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USE OF HIGH PRESSURE FLUIDS IN COAL MINES

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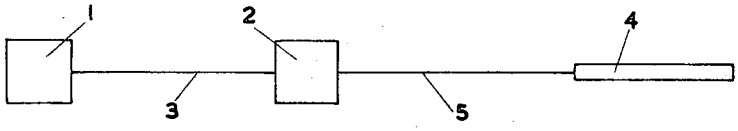


FIG. 1.

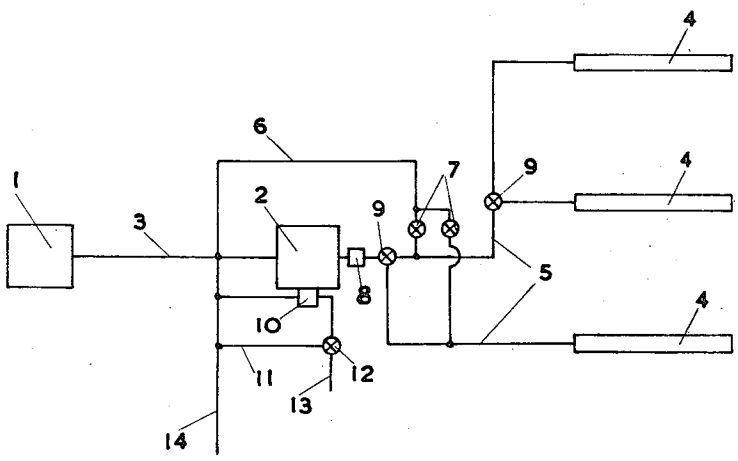


FIG. 2.

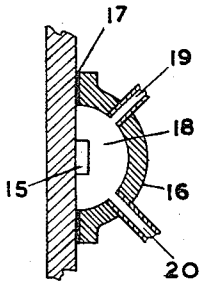


FIG. 3.

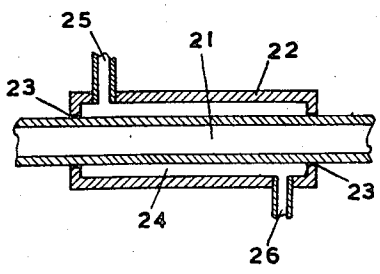


FIG. 4.

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USE OF HIGH PRESSURE FLUIDS IN COAL MINES

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This invention relates to improvements in the supply of a high pressure fluid medium, more particularly as applied to the winning of coal and shale and materials of like nature.

In the winning of coal, methods are known in which a charge of compressed fluid is released and allowed to expand rapidly in a bore hole so as to produce a blasting effect. This kind of method has previously been carried out with some success, either by introducing a fluid medium such as carbon dioxide in the liquid phase into a pressure resisting metal container, together with means adapted to cause venting of the fluid contents into a borehole when a predetermined pressure has been built up, or by the use of a fluid such as air, compressed to a very high pressure e. g. of the order of 7,000 or more pounds per square inch, with means for releasing the compressed fluid into a bore hole to produce a blasting effect.

The first-mentioned method has the disadvantage that a combustible composition and an igniter therefor are ordinarily present as part of the charge for raising the carbon dioxide to the release pressure, with the resultant requirement of heater cartridges and electric igniters. Also the use of carbon dioxide results in much handling of heavy containers with attendant transport problems; and the second-mentioned method has the disadvantage that in order to obtain a sufficient pressure of compressed air to give the desired blasting effect, it has been necessary to provide a compressor capable of compressing a large volume of air from atmospheric pressure to the required pressure, either in the vicinity of the working face, which is inconvenient and indeed often impossible on practical and economical grounds, or at the pit-head or other surface or underground station remote from the working face, which entails the use of considerable lengths of high pressure air lines leading to the working face, such lines being costly and further introducing some element of serious danger from accidental perforation or rupture of a part of such high pressure lines.

The present invention provides means for the convenient provision at a desired location of controlled quantities of air compressed to a relatively high pressure, such high pressure air being available for use in winning coal, shale or material of like physical conformation, or in the demolition of buildings. When applied to the winning of coal, the invention materially reduces or avoids the disadvantages of the above-mentioned prior methods, and consists in supplying air at the working face at a pressure sufficient to obtain the desired blasting effect, by means of a first compressor adapted to handle large volumes of air located at the pit-head, or at a convenient underground location remote from the working face, such first compressor being employed to distribute air compressed at a relatively low pressure through low pressure air lines to the vicinity of the working face, and then employing in such vicinity a second compressor adapted to handle relatively small volumes of already compressed air as compared with the first compressor, to compress air distributed through the low pressure air lines to the considerably higher pressures necessary to provide the desired blasting effect, such second compressor delivering air at such higher pressure to the discharge tube or the like in the bore holes through relatively short high pressure air lines, which may, if desired, have associated therewith an air receiver or reservoir, in which is stored compressed air from the second compressor in a quantity sufficient materially to reduce the time interval between coupling of the second compressor to an individual discharge tube and the actual discharge of the latter.

As will readily be appreciated, the method of the invention avoids the use of long lengths of costly high pressure air lines leading from a compressor remote from the working face, and thus also the dangers inherent in the presence of live high pressure lines in great length in roadways and galleries of mines. The further great advantage is obtained that since the second compressor is required to be able to handle only relatively small displacement volumes of air, its intake being of air already compressed by the first, remotely situated, compressor, such second compressor can be so limited in overall dimensions and weight as to be readily transportable, e. g. on a conventional track such as is normally employed to remove coal from the working face to the pit head; the second compressor can thus conveniently be transported without difficulty or expense to a succession of different points in the same or different seams in a mine and there connected at its intake to the low pressure air lines which are often already available in modern coal mines for use in operating coal-winning machinery of other kinds, such as bar or chain cutters, drills, vibrators, fans, etc. Motive force for driving the second compressor in the vicinity of the coal face is similarly normally readily available from the electricity power supply lines usually provided in coal mines at the present time, or from the low pressure air line; alternatively, hydraulic means may be employed for this purpose.

The output of the second compressor in the vicinity of the working face is fed through relatively short high pressure lines for use in blasting in any of the known methods.

As will readily be appreciated, the improved method of winning coal or the like is clearly eminently suitable for application to the demolition of buildings, and indeed, will find application in any context where there is normally provided a source of supply of low pressure compressed air.

The invention will now be described with reference to the accompanying drawing, in which is diagrammatically illustrated, by way of example, one manner of application of the invention to the winning of coal.

In the said drawing,

Figure 1 illustrates in the simplest diagrammatic form the basic integers of apparatus whereby the invention may be performed,

Figure 2 is a diagram illustrating one lay-out of apparatus for use in winning coal in accordance with the invention, and

Figures 3 and 4 are cross-sectional views of parts of the apparatus illustrated in Figure 2, hereinafter more fully referred to.

Referring to the said drawing, a relatively large-size compressor 1, adapted to handle large volumes of air at atmospheric pressure, and situated at a convenient location remote from the coal working face, is connected by low pressure air line 3 to a second compressor 2, located at a convenient distance from the coal working face, but relatively close thereto as compared with the compressor 1. Both the compressor 1 and the compressor 2 may be of any known kind, the compressor 2, however, being of readily transportable dimensions and weight suitable for passage through the roadways and galleries of mines, since it is required to handle only relatively small volumes of air

as compared with the first compressor, by reason of the fact that its intake supply is of air already compressed to a suitable pressure. The compressor **2** is connected by a high pressure air line **5** to a discharge or blasting tube **4** of known construction.

Preferably the compressor **1** may be that which is normally available and commonly employed in coal mines to supply air at a pressure of the order of 60–100 pounds per square inch, the low pressure air being then compressed by the compressor **2** to the required high pressures for blasting, which may be of the order of 7,000 to 10,000 pounds per square inch, or higher. In some cases, however, it may be found desirable, and is included within the concept of the invention, to employ the first compressor to compress the air in the first stage to a higher pressure than that normally available in the low pressure air systems commonly employed in coal mines, i. e. such normal pressures of 60–100 pounds per square inch may be increased considerably, even up to several thousands pounds per square inch.

As will be appreciated, by the use in accordance with the invention of two separately located compressors, the first compressing the air to a relatively low pressure, there is obtained a substantially complete avoidance, or at least a considerable reduction in, the danger and damage which might result from rupture of a pressure air line carrying air at blasting pressures, i. e. of the order of 10,000 pounds per square inch, which would always be present if a single compressor located remote from the working face were employed to feed air at such a blasting pressure through air-lines extending throughout the roadway system of the mine.

In order to facilitate maximum usage of the blasting means and thus economy in the employment of the apparatus of the invention, and/or in order further to ensure safety against any risk of accidents resulting from the use of high pressure air adjacent the working face, e. g. to reduce or eliminate any danger resulting from fracture of or damage to any part of the second compressor or of the air lines leading therefrom to the working face when blasting is to be effected, one or more of the following expedients may be adopted, as described with reference to Figures 2, 3 and 4 of the drawing.

Figure 2 of the drawing again shows the first compressor **1** connected by low-pressure air-line **3** to the second compressor **2**, and thence by high pressure air-line **5** to a number of discharge tubes **4**. At points in the system of likely local overheating, or in relation to parts of the apparatus which have most strain and are most exposed to the risk of fracture or breakage due to the high internal air pressure, the parts in question are provided with blow-off or safety valves exhausting to atmosphere or into the low-pressure air system, or are enclosed in extensions of the low-pressure air system, thus preventing such parts from coming into contact with explosive gas mixtures sometimes encountered in coal mines.

As shown in Figure 2, a potential danger point indicated at **10** as forming part of the last stage of the compressor **2** (for example, a blow-off or safety valve, or a water trap, which, if opened to atmosphere, will discharge with an almost explosive or undesirably violent effect), is enclosed in the low-pressure air-line **3**, by means of a low-pressure air loop **11**, provided with a three-way valve **12** through which air can be permitted to escape to atmosphere through line **13** or to pass through loop **11**, which is connected to the main low-pressure air line **3** by branch line **14**, which latter may be continued to any desired point in the low-pressure system where working air is required, e. g. to operate a drill, fan or other apparatus. Thus there is provided a non-explosive atmosphere surrounding the danger point, and/or means for cooling such point.

A part of the relatively low pressure air in the line **3** leading from compressor **1** to compressor **2** may be bypassed through line **6**, passing therethrough to lines **5** through one of the two valves **7**. The two valves **7** together with the valve **9**, afford means for passing such low-pressure air from line **6** to any one of the three discharge tubes **4** shown in the drawing. The said discharge tubes **4** may be provided at the discharge with cooling air from line **6**, e. g. if overheating thereof has taken place during discharge, or if desired, such low pressure air may be introduced within each of such discharge tubes so as to lessen the work to be done by compressor **2** to bring the pressure within the discharge tubes to the required blasting pressure. The two valves **9** are preferably automatically operable by means of pressure differentials in the series of discharge tubes **4**, in order to shut off further passage of high pressure air to a tube **4** after discharge thereof.

The device indicated by reference numeral **8** in Figure 2 of the drawing may be one of two alternatives, i. e., an "off-loader," on actuation of which the compressor is put out of operation, or a pressure relief valve, in which latter case it may be combined with any suitable audible and/or visible alarm or warning means, e. g. a whistle.

In operation, the pressure of the air supplied to each successive discharge tube **4** may be maintained at a safe pressure below the release pressure, i. e. below that predetermined pressure at which the discharge tube is designed to allow the high pressure air therein to escape to produce the desired blasting effect. To this end by the employment of the device **8**, or other suitable known pressure sensitive devices associated with the second compressor **2**, the compressor itself may be put out of operation or caused to discharge to atmosphere. Alternatively, a safety valve blow-off valve may be provided, e. g. adjacent each discharge tube, so constructed as to open when such pre-set pressure below the release pressure is reached. As will readily be appreciated, such pressure check means **8** or such blow-off valves may readily be taken out of circuit to allow the pressure on the discharge tube to build up to the release pressure by suitable controls provided for manual operation adjacent the working face. The compressed air issuing from the second compressor or from the blow-off valves may be arranged to pass through a whistle, or like noise-producing means, to serve as an indication to the operator that the discharge tube is then ready to be brought to the release pressure in order to effect a blasting operation.

It may further be found advantageous to incorporate in the high pressure air system known detector devices operated by undesirable or dangerous local rises in temperature to shut off, e. g. electrically, the drive of the second compressor.

Referring now to Figure 3, there is shown means for protecting a hypothetical danger point **15** on the casing of the second compressor **2**. A domed cover **16** of adequate strength is bolted, welded or otherwise secured to the casing **2**, preferably with a gas seal joint **17**, such cover **16** being provided with an inlet **19** and outlet **20** for low pressure air to pass through a chamber **18** formed by the cover **16**.

Similarly, where it is considered necessary or desirable to provide protection for any point or zone of the high-pressure system which may constitute a potential danger, e. g. due to local overheating, such point or zone **21** may be enclosed in a casing **22** secured around the zone **21** with a gas seal **23**, the casing **22** having an inlet **25** and an outlet **26** for low pressure air, such air passing through a chamber **24** enclosed by the casing **22**.

As will readily be appreciated, where water supply lines are available, as is often the case in coal and other mines, such water may be employed in place of the low pressure air as the fluid medium passed through the chamber **18** of Figure 3 or the chamber **24** of Figure 4, and for cooling the discharge tubes **4**.

It will be appreciated that in general, when carrying the invention into practice, a characteristic feature of

its embodiment will be the employment of relatively long low-pressure air-lines leading to the second compressor and relatively short high-pressure air-lines leading from the second compressor to the point of employment of the high-pressure fluid medium. Thus the low-pressure lines will normally be of the order of length of ten times that of the high-pressure lines, e. g. a low-pressure line of say two miles leading from the pit-head of a mine to a point adjacent the working face, the high-pressure air lines from such point to the working face itself being say one or two hundred yards only in length.

Similarly, the concept of the invention normally contemplates a great disparity between the relative pressures of the fluid medium in the part of the system leading to the second compressor and the part of the system between the second compressor and the point of actual employment of the high pressure medium. Thus the ratio between the high pressure and the low pressure parts of the system will normally be of the order of four to one, or greater.

It will nevertheless be understood that the invention includes within its ambit particular cases of employment of high-pressure fluid media in which the ratios of the lengths of the low-pressure to the high-pressure air-lines, and also of the high pressure to the low pressure part of the system, are of less degree than 10 to 1 or from 4 to 1 respectively.

I claim:

1. The method of winning coal or the like, which comprises the steps of compressing air to a relatively low pressure at a point remote from the working face of the coal and simultaneously delivering such air to a point adjacent the working face, further compressing such air at said point adjacent the working face to a pressure of from about 4 to about 10 times greater than such relatively low pressure and delivering such further compressed air to the working face, and controlling the delivery of such further compressed air so as to controllably expand such air within the confines of the coal to win the coal therefrom.

2. Apparatus for the winning of coal or the like in underground mines which comprises a blasting device including means for controllably releasing compressed gas therefrom at a predetermined blasting pressure, a first compressor having inlet and outlet means and being positioned at a point remote from the working face of the coal for producing compressed gas at a pressure substantially less than said blasting pressure, a second compressor having inlet and outlet means and being disposed at a point adjacent the working face of the coal for further compressing gas to said blasting pressure, a first elongated supply conduit connected between the outlet means of said first compressor and the inlet means of said second compressor and providing communication between said first and second compressors, and a second supply conduit connected between the outlet means of said second compressor and said blasting device and providing communication between said second compressor and said blasting device.

3. Apparatus as defined in claim 2, wherein said second compressor produces an outlet pressure which is at least four times as great as the inlet pressure thereof, said outlet pressure being at least approximately 7000 pounds per square inch.

4. Apparatus as defined in claim 2, wherein the outlet pressure of said second compressor is at least ten times as great as the inlet pressure thereto, said outlet pressure being at least approximately 7000 pounds per square inch.

5. Apparatus as defined in claim 2, wherein the length of said first conduit is at least ten times as great as the length of said second conduit.

6. Apparatus as defined in claim 2, wherein the outlet pressure of said first compressor is of the order of 60–100 pounds per square inch, and the outlet pressure of said second compressor is of the order of 7000 to 10,000 pounds per square inch.

7. Apparatus as defined in claim 2, wherein said first compressor has inlet pressure which is substantially atmospheric and an outlet pressure which is substantially in excess of 100 pounds per square inch, and the outlet pressure of said second compressor is at least approximately 10,000 pounds per square inch.

8. Apparatus as defined in claim 2, wherein said first compressor is located adjacent the surface of the mine whereby the inlet means thereof is subjected to uncontaminated gases.

9. A method of breaking solid material by blasting it with non-explosive gas compressed to blasting pressure which comprises compressing the gas in a first stage to a pressure substantially below the blasting pressure, passing a stream of the thus compressed gas to a remote point and then further compressing the gas in a second stage to blasting pressure, delivering the finally compressed gas to an adjacent discharge point, and controllably releasing said compressed gas to break the solid material by blasting.

10. The method as defined in claim 9, wherein the gas is compressed in the second stage to a pressure at least four times the pressure produced in the first stage of compression.

11. The method as defined in claim 9, wherein the gas is compressed in the second stage to a pressure at least ten times the pressure produced in the first stage of compression.

12. The method as defined in claim 9, wherein the first and second stages and the discharge point are so spaced from one another that the gas path length between the first and second stages is at least ten times the gas path length between the second stage and the discharge point.

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