Jan. 13, 1953 K. C. BUGG 2,625,104

BLASTING SHELL AND TIMING MEANS THEREFOR

Filed Feb. 4, 1950 4 Sheets-Sheet 1

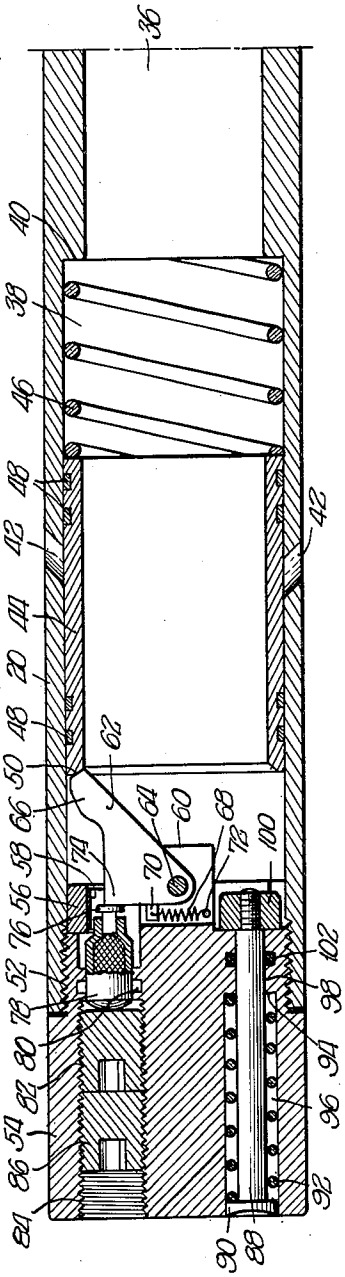


Fig. 1

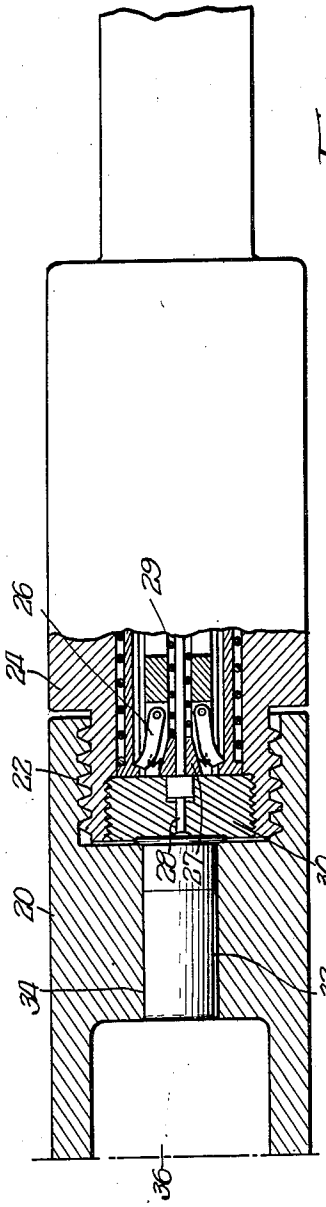


Fig. 2

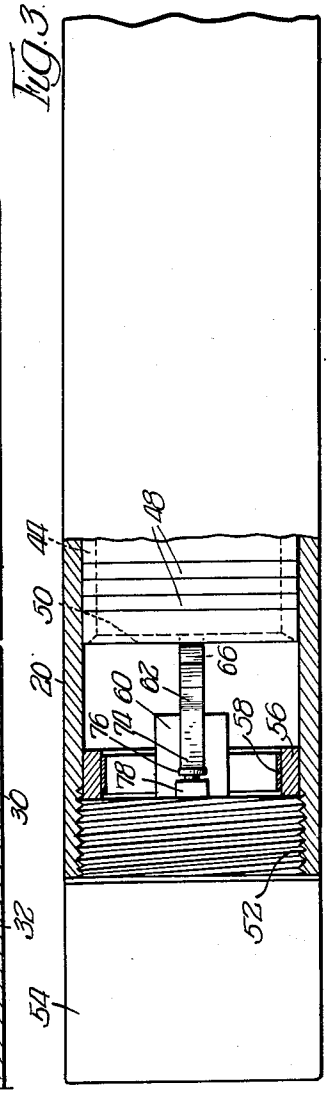


Fig. 3

INVENTOR.
Kenly C. Bugg,
BY Wilkinson, Huxley
Byron & Hume
Attys.

Jan. 13, 1953 K. C. BUGG 2,625,104

BLASTING SHELL AND TIMING MEANS THEREFOR

Filed Feb. 4, 1950 4 Sheets-Sheet 2

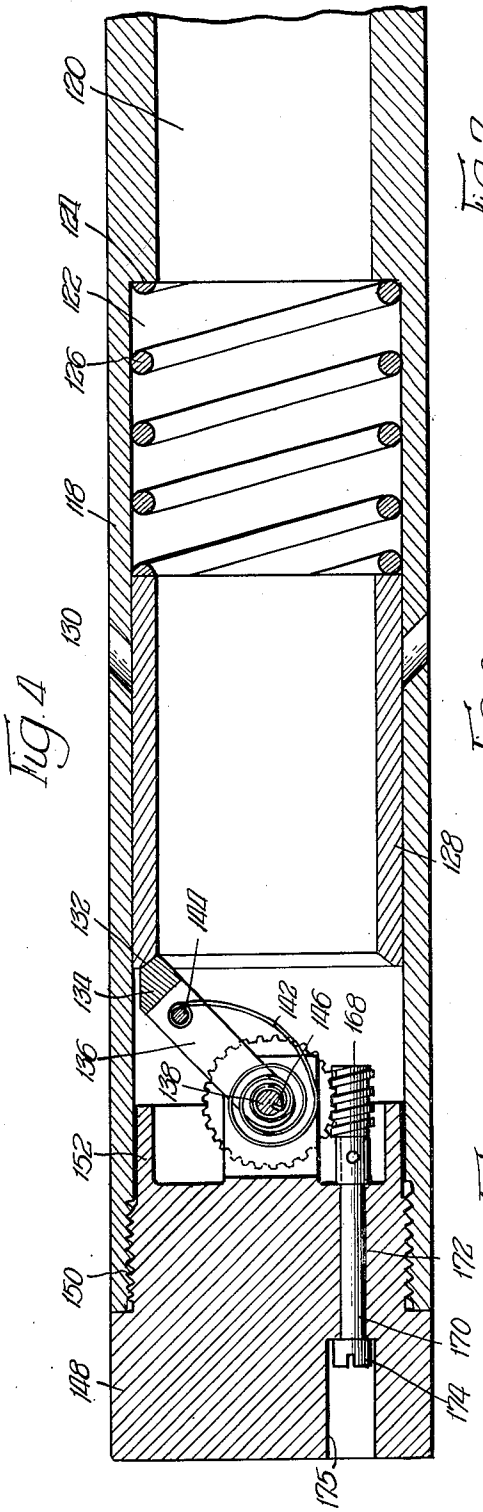


Fig. 4

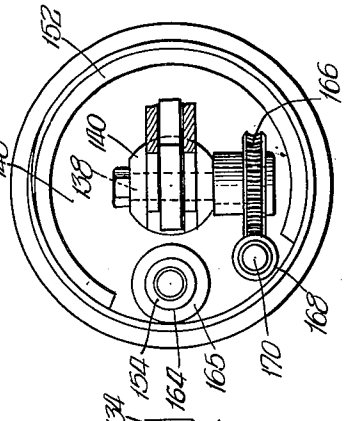


Fig. 7

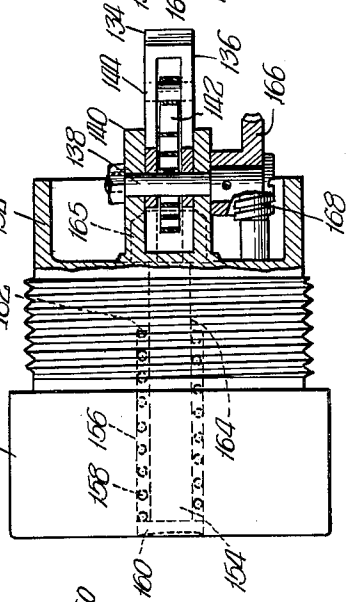


Fig. 6

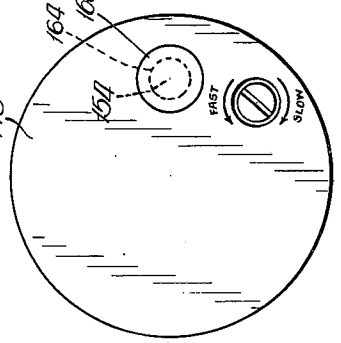


Fig. 5

INVENTOR.
Kenly C. Bugg,
BY
Atkinson, Huntley,
Byron & Hume
Attys.

Jan. 13, 1953 K. C. BUGG 2,625,104

BLASTING SHELL AND TIMING MEANS THEREFOR

Filed Feb. 4, 1950 4 Sheets-Sheet 3

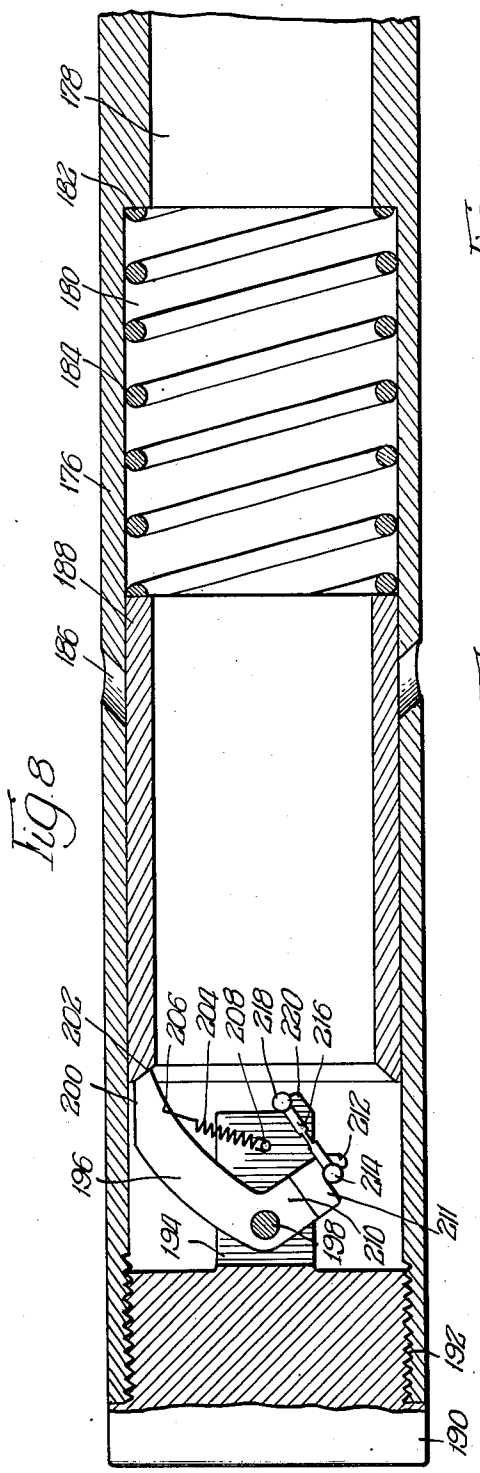


Fig. 8

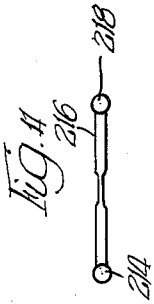


Fig. 11

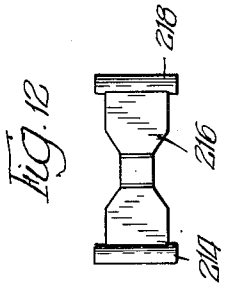


Fig. 12

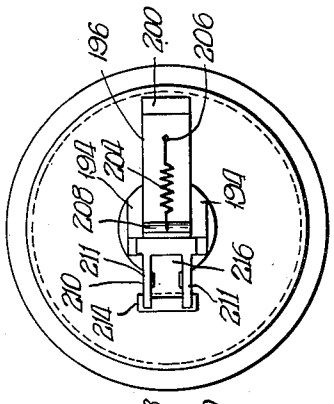


Fig. 10

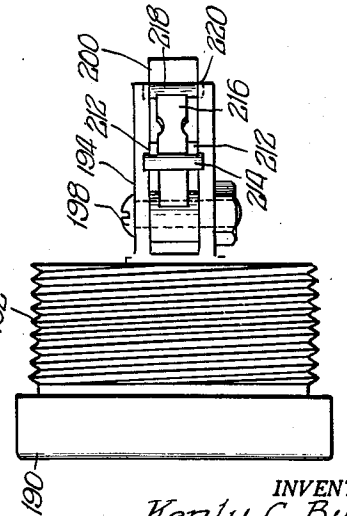


Fig. 9

INVENTOR.
Kenly C. Bugg,
BY Atkinson, Hurley
Byron & Hume Attys.

Jan. 13, 1953 K. C. BUGG 2,625,104

BLASTING SHELL AND TIMING MEANS THEREFOR

Filed Feb. 4, 1950 4 Sheets-Sheet 4

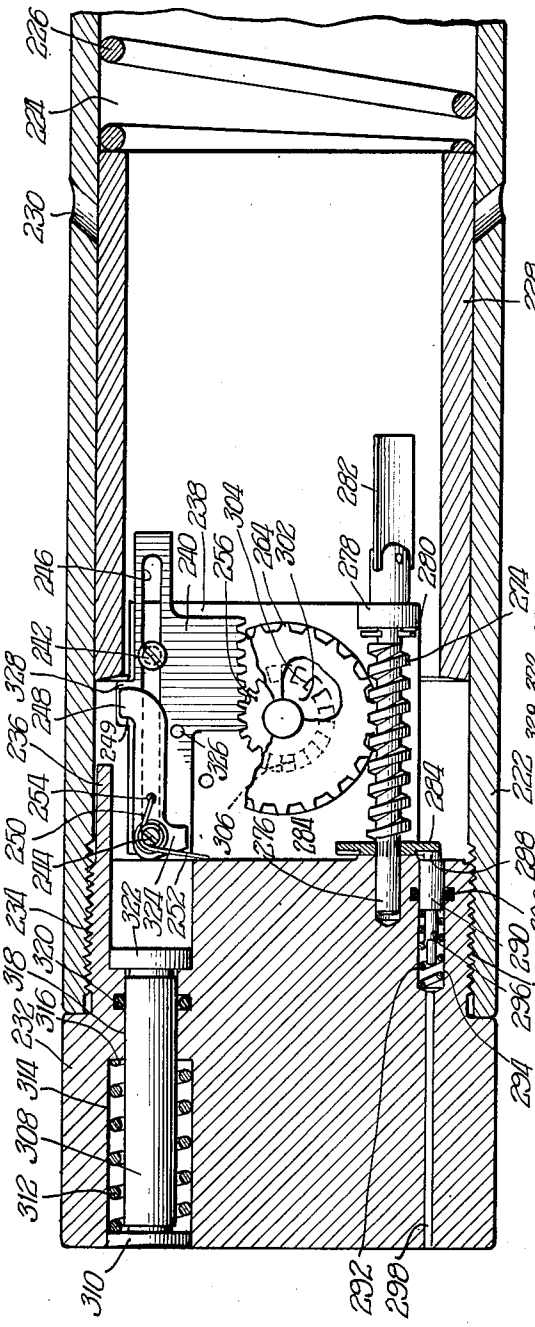


Fig. 15.

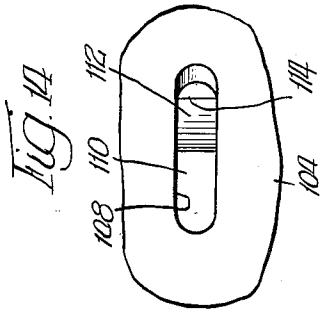


Fig. 14.

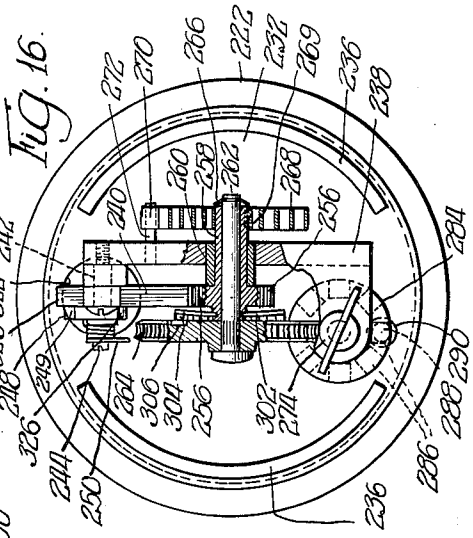


Fig. 16.

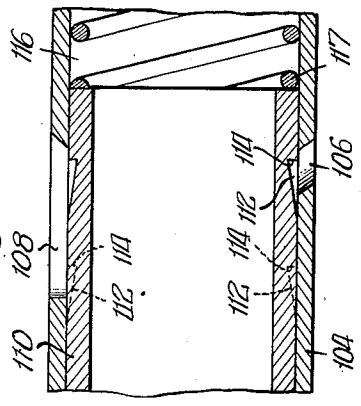


Fig. 13.

INVENTOR.
Kerly C. Bugg,
BY Hitkinson, Huntley
Byron & Hume
attys.

Patented Jan. 13, 1953 2,625,104

UNITED STATES PATENT OFFICE

2,625,104

BLASTING SHELL AND TIMING MEANS THEREFOR

Kenly C. Bugg, Fort Wayne, Ind., assignor to Materials Blasting Company, Inc., Fort Wayne, Ind., a corporation of Indiana

Application February 4, 1950, Serial No. 142,512

19 Claims. (Cl. 102—25)

1

This invention pertains to a blasting shell and timing means therefor wherein the pressure release is controlled in a predetermined manner.

An object of this invention is to provide a blasting shell provided with timing means for controlling the pressure discharge.

Another object of the invention is to provide a blasting shell provided with thermostatic controlled timing mechanism for thermostatically controlling the pressure discharge.

Another object of the invention is to provide a blasting shell provided with pressure controlled timing means for controlling the pressure discharge.

Another object of the invention is to provide a blasting shell wherein a commercial thermoreactive cell is adapted to be used for controlling the pressure discharge after a predetermined interval as after the complete oxidation cycle of the pressure building means is completed.

Another object of the invention is to provide a blasting shell wherein an adjustable bi-metallic element is utilized to control timing mechanism for controlling the pressure discharge.

Another object of the invention is to provide a blasting shell wherein a simple, relatively service free clock-work element is utilized to control the pressure discharge.

Another object is to provide an automatic release mechanism wherein any particular range of requirements of pressure release can be easily obtained.

Another object of the invention is to provide a blasting shell and control means therefor wherein the control means is adapted to be set to release the pressure from the shell at a predetermined interval after complete oxidation or combustion of the pressure building cartridge firing means (oxidizable means such as powder).

Another object of the invention is to provide an automatic, predetermined release means that is simple to maintain and is safe in operation.

Another object of the invention is to provide control means for pressure releasing cylinders, wherein the means comprises replaceable means such as a fusible link operable by the temperature of the oxidizable pressure building means.

Another object of the invention is to provide control means for pressure releasing cylinders, wherein the control means is positive in operation, is extremely safe, and is not susceptible of permitting operation of the release means by failure of the control means to inoperative position.

Another object of the invention is to provide control means for pressure releasing cylinders,

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wherein the pressure is released after complete or predetermined oxidation of the pressure building means so that upon pressure release there is no further oxidation whereby there is no danger of igniting adjacent dust or gas so that the device is usable as in closed flame mine operation.

Another object of the invention is to provide release means for blasting shells and the like which is capable of adaptation and operation with shells of various diameters.

With these and various other objects in view, the invention consists of certain novel features of construction and operation as will be more fully described and particularly pointed out in the specification, drawings and claims appended hereto.

In the drawings, which illustrate embodiments of the device and wherein like reference characters are used to designate like parts—

Figure 1 is a fragmentary sectional elevation through one form of blasting shell device embodying the invention, the section being taken adjacent the latch mechanism;

Figure 2 is a fragmentary sectional elevation through one form of blasting shell device embodying the invention, the same being taken adjacent the firing mechanism;

Figure 3 is a fragmentary sectional elevation through the form of blasting shell device shown in Figure 1, the same looking downwardly of said figure;

Figure 4 is a fragmentary sectional elevation through a modified form of blasting shell mechanism embodying the invention;

Figure 5 is an end elevation of the end closure for the blasting shell device illustrated in Figure 4, the same looking toward the right as viewed in Figures 4 and 6;

Figure 6 is an elevation, partly in section, of the latch mechanism, timing mechanism and end closure for the blasting shell device illustrated in Figure 4, the same looking downwardly of Figure 4;

Figure 7 is a plan view of the latching device illustrated in Figure 6, the same looking toward the left as viewed in said figure;

Figure 8 is a fragmentary sectional elevation of another modified form of blasting device embodying the invention;

Figure 9 is an elevation of the latch mechanism, timing mechanism and end closure for the blasting device illustrated in Figure 8, the same looking upwardly of said figure;

Figure 10 is a plan view of the latching device

illustrated in Figure 9, the same looking toward the left as viewed in said figure;

Figure 11 is a side elevation of the fusible link used in the blasting device illustrated in Figures 8 to 10, inclusive;

Figure 12 is a top plan view of the fusible link illustrated in Figure 11;

Figure 13 is a fragmentary sectional elevation through another modified form of blasting shell device embodying the invention;

Figure 14 is a plan view of one of the slots of the blasting shell device illustrated in Figure 13;

Figure 15 is a fragmentary sectional elevation through another modified form of blasting shell device embodying the invention; and,

Figure 16 is a sectional plan view of the latch mechanism, timing mechanism and end closure for the firing shell device illustrated in Figure 15, the same looking toward the left as viewed in said figure.

Referring first of all more particularly to the blasting shell device illustrated in Figures 1 to 3, inclusive, the shell device comprises the substantially cylindrical body member **20** threaded at its rear end, as at **22** (Figure 2), for the reception of mating threads of firing mechanism casing **24**, said firing mechanism being particularly shown and described in applicant's copending Application Serial No. 136,769, filed January 4, 1950. The firing mechanism is released as described in said application, suitable operating means releasing the pivoted latch members **26** after a predetermined movement thereof toward the right as viewed in Figure 2, to move the hammer **27** away from firing pin **28**. Such movement of hammer **27** compresses spring **29** whereupon upon release of latches **26** spring **29** moves hammer **27** to strike pin **28** causing it to move toward the left in closure **30** of casing **24**. Pin **28** is adapted to contact detonating means, not shown, in the firing cartridge **32**, said cartridge being received in the cylindrical cartridge recess **34** in the body member **20** of the shell device. Firing the cartridge **32** releases oxidizable pressure generating means into the substantially cylindrical cavity or chamber **36** of body member **20**

Chamber **36** communicates with the enlarged substantially cylindrical valve chamber **38**, a spring seat or shoulder **40** being formed between said chambers. Rearwardly directed pressure releasing passages or ports **42** are generally radially disposed from chamber **38** and are adapted to be controlled by means of the sleeve or sleeve valve **44**. That is, passages **42** are radially disposed with respect to the axis of body member **20**, and are directed in an outward and rearward direction from chamber **38**. Sleeve **44** is urged toward the left as viewed in Figure 1, that is, in a forward direction in body member **20** away from chamber **36**, by means of the spring **46** disposed between the rear end of said sleeve and the shoulder **40**. Sleeve **44**, if desired, may be provided with piston rings **48**, and is provided at its forward edge with the latching shoulder **50**. The forward end of housing **20** is provided with threads **52** for the reception of complementary threads of the forward end closure member or cap **54**. Bumper ring **56** is disposed in chamber **38** between end closure **54** and sleeve **44** and abuts the inner end of closure **54**, being retained in position by the retaining spring **58**, said bumper ring being preferably of relatively resilient material, such as hard rubber or plastic.

Closure member **54** is provided with spaced pedestal members **60** to which the latch or latch member **62** is pivoted as at **64**, latch member **62** being provided with the latch leg **66** adapted to engage shoulder **50** of sleeve **44**, being urged toward latching position by means of the spring **68** secured at one end to the latch member **62** as at **70**, the other end of said spring being secured as at **72** to pedestal **60**. Latch member **62** is provided with a shoulder **74** adapted to abut the operating plunger **76** of the thermo-reactive cell **78** disposed in the end closure **54**, being pressure sealed therein as by ring **80**. Cell **78** is provided with thermo-reactive means adapted to expand in a predetermined manner under the influence of predetermined temperature to move the plunger **76**, said means being adapted to expand under heat, and thereafter contract as the temperature cools down so that it is conditioned for its next use.

The cell is adapted to be adjusted in its position (and consequently the travel of the member **76** is adapted to be adjusted) by means of the adjusting nut **82** threaded in the end closure member **54** as at **84** and locked by means of the lock nut **86**. When the latch **62** is in the position illustrated in Figure 1, that is, when leg **66** engages shoulder **50**, communication between the chamber **38** and passages **42** is cut off. When the latch **62** has been released and the sleeve **44** has moved to a position to contact the bumper **55**, communication will be established between passages **42** and chamber **38**. In order to recock the device from this last mentioned position, that is, to move the sleeve to the position illustrated in Figure 1, a cocking plunger **88** may be employed slidably mounted in end closure **54**.

Said plunger **88** comprises the head **90** forming a spring seat for one end of the spring **92**, the other end of the spring being seated on the seat **94** of recess **96**. Plunger **88** extends through passage **98** and is provided with the head **100** adapted to be moved to engage the sleeve **44** to move it to the position illustrated in Figure 1, the plunger **88** preferably being pressure sealed by means of the ring **102**.

In the event it is desired to eliminate the cocking plunger **88**, a device such as illustrated in Figures 13 and 14 may be utilized. In this case body member **104** (corresponding to body member **20**) is provided with the rearwardly directed pressure releasing passages **106** (corresponding to passages **42**). One (or more, but preferably very few) of said rearwardly directed passages, such as passage **108** is elongated as illustrated in Figure 14 and at the top of Figure 13, and sleeve **110** (corresponding to sleeve **44**) is provided with a tapered recess **112**. This recess is disposed so that the deep portion or tool engaging shoulder **114** is accessible to a tool, i. e., is in the dotted line position shown in Figure 13 when sleeve **110** is in its forward or released position wherein chamber **116** of body member **104** communicates with passages **106** (and **108**) and is in the full line position shown in Figure 13 when the sleeve is in position to cut off communication between chamber **116** and passages **106** (and **108**). As before, spring **117** (corresponding to spring **46**) is disposed between a shoulder or seat (not shown) corresponding to seat **40** of Figure 1, and the seat formed on the rear end of sleeve **110**, urging said sleeve to a position wherein passages **106** (and **108**) communicate with chamber **116**.

Thus when the sleeve **110** has been moved forwardly by spring **117**, to permit communication

between chamber 116 and passages 106 and 108, in order to move the sleeve 110 to the position to disconnect communication between passages 106 and 108 and chamber 116, it is only necessary to utilize an instrument such as a screw driver or the like, inserting it through the elongated slot 108 to engage the recess 112 moving the sleeve against the spring 117 to a position where the latch, such as latch 62 (Figure 1) is operative.

In operation of this form of the device (Figures 1–3, 13–14) therefore, assuming the unfired cartridge 32 to be in position (Figure 2) and the firing mechanism in position, i. e., casing 24 secured to body member 20, and assuming that the latch 62 is in position where the latch leg 66 engages the shoulder 50, wherein sleeve 44 has compressed spring 46 and has cut off communication between the chamber 38 and passages 42 (chamber 116 and passages 106 and 108), operation of the firing mechanism as before described, will detonate the cartridge 32, causing release of the oxidizable pressure generating means, whereby the temperature caused by ignition of said generating means reacts on the thermo-reactive cell 78. A predetermined time will elapse before the predetermined pressure is built up in chamber 38 (and 116) and before a predetermined amount of heat has been absorbed by cell 78, but after the predetermined amount of heat has been absorbed by the cell 78, the operating plunger 76 will have moved a predetermined amount sufficient to release the locking leg 66 from engagement with the shoulder 50.

Spring 46 (and 117) is then free to move the sleeve 44 (and 110) toward the left as viewed in Figure 1 (and Figure 13) to a position to engage bumper 56, establishing communication between the inside of housing 20 (and 104) i. e., between chamber 38 (and 116) and passages 42 (and 106 and 108), releasing the pressure generated within the housing for its blasting effect, whereupon the pressure within the housing is reduced rapidly to atmosphere.

In order to recondition or reset the device for subsequent operation, the firing mechanism housing 24 is disconnected at 22 from the body member 20 (or 104), permitting the removal of the fired cartridge 32 and insertion of a new cartridge 32 in recess 34. The plunger 88 (Figure 1) may be depressed causing head 100 to move the sleeve 44 toward the right as viewed in Figure 1 to a position where the spring 68 causes the latch member 66 to engage shoulder 50. With the device shown in Figures 13 and 14 a suitable tool is engaged in recess 112, movement against shoulder 114 moving the sleeve 110 to the position shown in Figure 13, permitting latch 62 (Figure 1) to latch sleeve 110 in said position.

With devices of the character described in this application, wherein a sleeve valve is used, the operation of the device is always constant and predetermined, because of the balance in pressure around the sleeve, so that the control member (sleeve) is never working against or with pressure. With devices as herein described in the various modifications, it is further to be noted that after firing, due to the rapid reduction of the pressure within the device to atmosphere, the device itself is not overheated and the parts rapidly cool to atmospheric temperature, where they are easily handled and are conditioned for their subsequent operation.

Referring now to the device illustrated in Figures 4 to 7, inclusive, said device comprises the substantially cylindrical body member 118 adapted to be associated with firing mechanism, such as illustrated in Figure 2, the housing having the cylindrical cavity or chamber 120 communicating with the enlarged cylindrical valve chamber 122, whereby a spring seat 124 is provided for one end (the rear end) of spring 126, the other end (forward) of said spring 126 seating upon a spring seat formed at one edge or end (rear) of the sleeve or sleeve valve 128. Chamber 122 is adapted to communicate with the radially disposed rearwardly directed pressure releasing passages 130 (similar to passages 42, Figure 1), sleeve 128 being provided with the latching shoulder 132 at its forward edge for engagement with latch shoulder 134 of the latch or latch member 136. Latch 136 is pivotally mounted on spindle 138 supported at spaced supports 140.

A thermostatic element is used to operate the latch and in the embodiment shown a bi-metallic spiral spring 142 is shown, one end of spiral spring 142 being secured as at 144 to the latch 136, the other end of said spring 142 being secured as at 146 to spindle 138. Spring 142 urges the latch member 138 to a position where shoulder 134 engages shoulder 132. Supports 140 are mounted on end closure member or closure 148 adapted to be secured as at 150 to the forward end of body member 118. Closure 148 is provided with the inwardly projecting flange 152 forming a bumper for the sleeve 128, or the bumper may be a separate member retained by a spring such as illustrated in Figure 1.

In order to move sleeve 128 inwardly or rearwardly to the position illustrated in Figure 4, a construction such as shown in Figures 13 and 14 may be used, or cocking plunger 154 (Figures 5–7) may be used. Said plunger is mounted in recess 156, spring 158 being interposed between the head 160 of said plunger and the spring seat 162 formed in recess 156. Plunger 154 extends through passage 164, being suitably pressure sealed as by a ring 102 (Figure 1) and the inner end of said plunger is provided with head 165 adapted to engage the end of sleeve 128 whereby movement of the plunger 154 against the spring 158, that is, toward the right as viewed in Figures 4 and 6, will move the sleeve toward the right to permit spring 142 to move the latch member 136 to a position where shoulder 134 will engage the shoulder 132 of the sleeve.

In order to adjust the spring 144, spindle 138 is non-rotatably provided with a worm gear 166 adapted to mesh with worm 168 secured to shaft 170 journalled in passage 172. As before, shaft 170 may be made pressure tight by rings (not shown) similar to ring 102 (Figure 1). The end of shaft 170 is provided with the slotted adjusting head 174 disposed in recess 175, which head 174 may be rotated to adjust the tension of the spring. As before described, spring 144 is a thermostatic element, such as a bi-metallic element, which is adapted to be affected by the heat generated by the firing of the cartridge similar to cartridge 32, Figure 2, whereby said thermostatic element operates to move the shoulder 134 out of engagement with the shoulder 132, permitting spring 126 to move the sleeve 128 toward the left as viewed in Figure 4 (forwardly) establishing communication be-

tween the passages 130 and chamber 122, whereby the operation of this form of the device is similar to that already described with respect to Figures 1 to 3, inclusive. Cocking and subsequent operation of the device is similar to that already described with respect to Figures 1 to 3, inclusive, when the cocking plunger is used, or cocking mechanism may be used as shown and described with respect to Figures 13 and 14.

In the construction illustrated in Figures 8 to 12, inclusive, body member 176, similar to body member 20 (Figure 1), is provided with the chamber 178 communicating at its rear end with the firing cartridge recess as illustrated at 34 in Figure 2, the forward end of chamber 178 communicating with the enlarged valve chamber 180, shoulder 182 forming a spring seat for one end (rear) of spring 184. Chamber 180 communicates with the rearwardly directed, radially disposed, pressure release (discharge) passages 186 controlled by the sleeve 188. The end closure head 190 is threaded as at 192 to the forward end of body member 176, and is provided with the spaced, latch supporting pedestals 194 to which the latch 196 is pivoted as at 198.

Latch 196 is substantially of bell crank shape and is provided with a latch leg 200 adapted to engage the latching shoulder 202 provided on the forward edge of sleeve 188. Latch 196 is urged toward released position (i. e., out of engagement with shoulder 202) by means of spring 204, one end of said spring 204 being connected as at 206 to leg 200, the other end of said spring being connected as at 208 to said pedestal 194. Latch 196 is provided with a leg 210 having spaced members 211 provided with hook-shaped shoulders 212 for the reception of the transverse end 214 of the fusible link 216, the other transverse end 218 of said link being adapted to be received in the spaced hook-shaped supports 220 on spaced pedestals 194.

Assuming the device to be in the position illustrated in Figure 8, latch 196 is in position wherein the sleeve 188 prevents communication between the chamber 180 and the discharge passages 186. Firing the oxidizable pressure generating device, such as cartridge 32 of Figure 2, permits oxidation of the pressure generating means whereupon, after a predetermined time, link 216 is fused, permitting spring 204 to move the latch 196 in a clockwise direction, as viewed in Figure 8, releasing sleeve 188, whereupon spring 184 can move said sleeve 188 toward the left as viewed in Figure 8, thus causing communication to be established between chamber 180 and passages 186 which will cause operation of the device in a manner similar to that already described. Link 216 is so chosen that it does not fuse until a predetermined time, and when it is desired to subsequently use the blasting shell device, it is only necessary to remove closure 190 and replace link 216, which can only be done by slightly rotating latch 196 against spring 204. Closure 190 can then be reassembled to body member 176, the act of threading the closure or assembling the closure with the body member 176 moving sleeve 188 to cocked position, wherein communication is cut off between passages 186 and chamber 180.

Referring now to the form of device illustrated in Figures 15 and 16, said device comprises the body member 222, similar to body member 20 (Figure 1), being provided with valve chamber 224 (similar to chamber 38 (Figure 1)) communicating through a chamber similar to that shown at 36 in Figure 1, with a cartridge recess similar to recess 34 (Figure 1) whereupon oxidizable pressure generating means may be used to supply operating pressure to chamber 224. One end (the inner end) of spring 226 seats upon a shoulder in body member 222 (similar to shoulder 40, Figure 1), the other end of said spring seating on one end (inner end) of sleeve 228. Chamber 224 is adapted to communicate with rearwardly directed, radially disposed passages 230 after sleeve 228 has been moved by spring 226 toward the left as viewed in Figure 15.

The forward end of housing 222 is closed by means of the end closure 232 which is threaded thereto as at 234, the inner end of said closure extending inwardly of the housing as at 236 to provide end bumpers for the sleeve 228. Closure 232 is provided with the support 238 on which the rack 240 is slidably supported as through the pins 242 and 244, slot 246 being provided in said rack to permit sliding movement thereof with respect to support 238.

Latch member 248 provided with latch shoulder 249 is pivoted to pin 244 and urged in a counter-clockwise direction around the pin 244 by means of the spring 250, one end 252 of said spring abutting closure 232, the other end 254 engaging latch 248. Rack 240 engages pinion 256 provided on sleeve 258 (Figure 16) which is rotatably mounted in bearing 260 in support 238. Sleeve 258 is rotatably mounted on pin 262 which in turn is fixedly secured to worm gear 264, head 265 of pin 262 abutting the hub of gear 264 secured to said pin. The other end of said pin 262 is provided with a resilient washer 266 engaging the adjacent edge of sleeve 258 urging said sleeve in a direction relatively toward the left with respect to pin 262, as viewed in Figure 16.

Spring 268 has one end 269 secured to sleeve 258, the other end of said spring being secured as at 270 to pin 272 secured to the support 238. Gear 264 meshes with worm 274, said worm being rotatably mounted at one end as at 276 in end closure 232, and being journalled at its opposite end as at 278 in the support 238. Worm 274 is provided with a C-washer 280 acting as a thrust bearing and is provided with the pivoted fan governor 282.

Worm 274 is also provided with the stop disk or plate 284 having notches 286 therein adapted to receive the locking head 288 of the pressure operated piston 290, head 288 thereof being urged toward locking position by means of the spring 292 provided in recess 294 disposed in the end closure 232. Piston 290 is provided with the elongated stop member 296 adapted to limit the inward movement of the piston 290 in recess 294. A suitable bleed-out port 298 is provided communicating with recess 294 and a suitable seal ring 300 is provided in the closure 232 adjacent piston 290. Pinion 256 is non-rotatably provided with the clutch pawl plate 302 provided with the pawl projections 304 adapted to be engaged by the pawl recesses 306 provided in the gear 264, the projections and recesses being faced so that the clutch pawl plate 302 can only drive the gear 264 in one direction, that is, as determined by the unwinding of spring 268, or in a counter-clockwise direction as viewed in Figure 15 (rack 240 moving toward the left as viewed in Figure 15). Movement of the gear 264 to rotate worm 274 takes place only upon release of the head 288 from its engaged notch in stop plate 284.

In order to move the sleeve 228 to the position

illustrated in Figure 15, wherein communication is cut off between chamber 224 and passages 230, cocking plunger 308 is provided, head 310 thereof acting as a spring seat for one end of spring 312 disposed in recess 314 of closure 232, the other end of spring seating on seat 316. Plunger 308 extends through passage 318, being pressure sealed as by the ring 320 and is provided with the head 322 for moving sleeve 228 toward the right as viewed in Figure 15. This movement of sleeve 228 is accomplished by engagement between head 322 and projection 324 of rack 240 permitting inward movement of plunger 308 to move rack 240 inwardly, whereupon shoulder 328 on rack 240 engages the outer end of sleeve 228 to move said sleeve to a position where the sleeve clears latch shoulder 249 of latch member 248, permitting it to be moved by spring 250 to latched position (Figure 15). Movement to the position illustrated in Figure 15 permits spring 250 to move the latch 248 to latched position. Latch member 248 is provided with the trip shoulder 324 adapted to be engaged by the pin 326 provided on rack 240 to move the latch shoulder 249 to inoperative position.

Assuming the device to be in the position illustrated in Figure 15 wherein the spring 268 is properly energized, when the cartridge, similar to cartridge 22 in Figure 2, is fired, pressure built up within the chamber 224 to a predetermined amount will act upon the piston 290 moving the piston against the spring 292 a limited amount as determined by the stop 296. Movement of the piston 290 will release the head 288 from engagement with the engaged slot 286 of stop plate 284, permitting spring 268 to rotate gear 256 and to rotate gear 264 through clutch 302—306 to rotate worm 274 which is moved in a timed manner as controlled by the governor 282. This movement permits the rack 240 to move toward the left as viewed in Figure 15 until pin 326 engages shoulder 324, releasing engagement between the latch shoulder 249 and sleeve 226 permitting spring 226 to move the sleeve to establish communication between chamber 224 and ports 230, causing operation of the device in the manner already described. The pressure drop within chamber 224 will release plunger 290 causing locking engagement between head 288 and a notch 286 of stop plate 284, thus arresting movement of all parts of the timing mechanism.

In order to recondition the device for subsequent operation, cocking plunger 308 is moved inwardly, toward the right as viewed in Figure 15, causing the rack 240 to move toward the right as viewed in Figure 15 whereupon shoulder 326 of the rack moves the sleeve 228 to the position illustrated in Figure 15 wherein communication is cut off between chamber 224 and ports 230. This movement causes spring 268 to be re-energized, and is permitted because the projections and recesses on clutch 302—306 permit movement of the rack 240 and gear 256, slippage occurring between plate 302 and gear 264 which is necessary as the worm 274 and consequently gear 264 is held stopped by means of engagement between head 288 and a notch 286 in plate 284. Application of a new cartridge conditions the device for subsequent operation. This clock-work mechanism is so designed that it is operative to release the sleeve 228 after a predetermined time interval has elapsed from a release of the pressure by the firing of the cartridge or any other pressure means which may be used.

It is to be understood that this application is not to be limited by the exact embodiments of the device shown, which are merely by way of illustration and not limitation as various and other forms of the device will, of course, be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

I claim:

1. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed, rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means between said sleeve valve and inner end of said body member normally urging said sleeve valve toward said end closure to thereby connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position compressing said resilient means and cutting off communication between said chamber and ports, and time delay mechanism automatically operable after said firing mechanism has operated said pressure releasing means after a predetermined time for releasing said latch means to permit said resilient means to move said sleeve valve to connect said chamber and said ports.

2. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed, rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient mechanical means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, and time delay mechanism automatically operable after said firing mechanism has operated said pressure releasing means after a predetermined time for releasing said latch means to permit said resilient means to move said sleeve valve to connect said chamber and said ports.

3. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing

mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient mechanical means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, and time delay mechanism automatically operable after said firing mechanism has operated said pressure releasing means for releasing said latch means to permit said resilient means to move said sleeve valve to connect said chamber and said ports, and means for moving said sleeve valve to a position to permit said latch means to hold said sleeve valve in position cutting off communication between said chamber and ports.

4. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient mechanical means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, and time delay mechanism automatically operable after said firing mechanism has operated said pressure releasing means for releasing said latch means to permit said resilient means to move said sleeve valve to connect said chamber and said ports, and means for moving said sleeve valve to a position to permit said latch means to hold said sleeve valve in position cutting off communication between said chamber and ports, said last named means comprising a cocking plunger slidably mounted in said end closure, said plunger having a sleeve valve engaging head disposed inwardly of said end closure, a head accessible from the outside of said end closure for reciprocating said plunger, and resilient means between said last named head and end closure urging said first named head away from said sleeve valve.

5. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient mechanical means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, and time delay mechanism automatically operable after said firing mechanism has operated said pressure releasing means for releasing said latch means to permit said resilient means to move said sleeve valve to connect said chamber and said ports, and means for moving said sleeve valve to a position to permit said latch means to hold said sleeve valve in position cutting off communication between said chamber and ports, said last named means comprising an elongated port through said body member having the rear edge directed in the same direction as that of said first named ports, the forward end of said elongated port extending to a point more closely adjacent the end closure than said first named ports, said sleeve valve having a sloping recess extending inwardly to form a radial tool engageable shoulder adjacent the inner edge of said sleeve valve, said shoulder being disposed to be accessible through said elongated slot regardless of the position of said sleeve valve.

6. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, said latch means comprising a latch member pivoted to said end closure and having a latch leg engageable with said sleeve valve for holding said sleeve valve in the communication cut off position, resilient means urging said latch member toward said cut off position, said latch member having a shoulder, and a thermo-reactive cell adjustably mounted in said end closure operative against said shoulder to move said latch member to disengage said latch leg from said sleeve valve.

7. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve

valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, said latch means comprising a latch member pivoted to said end closure and having a latch leg engageable with said sleeve valve for holding said sleeve valve in the communication cut off position, resilient means urging said latch member toward said cut off position, said latch member having a shoulder, and a thermo-reactive cell adjustably mounted in said end closure operative against said shoulder to move said latch member to disengage said latch leg from said sleeve valve, and means for moving said sleeve valve to a position to permit said last named resilient means to move said latch leg to engage said sleeve valve in said cutoff position.

8. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, said end closure having a support extending into said chamber, a spindle pivoted to said support, said latch means comprising a latch member pivoted to said spindle, a temperature sensitive bimetallic spring disposed between said spindle and latch member urging said latch member to a position for holding said sleeve valve in the communication cut off position, and means for adjusting said spring comprising a worm gear fixed to said spindle, and a rotatable shaft rotatably mounted in said end closure having an adjusting head rotatable from externally of said end closure, said shaft having a worm disposed within said chamber and meshing with said worm gear.

9. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, said end closure having a support extending into said chamber, a spindle pivoted to said support, said latch means comprising a latch member pivoted to said spindle, and a temperature sensitive bi-metallic spring disposed between said spindle and latch member urging said latch member to a position for holding said sleeve valve in the communication cut off position.

10. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, said end closure having a support extending into said chamber, a spindle pivoted to said support, said latch means comprising a latch member pivoted to said spindle, a temperature sensitive bimetallic spring disposed between said spindle and latch member urging said latch member to a position for holding said sleeve valve in the communication cut off position, and means for adjusting said spring accessible externally of said end closure.

11. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, said end closure having a support extending into said chamber, a spindle pivoted to said support, said latch means comprising a latch member pivoted to said spindle, resilient means between said latch member and support urging said latch member out of engagement with said sleeve valve, and a fusible link interposed between latch member and support for holding said latch member in sleeve valve engaging position.

12. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner

end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, said end closure having a support extending into said chamber, a spindle pivoted to said support, said latch means comprising a latch member pivoted to said spindle, said latch member being substantially of bell crank shape having sleeve valve engaging latching leg and a link engaging leg having a hook shaped member, resilient means between said valve engaging latching leg and support urging said last named leg out of the path of said sleeve valve, said support having a hook shaped member extending in a direction opposite to said first named hook shaped member, and a fusible link having spaced ends received in said hook members for holding said last named leg in the path of said sleeve valve.

13. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, and timing means operable after said firing mechanism has operated said pressure releasing means for releasing said latch means to permit said resilient means to move said sleeve valve to connect said chamber and said ports, said timing means including a governor operable prior to release of said latch means to cause release of said latch means a predetermined time after operation of said pressure releasing means.

14. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, and timing means operable after said firing mechanism has operated said pressure releasing means for releasing said latch means to permit said resilient means to move said sleeve valve to connect said chamber and said ports, said timing means comprising a support secured to said end closure, a sleeve journalled in said support provided with a pinion rotatable therewith, a clutch member fixed to said pinion, a shaft rotatably mounted in said sleeve and having a worm gear secured thereto, said worm gear having clutch means cooperating with said clutch member, said clutch member and means causing said shaft and sleeve to rotate together in one direction but relatively rotatable with respect to each other in the other direction, a rack slidably mounted on said support and operable by said pinion, a latch moving pin on said rack for moving said latch means to release said sleeve valve, resilient means between said sleeve and support for urging said rack to latch release position, a governor member rotatably mounted in said end closure and support, a worm operable by said worm gear, a stop member fixed to said worm, and a pressure operated piston movably mounted in said end closure having a locking head for engaging said stop member, resilient means urging said piston toward position where said locking head engages said stop member, said rack having a sleeve valve engaging shoulder for moving said sleeve valve to communication cut off position, a cocking plunger slidably mounted in said end closure for moving said rack to move said sleeve valve to said cut off position energizing said resilient means between said sleeve and support, slippage occurring between said clutch member and means upon such movement of said sleeve valve.

15. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, and timing means operable after said firing mechanism has operated said pressure releasing means for releasing said latch means to permit said resilient means to move said sleeve valve to connect said chamber and said ports, said timing means comprising a support secured to said end closure, a sleeve journalled in said support provided with a pinion rotatable therewith, a clutch member fixed to said pinion, a shaft

rotatably mounted in said sleeve and having a worm gear secured thereto, said worm gear having clutch means cooperating with said clutch member, said clutch member and means causing said shaft and sleeve to rotate together in one direction but relatively rotatable with respect to each other in the other direction, a rack slidably mounted on said support and operable by said pinion, a latch moving pin on said rack for moving said latch means to release said sleeve valve, resilient means between said sleeve and support for urging said rack to latch release position, a governor member rotatably mounted in said end closure and support, a worm operable by said worm gear, a stop member fixed to said worm, and a pressure operated piston movably mounted in said end closure having a locking head for engaging said stop member, and resilient means urging said piston toward position where said locking head engages said stop member.

16. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, and timing means operable after said firing mechanism has operated said pressure releasing means for releasing said latch means to permit said resilient means to move said sleeve valve to connect said chamber and said ports, said timing means comprising a support secured to said end closure, a sleeve journalled in said support provided with a pinion rotatable therewith, a shaft rotatably mounted in said sleeve and having a worm gear secured thereto, a rack slidably mounted on said support and operable by said pinion, a latch moving pin on said rack for moving said latch means to release said sleeve valve, resilient means between said sleeve and support for urging said rack to latch release position, a governor member rotatably mounted in said end closure and support, a worm operable by said worm gear, a stop member fixed to said worm, and a pressure operated piston movably mounted in said end closure having a locking head for engaging said stop member, and resilient means urging said piston toward position where said locking head engages said stop member.

17. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for connection to firing mechanism, an end closure for the outer end of said body member, said body member adjacent the inner end being provided with a cartridge recess, said recess being adapted to receive oxidizable pressure releasing means operable by said firing mechanism, said body member having a valve chamber communicating with said recess and closed by said end closure, said body member having radially disposed rearwardly directed ports adapted to extend from said chamber through said body member, a sleeve valve slidably mounted in said chamber, resilient means for moving said sleeve valve to connect said chamber with said ports, latch means movable to position to latch said sleeve valve in position cutting off communication between said chamber and ports, and timing means operable after said firing mechanism has operated said pressure releasing means for releasing said latch means to permit said resilient means to move said sleeve valve to connect said chamber and said ports, said timing means comprising a support secured to said end closure, a sleeve journalled in said support provided with a pinion rotatable therewith, a shaft rotatably mounted in said sleeve and having a worm gear secured thereto, a rack slidably mounted on said support and operable by said pinion, a latch moving pin on said rack for moving said latch means to release said sleeve valve, resilient means between said sleeve and support for urging said rack to latch release position, a governor member rotatably mounted in said end closure and support, a worm operable by said worm gear, a stop member fixed to said worm, and a pressure operated piston movably mounted in said end closure having a locking head for engaging said stop member, resilient means urging said piston toward position where said locking head engages said stop member, said rack having a sleeve valve engaging shoulder for moving said sleeve valve to communication cut off position, a cocking plunger slidably mounted in said end closure for moving said rack to move said sleeve valve to said cut off position energizing said resilient means between said sleeve and support, so that upon release of said locking head from said stop member said rack may move to unlatch said latch means.

18. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for supplying fluid for supplying increasing pressure and temperature to said body member, an end closure for the outer end of said body member, said body member having a valve chamber for receiving said fluid, said valve chamber being closed by said end closure, said body member having radially disposed ports extending from said chamber through said body member, a valve disposed in said chamber for controlling passage through said ports, resilient means for moving said valve to port open position, latch means movable to position to latch said valve in port closing position, and means operable to release said latch means.

19. In blasting mechanism, the combination of a body member comprising an elongated substantially cylindrical member, said body member adjacent the inner end thereof being provided with means for supplying fluid for supplying increasing pressure and temperature to said body member, an end closure for the outer end of said body member, said body member having a valve chamber for receiving said fluid, said valve chamber being closed by said end closure, said body member having radially disposed ports extending from said chamber through said body member, a valve disposed in said chamber for controlling passage through said ports, resilient means for moving said valve to port open position, latch means movable to position to latch

said valve in port closing position, means operable to release said latch means, and means for moving said valve to a position to permit said latch means to hold said sleeve in port closed position.

KENLY C. BUGG.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,435,116	Armstrong	Jan. 27, 1948
2,502,694	Armstrong	Apr. 4, 1950
2,527,291	Armstrong et al.	Oct. 24, 1950