Feb. 25, 1941. S. G. FRANTZ 2,233,205

MINING CARTRIDGE

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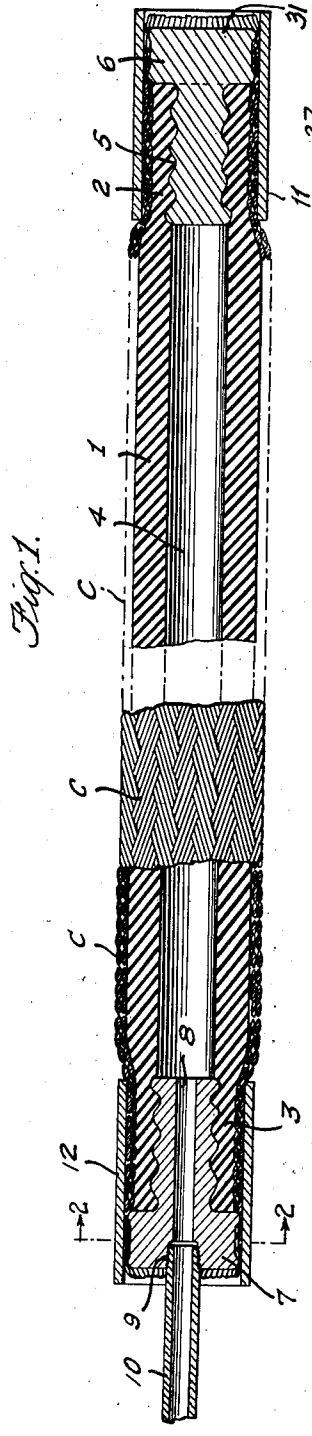

Fig. 1.

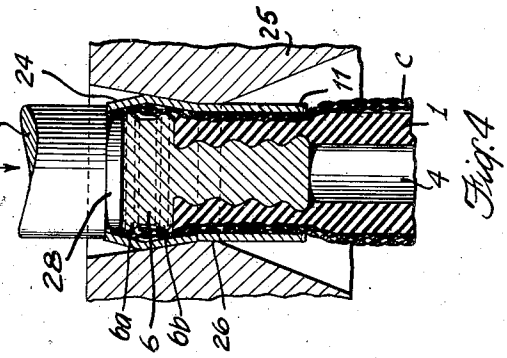

Fig. 4

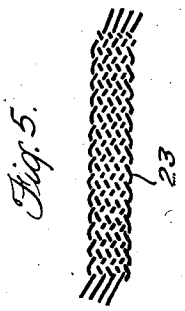

Fig. 5.

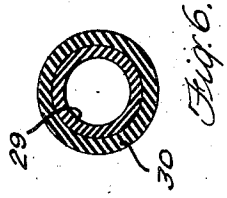

Fig. 6.

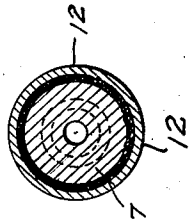

Fig. 2.

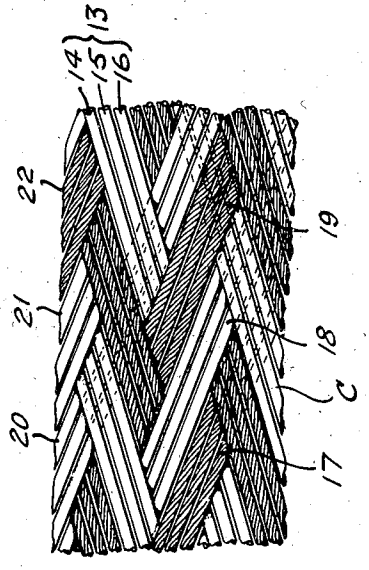

Fig. 3.

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Fig. 7.

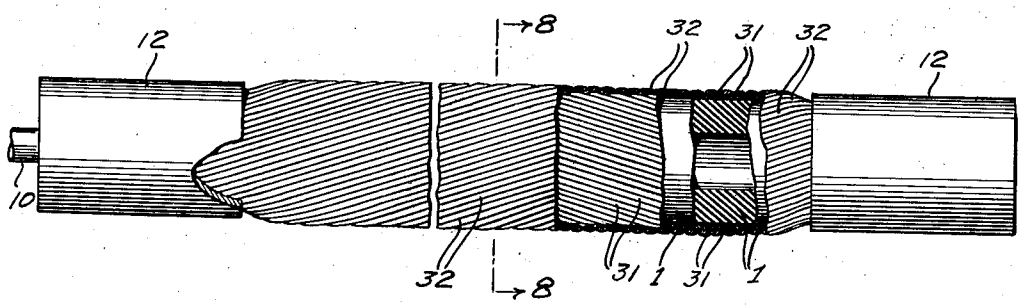


Fig. 8.

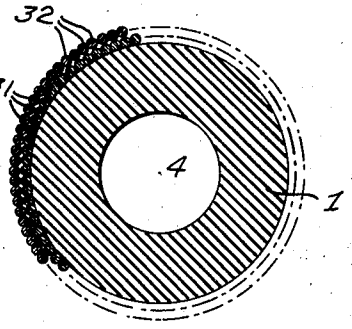


Fig. 9.

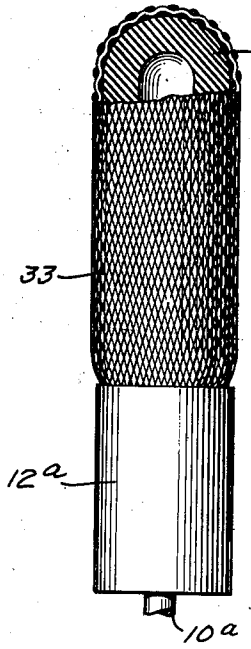
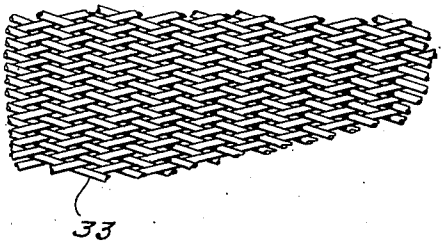


Fig. 10.



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Patented Feb. 25, 1941 2,233,205

UNITED STATES PATENT OFFICE

2,233,205

MINING CARTRIDGE

Samuel G. Frantz, Princeton, N. J., assignor to Brunson S. McCutchen, Princeton, N. J.

Application August 13, 1938, Serial No. 224,660

4 Claims. (Cl. 262—12)

This invention relates to an improved form of mining cartridge of the type disclosed in my prior Patent No. 1,808,162, issued June 2, 1931. In said patent a mining cartridge is described comprising a central rubber container which may be inflated under pressure, the container having a plurality of re-entrant portions and being surrounded by a flexible metallic envelope which expands and contracts with it. It is an object of the present invention to provide in connection with a central flexible container which has an exterior surface of generally cylindrical shape, an enclosing envelope which conforms closely to the form of the central container as it is inflated under a fluid pressure and is so constructed as to have a definite limit of expansion.

An object of this invention is to provide such a mining cartridge adapted to be easily inserted in holes previously drilled in a mass of coal, rock or other material which is to be dislodged and which is provided with a protective metallic covering constructed to permit the ready expansion of the cartridge under the action of an applied fluid pressure.

A further object of the invention comprises a mining cartridge in which a metallic covering of great strength in the form of wires laid spirally and interlaced together is provided.

A still further object is to provide in connection with a cartridge having a flexible central container, metallic end pieces for the container and metallic sleeves for firmly securing a surrounding metallic covering to the end pieces.

Other objects and advantages of the invention will be apparent from a consideration of the specification and drawings:

The following is a description of the invention in its present preferred forms, but it will be understood that various modifications and changes may be made therein without departing from the spirit of the invention and exceeding the scope of the claims.

The invention will best be understood by reference to the accompanying drawings in which.

Figure 1 is a longitudinal section of a cartridge the device being shown as it appears when an expansible bag comprising a part thereof is deflated and, for convenience in illustrating, broken off near the center and with the end of one portion shown in elevation;

Fig. 2 is a transverse section taken through line 2—2 of Fig. 1;

Fig. 3 is an elevation view of a portion of the protective metal covering of the cartridge;

Fig. 4 is a longitudinal section of one end of a cartridge showing the protective wire or cable covering in process of being secured in place;

Fig. 5 is an elevation view of a wire braid which may be used as a wire unit in one form of the protective covering;

Fig. 6 is a transverse sectional view showing a modified form of construction of the expansible container;

Fig. 7 is a view in elevation, partly broken away, of a cartridge having a modified form of protective metal covering;

Fig. 8 is a sectional view taken on the line 8—8 of Fig. 7, looking in the direction of the arrows;

Fig. 9 is a view in elevation, partly broken away, showing a modified cartridge having a further modified form of the protective metal covering; and

Fig. 10 is a fragmentary view showing a portion of the metallic covering of Fig. 9.

An expansible bag 1 formed of rubber or other elastic material and generally cylindrical in form is provided with a generally cylindrical shaped aperture 4 formed through its center. Fitted within the end portions 2 and 3 of the bag are metal plugs 6 and 7 preferably formed of brass, bronze or similar metal, plug 6 being solid so as to form a closure for one end of the bag. Plug 7 is provided with a central aperture 8 terminating in a threaded bore 9 into which may be screwed the threaded end of a pipe or other conduit 10 adapted to supply water or other fluid under high pressure to promote the expansion of the bag. The end plug 6 shown in Fig. 1 may also be perforated, if desired, to facilitate the escape of air from the bag.

In order to limit the expansion of the bag to a definite amount, to prevent its rupture and also to prevent its extension lengthwise when under pressure, I provide a covering generally denoted by the reference character C, which covering surrounds the bag and extends along and over the plugs 6 and 7 to which the ends of the covering are firmly anchored by the metal sleeves 11 and 12.

The covering is composed of flexible, tension-resisting elements which may be wires or cables. These elements are laid helically, making an angle with the axis whose tangent is substantially less than the square root of 2. There is a substantially equal number of these elements laid in opposite directions.

The elements may, for example, be arranged as two separate layers, one outside the other, the inner layer being left-hand pitch and the outer

layer right-hand pitch as shown in Fig. 7, or preferably groups of the helical elements may be braided together to form a tubular braid as shown in Fig. 3, in which the helical wires or cables are arranged in groups of three, each group alternately passing over and under three groups of the opposite directions. For example, the group 13 comprising the elements 14, 15 and 16 passes under the groups 17, 18 and 19 and over the elements of the three adjacent and parallel groups 20, 21 and 22. I have found that this arrangement of the elements provides a covering which contacts the bag at a sufficient number of areas as to adequately support it and at the same time to permit it to dilate a very substantial amount. It will be understood, however, that other groupings and arrangements may be used as, for example, two elements in each group which may be laid over two groups and then under two groups of elements laid in the opposite direction. Also each group of three elements may be replaced by a flat steel ribbon, or a braid composed of a plurality of fine steel wires braided together as shown at 23 in Fig. 5.

It is not essential that the wires forming the metallic covering be interlaced with one another, and in fact the minimum of frictional resistance to distortion is realized when there is no interlacing of the wires. Such an arrangement is disclosed in Fig. 7 in which the parts are all desirably identical with the corresponding parts of Fig. 1, save only that the wire sheath consists of inner and outer sets of wires 31 and 32, which sets are composed of right hand spirally laid wires and left hand spirally laid wires, respectively.

In a tubular structure of the kind under consideration limited by symmetrical sets of right-hand and left-hand flexible tension-resisting elements, such as wires, the tube may be expanded by internal pressure up to a certain point at which the wires are at a certain angle, and at which the volume is a maximum; further application of internal pressure will stress the wires, but will not cause further expansion without rupture of the wires.

If S is the length of one wire in one pitch of the helix, since the ends of the wires are not free to rotate or unwrap, S will be a constant in any cartridge regardless of the diameter at which S is measured.

At any diameter (pitch diameter of the helices) D, the circumference of the cartridge is πD. If the axial length of one pitch is designated x, and the angular inclination of the wires to the axis, α, we have the following relations:

$$\pi D = S \sin \alpha \quad x = S \cos \alpha$$

Now in a tube, closed at the ends and subjected to an internal fluid pressure p, the wall must carry both axial and tangential forces. The total axial tension T_a will be

$$\frac{\pi D^2 p}{4}$$

and if there are N wires in each set of helices, or a total 2N wires, each wire will carry a share of axial tension equal to

$$\frac{T_a}{2N} = \frac{\pi D^2 p}{8N} = \frac{pDS \sin \alpha}{8N}$$

In a section of tube one pitch long let us consider the tangential forces across the intersection with one wall of the tube of a plane passing through the axis. Each wire crosses this line once and only once in the length considered. The tangential force per unit of length is

$$\frac{pD}{2}$$

so that the total tangential force to be carried by the 2N wires in the pitch length x is

$$\frac{pDx}{2} = \frac{pDS \cos \alpha}{2}$$

giving a share of tangential force for each wire equal to

$$\frac{pDS \cos \alpha}{4N}$$

Now if the internal pressure is the only force acting on the structure, the forces per wire given above are the only forces, and since the wires are flexible, the wires will assume such an inclination α that tan α equals the ratio of the tangential force per wire to the axial force per wire, or

$$\tan \alpha = \frac{pDS \cos \alpha}{4N} \div \frac{pDS \sin \alpha}{8N} = \frac{2}{\tan \alpha}$$

Therefore

$$\tan^2 \alpha = 2, \quad \tan \alpha = \sqrt{2}$$

Thus when subjected to internal fluid pressure, a cartridge embodying this invention will expand freely to such a diameter that the wires approach as a limit an angle whose tangent is the square root of 2 with the axis; thereafter further expansion will be prevented, except for such slight amount as is permitted by the elastic elongation of the stressed wires. The less the friction between the elements the closer will be the approach to the limiting angle.

A suitable end construction for a cartridge of the kind described must comprise a closure for the bag 1 which is fluid tight at the maximum pressure to be employed, and also a positive anchorage for each and all of the helically laid elements of the covering C which are under high tension.

The metal sleeves 11 and 12 when tightly compressed into position on the end of the cartridge cooperate with plugs 6 and 7 to accomplish these two purposes. Furthermore, the sleeves must be made strong enough at the inner ends to successfully resist the radial component of tension in the helical elements where they enter the shell when the cartridge is expanded under pressure.

I have found that the end structure of Fig. 1, in which the two functions mentioned are provided for by the relatively soft bag 1 being tightly compressed on the smaller corrugated portion of plugs 6 and 7 and the cover C being tightly held against the larger sections of plugs 6 and 7, without the interposition of the bag material, gives satisfactory results.

In Fig. 4 is shown a practical and advantageous means for adequately securing the covering to the plugs and also for retaining the plugs securely to the ends of the bag. The end sleeve 11 is provided with a main cylindrical portion of larger diameter than the finished sleeve so as to easily pass over the wire covering when in place, its upper end having an inwardly turned conical shaped portion 24, the diameter of which at the top is approximately equal to that of the finished sleeve. The assembly, as shown, is inserted within a female die 25 which at the throat 26 has a diameter equal to the outside diameter of the finished sleeve. Upon application of a high pres-

sure to the plunger 27 of a hydraulic or mechanical press (not shown) the die constricts the sleeve forcing the elements of the covering C into firm engagement with the end portion 2 of the bag and causing its material to enter the grooves 5 formed in the plug, thereby securing the bag and plug together. The inward pressure also forces the material of the wires into the shoulder portions 6a and 6b formed on the enlarged head 31 of the plug, thereby firmly securing and anchoring the plug to the end of the wire covering. Also, as shown, the lower end of plunger 27 has a portion 28 of reduced diameter which engages the end of plug 6 to advance it through the die and upon the completion of the downward stroke of the plunger the outside diameter of the sleeve is substantially the same throughout. This means and method for securing together the several parts comprising the end of a cartridge is inexpensive and at the same time very effective in securing a strong union between the parts.

In structures of this type it has been practicable to realize expansions which caused the diameter to increase in the ratio of approximately 3 to 1.

In the form of the invention described, the bag 1 of Fig. 1 is composed of the same rubber composition throughout. In the modified form shown in Fig. 6, the central portion 29 of the bag is formed of a layer of soft rubber compound capable of being stretched a large amount and an outer layer 30 formed of a tough rubber compound less easily stretched. The layers may be vulcanized together to form the bag unit. Since the inner portion of the bag 1 is called upon to stretch by a much greater percentage than the outer portions, the construction illustrated in Fig. 6 is desirable where large ratios of expansion are required.

In Figs. 9 and 10 disclosure is made of a modified form of cartridge in which the elastic bag 1a is integrally closed at one end, and in which a metallic sheath 33 is made up in the form of a woven wire bag which surrounds the closed end of the rubber bag 1a. The wires composing the sheath 33 extend spirally in opposed directions about the body of the bag and are anchored at their ends within a sleeve 12a in the same manner in which the wires of Fig. 1 are anchored within the sleeve 12 of that figure.

I have described what I believe to be the best embodiments of my invention. I do not wish, however, to be confined to the embodiments shown, but what I desire to cover by Letters Patent is set forth in the appended claims.

I claim:

1. A mining cartridge comprising, in combination, a container generally cylindrical in shape and capable of radial and longitudinal expansion when subjected to internal pressure, and a complete cover for the container arranged to receive the full end thrust of the expanding container and to utilize the end thrust for limiting radial expansion, comprising end closure means and a flexible, protective, pressure transmitting sheath composed exclusively of two sets of helically laid, flexible, substantially inextensible tension resisting elements of equal but opposite pitch secured to the end closure means in torsionally balanced relation, the container as well as the tension elements being secured to the end closure means.

2. A mining cartridge comprising, in combination, a container generally cylindrical in shape and capable of radial and longitudinal expansion when subjected to internal pressure, and a complete cover for the container arranged to receive the full end thrust of the expanding container and to utilize the end thrust for limiting radial expansion, comprising end closure means and a flexible, protective, pressure transmitting sheath composed exclusively of two sets of helically laid, flexible, substantially inextensible tension resisting elements of equal but opposite pitch secured to the end closure means in torsionally balanced relation, said end closure means comprising a plug having a portion of lesser diameter and a portion of greater diameter, the associated container end extending around the portion of lesser diameter only, and the sheath extending around the portion of greater diameter, and clamping means for clamping the container and the sheath directly to the plug.

3. A mining cartridge comprising, in combination, a container generally cylindrical in shape and capable of radial and longitudinal expansion when subjected to internal pressure, and a complete cover for the container arranged to receive the full end thrust of the expanding container and to utilize the end thrust for limiting radial expansion, comprising end closure means and a flexible, protective, pressure transmitting sheath composed exclusively of two sets of helically laid, flexible, substantially inextensible, tension resisting elements of equal but opposite pitch secured to the end closure means in torsionally balanced relation, said container comprising an inner layer of soft rubber compound and an outer layer of a harder rubber compound closely united to said inner layer, both layers being expansible, but the outer layer being tougher and more resistant to expansion than the inner layer.

4. A mining cartridge comprising, in combination a container generally cylindrical in shape and capable of radial and longitudinal expansion when subjected to internal pressure, and a complete cover for the container arranged to receive the full end thrust of the expanding container and to utilize the end thrust for limiting radial expansion, comprising end closure means extending substantially across the entire end faces of said cover and a flexible, protective, pressure transmitting sheath composed of two sets of helically laid flexible, substantially inextensible tension resisting elements of equal but opposite pitch secured to the end closure means in torsionally balanced relation.

SAMUEL G. FRANTZ.