DEVICE FOR LOADING BORE-HOLES WITH EXPLOSIVE

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Filed Jan. 27, 1958, Ser. No. 711,417
Claims priority, application Sweden April 25, 1957
2 Claims. (Cl. 85—20)

This invention relates to a device for loading bore-holes with explosive.

More particularly this invention relates to a device for loading bore-holes with cartridges of an explosive constituted by a plastic mass or a powder.

Still more particularly this invention relates to a device for loading bore-holes with explosive of the kind described in the co-pending U.S. Patent 2,824,483 issued to Carl Hugo Johansson and substantially comprising a pipe insertable into the bore-hole and connectable to a source of a pressure medium upon introducing of the cartridges into the pipe. The cartridges are advanced by the pressure medium, preferably compressed air, within the pipe and discharged through the remote end of the pipe.

The pipe has for the greater part of its length an internal diameter greater than that of the cartridges but a reduced diameter at its remote end portion, said portion having an internal diameter corresponding to the thickness of the cartridges. Arranged on the inner face of said end portion with reduced diameter are knives or cutters which when the cartridges pass through said end portion cut the wrapping enclosing the explosive and made of paper or the like material. The final placing of the explosive in the bore-hole so as to fill said hole in spite of its diameter exceeding that of the cartridges is effected so that the cartridges after their passage past the end edge of the pipe with their wrapping cut up are packed off or compressed by the pipe which is pressed backwards at even intervals while being stepwise drawn back in the bore-hole.

Said loading device has come into widespread use and proved to afford considerably improved filling of the bore-holes resulting in an improved utilization of the bored hole volume. In the blasting of bedrocks very deep or long holes having a longitudinal dimension reading or even surpassing 10 and 15 meters are bored nowadays.

One consequence of this fact consists in that the pipes which in the practical realization of this method are made of metal, are composed of tubular members interconnected by means of particular coupling sleeves formed so as to have an external diameter only incomconsiderably surpassing the external diameter of the tubular members proper.

One main object of our invention is to provide a loading device of the kind described above which satisfies specifically high demands regarding safety against unintentional initiation of the explosive. For example, it must not under any circumstances occur that the explosive due to reciprocal movement of the pipe during the loading operation is subjected to such friction on the hard wall of the bore-hole as at any place to produce a temperature exceeding the temperature required to set off the charge. As is well known, the friction between two faces such as a metal face and a rock face is apt to cause an extreme heating of concentrated portions. In normal cases said heating does not harm since the developed heat is quickly conducted away from said portions. During the loading procedure compressed air escapes into the space between the wall of the bore and the pipe and it cannot be avoided that minor particles of explosive are carried along with the escaping air.

Extensive experiments with various metals have revealed that alloys of aluminum when brought into frictional contact with a rock face covered with an explosive have substantially greater tendency of causing an explosion than is the case with brass, for example. The experiments have been carried out under conditions which when the explosions actually occurred were harder than those prevailing under conditions met in the field of art. However, in order to be in a position to operate the loading device with complete safety very high safety margins are to be calculated with.

In this connection it may be mentioned that as an additional safety measure the loading of dry bore-holes is not allowed but with explosive of such composition as not to allow its content of components sensitive to shock such as nitroglycerin or nitroglycol to exceed predetermined limit values.

According to one main feature of the present invention the pipe is made at least for a portion of its length of a non-metallic material. Said non-metallic material is preferably a synthetic plastic material of a kind which permits lesty rubbing or grinding under high pressure on the rock surface without thereby setting off explosive present between the pipe and the rock surface. The same feature comports the advantage that the weight of the pipe is reduced which makes the loading operation much easier particularly when deep or long holes are to be filled with explosive.

Pipes of synthetic plastic material such as, for example, polyethylene have proved to have a mechanical strength sufficient for use under all climate conditions met anywhere and a low coefficient of friction on the rock surface, said friction under no conditions being capable of causing a concentration of heat of a magnitude entailing any risk of unintentional initiation of the explosive though highly sensitive to initiation. The pipe is preferably made flexible so as to make possible to form it as a coherent unit. The portion of the pipe projecting over the surface of ground may be deposited in the form of a coil or loop which nevertheless normally does not cause any difficulties in the advance of the cartridges.

Loading pipes of various material were tried in an experimental apparatus constructed by us. Under these trials an electric motor developing 2 hp, subjected the pipes to a reciprocal movement and caused them during said movement to rub in a groove having a half-circular section provided in a pipe, said groove being placed on a layer of explosive was disposed on the surface of the groove and the pipe was subjected to a varying pressure against the wall of the groove. When using pipes of aluminum or an alloy of aluminum it was possible to cause explosions with qualities of explosives of normal kind by moving the pipe reciprocally with a maximum speed of 2.2 meters per second and under a pressure thereon of 30 kp. (kilopounds). When using pipes made of polyethylene nothing happened even with a pressure of 55 kp. and the use of sensitive explosives although the groove was dried very carefully beforehand.

Another feature of the invention consists in the pipe on its internal face being provided with longitudinal grooves in order to avoid an excessive air pressure to be built up on one side of cartridges caught and stopped within the pipe. The longitudinal grooves on the internal face of the pipe are of great importance for attaining complete security in the use of our loading device. Without such grooves cartridges stopped on their way to the outlet end of the pipe have proved to cause so powerful an increase of pressure behind them to be built up that they later when released are accelerated to a very high velocity embodying the danger of an ex-
losion if the cartridges without restraint strike on the base of the hole. The danger of the cylindrical cartridges being stopped in the pipe is provoked when the pipe above the surface of ground has been deposited in a coil or loop having a radius as small as to allow undisturbed passage of the cartridges. The longitudinal grooves provided on the internal face of the pipe always allow the air to pass past caught cartridges so as to exclude any possibility of too great a pressure drop to be created between the front and rear faces of the cartridges. A further advantage inherent to the grooves is their allowing to make the inner diameter smaller than hitherto.

Further objects and advantages of the invention will become apparent from the following description considered in connection with the accompanying drawings which form part of this specification and of which:

FIG. 1 is a sectional view of a substantial vertical bore-hole which is being loaded by means of the device constructed according to the invention.

FIG. 2 is a view on a larger scale of the end inserted into the bore-hole shown in FIG. 1 of a pipe forming part of the device shown in said FIG. 1 and represented as a section along line II—II of FIG. 3 which in turn is a cross-section along line III—III of FIG. 2.

FIG. 4 is a sectional view following line IV—IV of FIG. 2.

FIG. 5 is a sectional view of a locating device and a cartridge magazine connected to the upper end of the pipe.

FIG. 6 is a sectional view following line VI—VI of FIG. 5.

Referring to the drawings reference numeral 10 designates a vertical bore-hole provided in the bed-rock. Said hole is to be filled with explosive by means of the loading device constructed according to the invention. The device comprises a pipe 12 or hose 12 made of synthetic plastic material and having a length exceeding the depth of the bore-hole. The end of the pipe 12 directed toward the base of the bore-hole has a portion 14 having a reduced internal diameter corresponding to the external diameter of the cylindrical explosive cartridges and thus being less than the internal diameter of the other portions of the pipe. The portion 14 may be manufactured by compressing the end portion of the pipe while heated and thereupon placing a sleeve 16 also made of a synthetic plastic material and welding it onto the compressed end portion 14. Suitably the sleeve 16 is given the same or a slightly smaller external diameter than that of the pipe 12 in general. A plurality of knives or cutters 18, (see FIG. 3) preferably three in number, are evenly distributed around the circumference of the compressed portion 14 with their edges extending radially inwardly from the internal wall of said portion 14. The knives have peripherally curved base portions 20 secured by welding between the portion of the tube and the sleeve 16. The internal face of the pipe 12 is provided with longitudinal grooves 22 extending over the whole length of the pipe with the preferred exception of the outlet portion 14. The grooves may have a part-circular cross-section and are preferably evenly distributed over the whole internal wall of the pipe.

A previously mentioned the pipe 12 is made of a synthetic plastic material which should have such composition as to be capable of sustaining the low temperatures which may be met during winter at the places of use without losing its mechanical strength. The synthetic plastic material should further be capable of being joined by welding to the polyethylene comply with these demands in a highly satisfactory manner. For the purpose of avoiding creation of electric potential differences by the operation of the device manufactured according to the invention it is further preferred to use in the device a synthetic plastic material treated to become anti-static in a manner known per se in prior art.

The end portion of the pipe 12 projecting out of the bore-hole carries a coupling 24 provided with a connecting socket 26 for a hose 28 communicating with a source of compressed air and attached to said locking device at 29 to the end of said pipe with the aid of a right angle to the longitudinal axis thereof. Attached to said locking device is also a tube 30 disposed coaxially with the longitudinal axis of said device. Located above said tube is a magazine 32 having the form of a top-open container adapted to receive a plurality of axially parallelly placed explosives 34 and having a cross-sectional contour tapering towards its base to the size of the diameter of the tube 30. Said cross-sectional contour of the container is preferably unsymmetrical, one of its sloping walls, for example the wall denoted 36 being slightly longer than the opposite sloping wall 38 in order to prevent cartridges from becoming jammed so as not automatically to fall down into the tube 30. Beyond the container 32 the tube 30 encloses a plunger 40 provided with a handle 42 displaced along a longitudinal aperture 44 formed on the top face of the tube. The cartridges fed from above into the tube 30 are successively advanced by the plunger 40 into the locking device 24 and therefrom into the pipe 12. The locking device has a flap 46 adapted to be pushed into open position by the cartridges through being pivoted upwardly around a journal 48. The flap 46 is located adjacent the rear portion of the tube 30 entering the locking device. The front portion of said device may taper towards the pipe 12.

In operation the pipe 12 of the loading device is inserted deeply into the bore-hole 10 so as to reach adjacent the base thereof. A charge comprising a greater plurality of cartridges of explosive which have the form of cylindrical bars with the explosive enclosed in a wrapping of paper or similar material is introduced into the magazine 32 so as to carri the cartridge to be positioned in the magazine with their longitudinal axis substantially in parallel. The cartridges are one after the other advanced by the plunger 40 past the flap 46. When a suitable number of cartridges has been fed into the pipe 12 compressed air is introduced through the hose 28. The compressed air acts on the flap 46 so as to allow said flap automatically to seal the communication with the tube 30. The cartridges are carried by the pressure fluid downwardly to the lower end of the pipe 12 and discharged through the portion 14 with the reduced diameter, the knives cutting the wrapping of paper or similar material of the cartridges into pieces. To pack the cartridges within the bore-hole the pipe 12 when step-wise or successively being carried upwardly is at equal interval pressed backwards against the mass of discharged explosive so as to cause said mass compactly in the core portion of the bore-hole as will be seen from FIG. 1.

The portions of the pipe drawn upwardly out of the hole may be deposited on the surface of ground in coils, loops or windings. If it should happen that at any place the radius of curvature becomes so small to allow the passage of the cartridges the grooves 22 will continuously permit the compressed air to flow through the pipe so much as to prevent a too high pressure from being produced behind the cartridges. When the cartridges are released for example by widening the curvature of the coil or winding said cartridges cannot be accelerated but to a speed far below the dangerous value of initiation of the explosive.

The portion of the pipe located adjacent the locking device 24 may be given a slightly larger external or internal diameter than that of the pipe. Due to technical reasons in the boring of holes in bed-rock the holes in particular when they are long or deep have a diameter successively reduced in the direction from the surface of ground. When loading the most interior part of the bore-hole a tube made of metal, preferably brass, may be used because such tube may be made with thinner walls and consequently a minor
external diameter than a pipe of synthetic plastic material. The pipe of metal is tightly attached to the pipe of synthetic plastic material and is provided with a discharge mouth of reduced internal diameter and fitted with cutters of the type described above. The discharge end of the pipe 12 may be provided with a mouth made of elastic material so as to be adapted to be adjusted in response to variations of the diameter of the cartridges. The pipe may be composed of tubular members having a carrier constituted by paper, board or similar material impregnated with a synthetic resin of suitable composition.

While one more or less specific embodiment of the invention has been described, it is to be understood that this is for purpose of illustration only, and that the invention is not to be limited thereby, but its scope is to be determined by the appended claims.

What we claim is:

1. A device for introducing units of explosive into bore holes comprising a flexible tube of a character to avoid creation and concentration of electrical energy sufficient to cause an explosion, said tube having a series of longitudinal grooves on the interior face of the tube for preventing the build up of excessive fluid pressure on one side of said explosive units and having an internally reduced discharge end, inwardly extending knives within such reduced portion adapted to engage the exterior of the units of explosive, a supply chamber for a collection of explosive units, said chamber having a discharge in communication with said flexible tube, a plunger for removing said units singly from said chamber into said flexible tube, a closure for said discharge, and a connection for a fluid under pressure between said closure and said tube whereby said explosive units may be introduced one at a time into said tube and forced by fluid under pressure through said tube into a bore hole.

2. A device for loading bore holes with explosive cartridges, comprising a flexible plastic semi-static pipe of an external diameter less than that of the bore hole, and having an internal diameter exceeding the external diameter of the cartridges, said pipe having its internal face provided with a multiplicity of longitudinal grooves, each groove being of less circumferential extent than the circumferential extent of the adjacent lands to avoid creation of an excessive air pressure on one side of cartridges disposed within the pipe by by-passing air through said grooves, said pipe having a charging end and a discharging end, and means for applying air under pressure to the charging end to discharge cartridges in the pipe through the discharge end thereof.

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