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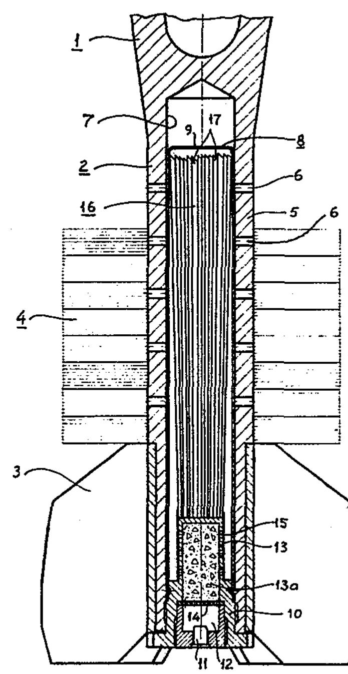
(54) **Propellant cartridge for a mortar projectile.**

(57) Propellant and ignition cartridge (8) designed to be enclosed in a cartridge tube (2) of a finned projectile (1). The walls (5) of the cartridge tube are provided with a number of through holes (6) so as to permit the outflow of powder gases from powder which has been ignited in the cartridge. The cartridge (8) has a casing (9) which is dimensioned so as to burst in the centre of the said holes (6). The powder consists of a group (16) of strips (17) which are held together in brush form. The pressure of the gases from the powder during a period of 0.5–3 ms, preferably 1–2 ms, after the said rupture of the casing (9) has taken place is greater than the «opening pressure» at which rupture takes place.



EP 0 090 155 A2

Propellant and ignition cartridge designed to be enclosed in a cartridge tube for a finned projectile

The present invention relates to a propellant and ignition cartridge designed to be enclosed in a cartridge tube for a finned projectile where the wall of the cartridge tube has a number of through holes so as to permit the outward flow of the powder gases from explosive powder ignited in the propellant cartridge.

Finned projectiles for mortars usually have a tail portion in the form of a cartridge tube which is surrounded by wings or stabilizing fins, and which encloses an ignition and propellant cartridge with suitable powder. Apart from this cartridge possibly a further quantity of powder is provided on the outside of the cartridge tube, usually in the form of a number of increment charges, of which some are often made up from thinner powder than the ramaining increment charges.

The cartridge tube is provided with a number of through holes to permit the exit of the powder gases. On the one hand the gases provide a propellant effect for the projectile, and secondly the requisite ignition impulse to any increment charges possibly present on the outside of the cartridge tube.

Hence the propellant cartridge has a double task, firstly to be a portion of the propellant charge, and secondly to be the ignition unit for the majority of the propellant charge. When the projectile is to be fired with the minimum charge, which can be solely the propellant cartridge, or the propellant cartridge and only one increment charge (that with the thinnest powder) it is essential that the propellant cartridge should provide complete uniform combustion of the powder charge in the barrel at the low pressure which is achieved with such a small charge. Generally the maximum pressure in the barrel in such cases is about 10 MPa.

Normally this performance on the part of the propellant cartridge at low charge has been achieved by combining two properties which contribute to uniform and rapid burning of the powder. A thin flake powder is used with dimension from 0.10 to 0.25 mm and the discharge holes made in the cartridge tube are blocked up so that the powder is well ignited before it is thrown out through the holes and it burns out finally at the lower pressure which prevails in the barrel. The thinner the powder, the less is the need for blocking up, and conversely. There are for example examples using extremely thin powder without any hole barriers at all. There are also embodiments having strong hole barriers made of board where the pressure can amount to 150-250 MPa in the cartridge tube before the powder and gases from the powder flow outwards.

These embodiments can be regarded as complying precisely with the requirements imposed on the propellant cartridge as regards giving a uniform propellant effect even at low charge. Problems arise with high charges, when the propellant cartridge is to function mainly as the ignition cartridge.

In order to ignite the partial charges placed around the cartridge tube, the hot gases flowing outwards from the system of holes are employed together with the powder particles which have been ignited but have not yet burnt out, which are normally flake powder in the form of flakes 1-3 mm square. The ignited powder in the propellant cartridge is subjected, on flowing outwards into the barrel where the volume is 10 times greater than that in the cartridge tube, to a considerable reduction in temperature and pressure which reduces its effect as the igniter impulse for the powder in the increment charge. The ignition impulse from the outflowing hot gases is very intensive but of short duration, usually less than 0.1 ms. Apart from the fact that this ignition impulse is of such short duration that ignition of the increment charges becomes less effective, the mechanical shock in the form of disintegration of the powder in the partial charge located nearest the holes is of considerable disadvantage, because this increases in uncontrolled fashion the total burning surface of the increment charge powder which is decisive for the continued combustion process.

This disintegration (crushing) of the increment charge powder as result of the high velocity and considerable mass per unit time of the outflowing gases, which is concentrated in the partial charge powder close to the cartridge tube holes, is particularly great, because the mechanical strength of the increment charge powder deteriorates as a result for example of cooling. The crushing is furthermore particularly serious and difficult to cope with if the increment charge powder has a relatively large minimum dimension. In other words, the coarser the powder in the increment charges, the more critical is the crushing of a portion of the charge. For known reasons it can often be advisable to choose relatively coarse powder in the increment charges for mortar systems if long ranges are required (high exit velocities), whilst maintaining the maximum barrel pressure relatively low.

Consequently the aim of the present invention is to present a propellant and ignition cartridge of the type specified on the preamble which provides uniform, fast and reliable combusion of the powder in the cartridge, and, in case of the provision of increment changes, without crushing of the increment charge powder taking place. This objective is achieved in that the propellant and ignition cartridge in accordance with the invention has the characteristics of claim 1.

Further developments of the invention are described in the subclaims.

The invention will be described in greater detail in the following by reference to the appended drawings which illustrate a preferred embodiment of the invention.

Figure 1 shows a longitudinal section through the rear portion of a mortar shell having a propellant and ignition cartridge in accordance with the invention. Figure 2 shows on an enlarged scale a longitudinal section through a propellant and ignition cartridge in accordance with the invention. Figure 3 illustrates the pressure in the propellant cartridge as a function of time, firstly with a known propellant cartridge, and secondly for two different cartridges in accordance with the invention.

Figure 1 illustrates the rear portion of a finned projectile in the form of a mortar shell 1 with a tail portion in the form of an essentially hollow-cylindrical cartridge tube 2 which is open at the rear. The rearmost portion of the cartridge tube 2 is surrounded by conventional guide fins 3 whilst its frontal portion is surrounded by eight sections of ring-shaped conventional increment charges 4. The wall section 5 of the cartridge tube 2 located inside and somewhat forward of the increment charges has a plurality of through holes so as to permit the outward flow of the powder gases from a propellant and ignition cartridge 8 which is situationed in the hollow cylindrical space 7 of the cartridge tube.

The propellant and ignition cartridge 8 includes a hollow cylindrical casing 9, open at the rear, the rear open end of which is attached over an ignition screw 10 which can be threaded into the cartridge tube 2.

The ignition screw 10 is provided with a conventional detonator 11 having a chamber 12 for expansion of the detonator gases. In front of the chamber 12 an ignition container 13 is provided, the ignition charge 13a of which, e.g. black powder or a pyrotechnic charge, communicates with the chamber 12 by means of holes 14 in the rear wall of the ignition container 13. The ignition container 13 has a plurality of radially-directed holes 15 which open out in the interior of the propellant and ignition cartridge 8.

One end of a batch 16 of extended powder strips 17 rests against the forward face of the ignition container 13. As indicated best in the embodiment shown in Figure 2, close to its rear end the strips 17 are held together by a clamp 18. By this means the batch of strips 16 exhibits a brush-like appearance, so that a ring-shaped space 19 which tapers at the front is formed between the batch 16 and the wall of the cartridge 8.

On ignition of the ignition charge 13a via the detonator 11 the gas and particles from the ignition charge 13a are led out into the ring-shaped space 19 and flow around and into the batch of strips 16 and ignite this.

By means of the arrangement described a uniform, rapid and reliable combustion is achieved, whilst at the same time it is prevented that any major portion of the powder is thrown out through the hole 6 in the cartridge tube 2.

The powder strips 17 extend over a major portion of the length of the cartridge casing 9, preferably over at least 75 % thereof. With the embodiment illustrated in Figures 1-2, the strips 17 extend from the forward end of the ignition container 13 mainly up to the forward end of the cartridge casing 9. The width of the strips 17 is preferably 0.4-0.9 times the diameter of the casing 9. The thickness of the strips which can be 0.3-1.0 mm is governed by the desired combustion duration. With this powder form extremely stable and uniform charge density is obtained over the entire length of the cartridge. These properties are accentuated if the strips 17 are held together in a batch, as shown for example at 18 in Figure 2. In accordance with an embodiment which is not illustrated the strips 17 can be sub-divided into several separate batches which are held together.

The casing 9 preferably comprises a thin metal plate, preferably aluminium tube. The thickness of the casing 9 is matched to suit the area of the individual exit flow holes 6, so that the opening of the holes 6 (stampings in the plate) takes place at an internal pressure which is suitable from the functional viewpoint.

The number of holes 6 is governed by the fact that the total hole area (total exit flow area) in relation to the total exposed surface available for combustion of the powder in the propellant cartridge is to provide the relationship between the burning powder surface and the discharge area which together with the combustion properties of the powder govern the "stagnation pressure" which is defined by the following equation:

$P = K_D \cdot Z \cdot r$, where

$$KD = \frac{A_{BR}}{A_M},$$

A_{BR} = total powder surface,
A_M = total discharge area for combustion gases,
Z and r = properties of the powder.

The stagnation pressure must be higher than the pressure at which the system of holes opens. This means that only a small portion of the powder in the propellant cartridge burns to provide the opening pressure. After the opening pressure has been achieved, the majority of the powder in the cartridge tube burns and the gases flow outwards during a period of time which can be selected so that the requisite, but not harmful, speed is obtained. This is appropriately 0.5-3 ms, preferably 1-2 ms calculated from the time when the holes open until the pressure in the cartridge tube has again dropped to the hole opening pressure after passage of the stagnation pressure (pressure peak). This time curve is obtained if the holes 6 of the cartridge tube, the casing 9 and the powder strips 17 are dimensioned as specified above.

The opening pressure should be selected at so high a level that the powder in the cartridge is sufficiently over ignited, but not so high that the shock of opening extensively crushes the partial charge powder located outside.

The opening pressure can, dependent on the various applications, be selected between 10-50 MPa and preferable be 20-40 MPa.

Hence the following elements in the system govern the results and are controllable:
Amount of powder
Minimim dimension (thickness)
Total exposed powder surface
Density of the powder
Combusion velocity of the powder and the powder factor

Hole diameter
Number of holes
Thickness and material quality in the tube.

Because, with this system, nearly all the powder in the propellant cartridge is guaranteed to be burnt in the cartridge tube, an increased ignition effect is obtained as compare with other methods. Because the discharge flow is increase in duration, this improves the ignition effect and particularly it reduces the harmful crushing effect involved in previous embodiments due to the extremely fast flow of the entire charge of the propellant cartridge in the form of gas and unburnt powder.

Figure 3 illustrates comparative tests using conventional propellant cartridges and propellant cartridges in accordance with the present invention. The curve A shows the pressure in a propellant cartridge with flake powder as a function of time, whilst curves B and C show the pressure as a function of time for two propellant cartridges in accordance with the invention with varying thickness for the powder strips. P and U denote the stagnation pressure and the opening pressure respectively.

Claims

1. Propellant and ignition cartridge (8) designed to be enclosed in a cartridge tube (2) of a finned projectile (1), where the walls (5) of the cartridge tube have a number of through holes (6) so as to permit the outward flow of powder gases from powder which has been ignited in the cartridge, c h a r a c t e r i s e d firstly in that the cartridge (8) has a casing (9) which is dimensioned so that at a predetermined pressure on the part of the said cartridge gases it will burst in the centre of the said holes (6), and secondly that the powder consists of a plurality of extended powder strips (17) which are orientated mainly in the lengthwise direction of the cartridge.

2. Cartridge as claimed in claim 1, c h a r a c t e r i s e d in that the strips (17) extend over a major portion of the length of the cartridge casing (9), preferably over at least 75 % thereof, and that the width of the strips (17) is 0.4-0.9 times the diameter of the cartridge casing (9).

3. Cartridge as claimed in any of the preceding claims, c h a r a c t e r i s e d in that the strips (17) are held together to form at least one group (16).

4. Cartridge as claimed in any of the preceding claims, c h a r a c t e r i s e d by means (18) for holding together, at least partially, the powder strips (17) against each other in the ends facing the ignition charge (13a), thereby providing a space (19) between the powder strips (17) and the casing (9) which is connected with the ignition charge (13a).

5. Cartridge as claimed in any of the preceding claims, c h a r a c - t e r i s e d in that the holes (6) of the cartridge tube (2), the casing (9) and the powder strips (17) are so dimensioned that the pressure of the gases from the powder in the cartridge tube (2) for a period of 0.5-3 ms, preferably 1-2 ms, after the said rupture of the casing (9) has taken place is greater than the "opening pressure" at which rupture takes place.

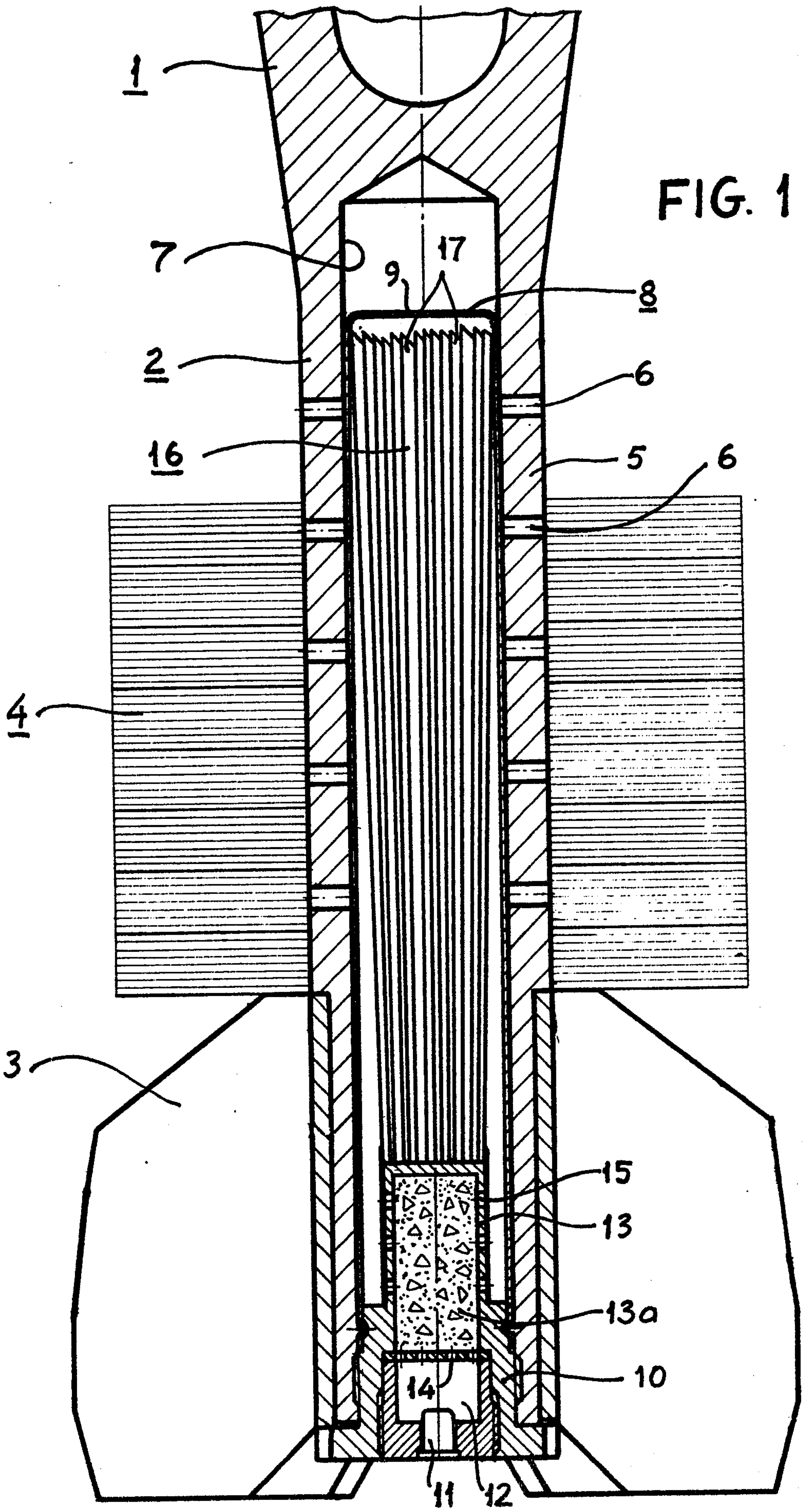


FIG. 1

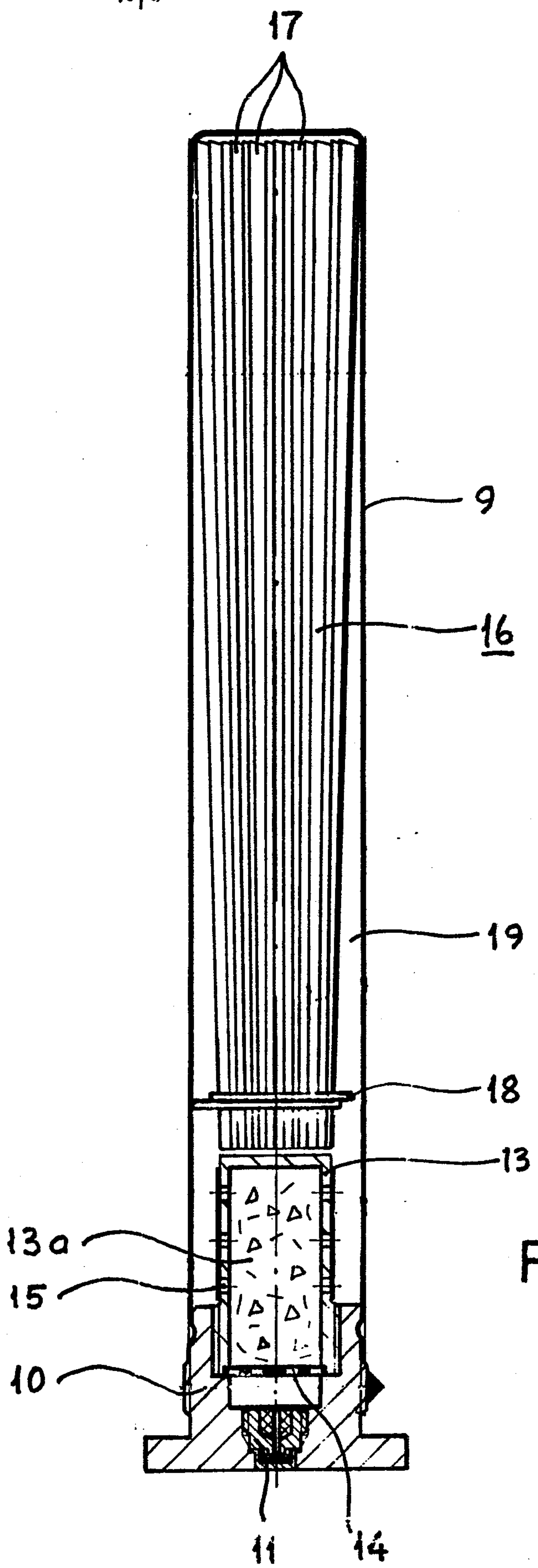


FIG. 2

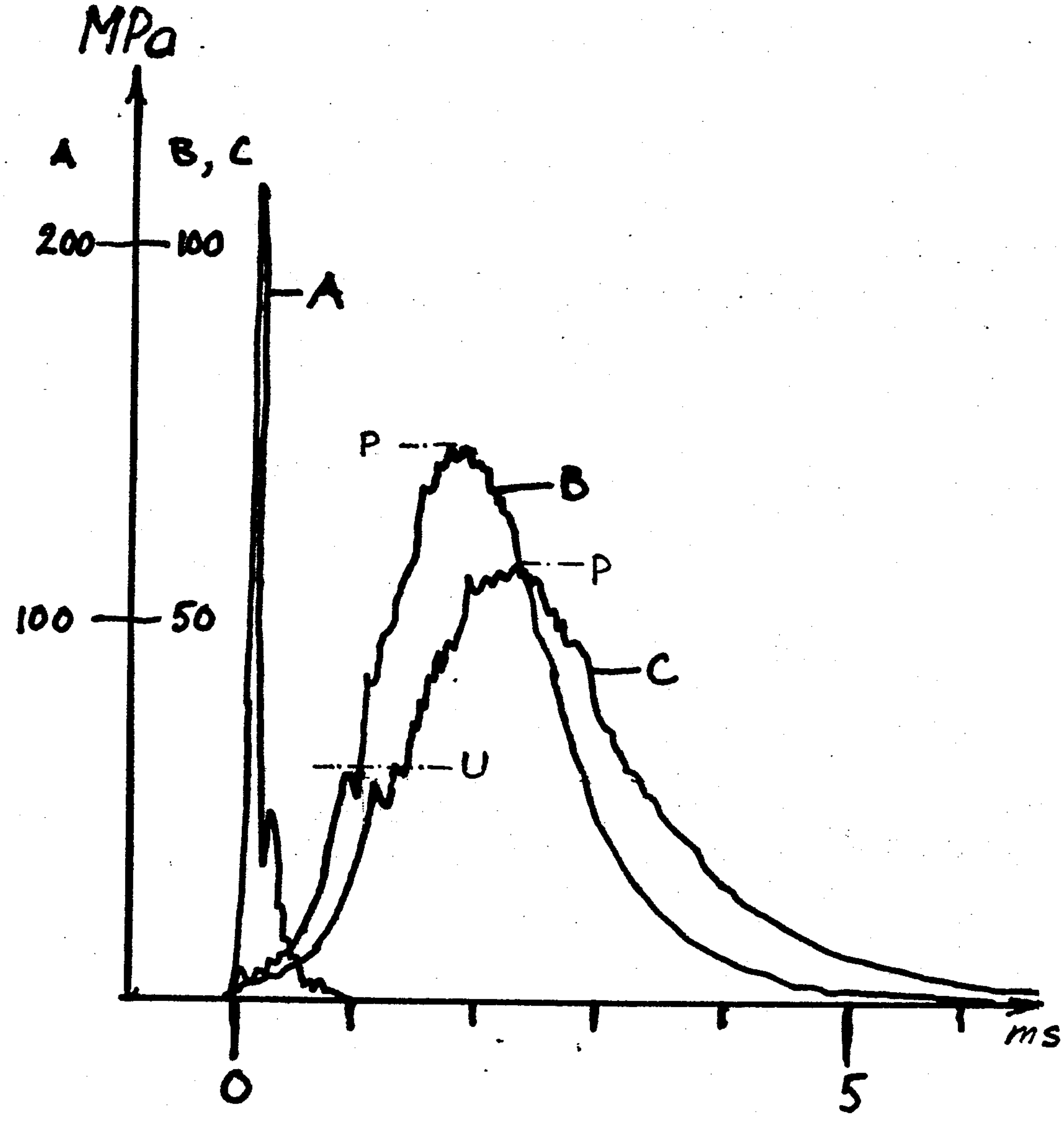


FIG. 3