

[54] APPARATUS FOR EXPLOSIVE WORKING OF METALS

[58] Field of Search..... 72/56; 29/421 E, 254; 220/16, 21, 83

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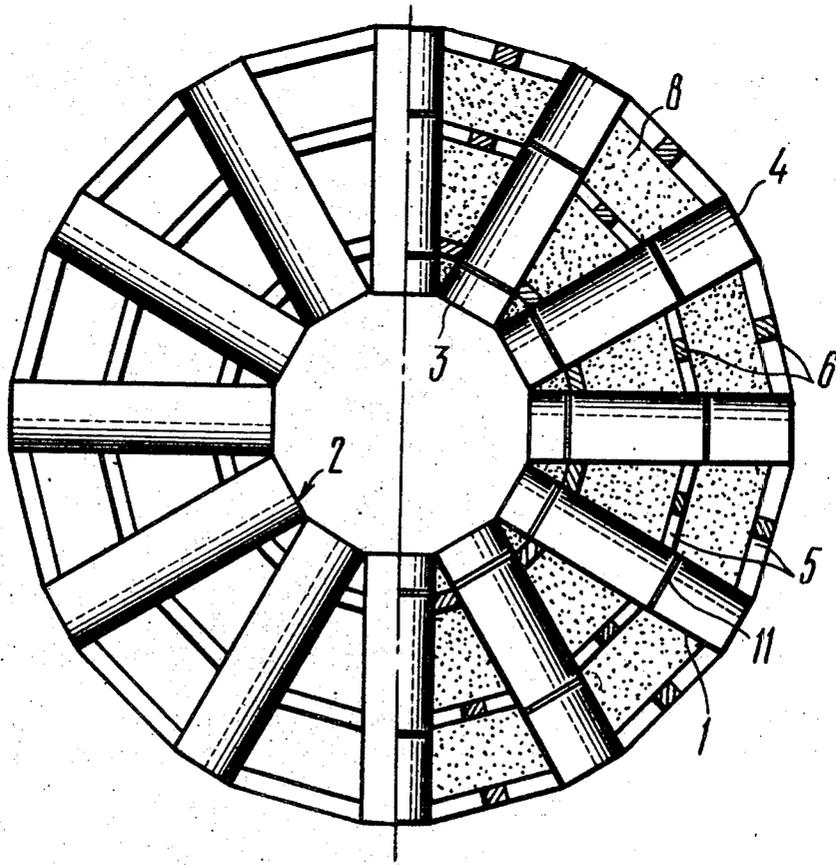
[57] ABSTRACT

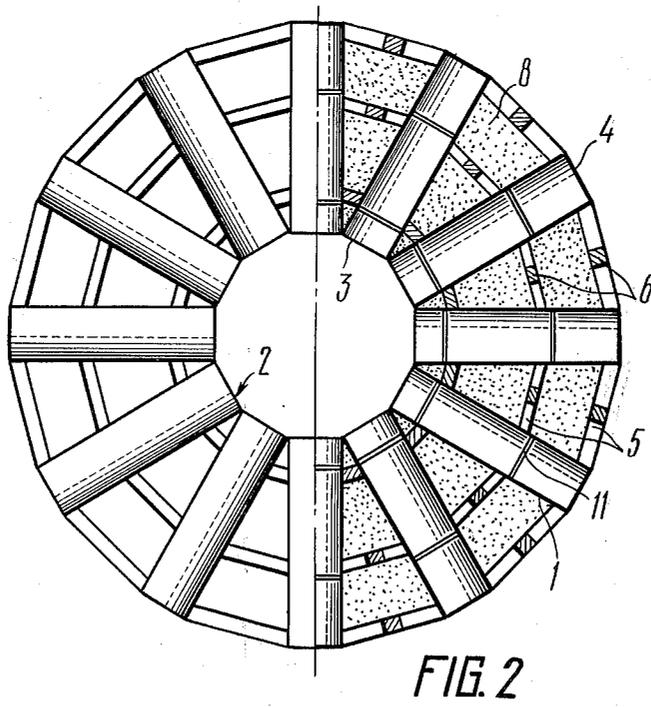
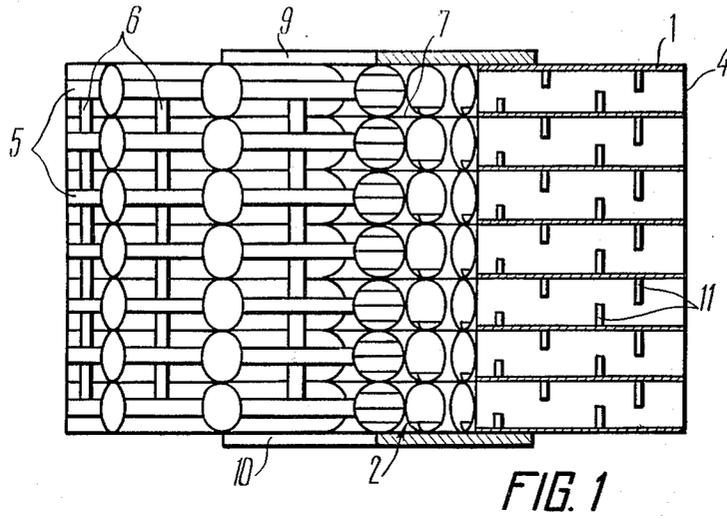
Explosive operating apparatus comprising a chamber formed by the end faces of a plurality of rectilinear pipes contacting each other edge-to-edge. The pipes are disposed at right angles to the imaginary surface of the chamber. The spaces between the end faces of the pipes are sealed off. The length of each pipe is equal to at least one half the smallest dimension of the chamber.

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10 Claims, 2 Drawing Figures





APPARATUS FOR EXPLOSIVE WORKING OF METALS

The present invention relates to the working of metals by an explosion operation, and more specifically to apparatus for explosive working of metals and the apparatus may be used, for example, in the practice of explosive working of metals when powerful charges of an explosive are used in the shop or field.

Apparatus is known for explosive working of metals comprising a chamber which is a single- or multi-layer vessel with a cover plate and bottom. The power developed in the chamber is determined by the permissible amount of the explosive to be detonated thereat and varies with the space in which the products of explosion can expand and with the strength of the body. An increase in the power of the explosion chambers is achievable by enlarging the working space, i.e., its overall dimensions, and strengthening the body and other parts of the chamber. An increase in the overall dimensions of the known chamber may impair its bearing capacity unless the thickness of its walls and the rigidity of the body are also increased (high rigidity is obtainable by using ribbed structures, for example) and so is the strength of the members serving to hold the bottom, manholes, etc. This, however, adds to the costs of production and operating costs of the known high-power explosion chambers.

The necessity of using heavy plate material for the body and other structural members of large explosion chambers entails a number of difficulties inherent in the process of fabrication, particularly those encountered in the stamping and eventual welding of structural elements of the body. A point to be noted is that the strength of the welds joining heavy plates is far less than that of the parental metal, particularly under the conditions of heavy dynamic loads to which the structure is exposed. The high cost of heavy plates is another problem as is its tendency for failure which may result in local defects of the chamber during an explosion. In general, the repair of defects of any nature as, for example, holes pierced by fragments and the like, fails to restore in conventional chambers their bearing capacity in full, e.g. by welding.

The above serves to characterize the most essential disadvantages of the known structures which hamper the development of high-power explosion chambers. In this connection it is appropriate to point out that powerful metal explosion chambers are not available at all at present and large-scale explosive processes for working metal for industrial uses are carried out in various shelters, such as tunnels, mines, etc., which are costly on the one hand and are generally located at a distance from the manufacturing plant on the other hand. As a result, the use of explosion working fails to attain widespread recognition in the industry.

An object of the present invention is to provide an apparatus for explosive working of metals which will allow detonation of the powerful explosive charges required for the fabrication or working of large articles.

This object is attained by providing an apparatus for explosive working of metals comprising a chamber in which the article to be worked and the explosive are disposed, the apparatus being characterized in that the explosion chamber is formed by the end faces of a plurality of rectilinear pipes contacting each other edge-to-edge and arranged essentially at right angles to the

imaginary surface of said chamber, the spaces between said end faces of the pipes being sealed off and the length of each pipe being equal to at least one half the smallest linear dimension of the chamber.

Such apparatus is suitable for simultaneous detonation of high and extra high-power explosive charges for explosive working of metals; moreover, it poses no manufacturing problems and is reliable in operation. It can be fabricated from thin-walled sections (pipes) displaying good mechanical properties and being more flaw-proof than heavy plates. The design is conducive to ease of manufacture, simplifying, for example, the welding of thin-walled members of the body; the apparatus utilizes the load-bearing capacity of the pipe material in a far more efficient way due to the fact that in the case under consideration advantage is taken of the stressing of the pipes in the circumferential and axial directions in succession; the apparatus also minimizes the danger of unserviceability of the apparatus due to local damage which can be rectified by replacing individual pipes by spare ones without impairing the reliability of the apparatus. Furthermore, an apparatus of the design disclosed herein is capable of absorbing the energy of gas flows in each pipe, its length being far longer than the overall dimensions of the chamber, and the fact that the total surface of the members of the body (pipes) is of considerable extent provides for a high rate of heat transfer from the gas flow to the pipes and then into the surrounding medium, preventing the overheating of the pipe walls when the apparatus is used, for example, under conditions of mass production.

According to the invention, contiguous pipes can be interconnected by tie plates and the space between said pipes can be filled with a filler material. Since the mass of the medium exposed to load is increased and the oscillations induced in structural members of the apparatus due to explosions are damped, the bearing capacity of the apparatus is increased by an additional amount.

The outside ends of said pipes can be sealed off so that there is the possibility of evacuating the chamber preparatory to an explosion and furthermore so that the products of explosion are prevented from being distributed into the atmosphere.

The present invention will be best understood from the following description of a preferred embodiment given in conjunction with the accompanying drawings in which:

FIG. 1 is a front elevation view, partly cut away, of the apparatus for explosive working of metals according to the invention; and

FIG. 2 is a plan view of the apparatus shown in FIG. 1 with the cover plate removed.

The apparatus for explosive working of metals comprises a plurality of rectilinear pipes 1 (FIG. 1) of circular cross-section disposed horizontally one above another in several tiers. In plan, the pipes are arranged fan-like and spaced equidistantly so that their end faces 2 facing each other form a cylindrical chamber 3. The edges of said end faces 2 of contiguous pipes 1 contact each other and the axes of the pipes 1 extend at right angles to the cylindrical chamber 3 at the points where each pipe bounds the chamber. In the preferred embodiment, the pipes 1 are disposed radially and the length of each pipe is equal to the diameter of the chamber 3.

The outside ends of the pipes 1 can be closed off by blanking-off plates 4 (FIG. 2) and the pipes 1 are rigidly secured to one to another at more than one point along their length by horizontal tie plates 5 which, in turn, are rigidly secured by vertical tie plates 6.

The spaces between the inside ends of the pipes 1 are closed off by specially shaped inserts 7 welded to the pipes 1 all the way around their circumference by composite welds. The void space between the pipes 1 is filled with a filler material such as sand, soil, metal shot and the like. The chamber 3 is provided with a metal bottom plate 10 and a cover plate 9.

Disposed in the bores of the pipes 1 are lugs 11 securely fixed to the walls of the pipes 1 so that there is a clearance between the ends of the lugs 11 and the pipes 1, said clearance being sufficiently wide to enable the gases to flow, whereas the height of said lugs increases towards each blanking-off plate 4 of a pipe 1. The lugs can be given any shape, and form any angle with the axes of the pipes 1 and be linked up with the blanking-off plates 4 rather than with the pipes 1, a rod disposed axially in each pipe serving this purpose. In this latter case, the lugs are fitted at right angles to the direction of gas flow.

The apparatus for explosive working of metals of the design disclosed can have the chamber 3 of any shape, e.g. in the form of a parallelepiped, cylinder, sphere, hemisphere, etc. In some cases, the arrangement can eliminate the need for traditional members of the known explosion chambers, such as cover plates and bottom plates. Thus, one of the pipes 1 can be used as a tunnel providing access into the chamber 1 and the bottom can be constituted of natural ground, the apparatus being held fast thereto by means of piles. The presence of the blanking-off plates 4 makes the evacuation of the chamber preparatory to an explosion a practical possibility.

The apparatus operates as follows. By analogy with the known explosion chambers, in the apparatus disclosed the articles to be worked and the explosive charge are placed at the center of the chamber 3. After the detonation, the products of explosion scatter around, including in the air which fills the chamber 3 (this applies to the case when no evacuation takes place) a shock wave of a shape close to spherical. On reaching the open ends of the pipes 1, the shock wave disintegrates into a number of separate gas flows which continue their travel along the length of each of the pipes 1. As the flow of gas progresses along the pipes 1, the material of the pipes are stressed circumferentially by the pressure existing behind the front of the gas flow. This action in combination with an intensive rate of heat transfer through the surface of the pipes 1, which is of considerable extent, tends to reduce the temperature and pressure of the gas flows as these progress through the pipes. On impinging against the blanking-off plates 4, the gas flows are arrested and the material of the pipes 1 is axially stressed so that more of the energy of the gas flow is absorbed and the temperature and pressure of the gas flows are further reduced. By virtue of interference coming into play, the interaction of the flows with the pipes 1 brings about damped oscillations of the pipes and a gradual dissipation of the energy, the high rate of heat transfer being another favorable factor along with the dampening of oscillations.

The filler material 8 filling the space between the pipes 1 serves as an additional means of increasing the bearing capacity of the chamber 3; it also adds to the inertia mass of the chamber 3 and enhances the damping effect of the pipes 1 due to the dissipation of the energy in said material 8.

The lugs 11 disposed in the bores of the pipes 1 serve to change the direction of gas flows so as to induce turbulence and cause impingement of the gas flows against the walls of the pipes 11 for the purpose of obtaining a more complete dissipation of the energy of the gas flows. Since the useful section of the pipes 1 decreases towards the blanking-off plates 4, the velocity of the gas flows is reduced at a rate which increases as the gas flows progress down the pipes 1 with the result that these are being stressed longitudinally in a more uniform manner.

The dimensions of the pipes are selected so as to provide for optimum metal requirements, high rigidity of the chamber 3 and the requisite rate of dissipation of the energy of the gas flows inside the pipes 1. Particularly, the length of the pipes 1 forming the chamber 3 is at least one-half the smallest dimension of the chamber 3. The dimensions and number of the tie plates 5 and 6 are selected so as to assure that the strength of the pipes 1 is equal to that of the chamber 3 under the conditions of pulsating and static loads, the latter resulting from the residual pressure of the products of explosion.

The articles to be worked and charges are placed into, and the articles withdrawn from, the apparatus with the aid of material handling equipment, access being provided through the upper opening in the chamber 3 closed by the cover plate 9 or through one of the horizontal pipes 1 serving in this case as an access tunnel. After an explosion, the chamber 3 and the pipes 1 are vented to remove the gaseous products of explosion.

Thus, by virtue of the fact that the main part of the apparatus, i.e., chamber 3, is formed by thin-walled pipes 1, the disclosed apparatus has a bearing capacity higher than that of the known explosion chamber, provided the metal requirements are of comparable order. As a result, the disclosed apparatus is capable of working under the conditions of much more powerful explosions than the known chambers. The ease of manufacture and reliability of large apparatus of the disclosed design are factors which enable their fabrication for mass production by explosive working of metals, using charges as large as several hundred kilograms.

What is claimed is:

1. An apparatus for explosive working of metals comprising a chamber in which articles to be worked an explosive disposed within said chamber can be disposed; said chamber being defined by end faces of a plurality of rectilinear pipes contacting each other edge-to-edge and arranged substantially at right angles to an imaginary surface of the chamber, and means sealing off spaces between said end faces of the pipes, the length of each pipe being equal to at least one-half the smallest linear dimension of the chamber.

2. An apparatus as claimed in claim 1 comprising tie plates rigidly bracing the contiguous pipes to one another, the void spaces between said pipes being filled with a filler material.

3. An apparatus as claimed in claim 1 wherein said pipes have outside ends remote from the end faces de-

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fining the chamber, and means are provided for sealing said outside ends of the pipes.

4. An apparatus as claimed in claim 1 wherein said pipes extend radially from said chamber and are disposed in tiers.

5. An apparatus as claimed in claim 1 wherein said end faces of the pipes are open, and means are provided in said pipes for changing the direction of gas flows therein produced by detonation of the explosive.

6. An apparatus as claimed in claim 5 wherein said means in said pipes for changing the direction of gas flows comprises internal lugs fixed to said pipes and extending thereinto.

7. An apparatus as claimed in claim 6 wherein said

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lugs project into said pipes in progressively increasing amounts the greater the distance from said chamber.

8. An apparatus as claimed in claim 1 wherein said pipes extend substantially horizontally and said chamber has a vertical axis.

9. An apparatus as claimed in claim 8 wherein said chamber has upper and lower ends, and said apparatus further comprises means closing the upper and lower ends of the chamber.

10. An apparatus as claimed in claim 8 wherein said pipes extend radially from said vertical axis of the chamber.

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