Jan. 17, 1956 F. W. HAYWARD ET AL 2,730,893

OXY-HYDROGEN FLASH DETONATOR TESTER

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FIG.1.

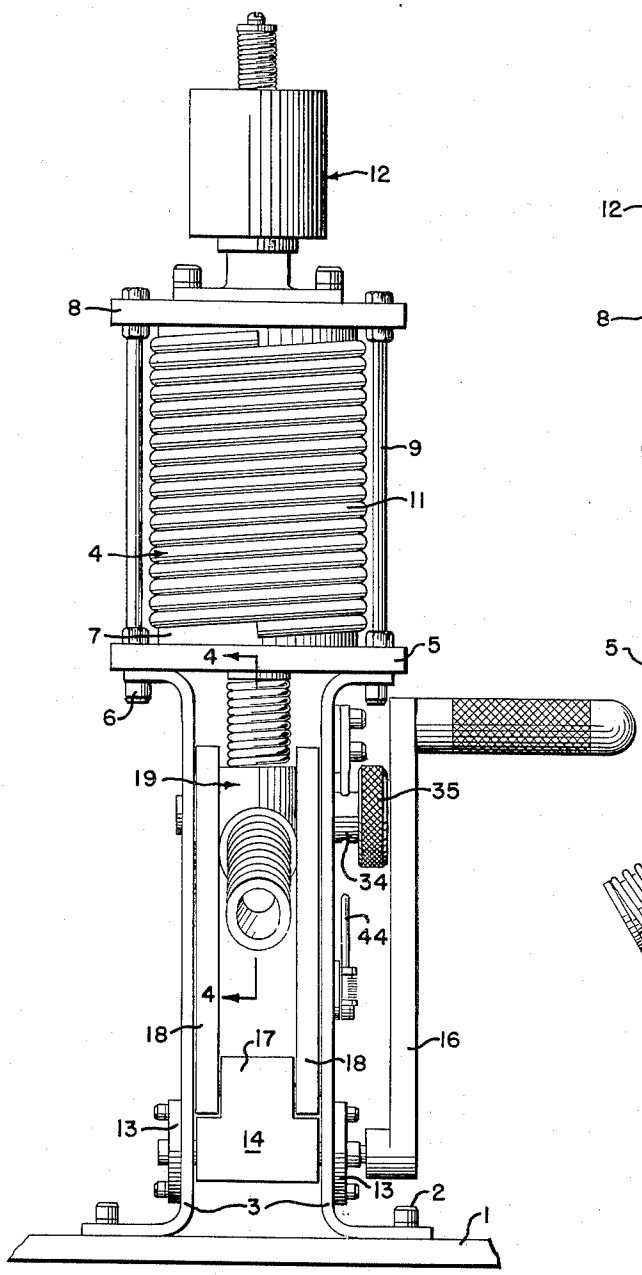
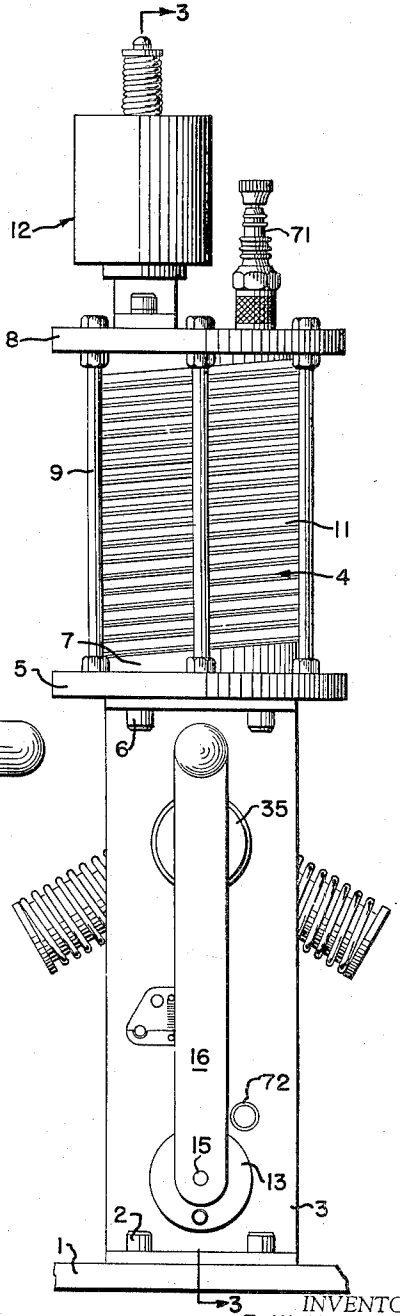


FIG.2.



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FIG.3.

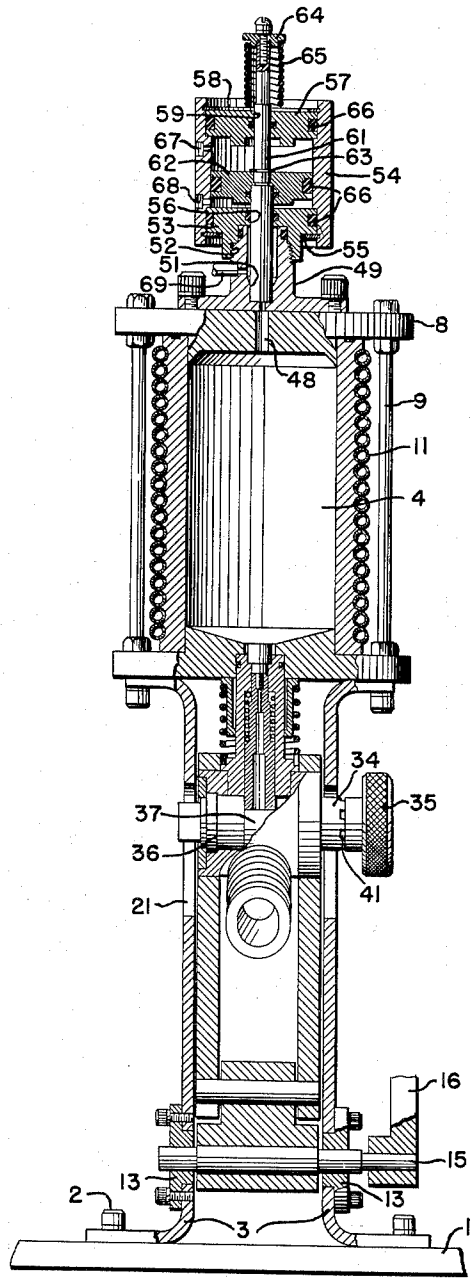


FIG.5.

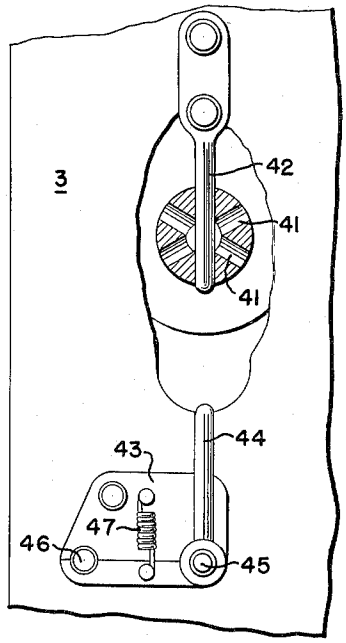
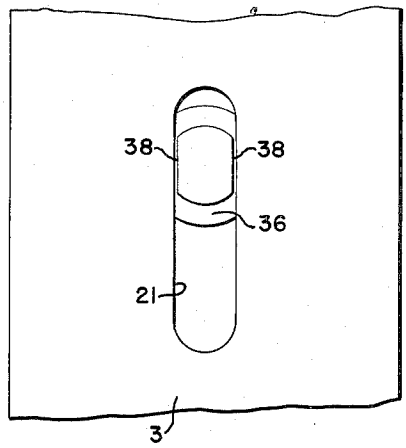


FIG.6.



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FIG.7.

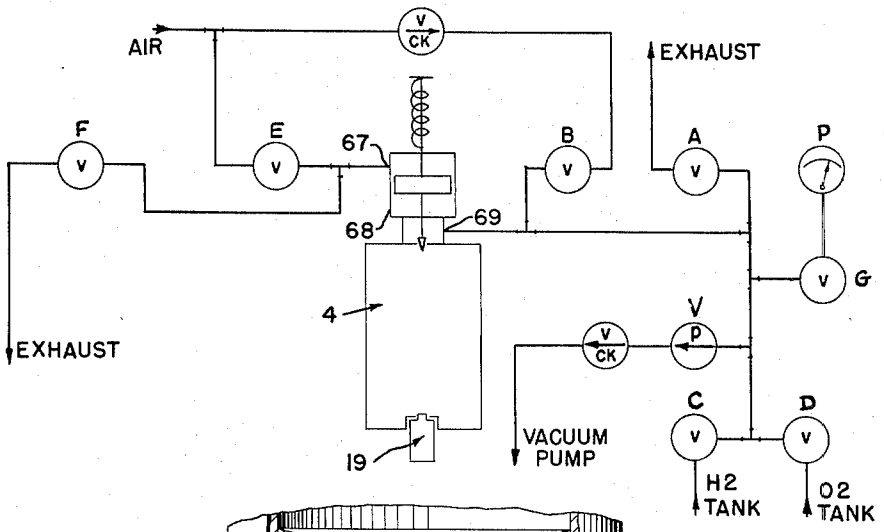
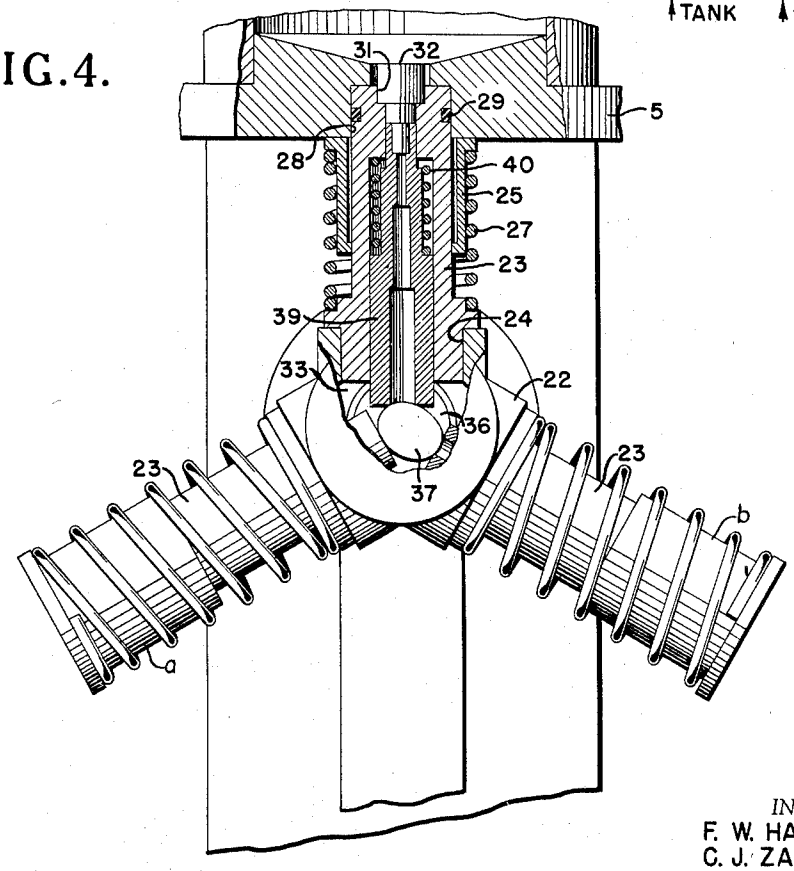


FIG.4.



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2,730,893

OXY-HYDROGEN FLASH DETONATOR TESTER

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Application June 27, 1952, Serial No. 296,028

11 Claims. (Cl. 73—35)

This invention relates to a testing apparatus for detonators of the flash type and more particularly to an oxy-hydrogen flash detonator tester.

Formerly in providing a quality control means for flash detonators the ignition point was determined by passing an oxy-hydrogen torch past the explosive. This method proved unsatisfactory in that the results obtained therefrom were completely unreliable. The temperature and flow rates of the gases could not be properly maintained and the torch tips were damaged from the detonation of the test charge. The invention disclosed herein overcomes these objectionable features.

The present invention contemplates the provision of an apparatus adapted to establish an effective means for testing flash type detonators and determining ignition temperatures of the explosive mixtures contained therein by firing the detonator within a water cooled explosion chamber. The lower end of this chamber has an opening therein whereby a detonator holder assembly may be inserted with a detonator to be tested held therein and exposed to the hollow interior of the explosion chamber. On the upper end of the chamber is mounted a spark plug and master valve assembly. The valve assembly provides a means whereby the oxygen hydrogen gas mixture may be admitted to the interior of the chamber. In addition in conjunction with the master valve is provided a means to exhaust the chamber and further to supply compressed air to blow out vapor and foreign particles deposited within the chamber as the result of an explosion. The chamber is supported upon brackets which are provided with slots within which is slidably and rotatably mounted the detonator holder assembly. This assembly comprises a triangular block having a bore in each face thereof, each of which bores is adapted to receive a sleeve which supports the detonator to be tested. A plunger is slidably supported within each sleeve and through coaction with a cam serves to eject the detonator following an explosion. A handwheel is provided on the outer face of a bracket which is adapted to rotate the entire detonator holder assembly and a latching arrangement coacts with this handwheel to prevent rotation in a counterclockwise direction. The holder assembly is supported on arms which are pivoted at their lower ends to a block which is fixedly mounted on a shaft rotatably mounted in the supporting brackets. On the outer end of this shaft is fixed a lever which when moved to a horizontal position will lower the entire detonator assembly out of contact with the lower plate of the explosion chamber. From the construction of the detonator holder assembly it is apparent that, as one sleeve is rotated by means of the handwheel out of alignment with the opening in the lower end of the explosion chamber, another sleeve moves into this position. As the assembly is rotated the plunger coacting with the cam causes the detonator in the sleeve being rotated out of alignment with the explosion chamber to be ejected. It is apparent therefore that there has been provided a detonator tester which overcomes the objections inherent in the prior art structures and which provides a safe efficient means for determining the ignition point of detonators.

An object of this invention is the provision of an apparatus for testing flash type detonators for establishing a quality control in which the variable factors such as the temperature and pressure of the gases may be accurately controlled.

Another object of the invention presently disclosed is the provision of a testing apparatus for flash detonators in which the method of initiation of explosion by combined shock and heat affords a close approximation of what occurs in a fuze train where initiation is accomplished by spit of a primer.

A still further object of this invention is the provision of a flash detonator testing apparatus which incorporates an ejecting means for a fired detonator with a loading means whereby the apparatus may be quickly and safely prepared for a test of a detonator thereby eliminating many of the hazards encountered in prior art structures.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is an elevational view of the apparatus embodying the invention;

Fig. 2 is a side elevational view of Fig. 1;

Fig. 3 is a vertical sectional view along the line 3—3 of Fig. 2;

Fig. 4 is an enlarged sectional view of the detonator holder assembly along the line 4—4 of Fig. 1;

Fig. 5 is a fragmentary view in elevation of the latching means for the detonator holder assembly;

Fig. 6 is a fragmentary elevational view at right angles to Fig. 1; and

Fig. 7 is a diagrammatic view of the plumbing employed in conjunction with the presently disclosed apparatus.

Referring now to the drawings wherein like numerals indicate like parts throughout the several views there is shown in Fig. 1 the apparatus which is supported on base plate **1**. Suitably secured to the base plate as by bolts **2** is a pair of brackets **3** the upper ends of which support the explosion chamber **4**. The explosion chamber comprises a lower plate **5** which is secured to the upper ends of the brackets by means of bolts **6**. This lower plate supports a cylinder or sleeve **7** upon which, in turn, is mounted the upper plate **8**. The upper and lower plates are secured together by means of elongated bolts or rods **9** extending therebetween whereby the cylinder is tightly held in position. The outer surface of the cylinder is suitably grooved to receive cooling coil **11** which is connected to a water supply. Securely mounted on the upper plate **8** is a master valve assembly **12** to be later described in detail.

There is provided a pair of bushings **13** mounted on brackets **3** near the lower ends thereof. A shaft **15** extends between these bushings and fixedly mounted on the outer end of the shaft is an arm **16**. Suitably secured on shaft **15** is a block **14** which is provided with an offset portion **17** upon which upwardly extending arms **18** are pivotally mounted. The upper ends of these arms support the detonator holder assembly **19**. Brackets **3** are slotted as at **21** (Fig. 3), to receive portions of the holder assembly. It is apparent that, as lever **16** is rotated from the vertical position shown in Fig. 1 to a horizontal position, the motion of the offset portion **17** of the block will cause the arms **18** to be lowered thereby causing the detonator holder assembly **19** to ride downwardly in slots **21** whereby the holder is moved to a position out of contact with the lower plate **5** of the explosion chamber.

The construction of the detonator holder assembly **19**

will now be described in detail. Referring to Fig. 4 it will be seen that there is provided a triangular block **22** having a sleeve **23** secured within a bore **24** in each face thereof. Slidably disposed on the outer surface of the sleeve is a flanged cup **25**. A compression spring **27** secured to a flange on the cup and block **22** serves to urge the cup outwardly. It can be seen that the lower plate **5** of the explosion chamber is provided with a central bore **28** within which fits the outer end of the sleeve. Sleeve **23** is provided with a peripheral recess within which fits an O-ring seal **29** to insure a leak proof fitting between the sleeve and the plate. Sleeve **23** is further recessed as at **31** to receive a detonator holder **32**. It is apparent that, when sleeve **23** is in the vertical position the detonator holder is exposed to the hollow interior of the explosion chamber and the bore in the lower plate is effectively sealed.

Triangular block **22** is provided with a bore **33** therethrough and a shaft **34** extends from one end thereof through the slot **21** in bracket **3**. Upon this shaft is mounted a handwheel **35**. Within bore **33** is a cylindrical block **36** having a cam surface **37** (Figs. 3 and 4), and having the outer end thereof provided with flat faces **38** (Fig. 6), which ride within slot **21** in bracket **3**. It will be seen, therefore, that as handwheel **35** is rotated to rotate detonator holder assembly **19**, cylindrical block **36** will remain stationary. Mounted within sleeve **23** is a plunger **39** which extends upwardly to a position beneath the detonator holder **32**. A compression spring **40** acting between flanged surfaces on the sleeve and plunger urges the plunger downward into contact with cam surface **37**.

From Fig. 4 it can be seen that as handwheel **35** is rotated after lowering the detonator holder assembly, plunger **39** will be forced outwardly by the cam surface thereby ejecting the detonator holder. At the same time the sleeve *a* is brought to the operating position beneath the cylinder while sleeve *b* is in a loading position. From this construction it is apparent that a series of tests of flash detonators may be made rapidly and without danger to the operator.

There is further provided a latching means to prevent rotation of the handwheel **35** in a counterclockwise direction which means is disclosed in detail in Fig. 5. Handwheel **35** is provided with a series of slots **41** (Fig. 3), extending therethrough which are spaced 60° apart. Fixedly mounted on a bracket **3** above slot **21** is an arm **42** which extends into a slot **41** when the detonator holder is in the position shown in Fig. 5. Pivotally mounted on a plate **43** secured to bracket **3** below slot **21** is an L-shaped link **44** whose pivot point is shown at **45**. Limit stop **46** is provided to permit rotation of link **44** only in a counterclockwise direction. Tension spring **47** serves to urge link **44** to the normal position shown in Fig. 5 with the link in contact with the limit stop. When the detonator holder assembly **19** is lowered by means of lever **16**, the end portion of link **44** extends into slot **41** sufficiently to prevent rotation of the handwheel in a counterclockwise direction but permitting rotation in a clockwise movement since the link **44** will be cammed outwardly of the slot **41**.

The master valve assembly is shown in section in Fig. 3. In top plate **8** of the explosion chamber there is provided a port **48** through which the explosive gas mixture is introduced. The valve assembly consists of a bottom plate **49** centrally bored as at **51** and threaded as at **52** to receive the lower cylinder head **53**. This cylinder head is held in place on cylinder **54** by means of spring ring **55** and is provided with a central bore **56**. Upper cylinder head **57** is held in place on cylinder **54** by means of spring ring **58** and is centrally bored as at **59**. Extending through the central bores **56** and **59** in the lower and upper cylinder heads respectively is a piston rod **61** which is slidably mounted therein and is provided with a piston **62** maintained thereon by means of a spring ring **63**. Piston rod **61** extends through the upper cylinder head and the outer end thereof is provided with a collar **64**. Compression spring **65** acts between this collar and the upper cylinder

head to urge the piston rod to the uppermost limit of movement thereof. Sealing means of the O-ring type **66** are provided at suitable points within the master valve assembly. The cylinder is further provided with ports **67** and **68** while the bottom plate is provided with a port **69** for reasons hereinafter explained more fully.

It is seen from Fig. 2 that the explosion chamber is further provided with a spark plug **71** which serves as a means for igniting the gas mixture and is provided with a firing circuit of any common variety (not shown). In Fig. 2 is also shown a cross bar **72** which is mounted between brackets **3** and serves as a stop to limit movement of block **14** to an aligned position with the lower plate of the explosion chamber.

In Fig. 7 is shown diagrammatically the plumbing arrangement used in conjunction with the present invention. All valves, other than those leading to the gas supply tanks, are of the solenoid type well known in the art and are normally closed so that energizing the solenoid opens the valve. Port **67**, Fig. 3, is connected to the pipe leading to the input master valve cylinder where as port **68** constitutes an air escape. Port **69** in the bottom plate is connected to the tubing leading through the manifold to the gas supply tanks and exhaust pump.

In the operation of the apparatus lever **16** is first brought to a horizontal position whereby the detonator holder assembly is lowered to a position out of contact with the explosion chamber **4** and that sleeve **23** which is in the loading position is loaded with the detonator to be tested. Handwheel **35** is then rotated in a clockwise direction whereby the loaded sleeve is moved to a vertical position in alignment with bore **28** in the lower plate of the explosion chamber. The lever **16** is then moved to a vertical position whereby the detonator holder assembly moves upwardly and the loaded sleeve is positioned within the bore in the lower plate of the explosion chamber.

The piston **62** and rod **61** are in the upper position due to the tension of spring **65** in which position port **69** is opened. The vacuum pump V is then energized so as to evacuate the manifold and firing chamber to a value as indicated by the pressure gauge P. The explosive gas mixture of hydrogen and oxygen in the ratio of 2 to 1 is then admitted to the firing chamber **4** by opening the manual valves C and D. When the desired quantity of each gas has been admitted into chamber **4**, as indicated by the pressure gauge P, the manual valves C and D are closed and the input valve E to the master valve assembly **12** is opened whereby air under pressure is admitted through port **67** to force piston **62** and rod **61** downwardly thereby closing port **69** and locking the hydrogen-oxygen mixture in chamber **4**. Valve A is then opened to bleed off the residual explosive gas mixture from the manifold leading from valves C and D to port **69**. The firing switch (not shown) is then closed whereby the spark plug **71** is energized to fire the gas mixture contained in chamber **4**. It is, of course, understood that the ignition of a predetermined quantity of the hydrogen and oxygen mixture, as indicated by the pressure shown at gauge P, produces a predetermined temperature in chamber **4** and to which the detonator is subjected, thus firing the explosive mixture contained in the detonator if the mixture is firable at such temperature, or the detonator mixture is not fired if the mixture is not firable at such temperature. It is clear from the foregoing that a plurality of detonators may be tested for flash firing at selected temperatures to determine the mean firing temperature and the high and low extremes of temperature at which the detonators will fire, and whether the detonators are within specified limits. Exhaust valve A is again closed which seals the manifold. The exhaust valve F to the master valve assembly **12** is opened whereby the piston **62** and piston rod **61** move upwardly to the normal position thereby opening port **69**. Whereupon valve G is opened to connect pressure gauge P to the firing chamber **4** and if the pressure read on the pressure gauge P is greater than the known pressure generated by ignition of the gas mixture, the detonator has

fired. The detonator holder assembly 19 is then moved downwardly out of the firing chamber 4 and valve B is opened whereby the firing chamber is cleared of any debris by an air blast. The apparatus is then prepared for another test by repeating the above cycle of operations.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed as new and desired to be secured by Letters Patent is:

1. A flash fired detonator testing apparatus comprising, an explosion chamber having an opening therein, holding means for containing said detonator and adapted to be moved into engagement with said chamber to close the opening therein, means for admitting an explosive gas mixture having a predetermined flash temperature to the interior of said chamber, and means for providing a spark within said explosion chamber to subject the detonator under test to said predetermined flash temperature of said explosive gas mixture thereby firing a satisfactory detonator.

2. In a device of the class described, a hollow housing having an opening therein, movable means for supporting a flash fired detonator within said opening so as to be exposed to the hollow interior of said housing, means including a valve assembly for admitting to the interior of said housing at predetermined pressures, predetermined quantities of an explosive gas and a combustion supporting gas having combustion temperature characteristics corresponding to a desired flash point temperature for firing a detonator under tests as an explosive gas mixture having a predetermined flash temperature and spark producing means mounted on said housing for igniting said explosive gas mixture thereby to fire an acceptable detonator.

3. In a testing apparatus for flash detonators, a firing chamber provided with a bore in the lower end thereof, vertically movable means for holding a detonator to be tested mounted beneath said firing chamber and adapted to be moved into a position wherein said means closes the opening in said firing chamber with the detonator held therein exposed to the hollow interior of said chamber, means including a valve mounted on said chamber adapted to admit an explosive mixture of predetermined quantities of a flammable gas and a combustion supporting gas thereto at a predetermined pressure, and spark means mounted on said chamber adapted to ignite the explosive gas mixture thereby to fire an acceptable test detonator.

4. A detonator testing apparatus comprising, means providing a firing chamber having an opening in the lower end thereof, means for holding a detonator mounted beneath said firing chamber and adapted to be moved upwardly into the opening in said firing chamber, a valve assembly mounted on the upper end of said firing chamber, means for admitting an explosive gas mixture having a predetermined flash temperature at a predetermined pressure to the interior of said chamber through said valve, and spark means mounted on said firing chamber and adapted upon actuation to ignite said explosive gas mixture thereby to fire an acceptable detonator disposed within said holding means.

5. A detonator testing apparatus comprising, means providing an explosion chamber having an opening in the lower end thereof, a pair of brackets provided with elongated slots therein adapted to support said explosion chamber, means for holding a flash detonator mounted within said slots and adapted to be moved vertically therein to a position closing the opening in the lower end of said explosion chamber, means supporting said detonator holding means within the opening, means for admitting an explosive gas mixture of a predetermined pressure to the interior of said chamber, and spark means mounted on said firing chamber and adapted upon actuation to ignite said explosive gas mixture thereby to fire an acceptable detonator disposed within said holding means.

6. In a device of the class described, means providing an explosive chamber having an opening in the lower end thereof, a pair of brackets having elongated slots therein supporting said explosion chamber, a detonator holder assembly slidably mounted in said slots and adapted to be moved vertically in said slots to close the opening in said explosive chamber, a block pivotally mounted between said brackets, a lever fixedly mounted on said block, a pair of arms pivotally mounted on said block in offset relation to the pivot point of said block with said brackets, the upper ends of said arms rotatably supporting said detonator holder assembly whereby upon movement of said lever the arms and said detonator holder are moved vertically in the slots in said brackets, means for admitting an explosive gas mixture having a predetermined flash temperature to the interior of said explosive chamber, and spark means mounted on said chamber for igniting said explosive gas mixture whereby upon movement of said lever to position said detonator holder to close the opening in the explosive chamber and ignition of said spark means an acceptable detonator will be fired by the predetermined heat generated with combustion of said gas mixture.

7. A detonator tester comprising, a hollow cylinder, upper and lower plates secured to said cylinder, said lower plate having a central bore therein, brackets having slots therein supporting said cylinder, a detonator holder slidably mounted in said slots, said detonator holder comprising three sleeves equidistantly spaced around the periphery of said holder, a handwheel mounted on said holder and adapted to be rotated to position one of said sleeves vertically beneath the bore in said lower plate, means for moving said detonator holder vertically in said slots whereby said vertically positioned sleeve will be moved to a position closing the opening in the lower plate, means for admitting an explosive gas mixture having a predetermined flash temperature to said cylinder, and means for providing a spark within said cylinder to ignite the explosive gas mixture whereby upon actuation of said spark means to ignite the gas mixture an acceptable test detonator held within the vertically positioned sleeve will be fired at said predetermined temperature.

8. A detonator testing apparatus comprising means providing an explosion chamber having an opening in the lower end thereof, a pair of brackets provided with elongated slots supporting said explosion chamber, a detonator holder rotatably and slidably mounted within said slots, sleeves equidistantly spaced around the periphery of said detonator holder, a plurality of plungers respectively disposed in said sleeves, cam means slidably mounted within the slot in one of said brackets, said cam means adapted to coact with said plungers whereby upon rotation of said detonator holder one of the plungers is forced outwardly in the sleeve to eject a detonator held therein, means for moving said detonator holder vertically within said slots whereby one of said sleeves may be moved to a position closing the opening in the lower end of the explosion chamber, means for admitting an explosive gas mixture having a predetermined flash temperature to said chamber and means for providing a spark within said chamber for igniting the explosive gas mixture therein whereby upon ignition of said explosive gas mixture an acceptable test detonator held by the sleeve within the opening in the explosion chamber will be fired.

9. In a device of the class described, means providing an explosion chamber having an opening in the lower end thereof, brackets having elongated slots therein supporting said explosion chamber, a detonator holder slidably and rotatably mounted within said slots, a handwheel mounted on said detonator holder, latching means mounted on one of said brackets and adapted to coact with said handwheel to prevent rotation of said detonator holder in one direction, sleeves mounted on said detonator holder and spaced equidistantly around the periphery thereof, said sleeves having recesses in the outer ends thereof to receive detonators, plungers slidably dis-

posed within said sleeves and spring urged to a retracted position, cam means slidably mounted in the slot in one of said brackets, said cam means coacting with said plungers and so arranged as to urge one of said plungers outwardly in the sleeve thereof to eject a flash fired detonator held therein in response to rotation of said handwheel through an angle corresponding to the angle of displacement of said sleeves, means for moving said detonator holder vertically in the slots in said brackets so that one of said sleeves is positioned to close the opening in the lower end of said explosion chamber, means for admitting an explosive gas mixture having a predetermined flash temperature to said chamber, and means for producing a spark within said chamber to ignite the explosive gas mixture whereby upon actuation of said spark means to ignite said explosive gas mixture an acceptable test detonator held within that sleeve closing the opening in the lower end of the explosion chamber will be fired at said predetermined temperature.

10. A detonator testing apparatus comprising, means providing an explosion chamber having an opening in the lower end thereof, a pair of brackets having elongated slots therein supporting said explosion chamber, a block having an offset portion pivotally mounted between the lower ends of said brackets, a lever fixed to said block, arms pivotally mounted on the offset portion of said block and extending upwardly therefrom, a detonator holder slidably mounted within the elongated slots in said brackets and rotatably mounted on the upper ends of said arms whereby rotary movement of said lever imparts vertical movement to said detonator holder, sleeves mounted on said detonator holder spaced equidistantly around the periphery thereof, a plurality of plungers slidably and respectively disposed within said sleeves and spring urged to a retracted position, cam means slidably mounted in the slot in one of said brackets and adapted to coact with said plungers, a handwheel secured to said detonator holder whereby upon rotation of said handwheel through an angle corresponding to the angular displacement of said sleeves one of said plungers is forced outwardly in the sleeve thereof to eject a detonator held therein, means for admitting an explosive gas mixture having a predetermined flash temperature to said explosion chamber, and means for providing a spark within said explosion chamber whereby upon movement of said lever said detonator holder and said sleeves are moved vertically and one of said sleeves having a detonator therein is positioned within the opening in the explosion chamber and upon actuation of said spark means the explosive gas mixture is ignited to fire an acceptable test detonator when the firing temperature is the same as or lower than the flash temperature of the gas mixture thereby providing an indication of the firing temperature of said detonator.

11. A flash-fired detonator testing apparatus comprising, means providing an explosive chamber having an opening in the bottom thereof, holding means for containing a detonator to be tested, means adapting the holding means to be moved into engagement with the chamber at said opening to close the opening therein, means for admitting a flammable gas and a combustion supporting gas as a combustible mixture of proportions preselected to display a predetermined flash temperature at a predetermined pressure in said chamber, said predetermined flash temperature being commensurate with a required test temperature for firing of an acceptable detonator, means for providing a spark within said explosion chamber after closure thereof by said holding means whereby ignition of said spark means fires the mixture to subject the detonator under test to said predetermined firing temperature condition within said chamber thereby firing an acceptable detonator.

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