Jan. 31, 1956 C W. MUSSER 2,732,897

METHOD OF AND APPARATUS FOR PERFORATING HOLLOW OBJECTS

Filed June 7, 1951 2 Sheets-Sheet 1

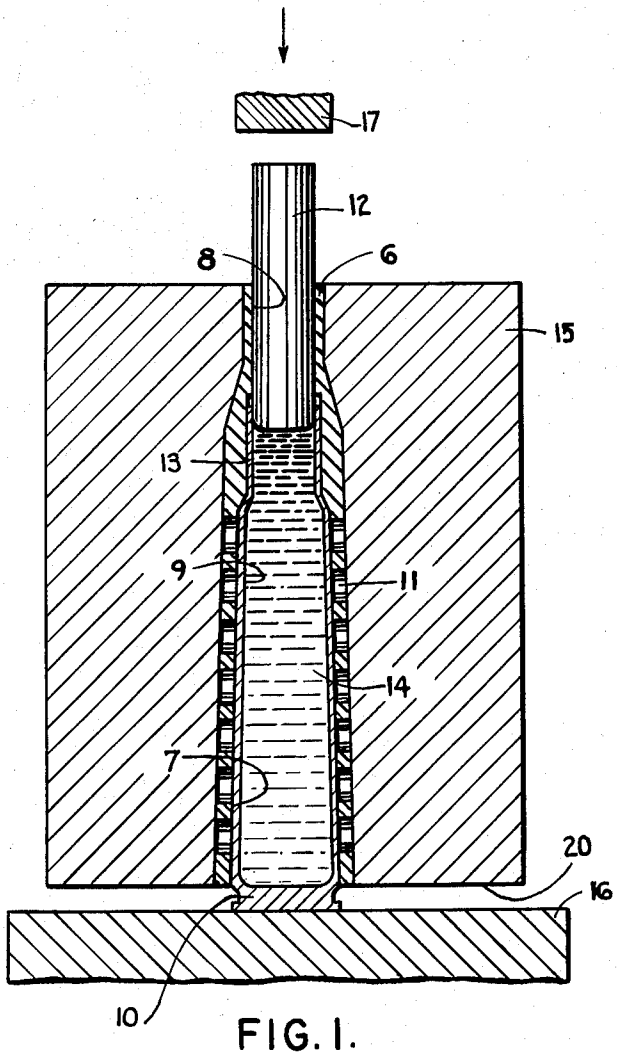


FIG. 1.

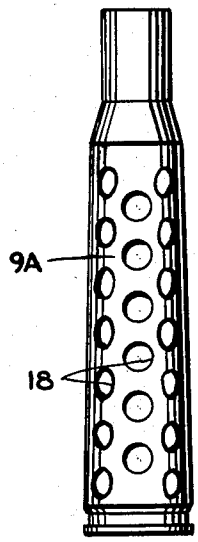


FIG. 2.

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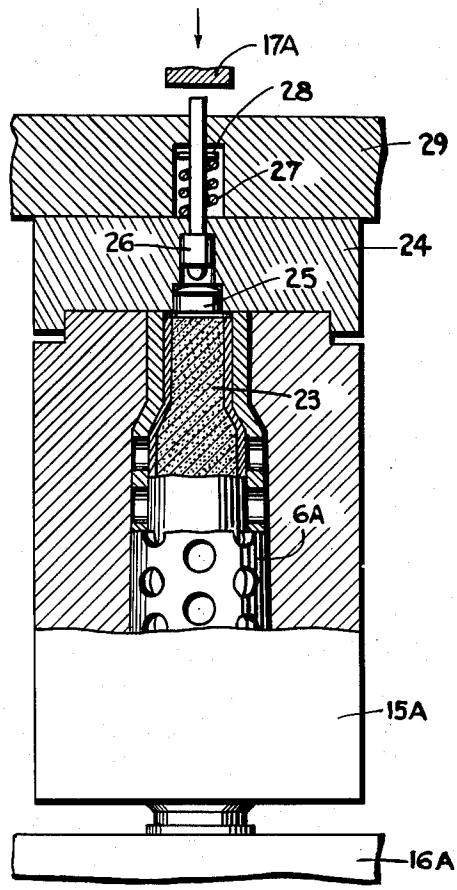


FIG. 3

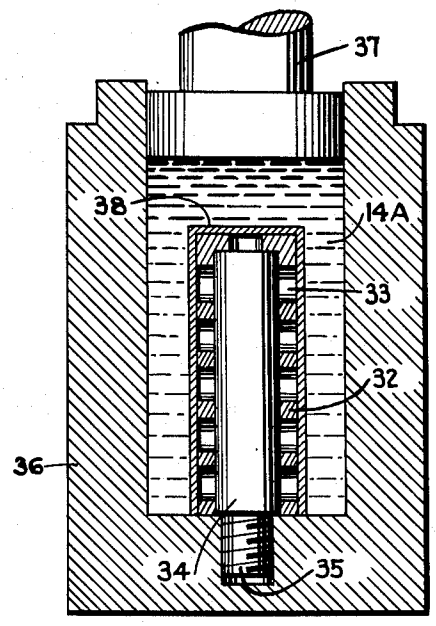


FIG. 4

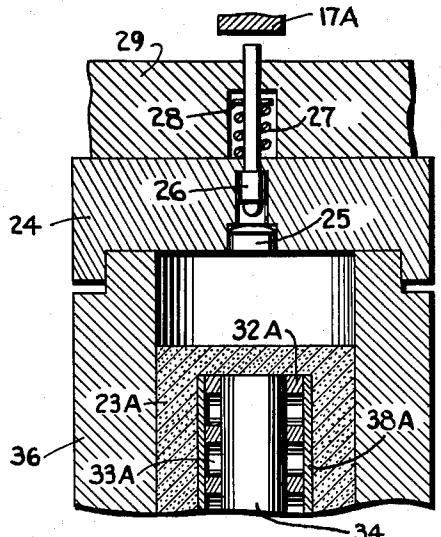


FIG. 5

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METHOD OF AND APPARATUS FOR PERFORATING HOLLOW OBJECTS

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Application June 7, 1951, Serial No. 230,360

6 Claims. (Cl. 164—90)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described in the specification and claims may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates broadly to the art of perforating hollow objects and, while not limited solely thereto, has special reference to perforating the tapered, cylindrical cartridge case wall of ammunition used in some recoiless firearms.

Ammunition of the type referred to in this description is exemplified in the following U. S. patents to W. J. Kroeger and C W. Musser: 2,466,714, "Recoilless Firearm and Ammunition Therefor," issued April 12, 1949; 2,472,111, "Recoilless Firearm and Ammunition Therefor," issued June 7, 1949; and 2,529,504, "Ammunition for Recoilless Firearms," issued November 14, 1950. Since the advent of these recoilless guns which use ammunition having a perforated cartridge case, there has been a great need for a method of and apparatus for quickly and satisfactorily accomplishing the perforating operation.

Those skilled in the mechanical arts realize that such work could be done in a variety of well-known ways employing a drill press, punch press, or similar type machine tool. However, such processes, if done with minimum conventional equipment, would be too slow; and, if done with maximum conventional equipment, would be too costly. Now, by means of my inventive method and apparatus, the perforating of cartridge cases, as well as numerous other objects, can be accomplished both quickly and economically, thus offsetting the disadvantages of existing prior art means.

My invention contemplates the use of rapidly applied, confined hydraulic or pneumatic pressure (applied either from inside or outside the object to be perforated) to accomplish multiple perforation of the object's wall in a substantially simultaneous manner.

In one form of my invention in which is used hydraulic pressure applied from inside the cartridge case, the cartridge case or other hollow object to be perforated is placed in a close-fitting sleeve or die fixture from which protrudes the case's head, or grooved end. The wall of the sleeve has accurately shaped and located openings therethrough which are arranged in the pattern it is desired to produce in the sidewall of the cartridge case. The sleeve, in turn, is placed in a close-fitting support block. A plunger is provided which slidably fits the mouth end of both the sleeve and the cartridge case in a substantially liquid-tight, piston-cylinder relationship. This plunger is designed so that a certain length thereof will always project from the mouth end of the sleeve a predetermined distance. Confined between the inner end of the plunger and the closed, head end of the cartridge case is a body of hydraulic fluid.

To perforate the cartridge case sidewall, pressure, preferably in the form of a sharp impact, such as that supplied by a drop hammer, is exerted upon the plunger

and the resultant force is transmitted to the body of hydraulic fluid. Because of the closeness of fit between the plunger and the sleeve, between the plunger and the cartridge case, between the cartridge case and the sleeve, and between the sleeve and the support block, and, further, because of the rapidity of action of the impact force, there is negligible, if any, leakage of the hydraulic fluid. When the pressure is great enough, those parts of the case's sidewall which are unsupported, because of the openings through the sleeve, are therefore punched out through those openings by one stroke of the plunger. In other words, the well-known punch-and-die action is simulated with the sleeve serving as the die while the role of the punch is efficiently assumed by the trapped hydraulic fluid under impact pressure. In this manner, the openings through the wall of the sleeve are reproduced in exact size and pattern through the wall of the cartridge case.

In another form of my invention in which is used pneumatic pressure applied from inside the cartridge case, an explosive powder is substituted for the hydraulic fluid, and the support means is fitted with a primer and a detonating means therefor. Subsequent ignition of the explosive powder generates sufficient force within the cartridge case to cause its perforation in a manner similar to that described above.

In cases where the shape of the object to be perforated lends itself to the insertion and removal of a mandrel, or like member, other forms of my invention are used in which the rapidly applied hydraulic or pneumatic pressure required to perforate the object is applied from outside the object, rather than from the inside as previously described.

In using externally applied hydraulic pressure, the object to be perforated is placed over a close-fitting die fixture having the required size, shape, and pattern of openings it is desired to duplicate in the wall of the object. The die fixture is then slidably positioned on a post which is secured, as by threads, in a container. The container next is filled with the necessary amount of a hydraulic fluid which is then subjected to a selected pressure from a plunger fitting inside the container in fluid-tight relationship. As before, those portions of the object's wall which are unsupported by the die fixture are perforated in accordance with the size, shape, and pattern of the openings in the die fixture.

In another form of my invention whereby I contemplate the use of an externally applied pneumatic pressure to perforate the wall of the hollow object, the object to be perforated is placed over a close-fitting die fixture having the required size, shape, and pattern of openings desired in the wall of the object. The die fixture is then slidably positioned on a post secured in the container. An explosive charge is placed in the container outside the object to be perforated, and the container is closed tightly by a lid which contains a primer mechanism. When the primer is detonated, in any convenient manner, its fire ignites the explosive charge. The resulting gas pressure produced is sufficient to perforate the wall of the object in accordance with the openings in the die fixture.

Having described the general purposes of my invention, and the means for accomplishing them, I will now discuss them in more specific detail.

One object of my invention is to provide a means for completely and simultaneously perforating a number of round or other shaped holes through the walls of cylindrical, or other shaped work pieces.

Another object is to provide a method of simultaneously multi-perforating cylindrical, or other objects, which utilizes pressure on a trapped fluid medium to furnish the shearing force required.

Yet another object is to provide a method of simultaneously multi-perforating cylindrical, or other objects, which utilizes pressure resulting from the ignition of trapped explosive, or like material, to furnish the shearing force required.

A further object is to provide a punch and die type combination for perforating in which the force normally supplied by the punch element is supplied by hydraulic or pneumatic pressure applied from inside or from outside the object to be perforated.

The foregoing and other objects and advantages of my invention will become apparent from an inspection of the following description and the accompanying drawings wherein:

Fig. 1 is a central, vertical section through one illustrative form of my inventive apparatus and a workpiece just prior to the perforation operation. This figure shows how a hydraulic fluid positioned within the workpiece may be adapted to furnish the pressure necessary to perforate the workpiece;

Fig. 2 is a view of the workpiece, in the form of a cartridge case, after the perforations have been made and the case removed from the Fig. 1 apparatus;

Fig. 3 is a modification of the Fig. 1 embodiment of my invention and shows how an explosive, or like material, positioned within the workpiece may be employed to supply the pneumatic pressure necessary to perforate the workpiece;

Fig. 4 is a view of another form of my invention showing how a hydraulic fluid outside the workpiece may be employed to produce the pressure necessary to perforate the workpiece; and

Fig. 5 is a modification of the Fig. 4 embodiment of my invention showing how an explosive, or like material, positioned outside the workpiece may be employed to supply the pneumatic pressure necessary to perforate a workpiece.

Perforation by means of internally applied hydraulic pressure

Fig. 1 shows that one form of my novel apparatus consists of a tubular sleeve **6** having concentric, axial recesses **7** and **8**. Recess **7** is shaped to accommodate the cartridge case **9** to be perforated in such a way that the closed, head end **10** of the case projects somewhat beyond the adjacent end of the sleeve. In the wall of sleeve **6** are a plurality of accurately sized and located openings **11** arranged in the pattern in which it is intended to perforate cartridge case **9**. Sleeve **6** will be seen to have close fitting contact with case **9** and therefore supports the case sidewall at all places except where there are openings through the sleeve.

Recess **8** slidably accommodates a plunger **12** in liquid-tight relationship with the sleeve. The plunger also has a similar slide fit, liquid-tight relationship with the mouth end **13** of the cartridge case. As Fig. 1 shows, the outer end of plunger **12** projects somewhat beyond the end of sleeve **6**.

Trapped between the plunger's inner end and the cartridge case's closed head end **10** is a body of hydraulic fluid **14** whose function will be explained later.

Sleeve **6** bearing cartridge case **9** is matingly accommodated in a support block **15** in such a way that the case's head end **10** projects beyond the block's base end **20**. Thus, the wall of sleeve **6** is supported by block **15** which possesses a sufficient amount of the bulk and strength needed safely to withstand the pressure generated within the apparatus during the perforating operation.

My apparatus is, for purposes of illustration only, shown associated with the bolster plate **16** and the drop hammer **17** such as are commonly employed on a forging machine or like apparatus. Since such machines are well known, only the named essential parts thereof are shown.

In the operation of this form of my invention, the cartridge case **9** to be perforated is filled almost to its top with hydraulic fluid **14** and then placed inside sleeve **6**. The sleeve with its contained case is then placed in support block **15**. The case, sleeve, and support block are then placed upon bolster plate **16** of the representative forging type machine. Plunger **12** is inserted into the sleeve and the aligned cartridge case neck until it rests atop hydraulic fluid **14**.

When the forging machine (not shown) is operated, hammer **17** approaches and strikes plunger **12**. Impact energy from the moving hammer is transmitted, by means of the plunger, to the trapped hydraulic fluid **14**. Because of the practically incompressible nature of the fluid, the pressure, in turn, is exerted against the sidewall of the cartridge case. When the pressure is great enough, the wall portions of the cartridge case which are unsupported by the sleeve because of openings **11** therein are punched out by the fluid. The punched-out slugs (not shown) are pushed by the hydraulic fluid through openings **11** in sleeve **6** and against the unyielding support block **15**.

It can easily be realized that with the proper amount of energy supplied by the hammer, enough energy can be generated to perforate all the holes in the cartridge case by one stroke of hammer **17**.

As hammer **17** ascends at the completion of the perforating operation, the finished case **9A** and the slugs (not shown) are removed from the apparatus and the operation is repeated. Fig. 2 shows the representative cartridge case **9A** after perforation by means of my novel method and apparatus. Holes **18** of required size, shape, and in proper location have been produced in the case's sidewall in conformity with the size and location of openings **11** in sleeve **6**.

Perforation by means of internally applied pneumatic pressure

In order to perforate the cartridge case by the means of an internally applied pneumatic pressure, I provide the sleeve and support block arrangement referred to above, but, in place of the hydraulic fluid, use is made of an explosive material **23** (see Fig. 3). As there shown, the support block **15A** is provided with a lid **24**. This lid contains a recess which accommodates a percussion primer **25** and a firing pin **26**, and is positioned atop support block **15A** so that the primer is in alignment with the explosive charge contained within the cartridge case to be perforated. As Fig. 3 shows, the firing pin is constantly urged away from the percussion primer by means of a coil spring **27** which exerts pressure against a pin **28** transfixing the firing pin.

Lid **24** is urged in any convenient manner, as by pressure plate **29**, against support block **15A** so as to effect a sealing relationship between that plate and the support block. To aid this sealing relationship, the cartridge case to be perforated rests upon a companion pressure plate **16A**.

In the operation of this form of my invention, a sharp blow from the hammer-like member **17A** is delivered to the firing pin. The firing pin is moved down to strike percussion primer **25**. Fire from the primer ignites the main explosive charge **23** located within the cartridge case. The force generated by this ignition generates sufficient pressure within the cartridge case to cause perforation of its sidewall in a manner similar to that already described.

Perforation by means of externally applied hydraulic pressure

Embodiments of my invention using externally applied hydraulic and pneumatic pressure are respectively shown in Figs. 4 and 5.

In the Fig. 4 embodiment, the object **38** to be perforated is placed over a close-fitting die fixture **32** having

the required size, shape, and pattern of openings 33 which are to be duplicated in the wall of object 38. The die fixture is then slidably positioned on a post 34 which is secured, as by threads 35, in a container 36. The container is then filled the necessary amount with a hydraulic fluid 14A which is then subjected to a selected impact pressure from a plunger 37 fitting inside the container in fluid-tight relationship. As before, those portions of the object's wall which are unsupported by the die fixture will be perforated in accordance with the size, shape, and pattern of the openings in the die fixture. Slugs (not shown) resulting from the perforating operation will be pushed into the openings in the die fixture from which they can subsequently be easily removed. If the force is applied with sufficient rapidity, post 34 referred to in this illustrative form of my invention may be eliminated, in which case the die fixture would be secured to the container in any convenient manner as by threads (not shown). The fact that the die fixture is hollow would enable the slugs resulting from the perforating operation to be easily removed.

Perforation by means of externally applied pneumatic pressure

In this form of my invention (see Fig. 5), the object 38A to be perforated is placed over a close-fitting die fixture 32A having the required size, shape, and location of openings 33A desired in the wall of the object. The die fixture is then slidably positioned on post 34 secured in chamber 36, and an explosive charge 23A is placed in the chamber outside the object to be perforated. The lid 24 and pressure plate 29 combination, earlier described in connection with Fig. 3, is placed in sealing relationship over chamber 36, and the explosive charge is ignited, as earlier explained, by hammer 17A striking firing pin 26. Gas pressure resulting from ignition of the explosive charge is sufficient to cause perforation of the wall of the object in conformity with openings 33A in die fixture 32A. As mentioned above in connection with perforation by means of externally applied hydraulic pressure, post 34 in this embodiment could also be eliminated, if desired, and the die fixture secured to the container.

Conclusions

My inventive method of and apparatus for perforating, of course, need not be restricted to use in the production of cartridge cases. Indeed, the application of my invention is quite adaptable in numerous other instances. For example, it would be quite advantageous in perforating irregularly shaped objects, or objects in which the axes of the perforations were at random angles to the object or to each other. Such cases may require the use of multiple sleeves, or of sleeves split in the fashion of molds, but the principle herein disclosed would nevertheless be the same.

It is understandable, too, that means other than a forging, or similar machine may be provided for quickly exerting the required force upon the plunger or firing pin. For example, the plunger or firing pin could receive energy generated by explosives or as a result of action similar to that found in the cylinder of an internal combustion engine.

From the foregoing, it will be seen that I have provided a means for completely and simultaneously perforating a number of round or other shaped holes through the walls of hollow, cylindrical and other shaped workpieces; that I have provided a method of simultaneously multiperforating cylindrical, and other objects, which utilizes pressure on a trapped fluid medium or pressure resulting from detonation of a trapped explosive to furnish the shearing force required; and, that I have provided a punch and die type combination for perforating in which the force normally supplied by the punch element is supplied by hydraulic or pneumatic pressure applied from inside or from outside the object to be perforated.

The above description should make it obvious to those skilled in the art to which this invention relates, or to which it is most nearly associated, that many variations and modifications of my novel method and apparatus could be made without departing from their original spirit and scope. I, therefore, do not wish to be limited by the narrow confines as presented by this merely illustrative presentation, but rather by the scope of the appended claims.

I claim:

1. Apparatus for perforating the wall of a hollow, substantially inelastic and non-flexible metallic object comprising a die fixture in snug fitting and relatively unyielding supporting relationship to the outside surface of the wall of said object and having openings of required size, shape and location, solid explosive means disposed within said object in contact with the inner surface of the wall thereof, said explosive means filling a major portion of said object for use when ignited instantaneously to exert sufficient gaseous pressure directly and with high velocity on said wall thereby to perforate said wall in conformity with the openings in said die fixture, and means to ignite said solid explosive means.

2. Apparatus for perforating the wall of a hollow, substantially inelastic and non-flexible metallic object comprising a die fixture in snug fitting and relatively unyieldingly supporting relation to one side of the wall of said object and having openings of required size, shape and location, means together with portions of the object providing a closed chamber on the opposite side of the wall of the object adjacent to the area thereof to be perforated, solid explosive means disposed within and substantially filling said chamber for use when ignited instantaneously to exert sufficient gaseous pressure directly and with high velocity on said opposite side thereby to perforate the object in conformity with the openings in said die fixture, and means to ignite said solid explosive means.

3. In apparatus for perforating the sidewall of a hollow substantially inelastic and non-flexible metallic object, the object's sidewall having an opening therethrough communicating with the hollow interior, the combination of a sleeve fitting around and relatively unyieldingly supporting the sidewall of said object and having lateral openings of required size, shape and location, an explosive charge filling a major portion of said hollow object adjacent the wall area to be perforated, a lid sealing the opening into said hollow object, and primer means to ignite said explosive charge thereby to generate sufficient pneumatic pressure within said hollow object so as to act with high velocity upon and thereby perforate its sidewall according to the size, shape and location of said lateral openings in said sleeve.

4. In perforating apparatus, the combination with a hollow, substantially inelastic and non-flexible metallic object of a sleeve fitting around and relatively unyieldingly supporting the sidewall of said object and having lateral openings of required size, shape and location, said sidewall having an opening therethrough communicating with the hollow interior of said object, an explosive charge filling a major portion of said hollow object adjacent the wall to be perforated, a rigid support block surrounding and unyieldingly supporting the lateral surface of said sleeve, a lid fitting said support block and sealing the opening into said hollow object, a percussion primer in said lid to ignite said explosive charge, a firing pin movably mounted in said lid for detonating said percussion primer, and a hammer in striking relation to said firing pin whereby to detonate said percussion primer to cause ignition of said explosive charge and thereby to generate sufficient pneumatic pressure within said hollow object so as to act with high velocity upon

and thereby perforate its sidewall according to the lateral openings in said sleeve.

5. In apparatus for perforating the wall of a hollow, substantially inelastic and non-flexible metallic object by means of an externally applied pneumatic pressure, the combination of means providing a chamber and having an opening thereinto, a die fixture supported in said chamber for snugly fitting the inside wall of the hollow object and having recesses therein of the size, shape and arrangement desired to be duplicated in the wall of the hollow object, an explosive charge filling a major portion of said chamber and surrounding the hollow object, means sealing said chamber means opening, and primer means for igniting said explosive charge, whereby sufficient pneumatic pressure is generated in response to igniting said primer means and applied externally to the hollow object to perforate those portions of the hollow object's wall in accordance with said die fixture openings.

6. In apparatus for perforating the wall of a hollow, substantially inelastic and non-flexible metallic object by means of an externally applied pneumatic pressure, the combination of a hollow container having an opening through a wall thereof, a sleeve-like die fixture supported within said container for snugly fitting the inside wall of the hollow object and having openings therein of the size, shape and arrangement desired to be duplicated in the wall of the hollow object, an explosive charge filling a major portion of said container and surrounding the hollow object, cover means on said container for sealing said container opening, a percussion primer carried by said cover means for igniting said explosive charge, and mechanical means carried by said cover means disposed for engagement with said percussion primer for detonation thereof, whereby ignition of said explosive charge will generate and apply sufficient pneumatic pressure externally to the hollow object and perforate the wall thereof in conformity with the openings in said sleeve-like die fixture.

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