Dec. 4, 1956 R. B. AITCHISON ET AL 2,772,632

BLASTING OF ROCK BODIES

Filed June 15, 1954

Fig. 1.

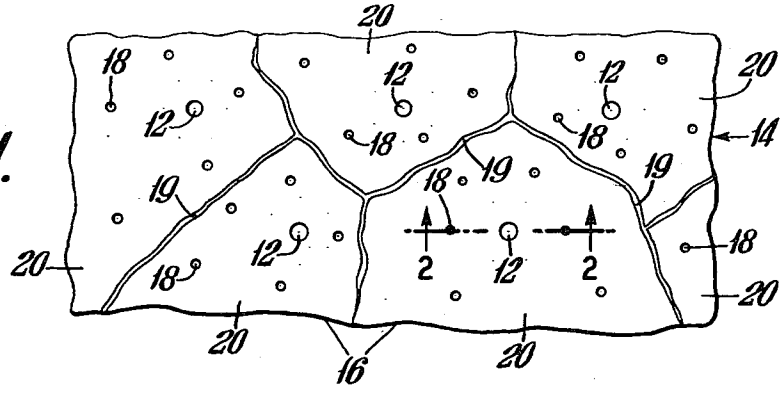


Fig. 2.

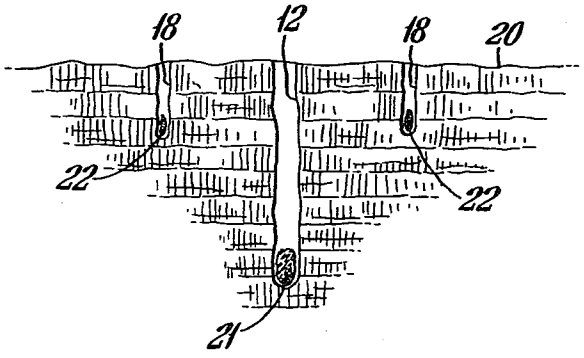


Fig. 3.

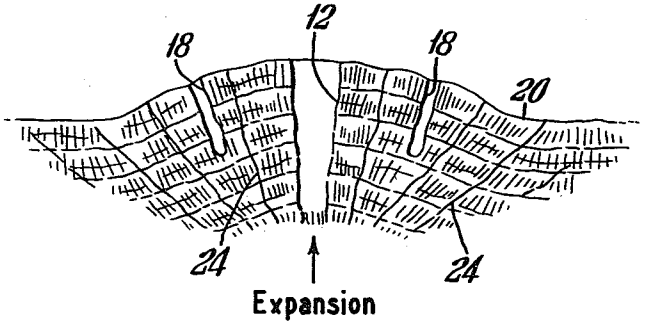
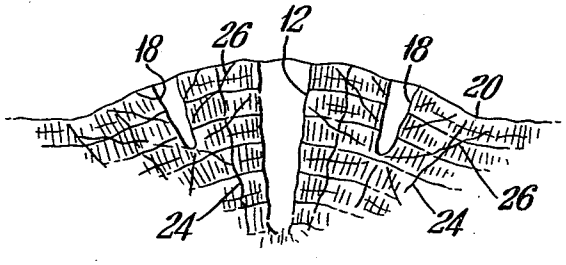


Fig. 4.



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BLASTING OF ROCK BODIES

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5 Claims. (Cl. 102—23)

The present invention relates to the blasting of rock bodies and, more particularly to a process for preparing rock bodies for such blasting.

Presently, large quantities of low grade iron ore are being removed from the taconite fields of Minnesota and subsequently processed to recover the iron values therefrom. In this and similar operations it is the practice to blast quantities of such ore from a vertical face of the body of the ore in a quarry-like operation. Heretofore, rows of blast holes were pierced, by methods such as the thermal mineral piercing process disclosed in U. S. Reissue Patent No. 22,964, parallel to the vertical face of the rock body, charged with explosives, and simultaneously detonated by rows to break large quantities of ore fragments from the rock body. It has been found, however, that some rock bodies, such as taconite, are notorious for large quantities of big boulders lying at the surface of the formation or close thereto. The standard blasting practice, described above, has not satisfactorily broken these boulders or reduced their size. They have been lifted with the blast only to settle back again on the pile of ore after the blast. It has, therefore, been necessary to force these large masses from the area to the quarry floor and there reduce them by secondary reduction procedures, such as further blasting and the like. Such operations are very costly, potentially hazardous and inefficient.

It is, therefore, the prime object of the present invention to provide a method of blasting such difficult rock bodies which will not require further secondary reduction of the fragments.

Other aims and objects will be apparent from the following description and appended claims.

In the drawing:

Fig. 1 is a plan view of a portion of a rock body, showing the arrangement of blasting holes employed in the practice of the method of the present invention;

Fig. 2 is a partial sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a partial sectional view taken along the line 2—2 of Fig. 1 at a time shortly after the beginning of the primary blast; and

Fig. 4 is a partial sectional view, taken along the line 2—2 of Fig. 1, a short time after the beginning of the synchronized satellite blasts.

In accordance with the present invention, and referring to the drawing, at least one spaced row of primary blast holes **12** are first pierced vertically in the rock body **14** parallel to a face **16** along which rock material removal is desired. A plurality of relatively smaller diameter satellite blast holes **18** are pierced around each of the primary blast holes **12** to a depth relatively shallow compared to the depth of the primary blast hole but deep enough to insure fragmentation of the large surface masses of rock. Each of the primary and satellite blast holes are loaded with explosive charges **21** and **22**, respectively, and then "stemmed."

The positioning of the plurality of satellite blast holes

18 around each of the primary blast holes **12** is determined by the position of cracks **19** on the surface of rock body **14**. As shown in Figs. 1 of the drawing, the satellite holes are so positioned around the associated primary hole to accomplish the maximum fragmentation of the surface boulders **20** formed by these surface cracks.

The sequence of detonating primary blast hole charges, or rows of such charges, may be varied in accordance with procedures well known to the art. The time delay between the detonation of a primary blast hole charge and its plurality of associated charges may vary up to about 50 milliseconds, best fragmentation results having been encountered where the delay time was sufficient to allow a substantial surface "doming" condition to develop after detonation of the primary change before the detonation of the plurality of associated satellite charges.

It has been found that when the satellite charges are simultaneously detonated at a short period of time, in the order of a few milliseconds, after the simultaneous detonation of a row of the primary charges, the large masses of surface rock are reduced and the need for secondary reduction of these bodies is eliminated.

It is believed that this surface fragmentation, unattainable with prior art blasting methods, is accomplished by virtue of the fact that the primary blasts cause a "doming" of the surrounding surface of the body, such as shown in Fig. 3 of the drawing, together with vertical cracking **24** of the body caused by the expansion resulting from the primary blast. Thereafter, at a time up to about 50 milliseconds after the primary blast, while the surface is still in the expanded ("domed") condition, the satellite blasts are simultaneously detonated and produce the further cracking **26**, shown in Fig. 4 of the drawing, which reduces the large surface masses of rock so troublesome to the prior art.

The method of the present invention has been employed in blasting large masses of taconite ore. In one such operation, two parallel rows of seven 6½ inch diameter primary blast holes, each primary hole being about 40 feet in depth and surrounded by a plurality of 1.25 inch diameter satellite holes 4 to 5 feet in depth, were charged and detonated. The primary holes in each row were disposed with 19 feet between centers and the distance between the rows was also about 19 feet. The rows of primary charges were detonated at 16 millisecond intervals and plurality of satellite charges were detonated simultaneously about 3 milliseconds after its associated primary charge.

The primary and satellite blast holes may be pierced by any means known to the art, but it has been found that the thermal rock piercing method disclosed in U. S. Reissue Patent No. 22,964 to C. J. Burch provides a method for piercing highly suitable blast holes in heat spallable materials, such as taconite and the like, in a minimum of time and with greater overall efficiency than mechanical drilling methods. In such thermal piercing method a blast hole is pierced in a rock body by directing an intensely hot, high velocity, oxy-fuel flame against the body to be pierced to spall off particles while concurrently introducing water into the flame zone where it flashes to steam and ejects the spalled particles from the hole as pierced. In this manner the rock piercing blowpipe is progressively introduced into the pierced hole until a blast hole of the desired depth is obtained.

What is claimed is:

1. In the art of blasting difficult-to-fragment rock bodies, the process which comprises, providing at least one row of substantially vertical primary blast holes in said body, said rows being substantially parallel to a face of said body; providing a plurality of smaller diameter substantially vertical satellite blast holes positioned in proximity with and around each of said primary blast

holes, said satellite holes having a shallow depth relative to the depth of said primary blast holes; charging each of said primary and satellite blast holes with an explosive charge; successively detonating, in the order of their distance from said face of said body, each row of said primary explosive charges; and detonating each plurality of satellite charges up to about 50 milliseconds after the detonation of the proximate primary charge but before the detonation of the next row of primary charges.

2. A method of blasting difficult-to-fragment rock bodies having substantial surface cracking comprising, providing at least one row of substantially vertical primary blast holes in said body, said rows being substantially parallel to a face of said body; providing a plurality of smaller diameter substantially vertical satellite blast holes positioned in proximity with and around each of said primary blast holes, said satellite holes having a shallow depth relative to the depth of said primary holes; charging each of said primary and satellite blast holes with an explosive charge; successively detonating, in the order of their distance from said face of said body, each row of said primary explosive charges; and detonating each plurality of satellite charges up to about 50 milliseconds after the detonation of the proximate primary charge but before the detonation of the next row of primary charges.

3. A method of blasting difficult-to-fragment rock bodies having substantial surface cracking comprising, providing at least one row of substantially vertical primary blast holes in said body, said row being substantially parallel to a face of said body; providing a plurality of smaller diameter substantially vertical satellite blast holes positioned in proximity with and around each of said primary blast holes, said satellite holes having a shallow depth relative to the depth of said primary blast holes; charging each of said primary and satellite blast holes with an explosive charge; successively detonating, in the order of their distance from said face of said body, each row of said primary explosive charges; and detonating each plurality of satellite charges at such time after the detonation of said proximate primary charge that the surrounding portion of said body is in the domed condition,

but before the detonation of the next row of primary charges.

4. A method of blasting difficult-to-fragment rock bodies having substantial surface cracking to form surface boulders comprising, providing at least one row of substantially vertical primary blast holes in said body, said rows being substantially parallel to a face of said body; providing a plurality of smaller diameter substantially vertical satellite blast holes positioned in proximity with and around each of said primary blast holes, said satellite holes having a shallow depth relative to the depth of said primary blast hole; charging each of said primary and satellite blast holes with an explosive charge; successively detonating, in the order of their distance from said face of said body, each row of said primary explosive charges; and detonating each plurality of satellite charges up to about 50 milliseconds after the detonation of the proximate primary charge but before the detonation of the next row of primary charges.

5. A method of blasting a body of taconite rock having substantial surface cracking comprising, providing at least one row of substantially vertical primary blast holes in said body, said rows being substantially parallel to a face of said body; providing a plurality of smaller diameter substantially vertical satellite blast holes positioned in proximity with and around each of said primary blast holes, said satellite holes having a shallow depth relative to the depth of said primary blast holes; charging each of said primary and satellite blast holes with an explosive charge; successively detonating, in the order of their distance from said face of said body, each row of said primary explosive charges; and detonating each plurality of satellite charges up to about 50 milliseconds after the detonation of the proximate primary charge but before the detonation of the next row of primary charges.

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