Oct. 3, 1967 W. B. TIJMANN ET AL 3,344,869

EARTH CORING DEVICE

Filed Sept. 3, 1965 2 Sheets-Sheet 1

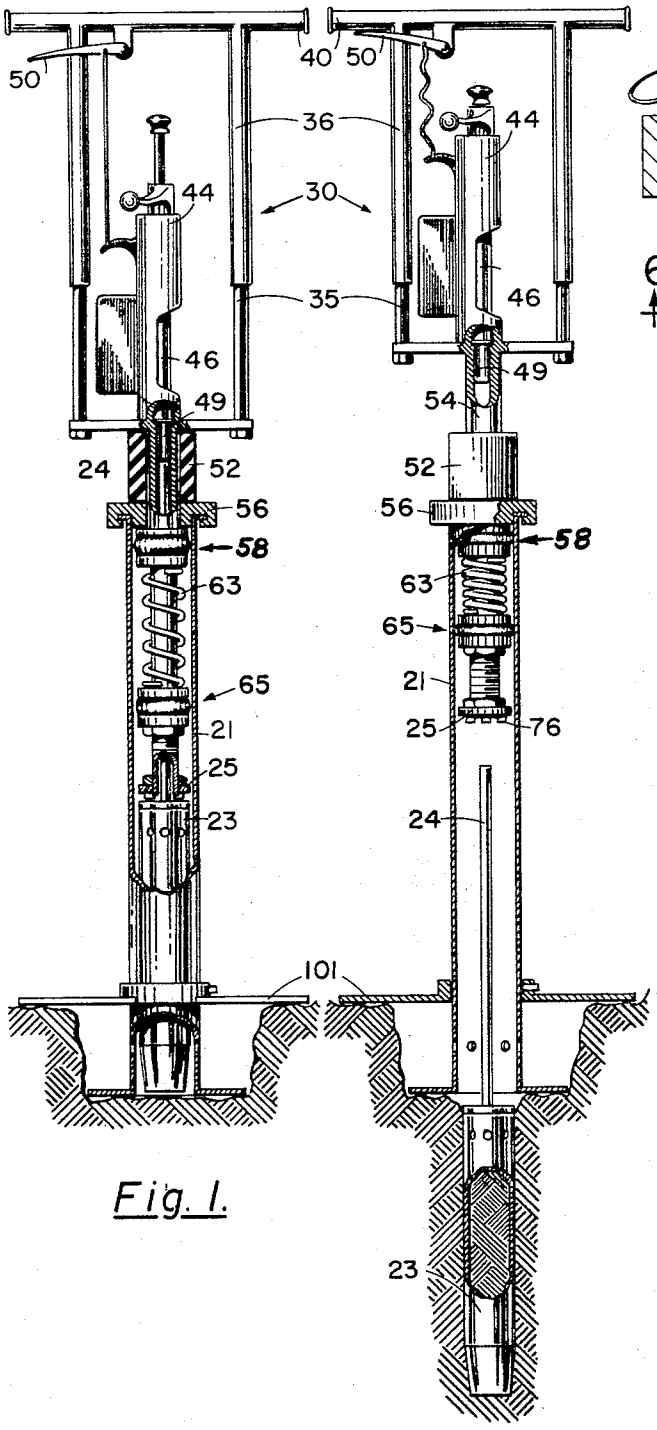


Fig. 1.

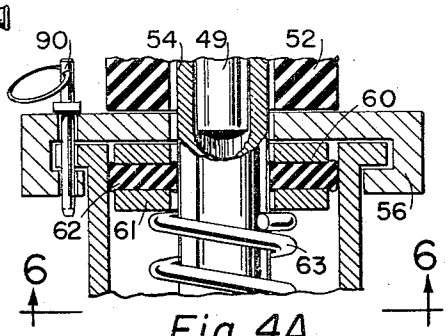


Fig. 4A.

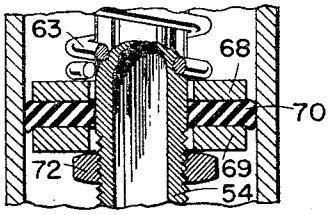


Fig. 4B.

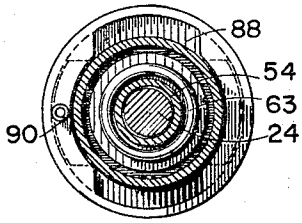


Fig. 6.

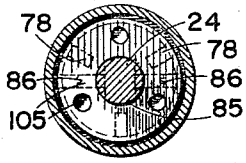


Fig. 7.

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EARTH CORING DEVICE

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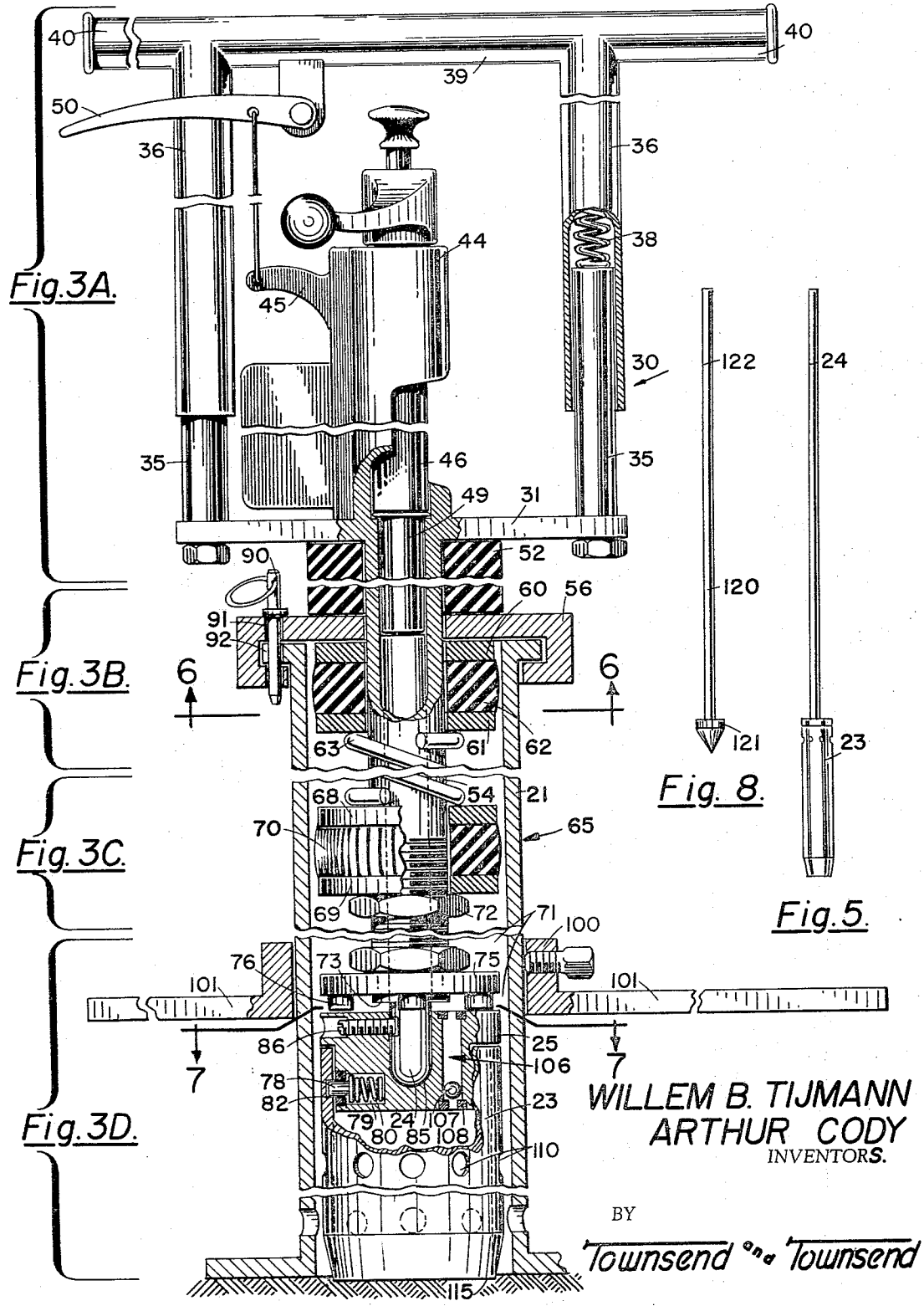


Fig. 3A.

Fig. 3B.

Fig. 3C.

Fig. 3D.

Fig. 8.

Fig. 5.

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United States Patent Office 3,344,869
Patented Oct. 3, 1967

3,344,869

EARTH CORING DEVICE

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Filed Sept. 3, 1965, Ser. No. 484,805
13 Claims. (Cl. 175—4)

This invention relates to an explosively driven device for retrieving a sample core of earth.

In soil analyses it is quite frequently necessary to provide means for establishing a sample profile of the earth surface. This is oftentimes accomplished by forcing a hollow cylinder into the earth and thence removing the cylinder to retrieve a sample which can be examined to determine the strata and other geological characteristics of the removed core. One of the principal problems in obtaining the aforesaid samples is in providing suitable apparatus for forcing the sample retrieving cylinder into the earth's surface. The problem is particularly accentuated when the earth's surface is formed of relatively hard materials which are highly resistant to the cylinder's penetration.

The object of the present invention is to provide a mechanism which operates by an explosive charge to force the sample retrieving cylinder into the ground with sufficient force to overcome the various earth configurations normally encountered in the aforesaid type of geological exploration.

While other devices have been formed for explosively motivating a core sampling cylinder, such devices have often encountered problems of absorption of recoil which render the device either unduly difficult or unsafe to operate and still require the necessary projectile force for adequate penetration.

In the present invention a threefold recoil system is provided in which three separate and accumulative recoil mechanisms are operable to absorb the recoil to the operator.

As a further object of the invention there is provided a sealing assembly which holds the expanding gas resulting from the explosive charge captive in a chamber at the head of the core sampling projectile in which the projectile forms one portion of the sealed chamber and the opposite portion is formed of a novel piston arrangement which functions to expand against a chamber wall under pressure and which is further yieldable to absorb a substantial portion of the impact of the explosive charge to the end of accomplishing both the seal and the recoil absorption in a single apparatus.

Another object of this invention is to provide a highly flexible and easy to use explosive type soil cylinder projectile mover in which a gun assembly is arranged for removable mounting onto a projectile carrying housing. The gun assembly is formed with a pair of pressure actuated expandable pistons which in a normal condition of operation are loosely fitted within the chamber to facilitate easy removal and attachment of the chamber and the gun. The two pistons are separated by a compression spring in such a way as to react to the expanding gases in the lower part of the chamber between the projectile and the lower of the two pistons and therein expand to a condition wherein the pistons form a complete gas seal against the chamber wall. The seal functions to cause the gas pressure to predominantly react against the soil sampling cylinder or projectile with the recoil being absorbed partially by some piston movement against the compression spring.

A feature and advantage of the present invention lies in the fact that the explosive gases are prohibited from entry into the recoil and sealing mechanisms, thus preventing the mechanism from being contaminated by the charge gases.

Another object of this invention is to provide within the aforesaid device a novel sampling cylinder adapted to particularly function within an activating chamber in which the top face of the cylinder is closed except for several apertures which are valved to prevent gas from traveling from the expansion chamber into the interior of the cylinder, thus retaining the expansion gases for full piston moving power without loss through the apertures. At the same instant when the cylinder enters the ground there is a pressure build-up between the ground or earth within the cylinder and the upper closed end. The apertures are so provided with the aforesaid check valves to cause the pressure release from the cylinder back into the expansion chamber.

A further feature and advantage of this invention lies in the fact that the expansion chamber is maintained in a sealed relationship throughout the power cycle until such time the pressure against piston movement approaches that of the motivating gases, so that by the release of the valve the full force and pressure can be applied to the cylinder movement by virtue of the release of the pressure chamber between the ground surface and the top of the cylinder.

A further object of the invention is to form the sample cylinder with apertures formed along its side walls for release of internal gas pressures after the cylinder has left its containing chamber by force of the explosive gases. The side apertures in combination with the check valve controlled apertures at the top of the cylinder thus provide a controlled pressure escape mechanism to facilitate more efficient penetration of the cylinder into the earth's surface.

Another object of this invention is to provide a simple mechanism by which the gun is formed with a barrel arranged in downwardly facing vertical orientation and in which further the ground sampling cylinder is attached to an upwardly extending vertical shaft mounted within the barrel to transmit torque from the explosive gas within the barrel to the ground sampling cylinder.

A further object of this invention is to provide a novel means for holding the ground sampling cylinder with its attendant rod maintained within the gun barrel in spaced elevation above the ground surface prior to firing which incorporates a magnetic fitting mounted to yieldably lock the cylinder and rod against the lower tip of the gun barrel.

Other objects, features and advantages of the present invention will be more apparent after referring to the following specification and attached drawings in which:

FIG. 1 is a cross-sectional view showing the ground or core sampling device prior to being actuated.

FIG. 2 is a view similar to FIG. 1 showing the device during the firing phase of operation.

FIGS. 3A, B, C, and D are enlarged, fragmentary sectional views of the coring device showing the device prior to actuation, in which

FIG. 3A shows the magazine section of the device;

FIG. 3B shows the upper expandable stationary piston;

FIG. 3C shows the movable piston; and

FIG. 3D shows the coring cylinder and its attachment to its driving arm.

FIGS. 4A and B are fragmentary sectional views similar to FIGS. 3B and C during the explosive phase of operation, in which

FIG. 4A shows the stationary piston and

FIG. 4B shows the movable or slidable piston.

FIG. 5 is a plan view of the core sampling cylinder with the shaft attached thereto.

FIG. 6 is a sectional view showing the coupling between the removable chamber and the gun assembly.

FIG. 7 is a sectional view showing the attaching mechanism for connecting the earth penetrating cylinder to its upper cover.

FIG. 8 is a plan view of an alternative projectile and its connecting shaft for use in non-sample retrieving hole boring applications.

The soil sampling device comprises a gun assembly **20** having a removably mounted chamber **21** depending therefrom and containing within the chamber a projectile **22** carrying the core sampling cylinder **23** and its projecting shaft **24** which is connected to the cylinder by a removable cap assembly **25**. The gun assembly is formed with a frame **30** having a cross member **31** supporting a pair of parallel spaced apart standards **35** over which are mounted recoil cylinders **36** spring connected to the top of the pins **35** by springs **38**. The top of the two cylinders is joined by a handle **39** having extensions **40** which can be conveniently grabbed and held by the hands of operators. Centrally mounted on cross member **31** is a rifle bolt assembly **44** which comprises a trigger **45**, a shell or cartridge receiving chamber **46**, and mechanism not shown which will fire a firing pin against the primer of an explosive carrying cartridge **49**. The aforesaid assembly can, for example, be the working bolt components of standard large caliber rifles, such as a 30 caliber military piece. Trigger **45** of bolt assembly **44** is carried by an extension trigger assembly **50** mounted under the extension **40** of handle **39** to facilitate firing of the mechanism while maintaining a firm grip on the handle extensions. Immediately below the frame bar **31** is a buffer ring **52** which surrounds the barrel **54** connected to the bolt assembly **44**. Buffer **52** is formed of an impact absorbing material which functions to absorb shock of recoil upon impact. Immediately below buffer plate **52** is mounted a work chamber connecting fitting **56** which is adapted to removably connect chamber housing **21** to the gun assembly. Underneath fitting **56** and mounted on barrel **54** is a permanently mounted compression actuated sealing piston **58** formed of two rigid rings **60** and **61** spaced apart and formed with a resilient ring **62** in the space therebetween. The bottom of the two rings **61** is slidably mounted on the barrel to be yieldable to be movable against resilient ring **62** in such a way as to cause the yieldable ring **62** to compress and expand radially when upward pressure is exerted against ring **61**. Below the slidable ring **61** and around barrel **54** is mounted a compression spring **63**. At the bottom of spring **63** is a second piston **65**, similar in construction to piston **58** having a pair of slidably mounted solid rings **68** and **69** spaced apart and mounted on barrel **54**. Between the two rings **68** and **69** is a compressible ring **70** adapted in a fashion similar to ring **62** to yield to compression between the two solid rings **68** and **69** and thereby expand.

When chamber housing **21** is mounted in a fitting **56**, the diameter of the two expandable rings **58** and **65** is slightly less than the bore diameter of chamber housing **21** until the explosive gases from shell **49** enter into expansion chamber **71** as will hereinafter be described. At that time the force of gases from the explosion causes pressure against ring **69** which is translated upwardly through compression spring **63** to the fixed plate or ring **60**. The aforesaid force causes the radial expansion of the two rings **58** and **65** against the bore of chamber housing **21** to cause a complete gas seal. Downward movement of ring **69** is restrained by a locked cover **72** mounted on barrel **54**. The bottom end **73** of barrel **54** is provided with a soil sampling tube **23** retaining plate **75**. Affixed at the bottom of plate **75** is a plurality of magnets **76** which are adapted to magnetically urge the top plate **25** of cylinder **23** thereagainst. Cylinder **23** is mounted to top plate **25** by a plurality of pins **78** which are fitted in apertures **79** along the sidewalls of the top plate and project outwardly under spring pressure by springs **80** to force plunger **78** into engagement with pin receiving apertures **82** formed in the inside wall of the soil receiving cylinder

23. The projectile shaft **24** is mounted in a spherically terminated aperture **85** formed at the top of cap **25** and held in place by lock screws **86**. The projecting shaft **24** is arranged to project upwardly within barrel **54** to a spot shortly ahead of the lower end of cartridge **49** and is formed of a diameter approximating the bore diameter of barrel **54**, so that the explosive charge from the cartridge will force the projectile shaft **24** out of the barrel in a manner analogous to the projectile of a bullet from a rifle. The force is thereby translated to the soil boring tube or cylinder **23** for force into the ground surface. Gas escaping between shaft **24** and the bore of barrel **54** will lead to the expansion chamber **71** which will react against the top of cap **25** and the solid washer **69**. The resilient force causes upward movement of washer **69** and the compression of the expandable rings **58** and **65** to cause a sealant at the upper portion of the chamber. Cylinder **23** is formed of a diameter approximating the diameter of the bore of chamber housing **21** and thereby resists substantial gas escapement between the outer wall of the cylinder and the bore of the chamber housing. Thus, compression chamber **71** is functionally sealed to prevent gas escapement and to hold captive the expanding gases for conversion to forceful movement of the cylinder into the ground. The chamber housing **21** is mounted to fitting **56** by the provision of flange quadrants **88** extending outwardly from the top of the housing and arranged to engage in bayonet joint fashion with lipped flanges **89** formed on the underside of fitting **56**. By this means the chamber housing is fitted into fitting **56** and rotated for firm engagement therewith. A lock pin **90** is arranged to pass through aligned apertures **91** and **92** to lock the two members in their attached position.

In operation, soil receiving cylinder **23** is mounted on its cap **25**. The cap in turn is mounted on projectile shaft **24**. Shaft **24** is then placed into barrel **54**. Magnets **76** magnetically engage cap **25** and hold it in position against the end of the barrel. Housing **21** is then fitted over the cylinder **23** and engaged into fitting or coupling **56** and there locked by pin **90**. The unit is then placed vertically immediately over the ground surface to be retrieved. The base of housing **21** is provided with an outer circular fitting **100** with two outwardly extending legs **101**. Fitting **100** is adjustably mounted on the outer wall of cylinder **21** to act as a support against the ground surface and on which the feet of the operator can be placed to add support to the device. Fitting **100** is adjustable in elevation to allow the device to be depended into a depression or hole where the exterior ground level is at a higher elevation than the hole. By this means the fitting **100** can be elevated to a position coincident with the ground level while the bottom of housing **21** is engaged with the bottom of the hole. Bolt assembly **44** is then opened and a cartridge **49** installed. The operator then by placing his hands on extension **40** and his feet on arms **101** fires the device by actuation of trigger **50** which in turn causes trigger **45** to fire cartridge **49**. The explosive gases react against the end of shaft **24** to cause the cylinder to be forced into the ground. Escaping gases thereafter expand into expansion chamber **71** to react against the top of cover **25** for further ground penetrating force against cylinder **23**. The reverse of the force is reacted against washer **69**, thus causing compression of the resilient washer **58** and **65** through compression spring **63**. This results in the sealing of the upper portion of the chamber and the absorption of the recoil by the combined effect of the expansion of the two washers **58** and **65** and the compression of spring **63**. Further recoil is absorbed by buffer plate **52** and still further recoil is absorbed by the springs **38** mounted within the handle or gun assembly **20**. As cylinder **23** penetrates into the ground, pressure is built up interiorly of the cylinder. Release of the pressure is afforded by a plurality of apertures **105** mounted in the top plate **25** and in which are formed a check valve **106** formed of ball **107** arranged

in a downward position to nest against a ball seat **108** for prevention of gas passage from expansion chamber **71** into the interior of the cylinder **23** but releasable to allow the reverse passage of gas when the pressure build-up within the cylinder is greater than the motivating force or pressure within expansion chamber **71**. Further pressure release is afforded by apertures **110** mounted in the side walls of cylinder **23** which will be open to ground or atmosphere upon the cylinder's reaching a point where the apertures are below the end of chamber housing **21**. Thus, by the provision of the two apertures **110** and **105** gas escape from the interior of the cylinder is accomplished. The end wall of cylinder **23** is tapered at **115** to allow the device to easily cut through the ground surface.

After firing, the complete assembly is removed by lifting it upwardly. The cylinder and projectile shaft **24** will remain in the ground. After removal of gun **20** and chamber housing **21**, shaft **24** is pulled upwardly to remove cylinder **23** from the ground. Cover **25** is then removed by depressing pin **78**. The soil sample contained within the cylinder is then in the customary manner transferred to an auxiliary chamber or cylinder for analysis. The device is then reassembled for repetition of the aforesaid process of operation.

As seen in FIG. 8, a projectile **120** can be substituted for cylinder **23** which comprises a bullet shaped projectile **121** mounted on a projecting shaft **122**. Hole boring projectile **120** is used in exactly the same manner as cylinder **23**. The force of the explosion from cartridge **49** will cause the projectile **121** to be driven into the ground thereby boring the desired hole.

While several embodiments of the present invention have been shown and described it will be obvious that other adaptations and modifications may be made without departing from the true spirit and scope of the invention.

What is claimed is:

1. A ground penetrating device comprising a cylindrical housing adapted to be mounted normal to a ground surface, a firing mechanism mounted on the upper portion of said housing, said firing mechanism including a cartridge receiving chamber, means for firing the cartridge within said chamber and a barrel extending downwardly into said housing, upper and lower rigid rings slidably mounted on said barrel, means restraining said upper ring against upward movement, an expandable resilient ring mounted around said barrel between said upper and lower rings and having an unexpanded inside diameter substantially equal to the outer diameter of said barrel and an outside diameter substantially equal to the bore diameter of said housing and expandable under compression to exert pressure against both the outer wall of said barrel and the bore of said housing, a projectile mounted within said housing, said projectile having a diameter substantially equal to the bore of said housing whereby the force of expansive gas from the explosion of said cartridge is reactive to cause the projectile to move outwardly into said ground surface and the pressure within said housing against the lower of said rings reacts to compress said resilient ring between said two upper and lower rings to form a gas seal to prevent gas escape from the upper portion of said housing.

2. A device according to claim **1** and wherein buffer shock absorbing means are mounted between said firing mechanism and said housing to absorb recoil, handle means mounted to said firing mechanism and compression spring means interposed between said handle means and said firing mechanism to additionally absorb shock upon recoil impact.

3. A ground penetrating device comprising a cylindrical housing adapted to be mounted normal to a ground surface, a firing mechanism mounted on the upper portion of said housing, said firing mechanism including a cartridge receiving chamber, means for firing the cartridge within said chamber and a barrel extending downwardly into said housing, a shaft adapted for mounting within the bore of said barrel, a projectile mounted on the end of said shaft and having a bore diameter substantially equal to the bore of said housing, and means mounted between the barrel and the bore of said housing to prevent gas escape upwardly from said housing.

4. A ground penetrating device comprising a cylindrical housing adapted to be mounted normal to a ground surface, a firing mechanism mounted on the upper portion of said housing, said firing mechanism including a cartridge receiving chamber, means for firing the cartridge within said chamber and a barrel extending downwardly into said housing, a shaft adapted for mounting within the bore of said barrel, a projectile mounted on the end of said shaft and having a bore diameter substantially equal to the bore of said housing, means mounted between the barrel and the bore of said housing to prevent gas escape upwardly from said housing, and magnetic means mounted on said projectile, the bottom end of said barrel being formed of magnetic material and actionable with said magnetic means to restrain said projectile against movement away from said barrel.

5. A ground penetrating device comprising a cylindrical housing adapted to be mounted normal to a ground surface, a firing mechanism mounted on the upper portion of said housing, said firing mechanism including a cartridge receiving chamber, means for firing the cartridge within said chamber and a barrel extending downwardly into said housing, a shaft adapted for mounting within the bore of said barrel, a projectile mounted on the end of said shaft and having a bore diameter substantially equal to the bore of said housing, means mounted between the barrel and the bore of said housing to prevent gas escape upwardly from said housing, said projectile being formed in the shape of a hollow cylinder, cap means mounted at the top of said cylinder to substantially seal the upper end of the cylinder, air passageway port means mounted in said cap to afford gas communication from the interior of said projectile.

6. A device according to claim **5** and wherein said port means includes check valve means adapted to allow fluid communication from the interior of said projectile outwardly and to prevent reverse gas flow.

7. A device according to claim **5** and wherein said port means includes check valve means adapted to allow fluid communication from the interior of said projectile outwardly and to prevent reverse gas flow, and wherein said projectile is formed with air communicating apertures in the sidewall of said projectile to allow gas escape from the interior of said projectile upon said projectile leaving the bore of said housing.

8. A ground penetrating device comprising a cylindrical housing adapted to be mounted normal to a ground surface, a firing mechanism mounted on the upper portion of said housing, said firing mechanism including a cartridge receiving chamber, means for firing the cartridge within said chamber and a barrel extending downwardly into said housing, upper and lower rigid rings slidably mounted on said barrel, means restraining said upper ring against upward movement, an expandable resilient ring mounted around said barrel between said upper and lower rings and having an unexpanded inside diameter substantially equal to the outer diameter of said barrel and an outside diameter substantially equal to the bore diameter of said housing and expandable under compression to exert pressure against both the outer wall of said barrel and the bore of said housing, a projectile mounted within said housing formed of a cylindrical member having a diameter substantially equal to the bore of said housing, cap means sealing the upper end of said projectile, a rod mounted on said cap means and having a diameter sufficiently small to allow said rod means to be inserted upwardly into the bore of said barrel.

9. A soil sampling device comprising a gun barrel, a cartridge chamber mounted in the upper portion of said gun barrel and means mounted on the upper portion of said barrel to fire cartridges carried in said cartridge chamber, a cylindrical housing adapted to be mounted over a ground area, means carrying said gun barrel coaxially in depending relation within said housing, a pair of rigid rings slidably mounted around said barrel, a resilient ring mounted between said rigid rings, spring means biased at the upper portion of said chamber and extending downwardly to the upper of said two rigid rings, a ground entry projectile having a diameter complementary with the bore of said cylindrical housing positionable below said barrel, having a diameter less than said barrel rod mounted on said projectile extending upwardly into said barrel whereby explosive gases emanating from a projectile fired from said chamber enter from between said rod and barrel into the area between the lower of said pair of rigid rings and said projectile to cause force against said latter ring and said projectile to force the projectile out of said housing and to compress said latter ring upwardly against the resilient ring to cause its outward expansion and engagement with the bore of said cylindrical housing.

10. A soil sampling device according to claim 9 and wherein said projectile comprises a cylindrical member having a cap mounted on the upper end thereof and wherein said rod is connected to the central portion of said cap.

11. A soil sampling device according to claim 9 and wherein said projectile comprises a conically tipped lower end having a conical tip extending from a central point upwardly to the rim of said projectile and said rod is mounted on the center of the projectile on the side opposite said tip.

12. A ground penetrating device comprising a cylindrical housing adapted to be mounted normal to a ground surface, a firing mechanism mounted on the upper portion of said housing, said firing mechanism including a cartridge receiving chamber, means for firing the cartridge within said chamber and a barrel extending downwardly into said housing, a resilient expandable ring mounted between the upper and lower ring of each pair, a pair of upper and lower rigid rings mounted on said barrel, means restraining the upper ring of the upper pair of rings against upward movement, the remainder of said rings being slidably mounted on said barrel, resilient means resistant to compression mounted between the lower of the upper pair of rings and the upper of the lower pair of rings, said expandable resilient rings having an unexpanded inside diameter substantially equal to the outer diameter of said barrel and an outside diameter substantially equal to the bore diameter of said housing and expandable under compression to exert pressure against both the outer wall of said barrel and the bore of said housing, a projectile mounted within said housing, said projectile having a diameter substantially equal to the bore of said housing whereby the force of expansive gas from the explosion of said cartridge is reactive to cause the projectile to move outwardly into said ground surface and the pressure within said housing against the lower of said rings reacts to compress said resilient ring between said two upper and lower rings to form a gas seal to prevent gas escape from the upper portion of said housing.

13. A soil sampling device comprising a gun barrel, a cartridge chamber mounted in the upper portion of said gun barrel and means mounted on the upper portion of said barrel to fire cartridges carried in said cartridge chamber, a cylindrical housing adapted to be mounted over a ground area, means carrying said gun barrel coaxially in depending relation within said housing, a pair of pairs of rigid rings slidably mounted around said barrel, a resilient ring mounted between the rigid rings of each pair, spring means mounted around said barrel to spring urge the two pairs of rings in opposite relation, said resilient ring having a diameter normally making less than sealing contact with the bore of said housing and the outer wall of said barrel and operable upon compression to form gas seals against the outer wall of said barrel and the bore of said housing, a ground entry projectile having a diameter complementary with the bore of said cylindrical housing positionable below said barrel, having a diameter less than said barrel rod mounted on said projectile extending upwardly into said barrel whereby explosive gases emanating from a projectile fired from said chamber enter from between said rod and barrel into the area between the lower of said pair of rigid rings and said projectile to cause force against said latter ring and said projectile to force the projectile out of said housing and to compress said latter ring upwardly against the respective resilient rings to cause outer expansion thereof and engagement with the bore in gas tight engagement with the bore of said cylindrical housing and the outer wall of said barrel.

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