Feb. 7, 1967 TOSHISHIGE SEKIGUCHI ETAL 3,302,840

EXPLOSIVELY ACTUATED FASTENER DRIVING TOOL

Filed April 26, 1965 4 Sheets-Sheet 1

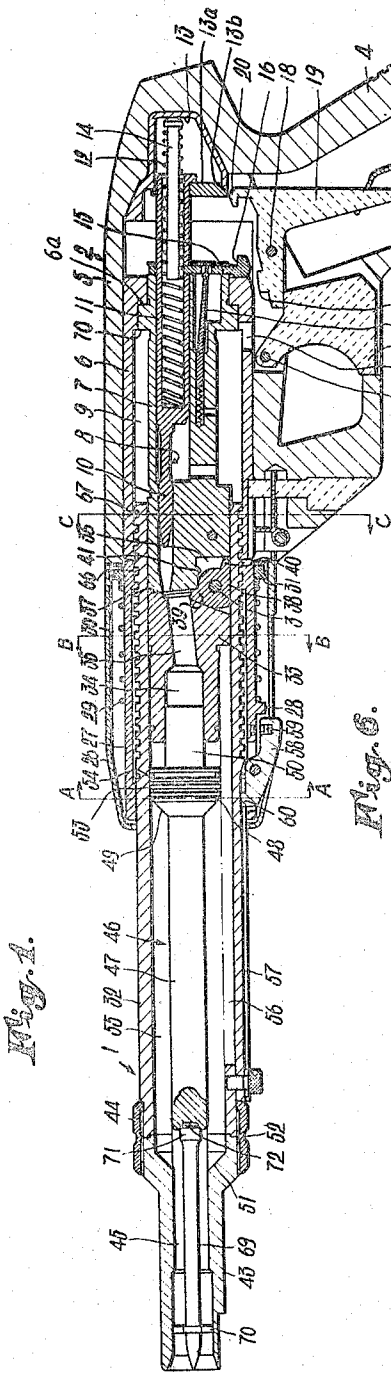


Fig. 1.

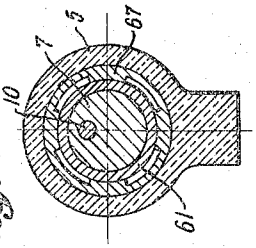


Fig. 7.

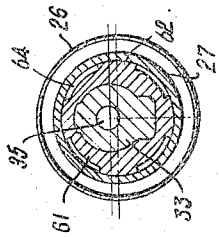


Fig. 6.

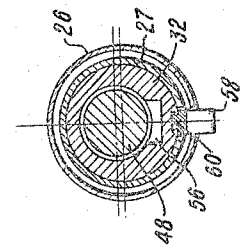


Fig. 5.

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EXPLOSIVELY ACTUATED FASTENER DRIVING TOOL

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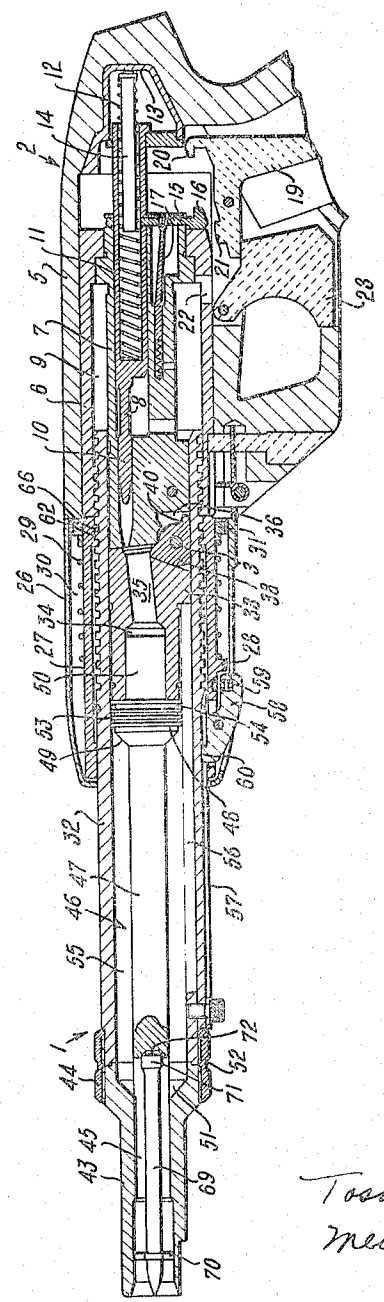


Fig. 2.

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Feb. 7, 1967 TOSHISHIGE SEKIGUCHI ETAL 3,302,840

EXPLOSIVELY ACTUATED FASTENER DRIVING TOOL

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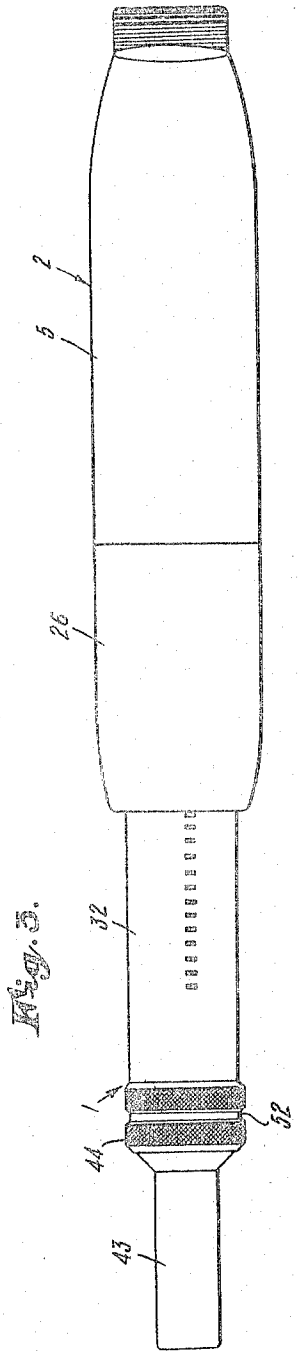


Fig. 5.

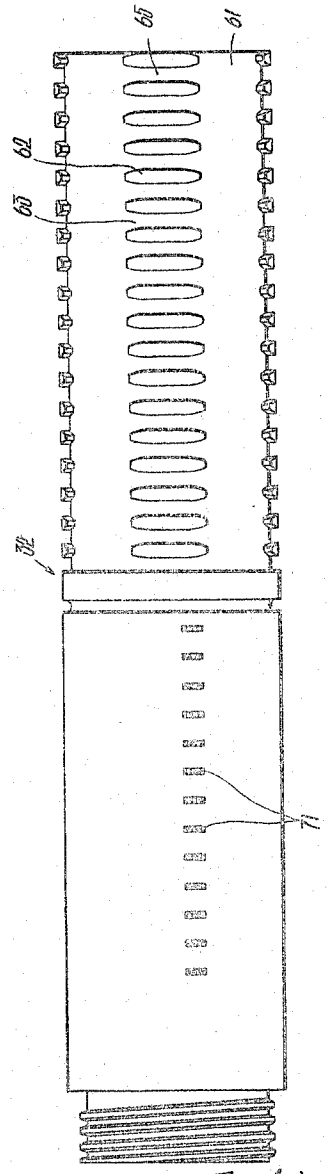


Fig. 4.

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EXPLOSIVELY ACTUATED FASTENER DRIVING TOOL

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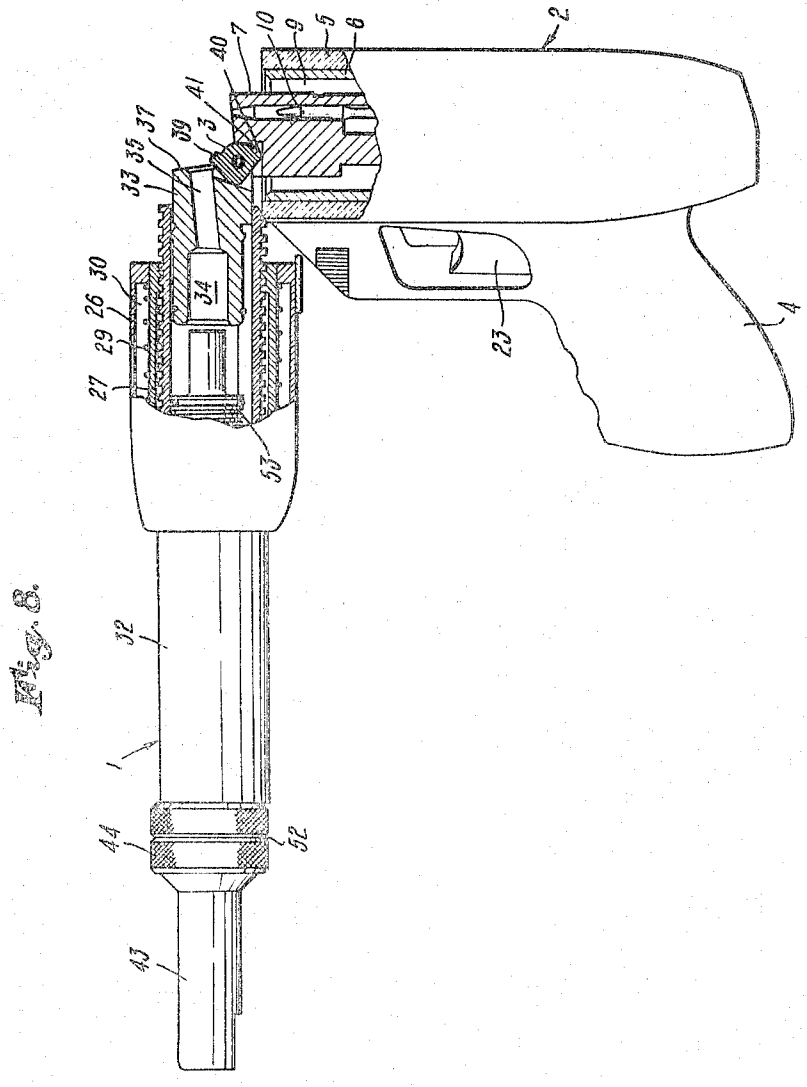


Fig. 8.

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United States Patent Office 3,302,840 Patented Feb. 7, 1967

3,302,840

EXPLOSIVELY ACTUATED FASTENER DRIVING TOOL

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Filed Apr. 26, 1965, Ser. No. 450,758
Claims priority, application Japan, Apr. 27, 1964, 39/23,747
7 Claims. (Cl. 227—8)

This invention relates to an explosively actuated power tool for driving fasteners such as studs, pins or the like into a wall such as of wood, steel, concrete or the like, and more particularly relates to improvements in an explosively actuated fastener driving tool of the type having a driving piston or plunger.

Various kinds of explosively actuated fastener driving tools of the type wherein the combustion gases of a cartridge cause an intermediate piston to be propelled and strike the fastener in the tool barrel to drive the same into the wall toward which the tool is directed are well known in the art.

However, conventional tools of this type have various drawbacks. For example, it is necessary to use cartridges having different explosive powers depending on the hardness of the wall into which the fastener is to be driven and also on the desired fastener penetration depth. Furthermore, it has been conventional for the operator to have a plurality of pistons having different lengths and to select a proper one from among them depending upon the particular length of the fastener.

In order to facilitate the speedy operation of the tools of this general type, it is necessary to make it easy to charge a cartridge into a cartridge chamber and to eject the used cartridge out of said chamber. Various proposals have been made to enable automatic ejection of the used or waste cartridge after the driving operation. However, the mechanisms are complicated and occupy a relatively large space.

Still another disadvantage of conventional fastener driving tools of the general type described is in that when the fastener (and hence, the plunger or piston) is excessively driven for some reasons such as excessive explosive power, or unexpected softness of the wall into which the fastener has been driven, causes a strong shock which adversely affects the tool.

It is well known that the general mechanism of fastener driving tools of this kind is similar to the usual pistol or gun operated with a ball-cartridge so that there is a danger that the tool (which should be solely for construction) is abused by being used with a ball-cartridge instead of a blank-cartridge.

It is well known that the interior of the driving tool, particularly the barrel is contaminated with the combustion products of the cartridge. The combustion products are corrosive and their accumulation adversely affects the smooth operation of the tool. Therefore, it is desired to prevent the accumulation of the combustion products and keep the barrel clean at all times.

Therefore, it is an object of this invention to provide an explosively actuated fastener driving tool of the piston-type which is easily adjustable to vary the explosive power even with a standard cartridge having a predetermined explosive power.

It is another object of this invention to provide an explosively actuated fastener driving tool of the piston-type which is easily adjustable to be adapted to various lengths of the fastener.

It is another object of this invention to provide an explosively actuated fastener driving tool of the piston-type wherein the used or waste cartridge can be automatically ejected by means of a very compact and simple ejecting mechanism.

It is still another object of this invention to provide an explosively actuated fastener driving tool of the piston-type wherein means is provided to prevent an undue shock from being transmitted to the tool.

Another object of this invention is to provide an explosively actuated fastener driving tool of the piston-type which is so constructed as not to be abused by being used with a ball-cartridge.

Still another object of this invention is to provide an explosively actuated fastener driving tool wherein the barrel is automatically cleaned to remove the combustion products of the fired cartridge at each driving operation.

Other objects of this invention will be clear from the following detailed explanation made with reference to the accompanying drawings in which:

FIG. 1 is a side elevation in longitudinal section of a fastener driving tool embodying this invention, with the barrel in the fully extended position;

FIG. 2 is a view similar to FIG. 1 but with the barrel in a slightly retracted position;

FIG. 3 is a plan view of FIG. 1;

FIG. 4 is an enlarged plan view of the barrel member;

FIG. 5 is a cross-section taken along line A—A of FIG. 1;

FIG. 6 is a cross-section taken along line B—B of FIG. 1;

FIG. 7 is a cross-section taken along line C—C of FIG. 1; and

FIG. 8 is another side elevation view of the tool, partly in section, the tool being folded with the front and rear parts of the tool in the open position.

Referring to the drawings, particularly to FIG. 1, the tool comprises a front portion 1 and a rear portion 2 foldably or divisibly connected to the front portion by a hinge pin 3. The latter portion 2 has a conventional grip 4 and includes a rear housing 5 connected to or formed integrally with the grip 4. Within the rear housing 5 there is slidably mounted a rear cylinder 6 within which is rotatably mounted on shoulder 6*a* a guide 7 for a firing pin assembly 8 with an annular space 9 between the cylinder 6 and guide 7.

The firing pin assembly 8 comprises a firing pin 10 carried by a hollow firing pin carrier 11 in which is mounted a coil spring 12 rotatably supported at its rear end by collar 13*a* rotatably mounted on shoulder 13*b* in the rear end wall 13 within the rear housing 5 so that the firing pin carrier 11 is urged forwardly. Indicated by the numeral 14 is a firing pin carrier guide rod extending into the carrier 11 as shown. A lock piece 15 having a pawl 16 at its end is normally urged upwardly by a leaf spring 17 into engagement with an opening formed in the wall of the firing pin carrier 11 and is slidable against the rear of shoulder 6*a*.

Within the handle housing 4 and extending into the rear housing 5 there is pivotally mounted at 18 a rocker arm 19 having a hook 20 at its rear upper end and an upward projection 21 at its forward end portion. The rear cylinder 6 has an opening 22 in which the projection 21 is engageable when the cylinder 6 is retracted. Indicated by the numeral 23 is a conventional trigger pivotally mounted at 24. The upper shoulder of the trigger 23 engages with the lower face of the rocker arm 19 as shown. When the tool is in the inoperative position shown in FIG. 1 the projection 21 is out of engagement with the opening 22 and the hook 20 on the rocker arm 19 is also out of engagement with the pawl 16 so that even if the trigger 23 is pulled the rocking movement of the arm 19 is prevented by its engagement with the rear cylinder 6 and the firing pin can not be operated. Indicated by the numeral 25 is a spring to urge the rocker arm 19 in the counter-clockwise direction. When the rear cylinder 6 together with the guide 7 and firing pin carrier 11 is

moved rearwardly as a unit during firing as will be set forth hereinafter (which is unitary due to the locking member **15** engaging all these members) against the spring **12** the opening **22** and pawl **16** come into a position engageable with the projection **21** and hook **20** respectively, so that when the trigger is pulled the rocker arm **19** can be rotated clockwise against the spring **25** with the projection **21** moving into the opening **22** and the hook **20** engaging the pawl **16** and consequently the lock member **15** is pulled downwardly against the spring **17** out of engagement with the opening in the firing pin carrier **11** with a result that the latter together with the firing pin **10** is driven forwardly by the compressed spring **12** to fire a cartridge. According to this arrangement, there are provided two safety measures, namely one is the engagement between the opening **22** and projection **21** and the other is engagement between the hook **20** and pawl **16**.

The front portion **1** of the tool comprises a front housing **26** within which is provided a front cylinder **27** which, when the tool is assembled, has the rear end abutting the front end of the rear cylinder **6** as shown in FIG. 1. An annular projection **28** is formed on the front cylinder **27** and a coil spring **29** is inserted in an annular space **30** (formed between the front housing **26** and front cylinder **27**) and between a ring **31** fixed to housing **26** and the annular projection **28** in order to urge the front cylinder **27** rearwardly.

Within the front cylinder **27** and rear cylinder **6** there is inserted a long barrel **32** extending forwardly beyond the front housing **26**. A cartridge plug **33** is inserted within the barrel **32**. The plug **33** has a forward cylindrical or piston holding opening **34** coaxial with the tool axis and a rear cylindrical opening or cartridge chamber **35** communicating with the forward cylindrical opening **34** and inclined rearwardly and upwardly as shown. The rear end face **37** of the plug **33** is inclined relative to the vertical cross-sectional plane and is normal to the axis of the cartridge chamber **35**. The forward end face of the guide block **7** is also inclined to conform with the rear end face of the plug **33**. The lower rear end portion of the plug **33** and the lower front end portion of the guide block **7** are cut away to form a space **36** therebetween for receiving an ejector piece **38** in the form of a cam which is pivotally mounted on the hinge pin **3** which is mounted in guide block **7** and plug **33**. The cam piece **38** has at its forward top portion an upward projection **39** which extends between the plug **33** and guide block **7** and into engagement with the rim edge of a cartridge (not shown) in the cartridge chamber **35**. The ejector cam piece **38** also has at its rear lower portion a projection **40** which, when the rear portion **2** is pivoted about the hinge pin **3** away from the front portion **1**, engages a projection **41** extending downwardly from the cutout portion of the guide block **7** so that the ejector **38** is rotated clockwise about the pin **3** with a result that the projection **39** also rotates clockwise to eject the cartridge out of the chamber **35** as shown in FIG. 8. When the tool is pivoted back to the original position, the projection **39** is pushed by the lower edge at the front end face of the guide block **7** into the original portion shown in FIG. 1.

A sub-barrel **43** is connected to the forward end of the main barrel **32** by means of a nut **44** bridging over these two barrel members and threadedly engaged thereon. Within the sub-barrel **43** there is formed a muzzle **45** of a reduced diameter which fits a piston or plunger **46** which comprises a piston stem **47**, an enlarged head portion **48** which merged into the stem through an inclined shoulder **49**, and a rear extension **50** which is adapted to be received in the piston holding opening **34** in the plug **33**. The sub-barrel **43** has at its rear end an inclined shoulder **51** which fits and abuts the shoulder **49** of the piston **47** when the latter is over driven. The nut **44** has a circumferential groove **52** so that when the piston **47** is unduly overdriven and the shoulder **51** is struck by the piston shoulder **49** the nut **44** is broken at the weak groove portion **52** by the unduly high shock and the sub-barrel **43** is separated from the main barrel **32**. Therefore, the unduly high shock is prevented from being transmitted to the main barrel **32** and to the other important mechanisms of the tool.

On the enlarged head portion **48** of the piston **46** there are a plurality of annular projections **53** with annular grooves therebetween. These projections **53** slidably engage the inner wall of the barrel **32**. Within at least one annular groove (preferably the rearmost one), there is mounted an O-ring or a friction ring spring **54** which serves not only to retain the piston **46** but also to slidably engage the inner wall of the barrel **32** so that the combustion products within the barrel **32** are scraped or wiped away during each driving operation to prevent undesirable accumulation thereof.

The barrel bore **55** is eccentric relative to the barrel **32** and within the barrel body and below the barrel bore is a groove **56** extending longitudinally of the barrel **32**. The barrel **32** also has in its lower outer wall a groove **57** extending longitudinally of the barrel **32** except along a threaded portion which will be explained in detail hereinafter. A lock member **58** pivotally mounted on front cylinder **27** and is partly exposed through the front housing **26** as shown. A coil spring **59** is arranged between the rear end portion of the member **58** and the front cylinder **27** to urge the lock member **58** clockwise so that the projection **60** is forced through an opening in the front cylinder **27** into the groove **57** on the barrel **32** so that the latter is prevented from rotating.

The most important feature of this invention is a novel measure for varying the axial position of the barrel **32** with respect to the plug **33** or cartridge chamber **35**. Referring particularly to FIGS. 4 and 6, a rear portion **61** of the barrel **32** has on its circumference a plurality of transversal ridges or projections **62** with spaces **63** therebetween as most clearly shown in FIG. 4. In the embodiment shown there are eighteen ridges **62** in one row. A plurality of such rows (e.g. four rows in the embodiment shown) is provided. The arcuate space **64** (FIG. 6) between the adjacent rows of ridges should be longer than the arcuate length of similar ridges provided on the interior walls of the front and rear cylinders **27** and **6**. In each row of ridges, the space or width **65** between the adjacent ridges **62** should be such as to fit a similar ridge on the front cylinder **27** and rear cylinder **6**. A ridge **62** in one row is in alignment with the corresponding ridge in the adjacent row.

On the inner wall of the rear portion of the front cylinder **27** there are also rows of ridges **66** corresponding to those on the barrel **27**. In the embodiment shown the number of ridges **66** in each row on the front cylinder **27** is two. Similarly, on the inner wall of the front portion of the rear cylinder **6** are also corresponding rows of ridges **67**. In the embodiment shown there are four ridges **67** in each row.

The arrangement is such that in the assembled state, the barrel **32** is engaged with the front cylinder **27** and rear cylinder **6**, with the ridges **62** of the barrel being positioned in the spaces formed by the ridges **66**, **67** on the front and rear cylinders as shown in FIGS. 1 and 2. In this way the barrel **32** is fixed against axial movement relative to the front cylinder **27** and rear cylinder **6**. The barrel **32** is also prevented from rotation by the lock **58** in engagement with the longitudinal groove **57** as mentioned before.

The above structure enables a user to vary the axial position of the barrel **32** with respect to the cartridge chamber **35**. This is very advantageous in a tool of this kind because the tool is adaptable to various lengths of fastener, studs, pins or the like and is also able to generate various explosive powers without the necessity of

exchanging the piston and without the use of cartridges having different explosive powers.

In the operative position shown in FIG. 1, the barrel 32 is in a forward somewhat extended position so that there is left a larger space at 34 between the cartridge chamber 35 and the rear end of the piston or plunger 46. Therefore, with a standard cartridge of predetermined power, the force acting on the piston 46 (and hence the stud 69) would be less than the force produced by the same tool in the operative state shown in FIG. 2 wherein the barrel 32 is retracted so that the space between the piston end and the cartridge chamber 35 is smaller. It will also be understood that when the barrel 32 is extended as shown in FIG. 1 it can receive a longer stud than in the case where the barrel 32 is retracted as shown in FIG. 2. The barrel 32 can be retracted through the space 9 until its rear end abuts the shoulder 70. It is preferred to provide indicator marks 71 on barrel 32 for indicating the degree of extension or retraction of the barrel 32 so that the operator can adjust the barrel position as he desires.

The operation of the tool including extension or retraction of the barrel 32 is as follows: After driving in the operative position of FIG. 1, the housing 26 is pulled forward against the spring 29 and the front assembly 26, 27, 32 along with the plug 33, block 7 and firing pin assembly 10, 11, 12, 13*a* and 14, which rotates within shoulders 6*a* and 13*b*, is rotated about 45° so that the ridges 62 disengage from the ridges 67 on the rear cylinder 6. Due to this disengagement, the said front assembly can now be pulled forwardly and the tool is broken open as shown in FIG. 8. At this time the waste cartridge is automatically ejected by means of the ejector 38 as explained before. If it is desired to vary the explosive power (the force to act on the piston) or to use a different length of stud, the lock 58 is released and the barrel 32 is rotated about 45° to disengage the same from the front cylinder 27, so that the barrel 32 can be extended or retracted relative to the front cylinder 27. The extent of the extension or retraction can be checked by referring to the indicator marks. Then the barrel 32 is reset by rotating it about 45° in order to engage the same with the front cylinder 27 and is locked in the new position by the lock 58. Then a stud 69 which may have a conventional disc 70 is inserted into the muzzle 45. The enlarged head 71 of the stud is received in a recess 72 formed at the front end of the piston 46 and the latter is retracted within the barrel 32 to a driving position. A cartridge (not shown) is charged into the cartridge chamber 35. Then the tool is pivoted back to the original position and the front assembly 26, 27, 32 is retracted with the rear end of the barrel extending into the space 9, and then rotated about 45° so that the barrel 32 again engages rear cylinder 6 as shown in FIGS. 1 and 2. The tool is now ready for operation. In operation, the muzzle end is placed against the wall into which the stud is to be driven and the tool is pressed against the wall so that the projection 21 on the rocker arm 19 will enter the opening 22 and the hook 20 will engage with the pawl 16. When the trigger 23 is pulled the firing pin 10 hits the rim of the cartridge to produce an explosion as described hereinbefore and the stud 69 is driven into the wall.

It will be noted that since the cartridge chamber 35 is inclined the tool cannot be operated effectively with a ball-cartridge because even if the ball-cartridge is charged and fired the ball or bullet will hit the wall of the opening 34 or barrel 32 and can not be projected effectively for shooting.

What we claim is:

1. An explosively actuated fastener driving tool having a front portion comprising a barrel, a cartridge receiving plug and on which said barrel is slidably mounted and a piston slidable in said barrel, and a rear portion comprising a firing mechanism, said plug being coupled to said firing mechanism, said front portion further comprising a front cylindrical member surrounding the barrel and having a plurality of projections projecting inwardly from the inner surface thereof and spaced along the length thereof, said rear portion further comprising a rear cylindrical member surrounding the barrel and having a plurality of projections projecting inwardly from the inner surface thereof and spaced along the length thereof at distances corresponding to the spacing of said projections on said front cylindrical member, said barrel having on its outer circumferential wall a plurality of projections which are spaced therealong at distances corresponding to the spacing of said projections on said front cylindrical member and engageable and disengageable with the projections on the front and rear cylindrical members, whereby the barrel is movable in an axial direction toward or away from the cartridge receiving plug when the projections are disengaged, while the barrel is locked in position against the axial movement when the projections are engaged.

2. An explosively actuated fastener driving tool as claimed in claim 1 in which the barrel further has a longitudinal groove therealong, and a lock member on said front portion engageable in said groove to lock the barrel against a rotational movement.

3. An explosively actuated fastener driving tool as claimed in claim 1 further comprising a sub-barrel at the forward end of the barrel having a reduced diameter portion at the free end thereof, and a nut having a circumferential groove therein and connecting said sub-barrel to said barrel so that when the piston is driven with an unduly high shock against the reduced diameter portion of the sub-barrel the nut is broken at the grooved portion and the shock is prevented from being transmitted to the barrel and to the structure provided within the tool.

4. An explosively actuated fastener driving tool as claimed in Claim 1 in which the cartridge receiving plug has a cartridge chamber inclined upwardly and rearwardly relative to the longitudinal axis of said plug.

5. An explosively actuated fastener driving tool as claimed in claim 1 in which the firing mechanism comprises a firing pin guide block having a front face abutting the rear end face of the cartridge receiving plug, the plug and guide block being cut away to define a space, an ejector cam piece which is pivotally mounted in said space, said front and rear portions being pivoted to each other on the pivoting axis of said cam piece, said cam piece having an upper projection adapted to engage the rim edge of a cartridge and a lower projection engageable by said guide block when said front and rear portions are pivoted relative to each other, whereby when the front portion and rear portion are pivoted relative to each other the ejector piece is rotated due to an engagement of the lower projection by the guide block to eject the cartridge out of the cartridge chamber.

6. An explosively actuated fastener driving tool as claimed in claim 1 in which the piston has an annular member thereon slidably engaging the inner wall of the barrel so that the barrel bore is cleaned each time the driving tool is operated.

7. An explosively actuated fastener driving tool as claimed in claim 1 and further comprising a trigger and a safety mechanism within the rear portion of the tool, said safety mechanism comprising a rocker arm operatively engaged with the trigger and having a projection at its upper forward end and a hook at its upper rear end, said rear cylindrical member having an opening therein into which said projection can enter only when the firing mechanism is in firing position, and a lock member having a pawl thereon with which the said hook is engageable for normally locking the firing mechanism, said hook releasing said pawl only when the said projection enters the said opening upon pulling the trigger.

No references cited.

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