U. THOMPSON, JR.

METHOD OF FORMING CAVITIES IN EXPLOSIVES.

APPLICATION FILED AUG. 27, 1917.

1,255,836.

Patented Feb. 5, 1918.

2 SHEETS—SHEET 1.

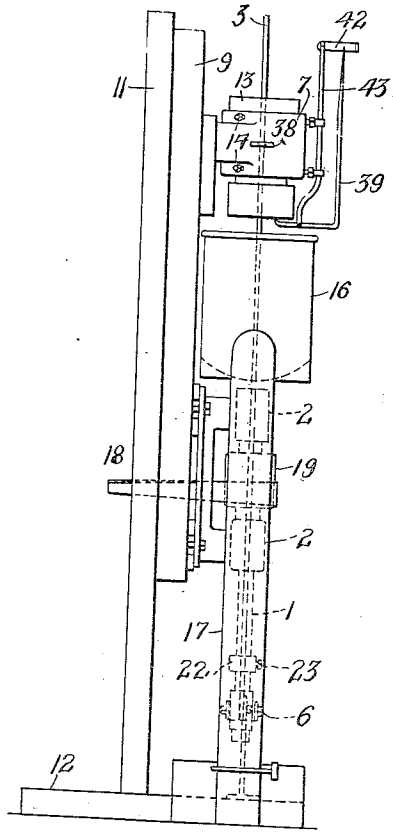


Fig: 1.

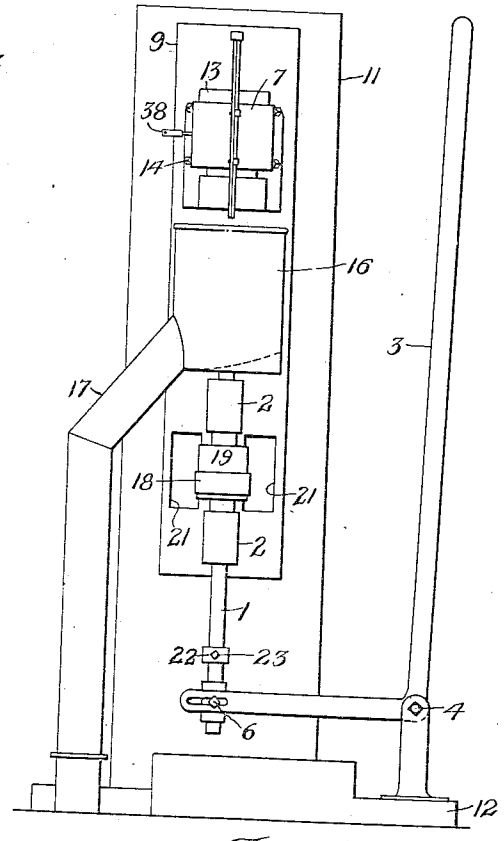


Fig: 3.

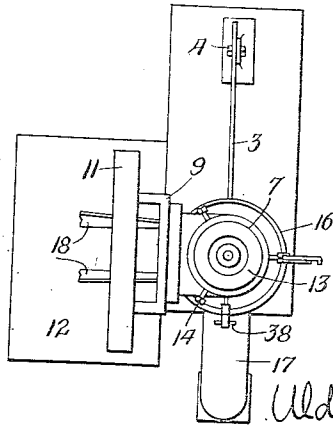


Fig: 2.

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2 SHEETS—SHEET 2.

Fig. 4.

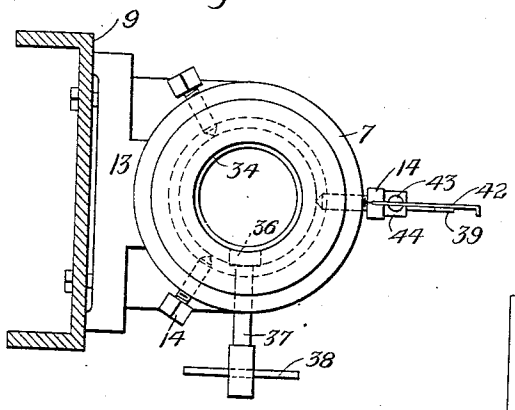


Fig. 6

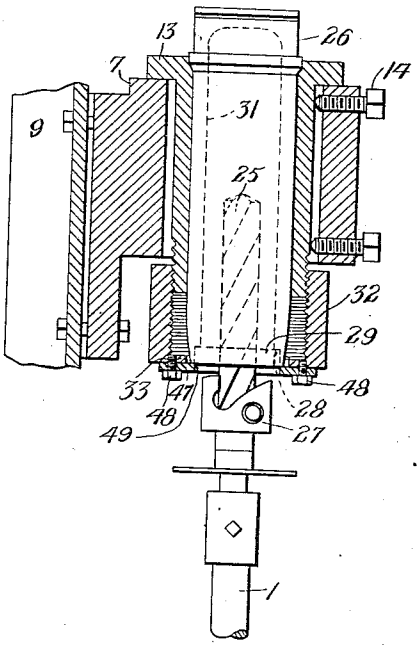
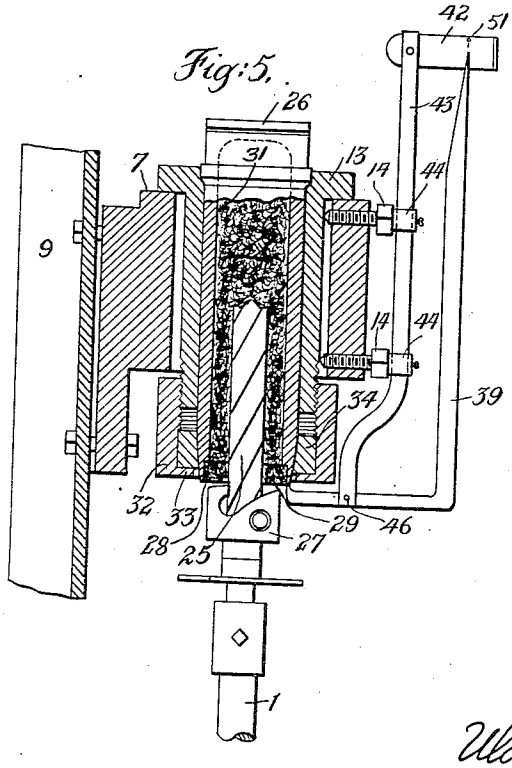


Fig. 5.



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UNITED STATES PATENT OFFICE.

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METHOD OF FORMING CAVITIES IN EXPLOSIVES.

1,255,836. Specification of Letters Patent. Patented Feb. 5, 1918.

Original application filed November 20, 1916, Serial No. 132,241. Divided and this application filed August 27, 1917. Serial No. 188,382.

To all whom it may concern:

Be it known that I, ULDRIC THOMPSON, Jr., a citizen of the United States, residing at city, county, and State of New York, have invented new and useful Improvements in Methods of Forming Cavities in Explosives, of which the following is a specification.

This invention relates to rapidly and safely forming recesses in high explosive material as, for example forming in high explosive shells recesses adapted to receive exploders or detonators.

This application is a division of my application Serial Number 132,241, filed November 20th, 1916 (now Patent Number 1,238,362 patented August 28th, 1917).

In producing high explosive shells it is customary to employ a steel shell having a cylindrical bore of a given diameter throughout almost its entire length and having a cylindrical bore of somewhat greater diameter for a short distance from its open end or mouth, thus affording an annular shoulder in the plane between the bores of the two diameters against which rests the head through which passes the detonator when the shell is completely assembled. The shell is first filled with high explosive material in molten form, the shell being filled completely, including the portion of the larger diameter at the mouth of the shell, so that the casting of explosive material is free from pipes and blowholes, the explosive material is removed from the portion of the shell of larger diameter and an axial hole of relatively small diameter is drilled in the explosive material contained in the portion of the shell of smaller diameter, so that the detonator may be inserted into the shell in intimate contact with the explosive material.

Heretofore it has been the practice to follow one of the following methods in producing a shell of the character outlined above. The first method consists in removing the material from the larger portion of the shell, *i. e.*, from the relatively short portion adjacent its mouth, and boring an axial recess in the explosive material in the smaller portion of the shell by means of a hand drill or a power drill. Another method consists in casting the high explosive around a casting plug or core, the core having a cylindrical base the size of the larger portion of the shell and having an axial protuberance of the proper size to form the axial recess in the explosive material occupying the portion of the shell of smaller diameter. However, both of these methods are unsatisfactory, the first for the reason that it is slow, tedious and unsafe, and the latter for the reason that the cast material contains blowholes and coarse crystals which seriously affect the density and explosive qualities of the shell and which leave the shell under-weight.

Furthermore, any method by which a portion of the explosive material is removed after the shell has been filled with cast material involves certain vital requirements among which may be mentioned the following. In the first place, great accuracy must be employed not only so that the detonator will be in intimate contact with the remaining explosive material, thereby properly to detonate the mass, but also so that the detonator will not jam when inserted before firing. Secondly, in removing the explosive material occupying the larger portion of the shell adjacent its mouth, the material must be cut accurately to the plane defined by the shoulder between the two portions of the shell of large and small bore, respectively, for the reasons that if the material is removed to a plane rearwardly of the shoulder the remaining material will not be held in place but will break loose from the walls of the shell thereby making the detonation ineffective or causing the shell to explode in the gun, and if the material is only removed to a plane forwardly of the shoulder the remaining material which extends forwardly of the shoulder is likely to be broken down when the detonator and other parts of the head are placed in position thereby causing the explosive to fall into the detonator recess and jam the exploder. And thirdly, in boring a recess of accurately predetermined depth it is necessary to determine the depth of the recesses with respect to some accurately machined external part of the stock which bears a known relation to the point or plane to which it is desired to bore. In the case of shells of the character described for example, the overall length of the shells may vary considerably due to allowed tol-

erances, but the distance from the mouth of the shell to the aforesaid shoulder is substantially constant for all shells of a given type and size and it is therefore essential to determine the depth of bore with relation to the forward edge of the shell.

The principal objects of my invention, therefore are to provide for the above and other cardinal requirements, thereby accurately and rapidly to bore recesses in explosive or other material; to remove all of the explosive material from the forward larger portion of a shell of the type referred to without rubbing the borings between metals which might cause an explosion and so that the forward end of the remaining material lies precisely in the plane defined by the aforesaid internal shoulder of the shell, and to bore an axial recess in the explosive material occupying the rearward portion of the shell of smaller bore; and to provide for properly positioning the shell or other stock with respect to a boring tool arranged to reciprocate back and forth along a fixed path.

Other objects of the invention will be apparent from the disclosure of the particular illustrations of my invention hereinafter more fully and at large set forth in connection with the accompanying drawings, in which

Figure 1 is a side elevation of the indicator type of apparatus whereby the method may be practised.

Fig. 2 is a top plan view of the apparatus shown in Fig. 1;

Fig. 3 is a front elevation of the apparatus shown in Fig. 1;

Fig. 4 is an enlarged top view of a portion of the apparatus showing the guide for laterally positioning the stock in alinement with the boring tool;

Fig. 5 is an enlarged vertical longitudinal section showing the means for both laterally and longitudinally positioning the stock with relation to the boring tool; and

Fig. 6 is an enlarged vertical longitudinal section of another embodiment of apparatus showing constant stop means for longitudinally positioning the stock.

As illustrated in Figs. 1, 2 and 3, the apparatus as a whole comprises a boring spindle 1 mounted to reciprocate vertically in bearings 2 and arranged to be reciprocated by means of a bell crank 3 pivotally mounted at 4 and engaging the lower end of the boring spindle 1 by means of a pin and slot connection 6. Above the boring spindle and in alinement therewith, is the mounting head 7 having a vertical longitudinal inner bore adapted to receive the shell sleeve 13. The boring head is mounted on a base 9 which in turn is secured to the upright 11 mounted on the foot piece 12. Within the supporting head 7 is mounted the tubular shell sleeve or guide 13 which has an outer diameter somewhat smaller than the inner diameter of the mounting head 7 and which is adapted to be laterally adjusted into accurate alinement with the boring tool and boring spindle by means of screws 14 extending through the mounting head. In order to remove the material cut away by the boring tool a hollow casing 16 is provided immediately beneath the mounting head 7 which communicates with a pipe 17 leading to an exhaust fan or other suitable means for withdrawing the borings from the casing. Suitable means for rotating the boring spindle comprises a belt 18 extending between a source of power and the pulley 19 on the boring spindle, openings 21 being provided in the base 9 and vertical support 11 to permit the passage of the belt. In order to limit the upward movement of the boring tool and thereby accurately bore the stock to a predetermined depth, a stop 22 may be adjustably mounted on the boring spindle by means of a set screw 23 and arranged in such manner as to engage the lower side of the lower bearing 2 when the boring spindle has reached its proper uppermost position.

Referring to the more detailed showing of the mounting head 7 and shell sleeve 13 and other parts shown in Figs. 4 and 5, it is evident that the shell sleeve may be laterally adjusted by means of the screws 14 accurately to center the boring spindle and boring tool with respect to the shell 26, and as above noted it is not only necessary laterally to adjust the shell with respect to the boring tool, but it is also essential that the shell be longitudinally positioned with respect to the path of reciprocation of the boring tool so that the cutting collar 27 on the boring tool will cut to the horizontal plane defined by the shoulder 28 between the portion 29 of the shell, which is of larger diameter, and the portion 31 of smaller diameter which extends from the shoulder 28 to the base of the shell.

The preferred means for longitudinally positioning the shell comprises a collar 32 having an annular shoulder 33 adapted to support a sleeve 34 of Babbitt or other suitable bearing material, this entire means and particularly the bearing sleeve 34 constituting a stop to limit the downward movement of the shell. While the collar 32 is shown as being threaded on the lower end of the shell sleeve 13 it may be connected to the sleeve in any other suitable manner, and indeed, it may be mounted on supporting means other than the sleeve 13, if desired. The inner bore of the bearing 34 is tapered in such manner as accurately to fit over the tapered forward portion of the shell 26 and is of such diameter that the forward portion of the shell projects slightly beyond the for-

ward face of the flange 33. The clamp 36 is provided in an interior recess of the shell sleeve 13 in contact with the outer surface of the shell 26 and by means of the screw spindle 37 and handle 38 is adapted to be forced against the shell under considerable pressure and thereby securely hold the shell in fixed position with respect to the shell sleeve 13 after it has been properly positioned by means of the adjusting collar 32.

In order accurately to indicate the proper longitudinal position of the shell 26, an indicating lever 39 is arranged to contact with the forward edge of the shell 26 at one end and to play over an indicating scale 42 at the other end. The indicating lever is preferably mounted near the shell end so that the free end of the lever playing over scale 42 will have a considerable range of movement and thereby afford greater accuracy of indication. A convenient means of so mounting the indicating lever comprises a rod 43 adjustably mounted in collars 44, bent inwardly at its lower portion and pivotally connected with the indicating lever at 46. The collars 44 may be mounted directly upon the mounting head 7 or they may be mounted by means of a pivotal connection upon the heads of the screws 14 in such manner that the screws and screw heads may be rotated without rotating the collars 44. The latter is the preferred method of mounting the rod 43 for the reason that it affords a very convenient means of automatically positioning the lower end of the indicating lever axially with respect to the shell 26, inasmuch as this form of mounting means maintains the distance between the axis of the shell and the rod 43 constant, this distance being determined by the radius of the shell plus the thickness of the shell sleeve 13 plus the length of the adjusting screws 14.

In the modified form of apparatus illustrated in Fig. 6 the indicating mechanism shown in Figs. 4 and 5 is replaced by a plate 47 secured to the forward face of the flange 33 by means of stud bolts 48 and thereby bearing a constant and fixed relation to the adjusting collar 32. The shell 26 bears against the upper face of the plate 47 around the periphery of the opening 49 which is concentric with the boring tool and which is of slightly greater diameter than the larger bore of the shell, the plate 47 functioning as a stop.

The operation of the indicating type of apparatus illustrated in Figs. 1 to 5, is as follows: The shell 26 after being entirely filled with cast explosive material is inserted in the shell sleeve 13 from the top until the forward tapered portion of the shell is seated in the bearing 34. The shell sleeve 13 is first centered with respect to the path of reciprocation of the boring tool by means of screws 14, after which the shell is longitudinally adjusted into the proper position by turning the adjusting collar 32 so as either to raise or to lower the shell as required.

The cutting collar 27 is of substantially the same diameter as the smaller internal bore 31 of the shell and when it has been advanced to the plane defined by shoulder 28 only a very thin ring of explosive material is left adjacent the edge of the shoulder so that the ring of explosive material disposed around the cutting collar 27 in the larger portion 29 of the shell is easily withdrawn from the mouth of the shell and may even fall out due to its own weight when the cutting collar reaches the plane of the shoulder 28. Owing to the fact that the cutting collar 27 is of slightly smaller diameter than the smaller internal bore of the shell it does not make contact with the shoulder 28 and thereby a common cause of premature explosions during the boring process is eliminated and the sharp cutting edge of the cutting collar is not impaired. The cutting collar 27 is mounted on the shank of the boring tool 25 and is so disposed longitudinally of the boring tool that when the cutting collar reaches the plane of shoulder 28 the boring tool has advanced the proper distance into the portion of the shell of smaller diameter to bore a suitable recess for the detonator.

In initially adjusting the path of reciprocation of the boring tool and in determining the normal position of the indicating lever either one of the following methods is satisfactory. The first method comprises first making a normal mark on the scale 42 as indicated at 51, adjusting the shell 26 longitudinally until the lever arm stands at the normal position, and then by means of one or more trial borings adjust the stop collar 22 on the boring spindle 1 so that the cutting collar 27 can be advanced only to the plane of the shoulder 28. The other method comprises first adjusting the stop collar 22 into approximately the correct position, then longitudinally adjusting the shell to the proper position by means of collar 32, after making one or more trial borings, and finally making a mark on the indicating scale 42 at the end of the indicating lever which thereafter constitutes the normal indicating point.

Owing to the fact that the shell is supported by means of the tapered bearing around its forward end instead of by means of a stop engaging its forward edge, the space beneath the mouth of the shell is left comparatively open so that the material cut away by the boring tool can freely fall from the recess and be removed by the suction chamber 16 and suction pipe 17. Thus the accumulation of explosive material on the

usual support disposed beneath the shell is eliminated, thereby avoiding explosions resulting from blows upon this material upon the insertion of new shells into the apparatus. Moreover, no mounds can accumulate upon my shell support to give the shell a false height relative to the travel of the boring tool.

The operation of the modified apparatus illustrated in Fig. 6 is similar to that of the apparatus shown in the preceding figures in so far as the determination of the position of the stop collar 22 on the spindle 1 and the determination of the position of adjusting collar 32 on shell sleeve 13 is concerned. However, owing to the shell being supported at the lower edge instead of upon a bearing surface engaging its tapered forward portion, it is automatically brought to rest in the proper longitudinal position, after the parts have been properly adjusted, and the necessity of indicating mechanism is eliminated. The danger of an explosion resulting from borings accumulating on the plate 47 and being detonated by dropping a new shell upon them is avoided by making the opening 49 somewhat larger than the inner bore of the mouth of the shell and by providing suction apparatus for carrying away the borings as they are formed, and the shell is properly positioned longitudinally.

Although the above described modifications of apparatus, which have been selected for the purpose of illustration, comprise two simple forms, it is evident that the methods employed in connection with these modifications may be applied to other types of shells such as base-loaded shells, for example, and to other types of apparatus, as for example, rotating turrets wherein several shells may be placed in the turret and thereby be brought successively into alinement with the boring tool.

It is to be understood that it is not essential to the method and that the apparatus herein disclosed need not be operated in precisely the position shown in the drawings, that is, in precisely a vertical position, but is of utility when employed in any position wherein the opening in the shell is directed somewhat downwardly, that is, in any position other than a horizontal position and other than a position in which the base of the shell is lower than the mouth of the shell. In order broadly to recite a position other than the two last mentioned positions, I have employed the expression "a fixed path having a vertical component," meaning by this a path other than one disposed horizontally.

While in accordance with the patent statutes, the improved method has been illustrated by reciting in detail steps by which it may be carried out and in connection with apparatus by which it may be performed, it is to be understood that the details may be varied and that it may be carried out by other apparatus than that illustrated without departing from its spirit; it is not therefore, limited to the precise details recited nor to practice with the apparatus shown in the drawings, the invention being pointed out in the appended claims as required by the patent statutes.

What I claim is—

1. The method of forming a cavity in explosive contained in a shell, which consists in supporting the shell with its axis having a vertical component whereby the borings tend to drop away from the shell under the action of gravity, and having its lower end open, and removing explosive material to form the desired cavity by relatively moving a drill and the shell whereby the drill enters into the explosive from the lower end of the shell along a path having a vertical component and conveying the borings of explosive away from the vicinity of the shell and drill by suction.

2. The method of forming a cavity in explosive material contained in a shell having directly communicating bores of different diameters, which consists in boring out the explosive contained in the bore of larger diameter, on a diameter not greater than the diameter of the lesser bore.

3. The method of forming a cavity in explosive material contained in a shell having directly communicating bores of different diameters, which consists in boring out the explosive contained in the bore of larger diameter, on a diameter not greater than the diameter of the lesser bore and removing from the larger bore the remaining explosive.

4. The method of forming a cavity in explosive contained in a shell, which consists in relatively moving the shell and a drill whereby the drill is entered into the explosive and limiting the penetration of the drill by the end of the shell at its mouth.

5. The method of forming a cavity in explosive contained in a shell having bores of different diameters, which consists in boring out on different diameters the explosive contained in the different bores respectively, the boring of larger diameter being carried out simultaneously with a portion of the boring of smaller diameter.

6. The method of forming a cavity in explosive contained in a shell having bores of different diameters, which consists in boring out on different diameters the explosive contained in the different shell bores respectively, the boring of larger diameter being carried out simultaneously with a portion of the boring of smaller diameter, the diameter of the boring in the explosive of the smaller shell bore being less than the diameter of the boring in the explosive of the larger

shell bore and the latter boring being not greater in diameter than the smaller shell bore.

7. The method of forming a cavity in explosive cast in a shell having bores of different diameters, which consists in advancing boring cutters or drills in fixed longitudinal relationship into the said explosive, the said cutters or drills being of different diameters to form holes of different diameters in the different bores respectively, the hole of larger diameter in the larger shell bore being not greater than the lesser bore.

8. The method of forming a cavity in explosive cast in a shell having bores of different diameters, which consists in supporting the shell with its axis having a vertical component whereby borings released tend to drop away from the shell and having its lower end open, removing explosive material to form the desired cavity by advancing drills or cutters in longitudinally fixed relationship into the explosive from the lower end of the shell along a path having a vertical component, the said cutters or drills forming holes of different diameters and the hole in the larger bore being of a diameter not greater than the diameter of the smaller bore, and gaging the penetration of the drills or cutters into the explosive by reference to the forward end of the shell.

9. The method of forming a cavity in explosive contained in a shell which consists in supporting the shell with its axis having a vertical component, whereby explosive released tends to drop away from the shell, and having its lower end open, and removing explosive material to form the desired cavity by relatively moving the shell and drills or cutters of different diameters and in longitudinally fixed relationship, whereby the said drills or cutters enter into the explosive from the lower, open end of the shell along a path having a vertical component and the boring of large diameter is carried out simultaneously with a portion of the boring of smaller diameter.

10. The method of forming a cavity in explosive contained in a shell which consists in supporting the shell with its axis having a vertical component, whereby explosive released tends to drop away from the shell, and having its lower end open, removing explosive material to form the desired cavity by relatively moving the shell and drills or cutters of different diameters and in longitudinally fixed relationship, whereby the said drills or cutters enter into the explosive from the lower, open end of the shell along a path having a vertical component and the boring of larger diameter is carried out simultaneously with a portion of the boring of smaller diameter and conveying the borings of explosive away from the vicinity of the shell and drill by suction.

In testimony whereof I have signed this specification this 25th day of August 1917.

ULDRIC THOMPSON, JR.