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3,277,785

FIRING MECHANISM FOR EXPLOSIVE DEVICES AND THE LIKE

Filed Aug. 3, 1964

2 Sheets-Sheet 1

FIG. 1.

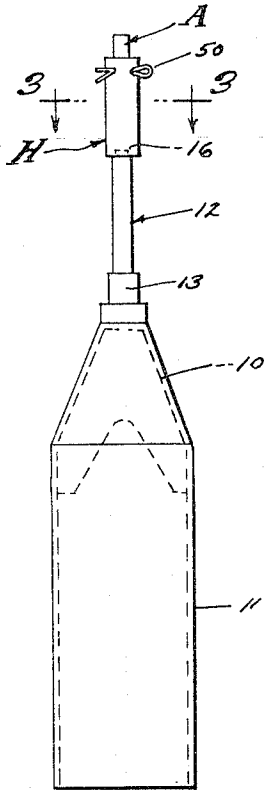


FIG. 2.

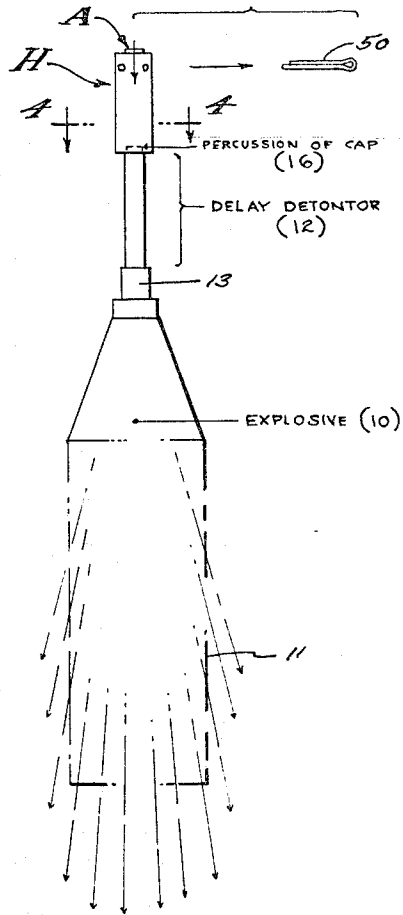


FIG. 3.

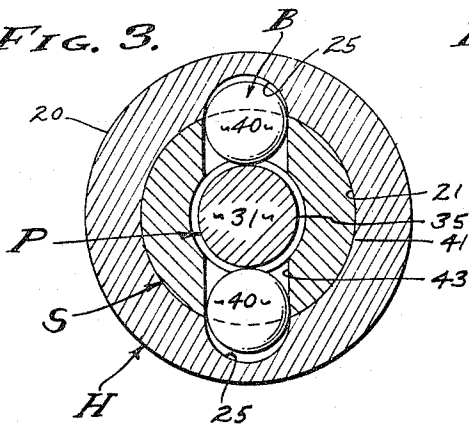
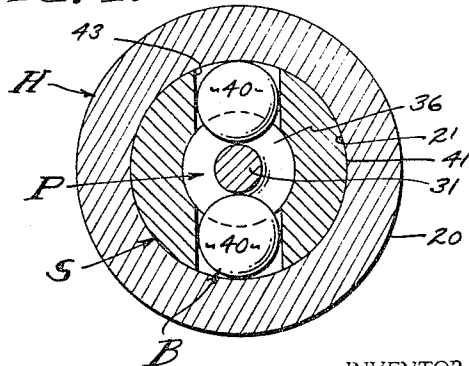


FIG. 4.



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FIG. 5.

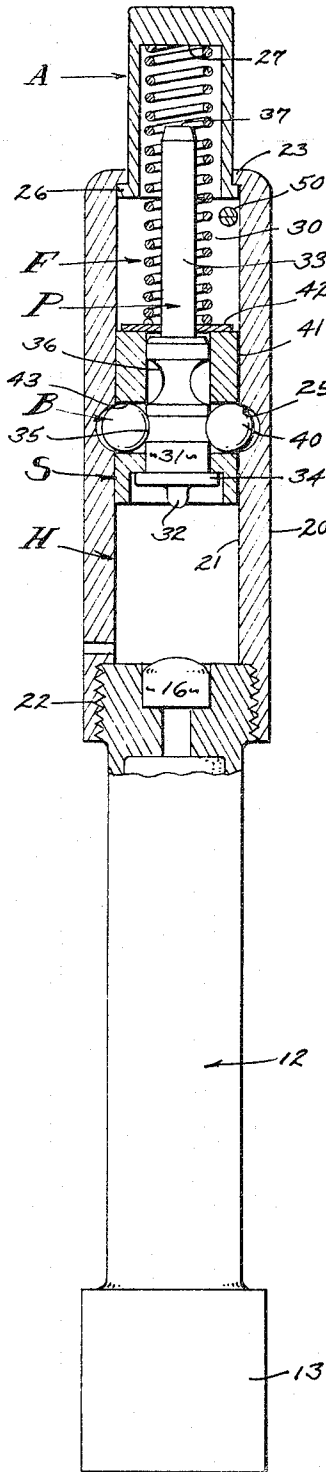


FIG. 6.

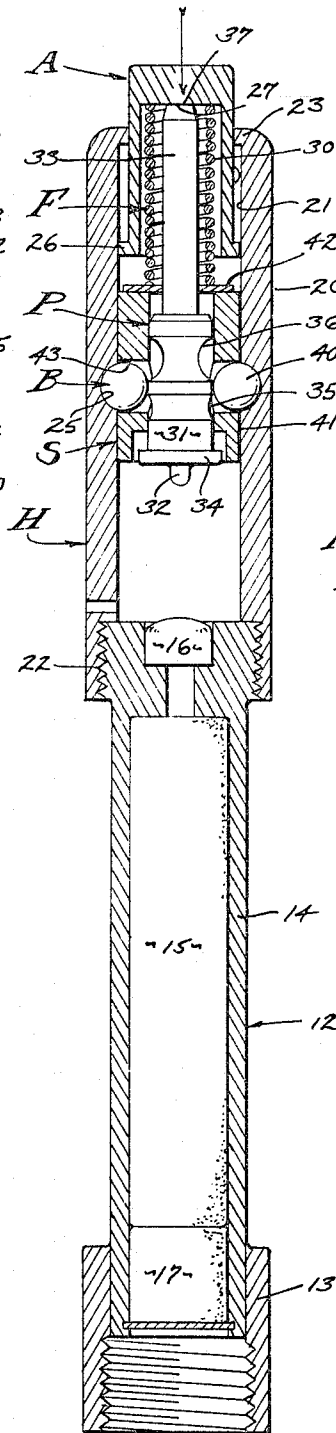
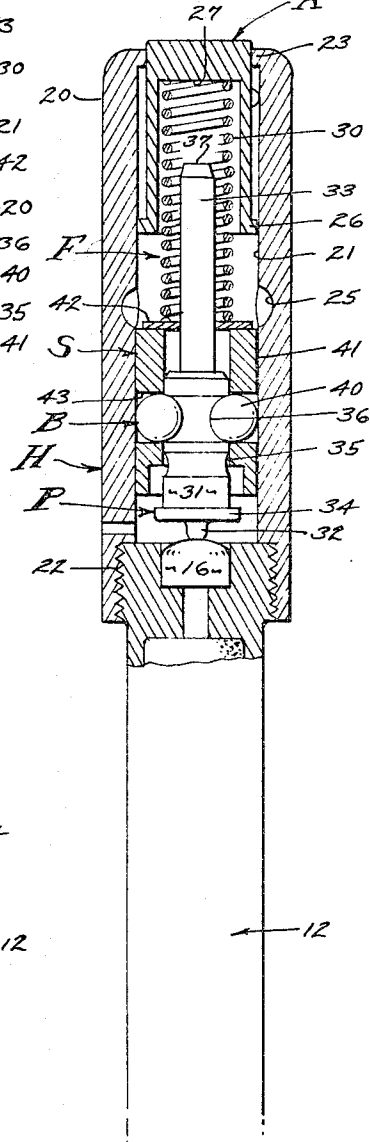


FIG. 7.



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FIRING MECHANISM FOR EXPLOSIVE DEVICES AND THE LIKE

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6 Claims. (Cl. 89—1)

This invention relates to an actuator for initiating action in a wide variety of devices which require the application of force and/or movement in order to promote the functional operation for which they are intended. Particularly, this invention relates to a triggering mechanism that has utility in firing explosive devices wherein a cap, or the like, is to be struck in order to detonate the device and thereby initiate explosive operation of said device.

Firing mechanisms are used in explosive devices for detonating the charges thereof, and most often such mechanisms must be expendable while retaining reliability characteristics. The art involved is highly developed and requirements are set wherein safety is a primary consideration. Therefore, a firing mechanism of the type under consideration must be foolproof, so to speak, and must meet certain standard requirements. Firstly, there must be provision for a safety which is positive in preventing actuation. Secondly, the firing pin must be retracted and unbiased when the mechanism is inoperatively safetied. Thirdly, it must be apparent from even the most casual observation as to the condition of the mechanism, whether it has been actuated or not. And there are other requirements which will be apparent from the following description.

An object of this invention is to provide a firing mechanism which meets the requirements set forth above and which is practical and inexpensive of manufacture.

Another object of this invention is to provide a firing mechanism wherein a single force exerting means in the form of a spring is operative to exert locking pressure to hold a firing pin retracted, and is also operative under altered conditions to exert striking pressure in moving said firing pin upon its release.

It is another object of this invention to provide a firing mechanism wherein a firing pin is locked in retracted position by a lightly biased spring and wherein said spring is capable of being additionally biased and engaged with a slide which in turn engages the firing pin to move the same with striking force when released, all to the end that said spring does not contact or engage the said firing pin during the inaction of the mechanism.

It is still another object of this invention to provide a firing structure of the character referred to wherein maximum inertia is obtainable from the parts which are included therein, only the housing and manually engageable pressure exerting part being ineffective in contributing essentially to the impact force exerted by the firing pin.

The various objects and features of this invention will be fully understood from the following detailed description of the typical preferred form and application thereof, throughout which description reference is made to the accompanying drawings, in which:

FIG. 1 is a side elevation of the firing mechanism assembled with a delay detonator and an explosive charge to be detonated, said assembly being illustrated in a safetied condition.

FIG. 2 is a view similar to FIG. 1 and shows the firing mechanism unsafetied and operated to cause percussion of a cap, followed by operation of the delay detonator, with consequent detonation of the explosive charge.

FIGS. 3 and 4 are enlarged sectional views taken as in-

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dicated by lines 3—3 and 4—4 on FIGS. 1 and 2 respectively.

FIGS. 5, 6 and 7 are enlarged detailed longitudinally sectional views showing the three major operative positions of the parts involved in the firing mechanism, FIG. 5 showing the mechanism in the unactuated safetied condition, FIG. 6 showing the relationship of parts during the triggering of the mechanism, and FIG. 7 showing the relationship of parts at the time of and following striking of a cap or the like.

The firing mechanism is shown as an elongated cylindrical assembly of parts comprising, generally, a housing H, an actuator A, a force exerting means F, a firing pin P, a slide S, and a locking means B. The housing H is the static body part of the mechanism, while the actuator A is incorporated therein as a manually operative and movable part which controls and biases the several functions of the structure. Also, an initial requirement of such a mechanism is the safety pin which is engaged in the housing H in order to fixedly position the actuator A relative thereto. These are the parts and/or elements that are fashioned and cooperatively interrelated as hereinafter described and which combine to establish the instant firing mechanism.

The device which is to be activated by the firing mechanism forms no part of the present invention, and such a device can vary widely as circumstances required. It can be a mechanical device which is activated by shifting of parts, or it can be a pyrotechnic device which is activated by percussion of a cap. For purpose of illustration the latter case is shown wherein a shaped charge 10 is supported by a tubular body 11, in this case a delay detonator 12 is fastened to the charge 10 by means of a coupler sleeve 13, and the firing mechanism herein disclosed is fastened to the detonator 12 for its support. The shaped charge 10 is an explosive charge focused along an axis for concentrated effect. The delay detonator 12 comprises a tube 14 containing a delay mixture 15 which, in practice, requires approximately thirty seconds for transmission of ignition from one end to the other. Therefore, a percussion cap 16 is located at one end and an explosive mixture 17 is located at the other end of the delay mixture, whereby a predetermined time interval is established between the initial percussion by the cap 16 and the terminal explosion by the mixture 17. The cap 16, and mixtures 15 and 17 can be of any suitable type ordinarily employed for the purposes set forth. As shown, the percussion cap 16 involves a deformable shell adapted to be struck and indented thereby in order to initiate its function to give off a percussive action. As shown, the cap 16 and mixture 17 are in communication with the intermediate mixture 15.

The housing H, actuator A and slide S are structural parts that are advantageously made of lightweight plastic material. However, it is preferred that the firing pin P be made of metal in order to have sureness of action and hardness for striking the percussion cap 16. It will be seen that these few main parts are easily formed as by molding and/or machining and each involves a minimum of features.

The housing H is an elongated cylinder having a smooth unobstructed exterior wall 20 and a smooth interior wall 21. The opposite ends of the cylindrical housing are open, one end being threaded at 22 and the other end being shouldered at 23. The threads at 22 are coupled to the tube 14, with the percussion cap 16 centrally carried within the threads at 22 and exposed to face toward the shouldered end of the housing. The said shoulder at 23 extends radially inward of wall 21. Intermediate the said ends of the housing there is a recess 25 indented in the wall 21 and forming part of the locking means B. The recess 25 can vary widely in configuration, being

shown as an annular recess of semi-arcuate cross section. As an alternate, for example, there can be one or more individual recesses, for instance a semispherical recess. In any case, recess 25 is substantially spaced from the cap 16 in order to permit sufficient travel of the moving parts to be described.

The actuator A is a manually depressable part telescopically related to the housing H above described. Although the actuator A could slide onto the housing H, it is preferred that it slide into the housing H, being operable from an extended position such as shown in FIG. 5 to a depressed position such as shown in FIG. 7. Extension of the actuator A is limited by a peripheral lip 26 that projects from the inner end thereof and engages the shoulder at 23. As shown, the actuator A is a hollow hat-shaped part extended a limited distance and adapted to be manually depressed to a position flush with the end of the housing. The top of the actuator A forms a seat 27 to engage with the force exerting means F.

The force exerting means F can vary in form and is preferably a simple helical compression spring 30 with its axis disposed along the axis of the cylindrical housing H. One end of the spring 30 engages seat 27 while the opposite end is free to engage and to operate the slide S. However, in no case does the said opposite end of the spring 30 engage the firing pin P.

The firing pin P is an elongated part of considerably lesser axial extent than the housing H, having the cylindrically turned body 31 with a forwardly projecting pin 32 and rearwardly projecting stem 33. The slide S is adapted to surround the firing pin P and is adapted to engage the said firing pin in order to move it forwardly. Therefore, the firing pin P has a head 34 at the forward end thereof and is adapted to be pushed by the slide. The body 31 is characterized by a pair of distinctive recesses 35 and 36, the recess 35 being a lock recess and the recess 36 being a release and fire recess. These recesses 35 and 36 together with the recess 25 hereinabove described are cooperatively related to form the lock means B with the cooperation of the slide S and intermediate lock elements 40. As shown, the recesses 35 and 36 are annular, each being semi-circular in cross section, and the foremost recess 35 being shallow while the rearmost recess 36 is deep. The recesses 35 and 36 are separated longitudinally by a minimum of body surface. The forwardly projecting pin 32 is a button-shaped extension of the body 31 and which is adapted to engage and to indent the shell of the cap 16. The rearwardly projecting stem 33 is a rod that extends from the body 31 to guide the spring 30 and has an end 37 to be engaged and moved forwardly by the seat 27 of the actuator A.

The slide S is a piston-shaped part slideably engaged within the housing H. The exterior 41 of the slide S is free to move within the interior 21 of the housing. The rear of the slide S is engaged and urged forwardly by the spring 30, there being a thrust washer 42 to effect transfer of thrust. The front of the slide S engages the head 34 of the firing pin P, while the rear of the body 31 significantly clears the thrust washer 42. Washer 42 freely passes the stem 33. Slide S is characterized by its one or more radially disposed guide openings 43 which are particularly adapted to control the movement of the lock elements 40. In the preferred form the lock elements 40 are balls in which case the guide openings are round in cross section. Therefore, the ball shaped lock elements 40 are free to move radially of the slide S.

The parts and elements of the firing mechanism are described above and the lock means B involves the lock elements 40 that are selectively engageable in the recesses 35 and 36. However, the previously described recesses 25 are of sufficient radial depth (outward) so as to permit displacement of the lock elements 40 from the recess 35. Also, the recess 36 is of sufficient radial depth (inwardly) so as to permit an accommodation of the lock elements 40 within the wall 21 of the hous-

ing H. However, in each instance the depth of recesses 25 and 36 are substantially less than half the diameter of the lock elements whereby radial inward biasing of the lock elements is a function when axial force is applied against the slide S by the spring 30.

FIG. 5 of the drawings illustrates the initially assembled and safetied condition of the firing mechanism, wherein the lock elements 40 are urged inwardly into pressured engagement with the firing pin body 31 by virtue of force exerted by the means F. As is shown, the actuator A is safetied by means of a retractable pin 50 disposed transversely through the housing H in the path of the said actuator. Thus, the actuator cannot be moved without retraction of the pin 50. In said inactive safetied condition the spring 30 of means F presses lightly upon the rear of the slide S and urges the slide forwardly. The radially disposed guide openings 43 in the slide present walls in a plane normal to the axis of the mechanism and for engaging the lock elements 40 so as to urge them forwardly. From FIG. 5 it will be seen that the recess 25 and interior wall 21 of the housing H cooperatively present a corner which engages the periphery of the rounded or ball-shaped lock member 40 at less than half its diameter, thereby establishing a resultant radially inward component of forces which press the member 40 into the recess 35. In this way the lock members 40 are engaged with the housing H to lock the firing pin P in a retracted position, by light spring pressure applied to the slide S which is also locked in said inactive position by the lock members 40.

FIG. 6 of the drawings illustrates the unsafetied and actuated condition of the firing mechanism, wherein the lock elements 40 are detented outwardly for subsequent release of the firing pin P and associated parts. As is shown, the actuator A is depressed or moved forwardly so as to engage the end 37 of the stem 33 and thereby move the firing pin P forwardly to displace the lock elements 40 from the recess 35. The lock elements continue to occupy the recesses 25 so as to retain the slide S immovable relative to the housing H, until further forward movement of the actuator A and consequent forward movement of the firing pin P. Said further movement (not specifically shown) brings the recess 36 within the lock elements 40, whereupon the resultant radially inward component of forces, above described, pressures the members 40 into the recess 36. At this point of function the spring 30 has been compressed a maximum and is conditioned to accelerate the firing pin P and associated parts.

FIG. 7 of the drawings illustrates the operated condition of the firing mechanism, wherein the released or triggered firing pin P has been accelerated by the spring 30 to strike the percussion cap 16. The lock elements 40 that have moved into the recess 36 have moved forwardly within the housing H and the energy momentarily stored in the spring 30 is expended. A feature of the mechanism is the coupled engagement of the firing pin P and slide S by the lock elements 40, which move forwardly together as one inertial body. Frictional engagement holds the movable parts in a forward position relative to the housing, to the end that the actuator A remains depressed and thereby indicates that the firing mechanism has been operated to trigger the firing pin P.

Having described only a typical preferred form and application of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any modifications or variations that may appear to those skilled in the art and fall within the scope of the following claims.

Having described my invention, I claim:

1. A firing mechanism for striking caps and the like, and including;
 - (a) an elongated housing having an interior wall with a cam-shaped recess therein,
 - (b) an axially movable actuator at one end of the

housing, the cap being fixedly positioned at the other end of the housing,

(c) an axially movable pin within the housing and operable to reciprocate between the actuator and cap, said pin having a body with a pair of axially spaced recesses opposing the first mentioned recess, one a lock recess toward the cap end of the pin and the other a release recess,

(d) an axially movable slide within the housing and operable independently between the housing and pin, there being a laterally disposed guide opening through the slide to align with said recesses,

(e) a shiftable lock member carried by the slide within said guide opening therethrough and normally engaged in and by the first mentioned cam shaped recess and urged thereby into said lock recess, locking the pin in a safety position,

(f) and force exerting means extended axially and compressively between the actuator and the slide,

(g) said actuator being engageable with the pin to shift the pin and thereby move said lock recess out of alignment with the guide opening and said release recess into alignment with the guide opening displacing said lock member from the lock recess and shifting said lock member from the first mentioned recess and into said release recess, whereby the pin and slide and lock member move to strike as one mass under influence of the force exerting means.

2. A firing mechanism as set forth in claim 1 and wherein the lock recess is normally engaged by the lock member restraining movement of the pin by the bias of the force exerting means, until displacement of said lock recess from alignment with the said cam-shaped recess through moving engagement of the pin by said actuator.

3. A firing mechanism for striking caps and the like, and including:

(a) an elongated housing having an interior wall with a concaved recess therein,

(b) an axially movable actuator at one end of the housing, the cap being fixedly positioned at the other end of the housing,

(c) an axially movable pin within the housing and operable to reciprocate between the actuator and cap, said pin having a body with a pair of axially spaced recesses opposing the first mentioned recess, one a concaved lock recess toward the cap end of the pin and the other a concaved release recess,

(d) an axially movable slide within the housing and operable independently between the housing and pin, there being a laterally disposed guide opening through the slide to align with said recesses,

(e) a shiftable and rounded lock member carried by the slide within said guide opening therethrough and normally engaged in and by the first mentioned concaved recess and said lock recess locking the pin in a safety position, said lock member being formed round on a radius greater than that of the concave radius of the first mentioned recess and said lock member being disposed to roll between the housing and pin,

(f) and force exerting means extended axially and compressively between the actuator and the slide, said guide opening pressing the lock member axially with respect to the first mentioned concaved recess and thereby establishing a radially inward component of forces urging the lock member into the lock recess,

(g) said actuator being engageable with the pin to shift the pin and thereby move said lock recess out of alignment with the guide opening and said concaved release recess into alignment with the guide opening

displacing said lock member from the lock recess and shifting said lock member from the first mentioned recess and into said concaved release recess, whereby the pin and slide and lock member move to strike as one mass under influence of the force exerting means.

4. A firing mechanism as set forth in claim 3 and wherein the concaved lock recess is normally engaged by the rounded lock member restraining movement of the pin by the bias of the force exerting means, until displacement of said concaved lock recess from alignment with said first mentioned concaved recess through moving engagement of the pin by said actuator.

5. A firing mechanism for striking caps and the like, and including:

(a) an elongated housing having an interior wall with a concaved recess therein,

(b) an axially movable actuator at one end of the housing, the cap being fixedly positioned at the other end of the housing,

(c) an axially movable pin within the housing and operable to reciprocate between the actuator and cap, said pin having a body with a pair of axially spaced recesses opposing the first mentioned recess, one a concaved lock recess toward the cap end of the pin and the other a concaved release recess,

(d) an axially movable slide within the housing and operable independently between the housing and pin, there being a laterally disposed guide opening through the slide to align with said recesses.

(e) a shiftable and spherical lock member carried by the slide within said guide opening and normally engaged in and between the first mentioned concaved recess and said lock recess locking the pin in a safety position, said lock member being ball-shaped on a radius greater than that of the concave radius of the depth of the first mentioned recess to roll between the housing and pin,

(f) and force exerting means extended axially and compressively between the actuator and the slide, said guide opening pressing the lock member axially with respect to the first mentioned concaved recess and thereby establishing a radially inward component of forces urging the lock member to seat in the concaved lock recess,

(g) and actuator being engageable with the pin to shift the pin and thereby move said concaved lock recess out of alignment with the guide opening and said concaved release recess into alignment with the guide opening displacing said spherical lock member from the concave lock recess and shifting said spherical lock member from the first mentioned recess and into said concaved release recess, whereby the pin and slide and lock member move to strike as one mass under influence of the force exerting means.

6. A firing mechanism as set forth in claim 5 and wherein the concaved lock recess is normally engaged by the spherical lock member restraining movement of the pin by the bias of the force exerting means, until displacement of said concave lock recess from alignment with the said first mentioned concaved recess through moving engagement of the pin by said actuator.

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