The test was applied to mixtures of explosive and stemming (sand or clay) in equal proportions. The sand used was finely powdered, dry, siliceous sand, the clay also dry, this condition being selected in preference to the damp state, as presenting greater risk of ignition. Four series of tests were applied, the intensity of the friction being progressively increased. First series: The (wooden) piston was accurately adjusted in the cylinder to reduce the play to a minimum, and the speed was 125 revolutions per minute. The machine was run continuously for eight hours a day during ten days, successive additions being made every hour of the mixtures of stemming and dynamite or powder. In no case was any explosion produced. Second series: The same apparatus was used, except that the wooden piston was replaced by one of iron, also fitted tightly into the cylinder. After eleven days the test was suspended, no explosion having been produced. Third series: In order to increase the friction the cylindrical piston was replaced by an iron one of slightly conical shape, the pump-barrel being tapered to correspond. The previous tests were repeated during four days, the machine being stopped every half-hour for the addition of small quantities of explosive into the cylinder. At the close of the experiment the concrete cylinder was found to be worn for a distance of several centimetres. The results were negative throughout. Fourth series: The same machine was used again, after adjustment, but the speed was increased to 375 revolutions per minute. This considerably increased the vibration, the foundation rocking continually, and producing knocks between the cylinder and piston. The machine was run for a whole day, with stops at intervals of a quarter of an hour for the addition of more explosive; but, though the cylinder was found to be worn and the piston to have become very warm, no ignition occurred. Sand mixtures alone were subjected to this test.

Although it would be inadvisable to conclude from the negative results furnished by these tests that there is no risk of ignition from friction in practical shot-firing, it may be assumed that the probability of accidents from this cause is small; the more so that the presence of fragments of explosive on the sides of the shot-holes is likely to be rare, provided the explosive has been properly packed in the cartridge.

The Committee consider that the foregoing tests, without having completely solved the whole of the problems investigated, have at least shown that: Sand stemming appears to give better results than clay in practice; sand stemming opposes greater resistance than plastic substances to blowing out, which is a factor of considerable importance in the case of fiery or dusty pits; the danger of ignition by friction in stemming shot-holes seems to be remote, whatever kind of stemming is employed. Consequently the Committee is of opinion that no reason exists for the exclusion of sand stemming in conjunction with safety explosives.

LOSSES WITH COMPRESSED AIR.*

The question as to the causes of loss in the transmission of power by the use of compressed air is very important to all who use it, and, as compressed air is much used in mining, it may be interesting to consider the subject and to try to summarise the causes of loss. We may set out by stating that: (1) When air (or any gas or steam) is compressed it becomes hotter; (2) when it is expanded it becomes cooler; (3) when it is heated its pressure is increased; (4) when it is cooled its pressure is reduced.

Compressed air is obtained by using cylinders fitted with specially arranged valves to admit air from the atmosphere into the cylinder during the return stroke, and to exhaust it from the cylinder into the air-receiver during the advancing—that is, the compressing stroke. The air-cylinders are generally in a line with the steam-cylinders, or tandem-wise, the two pistons being on the same piston-rod.

Suppose that an air-compressor compresses air which is at about atmospheric pressure (say, at 15 lb. per square inch), and at 63 degrees Fahr., into one-third of its former volume, by applying Boyle's law it is known that at a constant temperature its pressure would then be 45 lb. absolute pressure (15 lb. absolute pressure × 3), and (45 − 15) 30 lb. above the atmospheric pressure. But the temperature is not constant, it rises; and, in reality, the compression into one-third of its volume will in this case raise the temperature of the air from 63 degrees Fahr. to 360 degrees Fahr. Now, this temperature should give a pressure of about 55 lb. above the atmospheric pressure (instead of 30 lb.). If the air could be kept at this high temperature it would remain at this pressure, and all would be well, because in that case, when the air was used in the cylinder, it would expand from 55 lb. above the atmospheric pressure to the atmospheric pressure, and at the same time it would cool down from 360 degrees Fahr. to 63 degrees Fahr. If that could be done the air, when used, would give back practically the same amount of work as had been performed upon it in compressing it. But in actual practice the compressed air has to be taken a long way in iron pipes, and these pipes give out the heat. The compressed air is thus cooled, and if it should be cooled down to its original temperature, 63 degrees Fahr., while still occupying the same volume, its pressure would have fallen to exactly 30 lb. above atmospheric pressure, in conformity with Boyle's law. This is what actually does occur in practice. A loss of heat always results in loss of work.

It will be seen that a very low proportion of the work done in the steam-engines compressing the air is given off by the engines or motors using the compressed air, on an average from 25 to 30 per cent. only, so that two or three times as much fuel is consumed as would be necessary if steam were used direct; but, of course, there are circumstances in which no other motive force can be so well applied, unless it is electricity.

In summarising the causes of loss it would be well to classify the losses into those which may be called the primary and secondary causes respectively.

* Abstract from article by Mr. George Farmer in the *Journal of the British Society of Mining Students.*