July 26, 1955 L. K. LILJEGREN 2,713,825

FUZE

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Fig. 1.

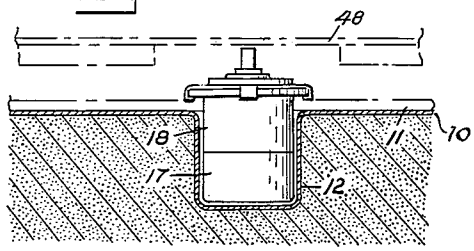


Fig. 15A.

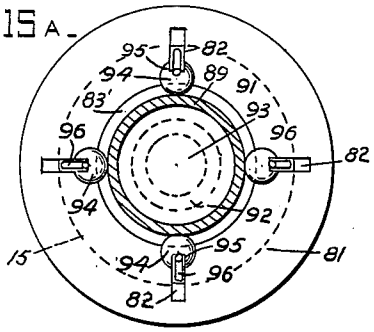


Fig. 8.

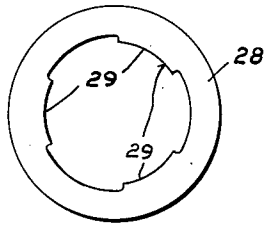


Fig. 6.

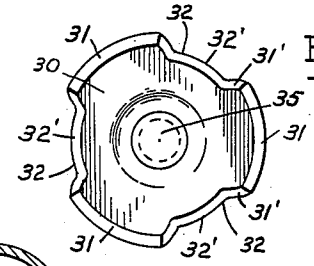
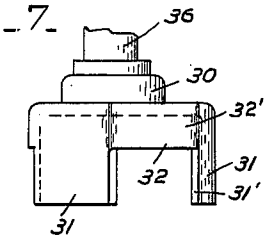


Fig. 7.



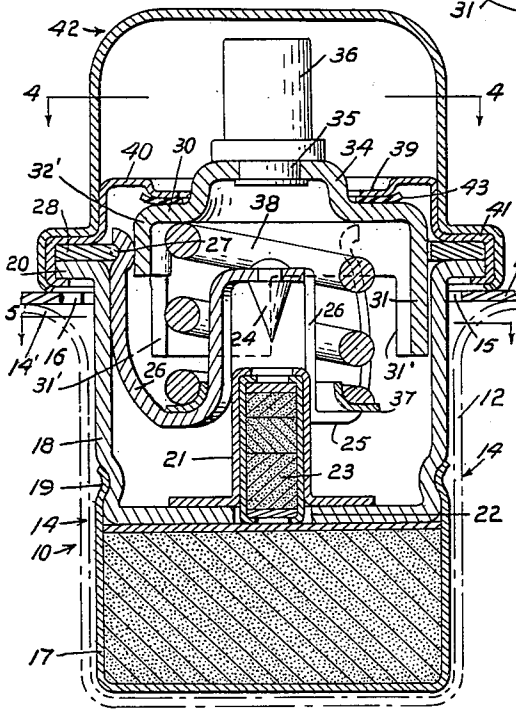
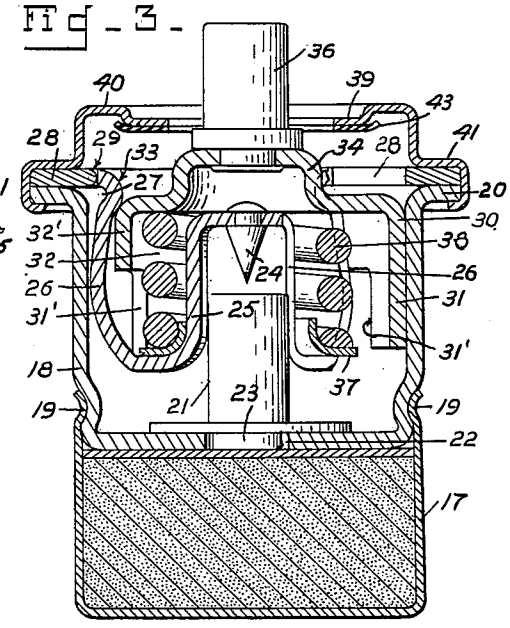


Fig. 2.

Fig. 3.



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FUZE

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Fig. 4.

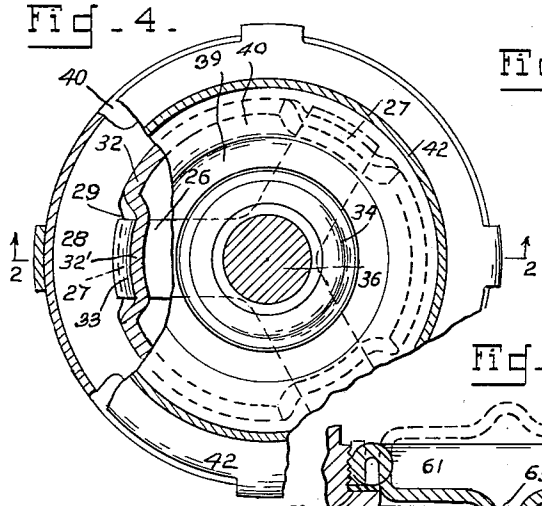


Fig. 5.

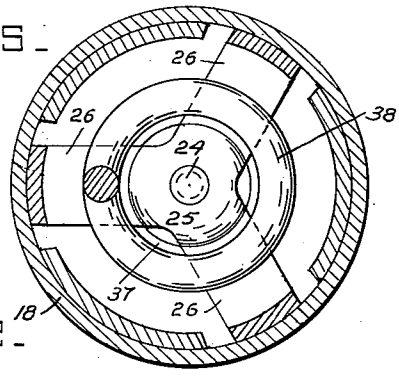


Fig. 12.

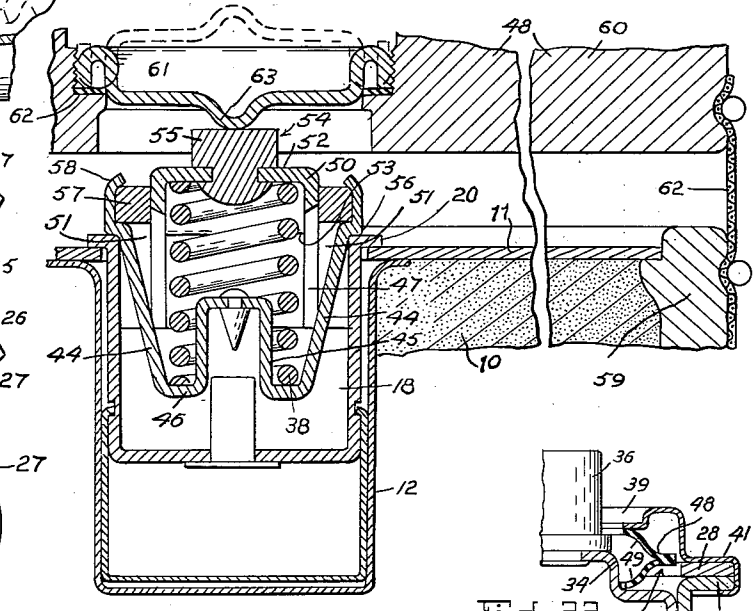


Fig. 9.

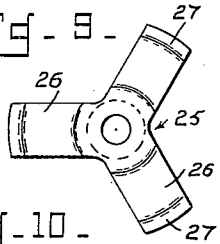


Fig. 10.

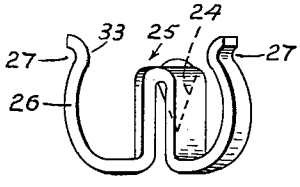


Fig. 22.

Fig. 11.

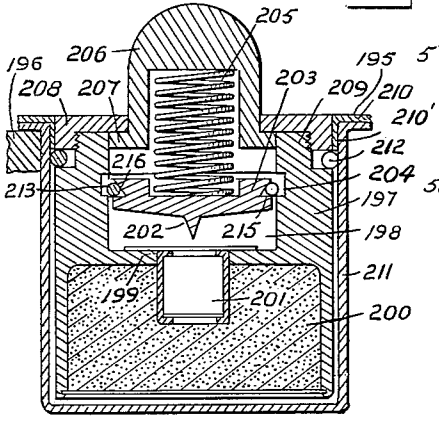
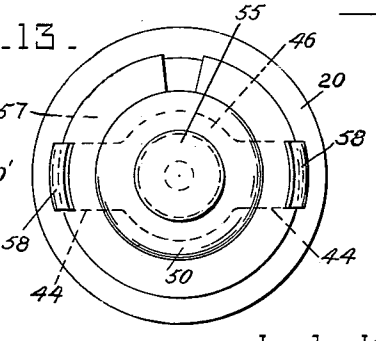


Fig. 13.



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FUZE

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Fig. 14.

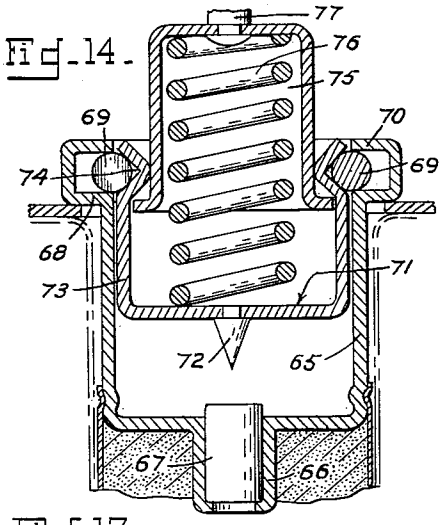


Fig. 15.

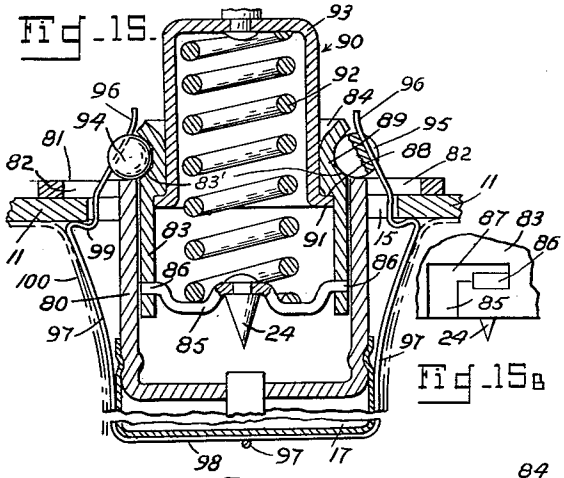


Fig. 15B

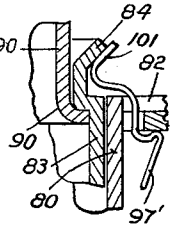


Fig. 15C

Fig. 17.

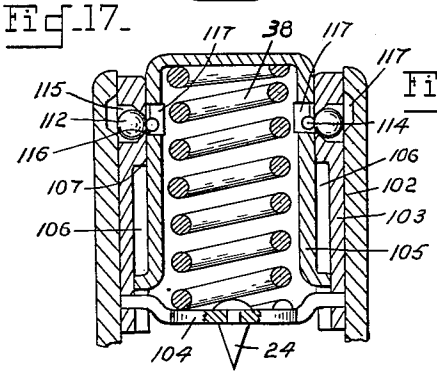


Fig. 16.

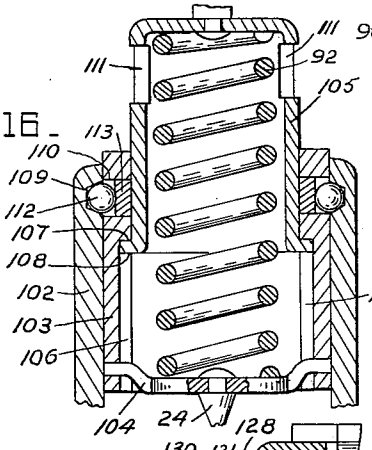


Fig. 18.

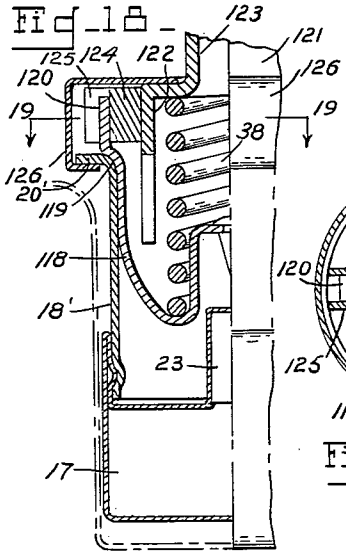


Fig. 19.

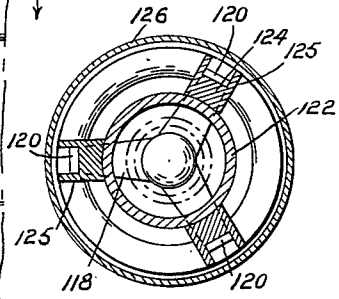


Fig. 20.

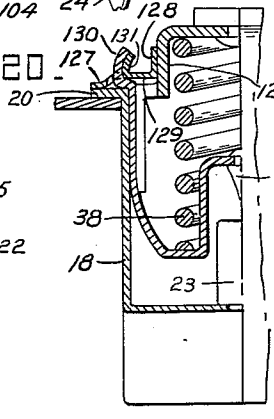
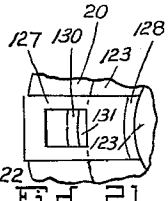


Fig. 21.



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United States Patent Office

2,713,825

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FUZE

Lyle K. Liljegren, Alexandria, Va., assignor to the United States of America as represented by the Secretary of War

Application September 23, 1944, Serial No. 555,565

3 Claims. (Cl. 102—70)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This application is a continuation in part of my prior application Serial No. 523,429, filed February 22, 1944.

The invention relates to detonating devices, ordinarily called fuzes, adapted to operate in response to pressure to detonate a percussion-sensitive explosive, so as to initiate explosion of a mine charge of maximum energy.

It is an important object of the invention to present a construction utilizing a driving spring of ample proportions and power to drive a firing pin into a detonator with great certainty, yet in which the spring is normally free of stress, and the firing pin subject to no force tending to operate it, but on the contrary is locked in a safe position and not capable of release or operation by accidental omission of parts in assembly or failure to completely adjust or properly arrange parts of the device during manufacture or in installations.

A most important purpose is to assure effective functioning of the device in service conditions, to the end that a spring loaded firing pin will be operated with a minimum liability of impairment due to deterioration of materials or impedance by dust or detritus. It is specially an aim to avoid placing the operating spring permanently under stress and also to present a novel means for developing the proper stress and action of the spring immediately on requirement. This contributes to ease and simplicity of assembly, minimizing operations, time and apparatus required.

Along with the foregoing it is also sought to present an article of compact and comparatively small size which may be produced principally from sheet metal stampings, at low cost.

A special aim is to present a fuze which—after arming—will be safe from liability of accidental operation by shock, such as might occur if the article is dropped, and particularly to so construct it that it will be free of liability of functioning by pressure waves and other shocks incident to detonations of nearby mines. In addition to making my mine safer for own personnel, the last mentioned quality makes my mine more effective against the enemy when the latter is conducting mine clearing operations.

A highly important feature of value sought in the invention is a capability of ready concealment in roadways and elsewhere.

Additional objects, advantages, and features of invention reside in the construction, arrangement and combination of parts involved in the embodiment of the invention, as may be understood from the following description and accompanying drawings wherein:

Figure 1 is an elevation of the fuze in safe condition in a mine, approximately actual size as heretofore constructed;

Figure 2 is a vertical cross section thereof greatly enlarged;

Figure 3 is a similar view with the plunger depressed, at the instant of freeing of the spider and firing pin;

Figure 4 is a section on the line 4—4 of Fig. 2, part of the upper case broken away;

Figure 5 is a horizontal section on the line 5—5 of Fig. 2;

Figure 6 is a bottom view of the plunger or pressure cup;

Figure 7 is an elevation of the pressure cup;

Figure 8 is a plan of the anchor ring;

Figures 9 and 10 are top and elevational views of the spider;

Figure 11 is a vertical section of a first modification;

Figure 12 is a similar view of a second modification;

Figure 13 is a top view of the pressure cup and case assembly in the second modification;

Figure 14 is a vertical section of a third modification;

Figure 15 is a similar view of a fourth modification;

Figure 15–*a* is a top view thereof;

Figure 15–*b* is a fragmentary elevation of the lower part of the slide in the fourth modification;

Figure 15–*c* is a fragmentary section of the plunger, slide and case of Fig. 15 showing a modification of the retarder means;

Figure 16 is a vertical section of a fifth modification;

Figure 17 is a similar view of a sixth modification at the instant of release of the slide;

Figure 18 is a vertical section of a seventh modification;

Figure 19 is a section on the line 19—19 of Fig. 18;

Figure 20 is a vertical section of an eighth modification;

Figure 21 is a top view of the spacer in the eighth modification.

Fig. 22 is a fragmentary sectional view similar to Fig. 3, showing the preferred form of gasket between the plunger and upper case.

There is illustrated at Figure 1 a mine **10** comprising a suitably cased high explosive, having a top plate **11** and having a central well **12**, in which there is inserted a fuze **13** to be described. The well comprises a very thin sheet metal cylindrical cup **14** (Fig. 2) flanged and secured to the under side of the plate **11**, which is apertured as at **15**, the cup having a lip **14'** curved outward adjacent the plate, the edges of the latter at the opening projecting over the curved part of the lip so as to afford some space under the plate **11** and over the lip **14'**. A number of small slots **16** are formed in the edge portion of the plate **11** around the opening **15**.

The fuze comprises a booster cup **17** in which a booster explosive such as tetryl may be compressed. A cup-shape case or body **18** is connected by a cannelure **19** with the rim of cup **17**. The upper edge of body **18** is formed with a planiform outturned flange **20** set over the top plate **11** of the mine. The bottom of the case **18** is formed with an axial opening **22** over or in which there is fixed an inverted cup **21** which extends upward into the space within the case **18** and has the usual opening at the top to receive a firing pin. The cup **21** contains a primer **23** in position to be detonated on downward movement of firing pin **24**.

The firing pin **24** is carried by the hub of a spider **25** from which there project three equally-spaced arms **26**. Each arm is first bent downwardly, then outwardly and upwardly, terminating in a plane a little above the hub. The downwardly-extending portions of the arms are spaced to embrace cup **21** with plenty of clearance and the clearance between the lowermost portions of the arms and the bottom of the case **18** is sufficient to permit movement of firing pin **24** into primer **23**.

The arms **26** extend above the flange **20** of the case **18** and have transverse grooves or detents **27** pressed in their outer sides close to their extremities and above the flange **20**. Each arm **26** is offset inward at its extremity

to accommodate the groove, forming a heel at the inner side as at 33. A planiform anchor or detent ring 28 is laid flat on the flange 20 of the case flush with the outer edge of the flange, the inner edge of the ring being alined with the inner vertical rectilinear surface of the case wall except adjacent the arms 26, where as shown in Figure 8 respective inward extensions or flanges 29 are formed thereon projecting inwardly beyond the wall of the case and having rounded edges set in the grooves 27 of respective arms 26. By the hooking of the grooves 27 on the flanges 29 the spider and firing pin are supported against vertical movement in either direction. The upper sides of the grooves 27 slope upwardly and outwardly and on application of adequate pressure downward on the spider the arms, tend to be cammed inward by the rounded edges of the flanges, to free the spider and firing pin for downward movement. A pressure cup 30 shaped as clearly shown in Figures 2, 3, 6, and 7, is fitted slidably in the case 18, and has a generally cylindrical depending wall portion 31, fitted to the wall of the case but crimped at the sides adjacent the arms 26 of the spider 25 so that channels 32 are formed to freely accommodate arms 26. The wall portion 31 is vertically slotted at 31' in each channel 32 from its lower edge opposite each arm to a level below the heel 33, and behind the heel the upper wall of the plunger serves as a stop 32' to engage the heel and prevent inward clearing movement of the arms 26. This unslotted wall part 32' of the plunger extends a distance above the inwardly set heel portions 33 of the arms to a lower flat annular head part of the plunger. The plunger is stamped from sheet metal and has a top head portion 34 centrally raised and substantially horizontal at the extreme upper part and having a tenon 35 of a presser button 36 set therein, this button extending a suitable distance above the head of the plunger corresponding to the length of stroke required, as will appear.

A ring or spider washer 37 is laid on the bases of the arms 26, upon which is set a heavy, helical coil firing spring 38, the upper end of which, when free of pressure, supports the pressure cup 30 in the position shown in Fig. 2 and described subsequently. This spring may be of a size to yield to a pressure of not less than 60 pounds. As a seal for the case, a thin gasket washer 43 of rubber or the like is laid on the lower annular flat part of the head of the plunger, and confined under an annular downwardly pressed flange 39 of an upper case member or stop plate 40 of thin metal, the base of which includes a horizontal part 41 resting on the ring 28, then extending downward therearound and around the flange 20, being crimped inward under the flange 20, so that the case parts and ring 28 are sealed and secured in rigid joined relation. The flange 39 presses the gasket upon the head 34 sufficiently to slightly stress the spring 38 and so maintain a water tight seal there.

As a safety measure, a dome-like protective metal cap 42 is provided, the base of its wall fitted around the upper case 40 and resting on the flat part 41 of the upper case while its edge has tongues extended downwardly around the edges of the ring 28 and flange 20, and slightly crimped thereunder, so that it is securely retained in place during shipment and after assembly of the device on a mine, but may be removed by moderate force applied laterally to one side of the upper part of the cap, or hooked off by any pointed or edged instrument applied to the inturned edge.

In use, the mine bodies 10 may be prepared and shipped to bases, as shown, excepting the firing fuse assembly shown in Figs. 2 and 3. A fuse assembly may then be added to each mine body to complete the mine at the time they are to be distributed for use, the caps 42 being left in place until the mines are emplaced. The complete mine and fuse may alternatively be shipped complete with a high degree of safety. It is an important advantage of the invention that the mines may be armed by removal of the caps 42, and handled extensively thereafter with comparative safety owing to the extent of movement and relatively large force required to operate the plunger. The mine for antitank use will contain about five pounds of TNT although this may be varied as required, and if the mine should be dropped from the hands of a person so as to land inverted with the button 36 engaging the floor or ground, the force of momentum thus developed would be absorbed by the spring 38 without liability of detonation. Likewise, in dropping the device in various positions from considerable heights the factor of safety compares favorably with that attained by use of safety pins or keys as heretofore used in other devices. Liability of accidental detonation due to impact with or by other objects is also at a minimum on account of the low inertia of the fuse article and the low degree of force possible in such shocks in ordinary handling.

The action of the device after mine placement armed for offensive action is as follows: Upon imposition of a weight upon the button 36 exceeding 80 pounds, the plunger 30 is moved downwardly, and this movement may be quite slow without impairing the effectiveness of action of the device. In this movement the spring 38 is gradually compressed, the stress thereof increasing progressively and being communicated to the ring 37 and spider arms 26, which tend thereby to slip horizontally inward on the flanges 29 of the anchor ring and free themselves for downward movement of the hub 25 and firing pin 24. This inward movement of the ends of the arms is prevented at first by the wall 31, until a maximum compression of the spring 38 occurs, at which stage the stop parts 32' of the wall 31 pass below the inset heel portions 33 of the arms, leaving spaces in the channels 32 for the arms to flex inwardly, and the upper lips of the grooves 27 become freed from the flanges 29. The driving spring thereupon reacts downward with great rapidity and force, driving the firing pin into the detonator 23. Detonation is thereby initiated and communicated to the booster and the main charge in the mine.

In Fig. 11 a simplification of the device suited to limited use is shown in which a case 195 is provided having a main charge 196 and having set in its top a detonator and firing unit combined including a fuze body 197 suitably set into the main charge. The body is cylindrical, on a vertical axis, and has a large chamber 198 open through the top of the body, a central bottom port 199 opening therefrom into a lower chamber concentric with the body and having a booster charge 200 therein. A primer 201 is fixed in the port 199 and a firing element is vertically reciprocable in the chamber 198, consisting of a peripherally grooved head 203 and a pin 202 on its lower side, arranged to engage the primer at its lower limit of movement. The wall of the chamber 198 is also grooved at 204 in alinement with the groove of the head 203. The head is centrally recessed and has seated therein a helical spring 205 the upper end of which is entered loosely in a deep recess in the underside of a dome-like pusher 206 of a diameter less than that of the chamber 198, but having a base flange 207 slidably fitted in the chamber and retained by a screw ring 208 engaged on a relieved and externally threaded upper part 209 of the body 197.

The top plate 210 of the mine body is formed with a downwardly flanged opening to receive the ring 208 snugly fitted therein, and a well case 211 is secured to the underside of the plate 210 without the flange on plate 210. A *c*-spring 212 is set under the flange 210' last named and over a shoulder 213 formed by the relief of the upper periphery of the body 197 below ring 208, to hold the detonator assembly in place.

An elastic rubber snap ring and seal or a metal *c*-spring at 214 is fitted around the head 203 between a groove 215 therein and the groove 204, to engage partly in both grooves. The groove 215 in the head 203 is immediately adjacent the top of the head, only a V-shaped edge 216 intervening, so that the snap action is prompt after the

flange 207 of the plunger engages the top of the head 203. The upper side of the groove slopes upward and outward, so as to facilitate outward camming of either the rubber ring or a metal *c*-spring.

In operation of this form of device the plunger descends compressing the spring, but the firing pin is delayed by the ring or *c*-spring 214 until the plunger has nearly completed its movement and positively engages the head 203 of the firing pin. Thereupon, provided the weight on the plunger exceeds that predetermined for the expansion of the ring 214 by the inclined upper wall of the groove 215, the ring 214 yields, allowing the firing pin to be driven against the detonator. In case a rubber ring is used at 214, the compression of the ring to a small cross section, against the angular edges of the grooves may be availed of to permit final detonating movement of the head 203.

In Figs. 12 and 13 there is shown a second modification in which the mine 10, the well 12, the lower case body 18, and the spring 38 may be constructed as before described. The spider or slide has two arms 44 from the cup-like inverted hub 45, extending diagonally upward and outward from an annular base flange 46 on the lower open end of the hub 45 and the arms pass through slots 47 in a plunger 50 corresponding to the slots 32 of the first plunger, the arms 44 extending above the flange 20 of the lower case body. The plunger or pressure cup 50 in this instance closely corresponds to the plunger 30 in form, fit, and function, but differs in that the two diametrically opposed wall parts 51 corresponding to the parts 31 are of less height, being inset at its upper part immediately over the slots 47 and shaped as a continuous cylindrical upper wall 52 of reduced diameter and slight altitude, joined to the lower part 51 by horizontal shoulders 53 between the recessed parts of the wall 51. The head 54 of the plunger extends flat across the top of the wall 52 and has a central flat-top button 55 conventionally set therein.

The arms 44 are bent horizontally outward over the flange 20, forming hanger shoulders 56 resting on the flange 20 and supporting the hub 45 at elevated position around the detonator. The firing pin 24 is fixed in the upper end of the hub 45 as before, and in the position last named is spaced similarly above the detonator. With the spring 38 set on the flange 46 of the hub and within the wall 52 against the head 54, approximately free of load, the shoulders 53 are at a level with the upper sides of the hanger shoulders 56. A split ring 57 square in section, with rounded outer corners is set on these shoulders 53 and extending outwardly over the shoulders 56 a short distance. The ends of the arms 44 are bent upwardly close against the outer face of ring 57 forming presser fingers 58, the extremities of which are slightly inturned over the ring to retain the same against upward displacement. The ring 57 is a split metal ring or *c*-spring normally under contractile stress tending to assume a smaller diameter, and so binding upon the wall portion 52. The arms 44 may also have a set tending to swing inward so as to clear the upper end of the case body 18 and flange 20, although this is not essential. The shoulder 56 may be inclined upward toward its outer part if desired, so that when free otherwise the end of the arm may be readily cammed inward by the top of the case under an adequate load on the spider. It will assume some inclination by flexing of the arms 44 under load of the spring, however.

The detonators herein may be utilized in various ways either as roadlocated units as in the preceding descriptions wherein the plungers or buttons may be directly engaged by tracks or tires of vehicles or the feet of personnel, or they may be used in conjunction with pressure-sustaining and transmitting means, such as a board or other piece laid across the plunger or button in such manner that the board will yield to passage of a vehicle, or they may be set in various forms of mines, with load communicating members 48. Thus in Fig. 12 I have shown a portion of a ceramic container 59 or basin in which the bursting charge is contained, and over this a presser plate 60 is mounted in spaced relation, having a large superficial area and supported on the button 55 by means of a knob 61 screwed removably in the plate 60 and having a central reduced nodule 63 resting centrally upon the top flat face of the button 55. The plate 60 is horizontally coextensive with the basin 59 and spaced sufficiently therefrom so that if one side of the plate is depressed to the lip of the basin it may be still depressed centrally as a lever, to move the plunger downward for the full stroke of the latter in the degree to be described. Similar means for operating other of the fuse forms herein shown may also be utilized. A flexible closure 62 is shown lapping the opposed edge portions of the basin and plate 60.

In the operation of the fuse of Fig. 12 when the plunger is moved downward, spring 38 is compressed upon flange 46 of the spider, wall portion 52 sliding downward within ring 57. Movement of the firing pin is opposed by engagement of shoulders 56 on the upper edge of the case 18, and clearance of these hanger parts from the case is prevented by the ring, which in turn is prevented from contracting by the wall portion 52 until the head 54 passes below the ring. As soon as the latter extent of movement is completed the contraction of the ring and the inward spring or camming of the arms 44 frees the spider and the spring thereupon impels the spider downward driving the pin 24 into the detonator.

The knob 61 in the present instance is recessed opposite the button-engaging part, and may be removed and replaced in inverted position, as a safety cover, in which event the recess in the knob will accommodate the button 55 without operation of the latter, when the plate 60 is depressed.

In Fig. 14 I have shown a fuze unit adapted to be similarly set in a mine. It is principally an embodiment of the device of Fig. 12 using a rubber ring or split metal ring at 69, and adapted otherwise to be stamped entirely from sheet metal.

The case 65 is a cylindrical drawn cup member to fit in the fuze well of the mine, and having a reduced integral depending tubular neck 66 at its bottom in which the detonator 67 is set, a booster being held thereon in the same manner as first described. The upper edge portion or lip of the case is flanged at right angles at 68, so that the flange may set over the top of the mine as before, and an expansible split ring 69 is set thereover, retained by inturned tongues 70 formed as radial extensions bent upward and then inward parallel to the flange 68. The ring is free for radial sliding expanding and contracting movement of the ring under the tongues. The firing pin spider 71 comprises a disc having the firing pin 72 centrally set therein on the underside as before, the disc having arms 73 extended upwardly, slidably fitted in the case, and having upper hanger end portions bent inwardly and then outwardly forming laterally open V-shaped recesses 74. The distance vertically across the open side of the recess in each arm is approximately equal to the cross sectional diameter of the ring, so that the latter may set a substantial distance within the recess, and prevent upward or downward movement of the spider except by inward yielding of the arms 73 or outward expansion of the ring 69. With the ring set in the V-shaped recesses 74, the firing pin is supported in elevated position as shown. The plunger 75 is a simple inverted cylindrical cup set over the firing pin disc and of a diameter to fit slidably between the arms 73 below the V-shaped portions of the arms. It is outwardly flanged at its lower part so that it cannot be withdrawn past the V-shaped parts after assembly, and a helical spring 76 is set over the disc of the spider and extended upward within the plunger and confined suitably by the

closed upper planiform head end of the plunger, as illustrated. This head may have a button 77 set therein extended upwardly to a sufficient distance to assure full stroke operation of the plunger by engagement of traction elements of passing vehicles thereon or the like. The height of the plunger is somewhat greater than the vertical distance from the disc of the spider to the angle at 74, so that the arms 73 are not permitted to flex inward at any time in this device.

On operation of the plunger 75, it will yield to comparatively moderate weight so as to put the spring under adequate stress to operate the firing pin when the spider is released. After full compression of the spring, however (which may yield to, say, fifty pounds pressure), and engagement of the spider disc by the open lower end of the plunger 75, the ring 69 still opposes downward movement of the spider, owing to the support afforded by the outer sides of the V-shaped parts engaged partly over the ring. If the weight applied is less than that predetermined and governed by the proportions and treatment of the material of the ring 69, the fuze will not be fired at all, and if the weight causing the partial operation is removed, the device will return to initial or normal armed condition. This is also true of the devices of Figures 12 and 13 if constructed to function similarly with corresponding inclination of the shoulders 56 and proportioning of the parts. The ring 69 may oppose expansion by the arms when weight is applied to the button 77, up to several hundred pounds, depending on the intended operation of the mine. Thus, it may be desired to avoid detonation by personnel, or even light motor vehicles, and to effect detonation only after depression of the button by some such vehicle as a tank. Or it may be proportioned so as to yield to lesser weights.

In the device of Figs. 1 to 10, after the head 34 has passed to a sufficiently low level to clear the parts 27, the strength of the spring 38 will ordinarily be sufficient to drive the firing pin downward, but in case of an impedance of the movement of the slide which the spring can not overcome, the upper ends of the slots 31 will engage and positively move the arms 26 downward.

The plunger in all forms of the invention may be said to have a detonating position when the slide is able to operate by the force of the spring. This position in the device of Figures 1 to 10 may be that at which the stop portion 32' passes below the heel 33, or if the device functions as in Fig. 12 and others, it may be that position immediately after the lower edge of the plunger has positively engaged and moved the slide and has cleared the latter from the impedance to its movement by the rings such as 69 or 57.

In Figs. 15 to 15c there is illustrated a construction in which a case 80 is provided similar to the one 18 with the exception that its top flange 81 is radially slotted as at 82 at a number of places. It is set in the top of a mine in the same way as before described with the attached booster cup 17 before mentioned. A cylindrical slide body 83 is set in the case, having an external circumferential channel 83' forming an upwardly sloping wiper lip 84 adapted to move downward into the case 80 on firing operation.

A spider 85 is set in the bottom of the slide body 83 so as to form part of the slide and having the firing pin 24 set thereunder as in the other forms of the device described herein. The spider is a simple disc having a plurality of radial tongues 86 thereon, offset slightly upward and engaged in bayonet slots 87 in the lower edge of the open lower end of the slide body. The inner ends of the slots 87 have drops or deepened inner portions into which the tongues 86 drop to prevent rotary movement of the latter outward from the slot as long as the disc is pressed upon by the driving spring.

The channelling of the upper end of the slide presents an interior shoulder 88 within the slide, and a cylindrical neck portion 89 of the same reduced diameter extending from the shoulder 88 upward to the base of the lip 84. A plunger 90 is provided consisting of a simple cylindrical inverted cup with an outturned flange 91 of small radius at its lip. The body of the plunger is fitted slidably in the neck 89, and its flange 91 is engaged under the shoulder 88 and slidable within the plunger. A driving spring 92 is set within and initially slightly confined between the head 93 of the plunger and the spider—that is to say, it is not under compression sufficient to drive the firing pin, but may be fitted so as to avoid rattling movement. The height of the plunger is somewhat greater than the distance from the tops of the tongues 86 to the top of the slide.

Set in the channelled upper end of the slide and over the flange 81 in Figs. 15 and 15–a, there is a plurality of balls 94 of a size to rest with their centers over the wall of the case and their inner parts against the neck 89 and flange 84 as in Fig. 15. These balls have shallow kerfs 95 in which there are set respective arms 96 of two wire springs 97, substantially U-shaped and having flat bights 98 set across the bottom of the booster case, the arms of each spring being engaged in diametrically opposite balls.

The extremity of each arm is inclined inwardly at its upper part and the spring is tensioned so as to bear inwardly and downwardly on the balls. Thereby, the balls support the slide in elevated initial and normal safety position. The arms of the spring extend downwardly through the top plate 11 of the mine and rest against the edge of the aperture 15 in this plate. Immediately below the plate 11 each arm of the springs is formed with an outturned shoulder-like part 99 close to or against the plate 11 and holding the spring against upward movement from within the well 100 of the mine, the well being channelled or flared at the upper part to accommodate the parts 99. By this construction the fuze being assembled complete as in Fig. 15, but apart from the mine, may be presented through the aperture 15 in the top plate of the mine and forced into the well until the shoulder portions 99 of the springs snap laterally outward from the fuze and engage under the plate 11 as a retainer for the fuze assembly. The springs are shaped initially so as to spring outwardly at the shoulder parts 99, by reason of the bearing of the end portions of the arms upon the balls. The bearing of the springs on the balls is in such direction that the slide and plunger assembly is held in place in the case, and the spring thus serves the triple function of retaining the fuze assembled; securing the fuze in the mine, and as a loader for the slide and firing pin by opposing outward movement of the balls until the driving spring is under sufficient compression to cause outward camming of the balls by the wiper lip 84, or until the plunger directly presses the slide downward against the opposition of the balls.

In the operation of this device, when the plunger is depressed the driving spring 92 is compressed, and before the lower edge of the plunger engages the spider the spring is under more than ample operating tension to drive the firing pin into the detonator. But by increasing the strength of the springs 97 the movement of the slide may be opposed until the plunger engages directly against the spider. Then the flange 91 finally engages the bases of the tongues on the disc of the spider 85, so that the full weight of the operating object is applied directly to the slide. This finally causes the lip 84 to cam the balls outward against the opposition of the springs 97, if the predetermined operating weight is equalled. The lip 84 finally clears the balls and frees the slide, which is thereupon driven downward by the spring 92, until the firing pin engages the detonator.

If desired, the balls 94 may be omitted, and the spring suitably shaped as at 97' in Fig. 15–c to present inclined wiper ends 101 to engage slidingly under the lip 84 in place of the balls.

In Fig. 16 there is shown a further modification in

which a cylindrical case **102** is provided which may be installed in ways analogous to the use of the cases before described, and a slide **103** similar to the one **83** is fitted therein with a spider **104** set across its bottom similar to the spider **85** and held in the slide in the same way. The wall of the slide is thickened, and a plunger **105**, somewhat similar to the one **93** in Fig. 15 is engaged in the slide in the same relation as first described, and a driving spring **92** is similarly mounted thereunder.

The wall of the slide has a plurality of longitudinal channels in its lower part as at **106**, stopping at shoulders **107** at their upper ends, and the plunger is formed with outturned flanges **108** at its lower end engaged in respective channels **106**, to hold it against rotation in the slide and to limit its upward movement therein.

A circumscribing groove **109** is formed in the inner face of the casing **102** near its top, and the slide has formed therethrough a series of ports **110** in such position as to register with the groove **109** when the slide is at the upper limit of its movement in the case, which is its normal and initial safe position. The plunger also has a similar series of ports **111** adapted to register with the ports **110** when the plunger is near the lower limit of its movement in the slide. A ball **112** is provided for each port in the slide, of a diameter approximately the same as the thickness of the thick wall of the slide above the channels **106**, and the groove **109** is of a depth from the inner face of the case to the bottom of the groove approximately equal to one half the diameter of the balls. The lower sides of the grooves are inclined downward and inward.

With the plunger elevated and the balls equally engaged in the grooves and respective ports of the slide, a spacer **113** is located in the inner part of each port **110** of the slide, between the ball and the side of the plunger, these spacers serving to hold the balls outward in the groove in position where they will support and prevent downward movement of the slide by engaging the lower side of the groove and the upper sides of the ports **110**. The groove is of such width as measured longitudinally of the case as to fit the balls and the ports **111** are proportioned so as to fit close to the balls at top and bottom, thus preventing movement of the slide either upward or downward. The spacers **113** and ports **110** may be either circular or rectangular. The ports **111** of plunger may be slightly larger and extend higher than the ports **110**, and the spacers **113** are rounded at their outer edges to facilitate their sliding movement into the ports **111**, as will appear.

In the operation of this device the driving spring is loaded except on downward movement of the plunger, and as the plunger is depressed tension of the spring increases until the ports **111** register with the ports **110**. Thereupon the pressure exerted by the driving spring causes camming of the balls inwardly by the lower side of the groove **109** and the balls bear against the spacers **113**, forcing the latter inwardly into the ports **111**. The latter extend sufficiently high in the plunger to be clear of the spacers during further and final movement of the plunger after first registry of the ports **111** and **110**, so that free, full clearing movement of the spacers is assured. After the balls have moved inward a short distance, the camming action of the groove will develop greater effectiveness as the lower side of the groove engages more elevated parts of the balls which incline at a more acute angle to the direction of pressure being exerted on the balls. The latter will thus complete their final movement rapidly and clear the slide for free downward movement. This movement of the slide will now occur, the slide carrying the balls with it in the ports **110**, and the firing pin **24** in the spider will engage any detonator which may be positioned in proper relation thereto.

In Fig. 17 the structure is the same as that of Fig. 16 excepting the form and size of the ports in the slide **103** and plunger **105'** and the spacer. In this instance a small ball **114** is utilized as the spacer, its diameter being approximately one half that of the ball **112** or less, and the inner side of the port **115** in the slide is tapered to an elevated aperture **116** forming the inner opening of the port, this aperture being slightly larger than the small ball. The port **117** of the plunger has its lower side positioned to clear the aperture **116** when the plunger nears the lower limit of its movement, and may extend to any suitable height to avoid interference with the ejection of the small ball through the aperture **116**. The functioning of this device is substantially the same as that of the device of Fig. 16, but enables the use of small stock steel balls for the spacer, and the tapering of the port **117** obviates irregularity of spacing function of the small ball by centering it with respect to the larger ball, at initial positions of the parts.

In Figures 18 and 19 there is a cylindrical case **18'** open at the top and closed at the bottom by a plate with detonator **23**, and a booster case **17** adapted to be set in the mine well in the same way as in the species previously described. A slide **118** similar to **25** (Figs. 9 and 10) is shown but instead of the extremities of its arms having the hook recesses, the end portions of the arms are turned outward to form shoulders **119** which may set over the top edge **20'** of the case **18'**, and from the outer part of each shoulder a finger **120** is extended upwardly a short distance. The anchor ring **28** is omitted. The driving spring **38** is set on the slide as before and the plunger **123** engaged thereover as before. The plunger **121** in this instance corresponds generally to **31** (Figs. 6 and 7) but does not require channels therein, the wall of the plunger having an inset cylindrical stop wall **122** extending entirely around the head **123** of the plunger. The fingers **120** lie parallel to the stop portion **122** before described, and set between the fingers **120** and stop **122** there are detent or spacer blocks **124**, each having small lugs **125** extended outwardly on each side of the finger **120** to prevent displacement of the block circumferentially from the finger. An upper case **126** corresponding to the one **40** is provided, enclosing the upper body of the plunger and the fingers **120** and blocks **124**, its top being apertured to receive the upwardly pressed central head portion **123** of the plunger.

The blocks **124** prevent the shoulders **119** from drawing inward as long as the plunger is elevated sufficiently for the stop **122** to engage inner sides of the blocks. When pressure is applied to the plunger, the driving spring is loaded and as the stops **122** move below the blocks, the slide is freed and is driven with the firing pin **24** into engagement with the detonator.

Other features of construction applicable to this last described device, may be added combined or applied as elsewhere disclosed herein or otherwise developed.

The device in Fig. 20 may have parts corresponding to all those described in Figs. 18 and 19, but the detent or spacer block **127** here comprises a small rectangular blank of sheet metal bent to substantially L-shaped form so as to form an upstanding inner wiper plate **128** bearing against the stop **122** and a base plate **129** lying slidably on the top flange **20** of the case, extending outward from the stop **122** of the plunger. The latter plate is apertured to receive the upwardly extending finger **130** of the spider arm therethrough, the material of the plate displaced to form the aperture being struck upwardly but left attached at the inner side of the aperture, curved upward and inward to form a thrust flange **131** against which the finger rests. In addition the finger extremity is curved inward slightly over the thrust flange and serves to retain the block **127** against slipping longitudinally upward from the finger.

The function of this device in operation is substantially the same as that of the device of Fig. 18, as described above.

It will be apparent that a device may be constructed

embodying features from several or all of the forms illustrated, and while the invention has been shown and described meticulously in the best forms thus far devised, it will nevertheless be understood that these are purely exemplary and that various modifications of construction, arrangement and combination, substitution of material and equivalents, mechanical or otherwise, may be made without departing from the spirit of the invention set forth in the appended claims.

It will be understood that where the ring **28** is not used, and if it is omitted from the device of Figs. 1 to 10, with corresponding modification of the hanger arms to engage over the flange **20**, the latter and/or corresponding parts in the other views or modifications may be termed an anchor flange.

A preferred form and application of gasket **43** to maintain a water-tight closure at all times between the flange **39** of the upper case and the plunger **30** is shown in Figure 22, where the gasket **43** is shown at an accordion element having a single fold or pleat **48** presented outwardly, and two inwardly extended leaves **49**, the edges of which are continuously cemented respectively to the flange **39** and the lower flat of the head **34** of the plunger.

I claim:

1. In a percussion fuze, a tubular casing having one flanged end open, a primer cup in said casing centrally fixed to the other end thereof and projecting axially upwardly therefrom, a spider comprising a central portion and a plurality of radial resilient arms, each said arm extending downwardly, then radially outwardly, then upwardly and terminating in a detent above the level of said central portion, said downwardly-extending portions loosely embracing the upper portion of said primer cup, a downwardly-projecting firing pin depending from said central portion, an annular detent ring secured to the flange of the open end of said casing and projecting radially inwardly of the inner wall of said casing, an inverted generally cylindrical pressure cup having its side walls engaging said detents to hold the same in engagement with said ring to initially immobilize said spider with its firing pin spaced above said primer cup, an initially unstressed compression coil spring seated at one end on the radially outwardly extending portions of said spider arms and seated at the other end on the closed upper end of said cup, said pressure cup acting to compress said spring in response to initial downward movement of said cup between said detents and thereby urge said spider downwardly, said pressure cup moving out of contact with said detents after a predetermined downward movement to thereby release said spider and firing pin to the action of said spring.

2. A percussion fuze as recited in claim 1, said pressure cup slidably fitting said casing and having inwardly-pressed axial channels in its peripheral wall, the bottom of each channel initially engaging a respective detent to hold the same in position over said ring.

3. In a percussion fuze, a cylindrical casing having an outwardly-turned flange at one end and having its other end closed except for a central aperture, a primer cup secured in said central opening and extending into said casing, a spider comprising a central portion and three equally circumferentially-spaced arms projecting therefrom, each said arm being bent axially in a direction toward said cup, then radially outwardly, then axially in the other direction and terminating in a detent, a firing pin secured to and depending from said central portion, a detent ring on said flange and having radially inwardly projecting portions each engageable with a respective detent, an inverted pressure cup slidably fitting said casing and having three axially-extending channels in its side walls, the bottom of each channel engaging a respective detent to hold the same in engagement with said ring and thereby immobilize said spider, a normally unstressed coil spring seated at one end on the radial portions of said spider and at the other end on the bottom of said cup, an operating button centrally secured to the bottom of said cup and projecting upwardly therefrom, a centrally apertured stop plate restricting motion of said pressure cup out of contact with said spring, and a protective cap enclosing said button, said protective cap and plate having mating flanged ends crimped over said detent ring and casing flange to secure said casing, ring, plate and protective cap in assembled relation, said pressure cup, when forced inwardly by pressure on said button, stressing said spring and releasing said detents after moving a predetermined distance, to thereby effect movement of said firing pin into detonating relation with said primer cup.

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