore of the piston 13 a spring-loaded ball 23 is provided which engages a circumferential groove of the piston rod 19 thereby coupling the piston 13 and the piston rod 19 with each other. The space 22 is connected to the scavenging cylinder 26 by means of the channel 25.

The piston 6 is provided with a downward directed pipe-like extension 27 connected to the chamber 10 through the channel 28 and guided in the bore 26 of the housing 1. The pipe 27 is closed at its lower end by a valve 30 which can be lifted from its seat 33 by means of a rod 33 the position of which can be regulated by a lever 31. The bore 29 is connected through the channel 34 to a chamber containing a pressure medium and adapted to take the piston 35 which operates the fuel injecting pump 38 or an igniting device if a combustible gaseous mixture is introduced into the combustion space. A ventilating bore 29a is provided above the valve seat 33.

The regulating rod 37 of the fuel injecting pump 36 is connected to a piston 38 one face of which is loaded by a spring 39 while the opposite face is loaded by the pressure maintained in the chamber 10 and transmitted through pipe 40. The spring 39 tends to drive the piston 38 into its position of rest in which a minimum quantity of fuel is injected.

The tools illustrated are provided with pumps which automatically supplement the charge of the chamber 10. In case of Fig. 1 the pump comprises a piston 41 guided in a corresponding bore 42 of the piston 7. The bore 43 of the piston 41 is alternately connected through valves 44 to the atmosphere and the chamber 10 respectively. In case of Fig. 2 the charging pump comprises a piston 45 extending from the piston 6 in downward direction and guided in a bore 48 of the housing 1. The pump is provided with two valves 48 the upper one of which serves as outlet valve and controls the connection through the channel 47 to the chamber 18.

In the embodiment shown in Fig. 2 a fuel supply tank 71 and a lubricating oil tank 72 are provided on the upper end of the tool. The chamber 10 is provided with a charging opening normally closed by an automatic valve 49.

According to Fig. 1 the ignition space is formed by a circumferential groove 50 in the wall of the combustion space 2; in case of Fig. 2 the ignition space is formed by cavities 51 in the piston 5 and the anvil piston 3.

The cooling of the tool is illustrated in Fig. 1. The combustion space 2 is surrounded by a cooling jacket 52; the anvil piston 3 is provided with a hollow space 53 connected to the jacket 52 through the opening 54 and to the inlet 56 for the cooling medium through the opening 56. The cooling medium leaves the jacket 52 at 58.

Fig. 3 shows schematically the side elevation of a pile-driver 60 with inlet 56 and outlet 58 for the cooling medium. The flexible pipes 61 and 62 connect the cooling jacket of the tool to a conventional cooler 63. The motor 64 drives the blower 65, the water circulating pump 66 and the compressor 67, these machines being mounted on the compressed air vessel 69, which in turn is carried by wheels **70**. The vessel **69** is charged by the compressor **67** and has open connection with the pressure medium chamber **10** of the tool.

The service and the operation of the illustrated tools are as follows:

The chamber **10** is first charged with pressure fluid, f. i. compressed air which is admitted through valve **49**. Thereafter the piston rod **19** and the piston **13** are raised into the starting position by means of the lever **20**. The pressure medium can now flow from the chamber **10** through the channels **15** and **16** into the circular space **17** and drive the operative tool member **5, 6, 7** upwardly. As soon as the lower edge of the piston **6** slides over the mouth **25***a* of the channel **25**, the pressure medium will flow through the channel **25** into the space **22** and drive the piston **13** downward into its initial position. Hereby the piston **13** can slide over the piston rod **19** due to the elastic ball coupling. The piston rod **19** is returned into its initial position by the spring **21** as soon as the lever **20** is left free. The space **17** has now open connection through the channel **16** with the atmosphere, so that the operative tool member will perform the first working stroke.

By using pressure fluid for starting the tool the pressure in the chamber **10** will decrease more or less; in consequence thereof the spring **39** pushes the piston **36** towards its initial position, so that only a reduced quantity of fuel is injected. Hereby the working member **5, 6, 7** is prevented from raising too high due to the reduced counter-pressure within the chamber **10**. As soon as the gas pressure increases the injected quantity of fuel is automatically increased too. Additional hand-operated means for regulating the injection may be provided, if desired.

As soon as the operative member **5, 6, 7** reaches the anvil **3** or shortly prior to this moment the valve **30** is raised from its seat **33** by the rod **32**, so that pressure fluid is admitted through the bore **28** and the channel **34** to the piston **35** and drives the latter towards above. Hereby the pump **36** is operated which injects a certain quantity of fuel into the combustion space. During the combustion the operative member moves upwardly; the pipe-like member moves upwardly too so that the channel **29***a* becomes free and the piston **35** can return into its initial position. In the same manner f. i. a lubricating oil pump can be operated, which preferably is also connected to the piston **35**.

During each second stroke the pump **41, 42** respectively **45, 46** delivers compressed air into the chamber **10**. The pump is so measured that it can supply the maximum air quantity which may be required. The air exceeding the quantity required may be exhausted through an automatic pressure valve.

If desired and particularly in connection with large percussive tools an auxiliary unit as shown in Fig. 3 may be provided.

The motor **64** drives the blower **65** and the water circulating pump **66** of the cooler **63** hereby securing the cooling of the internal combustion engine of the tool. The motor **64** further drives the compressor **67** which supplies compressed air into the vessel **69** connected to the chamber **10**.

If the auxiliary unit according to Fig. 3 is used, it is of course not necessary to provide the tool with a pump for supplementing the charge of the chamber **10**. On the other hand the auxiliary unit will be more simple by omitting the compressor **67** and eventually the vessel **69** too, if a pump for supplementing the charge is provided and if a separate pressure fluid source for initially charging the chamber **10** is disposable.

If a driving motor is provided in either case, the blower, the water circulating pump and the compressor may be provided with means for coupling them with the said motor. Pile-driving plants are usually provided with a motor operating a windlass and supported by the trestle of the plant. In this case the mentioned auxiliary engines may be mounted on the trestle and coupled with the windlass motor.

JOSEF WOHLMEYER.