PROCESS FOR THE PRODUCTION OF EXPLOSIVE DEVICES SURROUNDED BY A CASE

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ABSTRACT
A process for the production of explosive devices surrounded by a case wherein an explosive charge is placed in a matrix mold and a pressing tool is moved in one direction of the mold to apply a force to one of mutually opposite end portions of the explosive device formed by the pressing operation. Subsequently, the explosive device is placed in a case having an open end with the other mutually opposite end portion proximate to the open end. A pressing tool is then moved to apply a force to the other mutually opposite end portion of the explosive device such that in the two pressing operations, a pressing tool is effective on the mutually opposite end portions to provide the explosive device with a uniform density. The process also includes the press molding of a detonation inhibiting barrier within the case prior to placing the explosive within the case and subsequently sealing the open end of the case with a sealing member.

14 Claims, 4 Drawing Figures
PROCESS FOR THE PRODUCTION OF EXPLOSIVE DEVICES SURROUNDED BY A CASE

This invention relates to a process for the production of explosive devices surrounded by a case, wherein the explosive is molded by means of pressure with a molding tool within the case which is open on one side.

In explosive devices, particularly hollow-charge elements, it is often important to obtain a high penetration effect at a minimum weight. The basic prerequisite for a high penetration effect in a hollow charge is that the detonation progresses exactly concentrically in radial zones with a maximally high detonation velocity. In order to obtain this objective, the metallic parts must be very accurately machined and the initiation must take place in the center. Furthermore, the proportion of the charge which is a high explosive, as well as the density thereof, must be maximally high. Also, the density must be uniform, and, in particular, no air gaps must be present which could cause the detonation front to become nonuniform.

A conventional process for the manufacture of hollow explosive charges resides in casting the explosive into the case provided for this purpose which process is economical. Since an explosive which lends itself to casting has a low detonation velocity, it is possible to admix thereto up to 60% by weight of high explosive. For high-efficiency charges, special casting procedures are employed which make it possible to cast explosive charge elements having 70–80 percent by weight of high explosive. However, these special processes are unsuitable for mass production purposes. Consequently, cast hollow charge devices normally contain a relatively low proportion of high explosive. Therefore, they have a minor density and a low detonation velocity with a correspondingly poor penetration effect. Highly sophisticated casting methods, which make it possible to produce hollow explosive charges having a higher penetrating power are, however, uneconomical. Furthermore, it is necessary in case of cast hollow charges to cement the charges subsequently into the cases. The charges lose a part of their efficiency when exposed to variations in temperature. A disadvantage which generally occurs during casting resides in that large amounts of explosive must always be provided in the batch being processed and this represents an increased danger during manufacture.

Pressing methods are also known for the production of hollow explosive charges having a high penetration. By means of these methods, it is possible to utilize up to 97 percent by weight of high explosive. Basically, two pressing methods are utilized:

1. Bilateral pressing operation in a special mold with subsequently cementing the product into the case; and
2. Direct pressing operation conducted in the case by means of a press punch.

The former procedure is the one employed customarily. In this method, there is the danger that air gaps between the case and the hollow charge will interfere with the progression of the detonation and will reduce the stability during firing shock and transport vibrations, where crack formation can occur. Furthermore, it is very difficult to center the explosive charge accurately within the case.

The latter procedure is employed primarily for the production of small hollow charges, for example for the manufacture of initiation charges for blast furnaces.

However, these do not involve high-efficiency charges. Starting with a certain size, a high density difference occurs within the structure of the explosive.

It is therefore an object of this invention to provide a process for the manufacture of explosive devices wherein the proportion of high explosive can be made large and which makes an exact manufacture possible without the danger of crack formation and density variations, together with accurate centering.

This object is attained, in accordance with this invention, by executing, prior to the pressing operation within the case, an additional preliminary pressing operation in a matrix mold, wherein the explosive is exposed to pressure from the side which, during the subsequent pressing operation within the case, is in opposition to the open side of the case, in such a manner that, in both pressing operations, the moving pressing tool is effective on mutually opposite points of the explosive device.

In the process, in accordance with the present invention, the proportion of high explosive can be 95–97 percent by weight. Since the manufacturing procedure takes place in an accurate tool, any asymmetry or air gaps are avoided. The pressing operation takes place in two successive operating steps from different sides, so that the density of the thus-produced explosive device is extraordinarily uniform. Since the second pressing step is effected directly in the case, the explosive charge firmly contacts the case and is extremely resistant to external influences and the charge is exactly centered.

The process of this invention can also be employed for the production of hollow explosive charges with detonation wave control. In such hollow explosive charges, an inert body is arranged in the zone of the primer, surrounded by an annular charge. This makes it possible for the ignition to be transmitted annularly and thus uniformly from the outside to the hollow explosive charge. In order to manufacture such explosive devices, the provision is made according to the invention to incorporate by pressing into the case a detonation-inhibiting barrier surrounded by an annular charge, before the explosive is inserted in the case. The barrier can be centered by means of a centering pin extended through the ignition opening of the case. This initial operating step is followed by pressing the explosive charge, already preliminarily pressed in the mold, within the case.

These and further objects, features and advantages of the present invention will become more obvious from the following description when taken in connection with the accompanying drawings which show, for purposes of illustration only, several embodiments in accordance with the present invention, and wherein:

FIG. 1 shows the first pressing operation in the matrix mold during the production of a simple hollow explosive charge, and
FIG. 2 shows the second pressing operation in the case.

FIG. 3 shows the additional process step when manufacturing a hollow explosive charge with controlled guidance of the detonation wave, and
FIG. 4 shows the subsequent pressing of the already preliminarily pressed hollow explosive charge within the case.

In the production of a simple hollow explosive charge without control of the detonation wave, according to FIGS. 1 and 2, the explosive 3 is first introduced into a
matrix 2 fashioned as hollow cylinder. From below, the conically shaped lower forming die 4 of the pressing tool is inserted. After the exactly dimensioned quantity of explosive has been fed into the matrix, a pressure is exerted from above on the explosive 3 by means of the upper forming die 1 of the pressing tool. The matrix 2, as well as the lower die 4, retain their position, while only the upper die 1 is being moved. This results in the density distribution as indicated in FIG. 1, wherein the greatest explosive density occurs in the proximity of the upper die, whereas the pressure effect is increasingly reduced in the downward direction.

After the termination of the first pressing step, the second pressing operation is executed in accordance with FIG. 2. For this purpose, the explosive, now already molded into an explosive device 3', is inserted in the projectile case 5. The projectile case 5 consists of a tubular sleeve closed off at its lower end face, or merely having an opening 6 for the insertion of a primer while it is completely open at its upper end face.

The explosive device 3' is inserted in the projectile case 5 in such a manner that the conical recess 7, produced during the first pressing step by the bottom die 4, now opens toward the top. The explosive device 3' is thus inserted as compared to the first pressing step. After introduction into the projectile case 5, a copper funnel 8 is inserted in the conical recess 7; this funnel sealingly closes off the projectile case 5 after the projectile has been completed.

In this process step, a somewhat wider, tubular matrix 2' is used than in the first process step, because the projectile case 5 is an additional component of the press mold. Also the lower die 4' has a different shape in this figure. At its upper side 6, the die 4' is matched to the configuration of the lower end face of the projectile case 5 and fully supports the projectile case 5.

During the second pressing step, the conical tip of the top die 1' is pressed from above against the copper funnel 8 and thus compresses the explosive device 3'. The latter is compacted primarily in the funnel zone during this operation, so that the finished charge in total has a uniformly high density. During this subsequent compression, firm contact is also established among the molded charge, the projectile case, and the funnel.

What is known as a hollow explosive charge with controlled guidance of the detonation wave by means of an inserted barrier, the first pressing step according to FIG. 1 is the same as described in the previous embodiment. However, prior to executing the second pressing step, as shown in FIG. 3, the projectile case 5'' receives a prefabricated explosive device 9, together with a barrier 10. Instead of using a prefabricated explosive device, i.e. one which has been compacted in a special pressing operation, it is also possible depending on the particular circumstances to introduce the explosive in pulverized form into the projectile case 5'' and compressing the explosive, as in FIG. 3, together with the barrier 10 superficially embedded therein, only within the case by means of the cylindrical top die 1''. As shown in FIG. 3, the barrier 10 is centered by means of a centering pin 11 inserted from below through the ignition or primer opening of the projectile case 5''.

According to FIG. 4, the preliminarily compressed explosive device 3' and funnel 8 are inserted in the projectile case 5'' and a pressing step similar to the step of FIG. 2 is carried out. That is preliminarily compressed explosive device 3' is pressed from the funnel side by means of the movable die 1'.

Several examples of the process will be explained in greater detail below.

EXAMPLE 1
A hollow explosive charge produced according to the process of this invention, with a diameter of the explosive of 64 mm. and made up of a mixture of 295 g. of cyclonite as the high explosive and 15 g. of wax for stabilization, wherein the cyclonite has a grain size distribution, according to a screening analysis, of 18 percent by weight with 0.75 - 0.5 mm., 60 percent by weight with 0.5 - 0.3 mm., and 22 percent by weight with 0.3 - 0.15 mm., was subjected to a blasting experiment at a distance of 140 mm. from a homogenous steel block having a minimum tensile strength of 60 kp./mm² and resulted in an average penetration depth of 410 mm.

The charges produced in accordance with the pressung method of this invention exhibit a high and uniform density which is not impaired even by outside influences. This was L to be true by subjecting nine test charges to a destructive test to determine the density of the explosive; three of these charges were tested immediately after manufacturing, i.e. without being exposed to environmental influences, three were tested after a storage time of 7 days at 65°C., two after a storage time of 7 days at -4°C., and one charge was tested after being stressed by vibration and shock forces. The density was found to be 1,700 × 10.033 - 0.065 g/cm³. This value is very high and, in spite of high initial stressing of the test specimens, shows a relatively low range of variation resulting in uniform penetration effect.

EXAMPLE 2
The density of such a hollow charge can be further improved to a minor extent by a specific grain size selection for the explosive. Experiments with screened explosive having a maximum granular size of 0.37 mm. yielded, with the same charge structure and likewise 295 g. of cyclonite and 15 g. of wax, a penetration effect of, on the average 414 mm., demonstrating a small increase in the penetration effect. However, it is more advantageous for economical reasons to select the grain size distribution, according to Example 1, as it is obtained during the manufacture of the explosive.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It should therefore be understood that within the scope of the appended claims, the invention may be practices otherwise than as specifically described.

What is claimed is:
1. Process for the production of explosive devices surrounded by a case comprising the steps of placing an explosive charge in a matrix mold, moving a pressing tool in a first direction within the mold to apply a force to the explosive charge to compress the charge and form an explosive device of a predetermined shape with mutually opposite end portions, the pressing tool during the movement thereof applying the force to one of the mutually opposite end portions, placing the explosive device within a case having an open end such that the other mutually opposite end portion of the explosive device is arranged proximate thereto, and moving a pressing tool to apply a force to the other mutually opposite end portion of the explosive body within the case such that in the two pressing operations, a pressing tool is effective on the mutually opposite end portions of the explosive device to provide the explosive device with a uniform density.
2. A process according to claim 1, further comprising the step of press molding a detonation inhibiting barrier surrounded by an annular charge within the case prior to placing the explosive body within the case.

3. A process according to claim 2, wherein the case has an ignition opening in the end opposite the open end thereof and further comprising the step of extending a centering pin through the ignition opening of the case and centering the inhibiting barrier with the centering pin.

4. A process according to claim 1, further comprising the step of placing a sealing member in the case after placing the explosive device within the case and then moving the pressing tool against the sealing member to apply the force to the other mutually opposite end portion of the explosive device and seal the open end of the case.

5. A process according to claim 1, wherein the matrix mold is a tubular mold having one end portion closed by a conical member extending into the mold, and moving the pressing tool through the open end portion of the mold in the direction of the closed end portion.

6. A process according to claim 5, wherein the pressing tool has a flat end face and moving the flat end face into contact with the one mutually opposite end portion of the explosive device to provide the one mutually opposite end portion of the explosive device with a substantially flat end surface, the other mutually opposite end portion being provided with an end surface conforming to the conical member extending into the mold.

7. A process according to claim 6, wherein the pressing tool for movement into the case has a conical end surface conforming to the conical end surface of the explosive device and moving the conical end surface toward the conical end surface of the explosive device.

8. A process according to claim 7, further comprising the step of placing a conical sealing member conforming to the conical end surface of the explosive device in the case after placing the explosive device in the case and moving the pressing tool with the conical end surface against the sealing member to apply the force to the explosive device and to seal the open end of the case with the sealing member.

9. A process according to claim 8, further comprising prior to placing the explosive device in the case, press molding a detonation inhibiting barrier surrounded by an annular charge within the case.

10. A process according to claim 9, wherein the case has an ignition opening in the end opposite the open end thereof and further comprising the step of extending a centering pin through the ignition opening of the case and centering the inhibiting barrier with the centering pin.

11. A process according to claim 10, further comprising disposing the case within a mold prior to placing the explosive device within the case.

12. A process according to claim 1, further comprising disposing the case within a mold prior to placing the explosive device within the case.

13. A process according to claim 1, comprising providing the explosive charge with a high proportion by weight of high explosive.

14. A process according to claim 1, comprising providing the explosive charge with a high proportion of high explosive in excess of 95 percent by weight.