## EXAMINATION OF EXPLOSIVES WITH A VIEW TO SAFETY IN THEIR USE.

THE United States Bureau of Mines gives very careful consideration to the explosives used in blasting operations. In a recent bulletin it publishes a list of some 130 brands that it considers under the name of "permissible explosives." This signifies that the brands have successfully passed certain tests made by the bureau and that each may be used in accordance with the conditions prescribed by it. It is specified, however, that even the explosives that have passed those tests and are named in this list as permissible explosives are to be considered as permissible explosives only when used under the following conditions:—

I. That the explosive is in all respects similar to the sample submitted by the manufacturer for test.

2. That detonators—preferably electric detonators are used of not less efficiency than those prescribed, namely, those consisting by weight of 90 parts of mercury fulminate and 10 parts of potassium chlorate (or their equivalents).

3. That the explosive, if frozen, shall be thoroughly thawed in safe and suitable manner before use.

4. That the quantity used for a shot does not exceed  $1\frac{1}{2}$  pounds (680 grams), and that it is properly tamped with clay or other non-combustible stemming.

It must not be supposed that an explosive that has once passed the required tests and has been regarded as permissible, is always thereafter to be considered a permissible explosive, regardless of its condition or the way in which it is used. Thus, for example, an explosive named in the permissible list, if kept in a moist place until it undergoes a change in character, is no longer to be considered a permissible explosive. If used in a frozen or partly frozen condition, it is not when so used a permissible explosive. If used'in excess of the quantity specified (1½ pounds), it is not, when so used, a permissible explosive. And when the other conditions have been met, it is not a permissible explosive if fired with a detonator of less efficiency than that prescribed.

Moreover, even when all the prescribed conditions have been met, no permissible explosive should necessarily be considered as being placed permanently on the permissible list, for the bureau reserves the right, on fuller information concerning the conditions which lead to safety, to revise this list, but any permissible explosive when used under the prescribed conditions may properly continue to be considered a permissible explosive until notice of its withdrawal or removal from the list has been officially published.

Furthermore, the manufacturers of a permissible explosive may withdraw it at any time when introducing a new explosive of superior qualities. And after further experiments and conferences the bureau may find it advisable to adopt additional and more severe tests to which all permissible explosives may be subjected, in the hope that through the use of such explosives only as may pass the more severe tests the lives of miners may be better safeguarded.

The published list of the bureau gives the name of the brand, the class to which it is designated, the required efficiency of the detonators to be used, the unit deflective charge, the rate of detonation in a  $1\frac{1}{4} \times 8$ -inch cartridge, and the name of the manufacturer.

The unit deflective charge is determined by the ballistic pendulum, and is expressed in grams of the

quantity of explosive that is required to swing the pendulum mortar the same distance as one-half pound (227 grams) of the standard 40 per cent. "straight" nitroglycerin dynamite of the Pittsburgh Testing Station. Many observers have expressed the opinion that the "coalgetting" strength of permissible explosives is represented better by the results of this test than by the results of any other single test yet devised.

The rate of detonation gives, in feet per second and meters per second, the relative velocity of detonation of the explosives. The adaptability of a permissible explosive to a particular coal-mining condition depends greatly on its rate of detonation. For certain work in which a shattering effect is desired, as in driving through or "brushing" rock, or in producing coal for coke making, the explosive reaction should be rapid, and for such work permissible explosives having a high rate of detonation should be selected. Similarly, for shooting down a soft friable coal to produce lump or steam coal, a permissible explosive should be selected that detonates slowly and hence gives a more prolonged pressure. In medium hard coal an explosive having an intermediate rate of detonation may be expected to be most suitable.

Although these relations usually hold, they do not always, because coals differ in hardness and coal beds differ in the number and position of the joints, partings, and shale bands. Such facts have to be considered in selecting an explosive for mining coal.

An explosive having a very low rate of detonation is not always the best for mining a soft friable coal, because some of its energy may be lost by its gases escaping through cracks and fractures in the bed. Under such conditions an explosive having an intermediate rate produces the most economical results.

**Classes of Permissible Explosives.**—In order that the user of explosives may know the nature and characteristic component of each of the permissible explosives, and that he may be able to select an explosive to meet a specific requirement, the designation and characteristics of each class are given below:—

Class 1, ammonium-nitrate explosives.—Here belong all the explosives in which the characteristic material is ammonium nitrate. The class is divided into two subclasses. Sub-class a includes every ammonium-nitrate explosive that contains a sensitizer that is itself an explosive. Sub-class b includes every ammonium-nitrate explosive that contains a sensitizer that is not in itself an explosive. The ammonium-nitrate explosives of sub-class a consist principally of ammonium nitrate with small percentages of nitroglycerin, nitrocellulose, or nitrosubstitution compounds which are used as sensitizers. The ammonium-nitrate explosives of sub-class b consist principally of ammonium nitrate with small percentages of resinous matter or other non-explosive substances used as sensitizers.

All of the ammonium-nitrate explosives readily absorb moisture from the atmosphere, and great care should be taken in storing them or in using them in damp places. They are not suitable for use in wet mines. If in such mines a cartridge of an ammonium-nitrate explosive is opened and its contents exposed for only a few hours to the damp atmosphere, the explosive may deteriorate and later fail to detonate completely. The ammonium-nitrate explosives when stored in well-ventilated magazines for only a few months have shown signs of deterioration. For this reason the ammonium-nitrate explosives should be obtained in a fresh condition and should be used as