

March 6, 1951

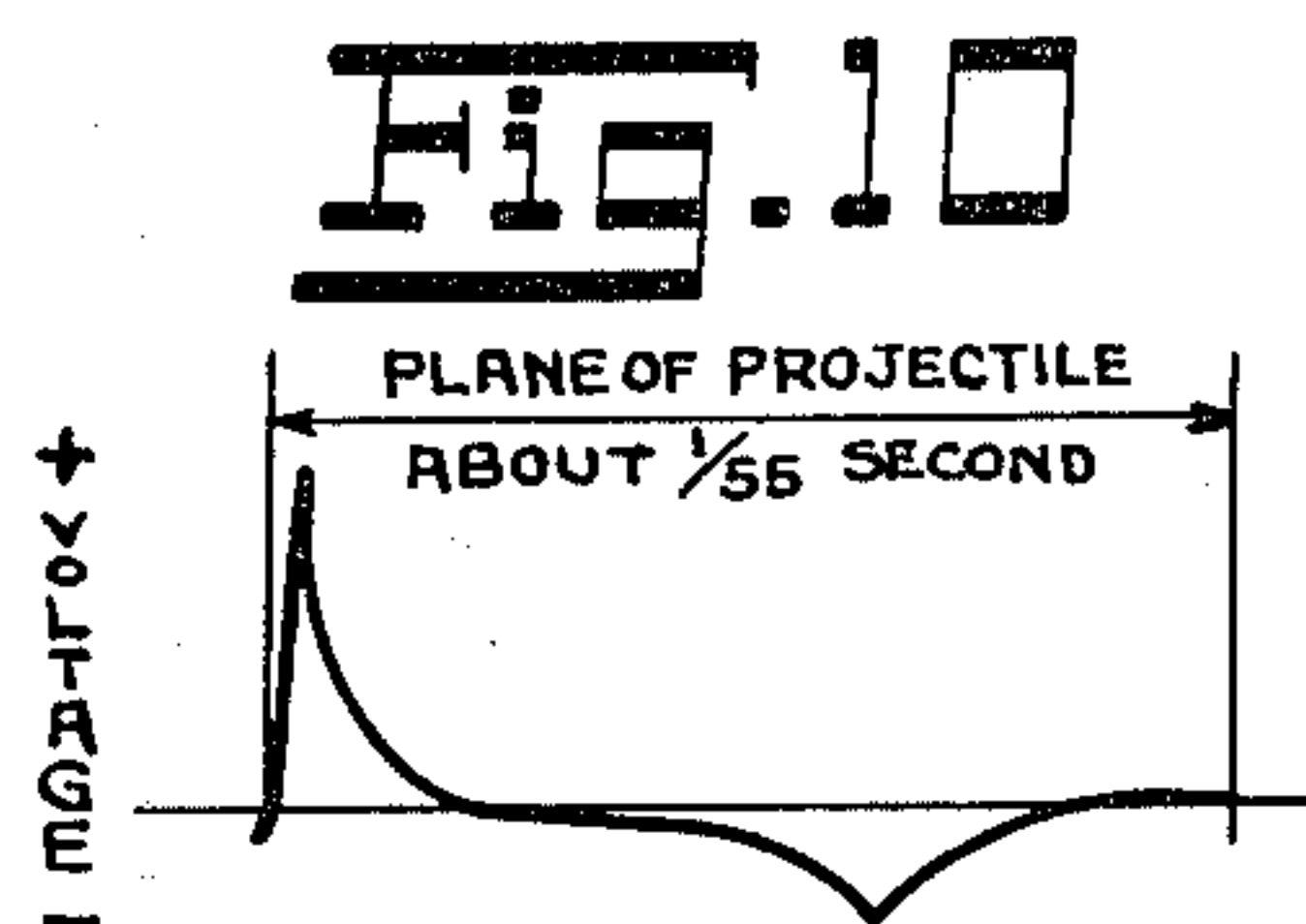
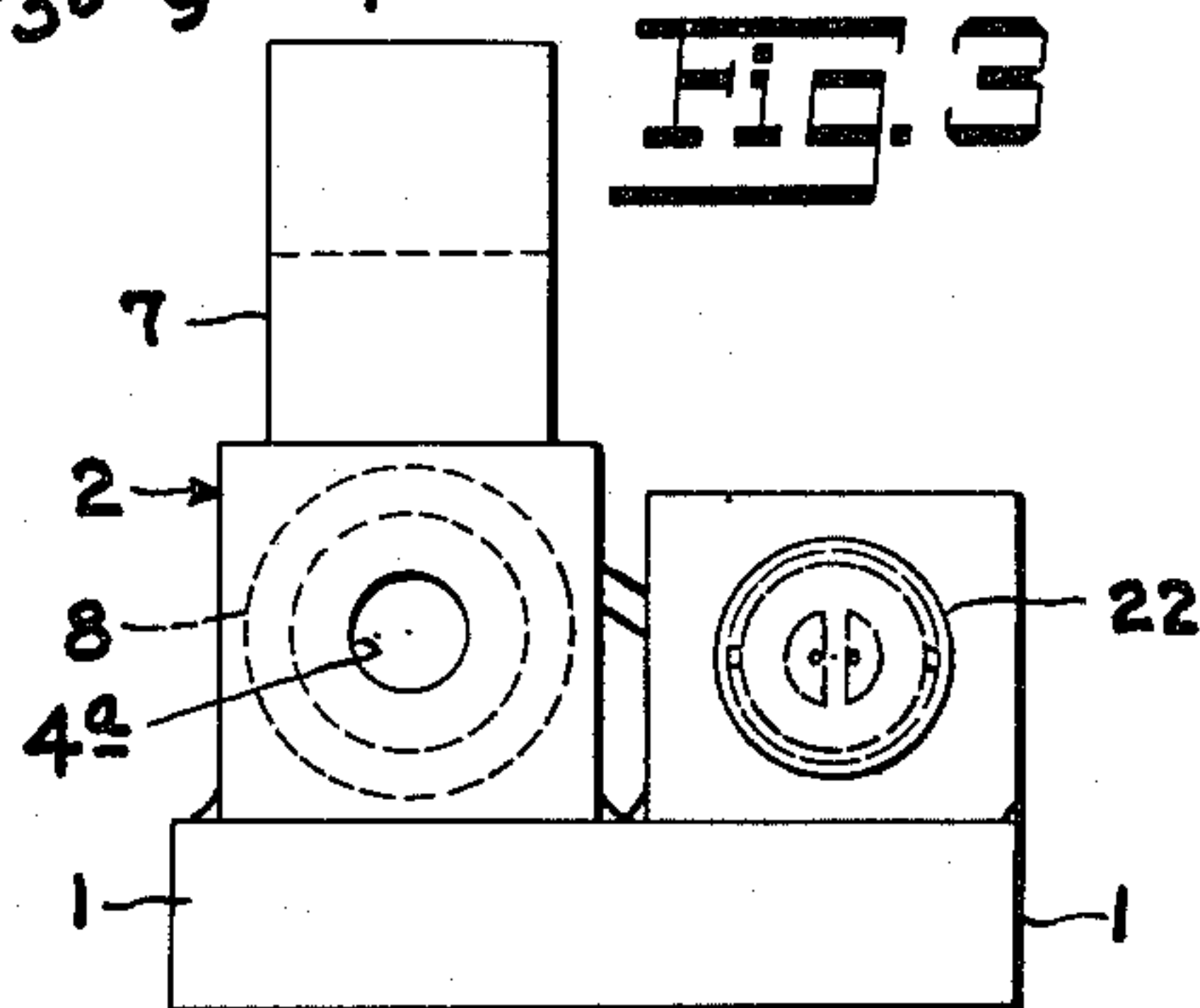
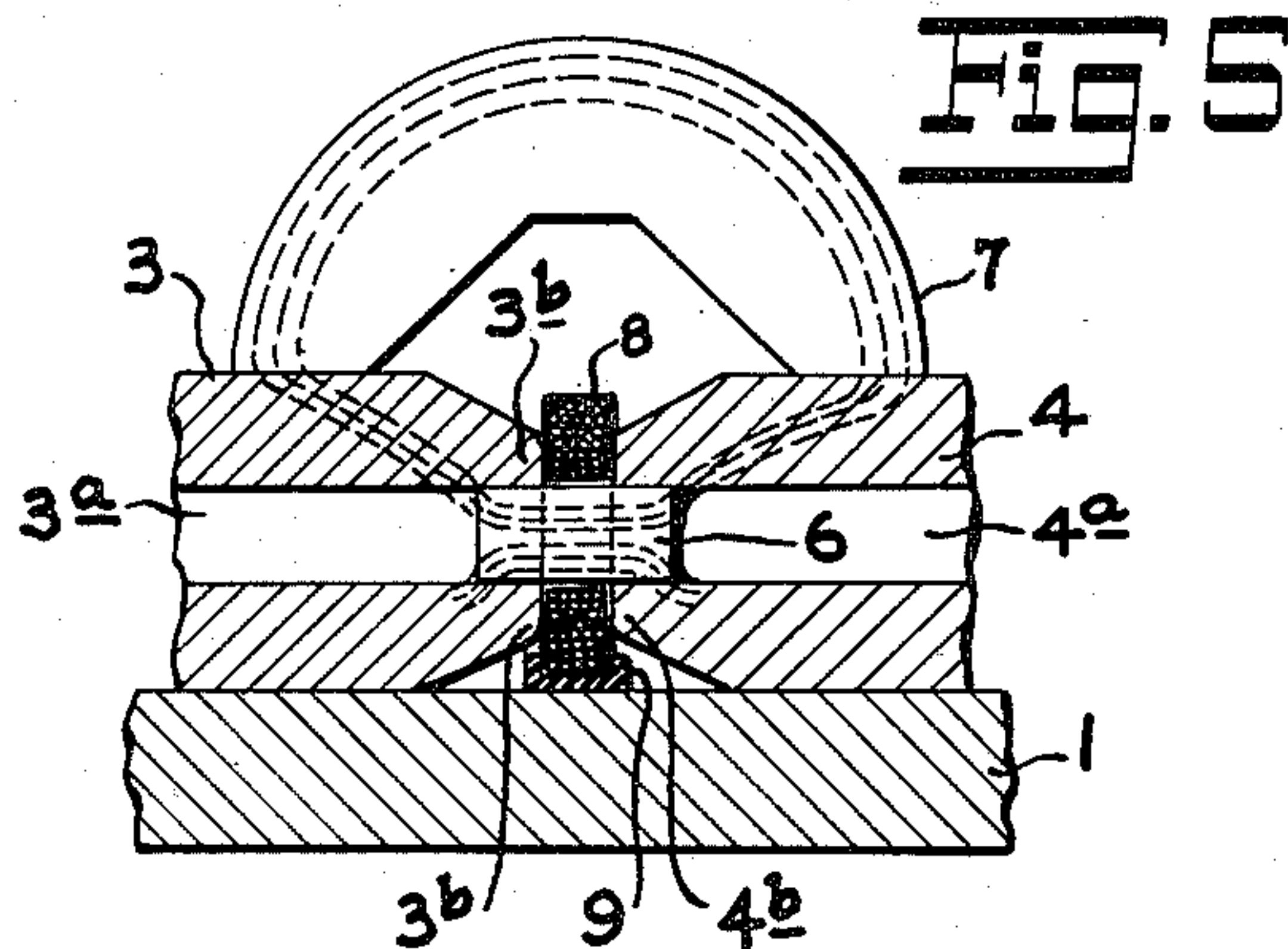
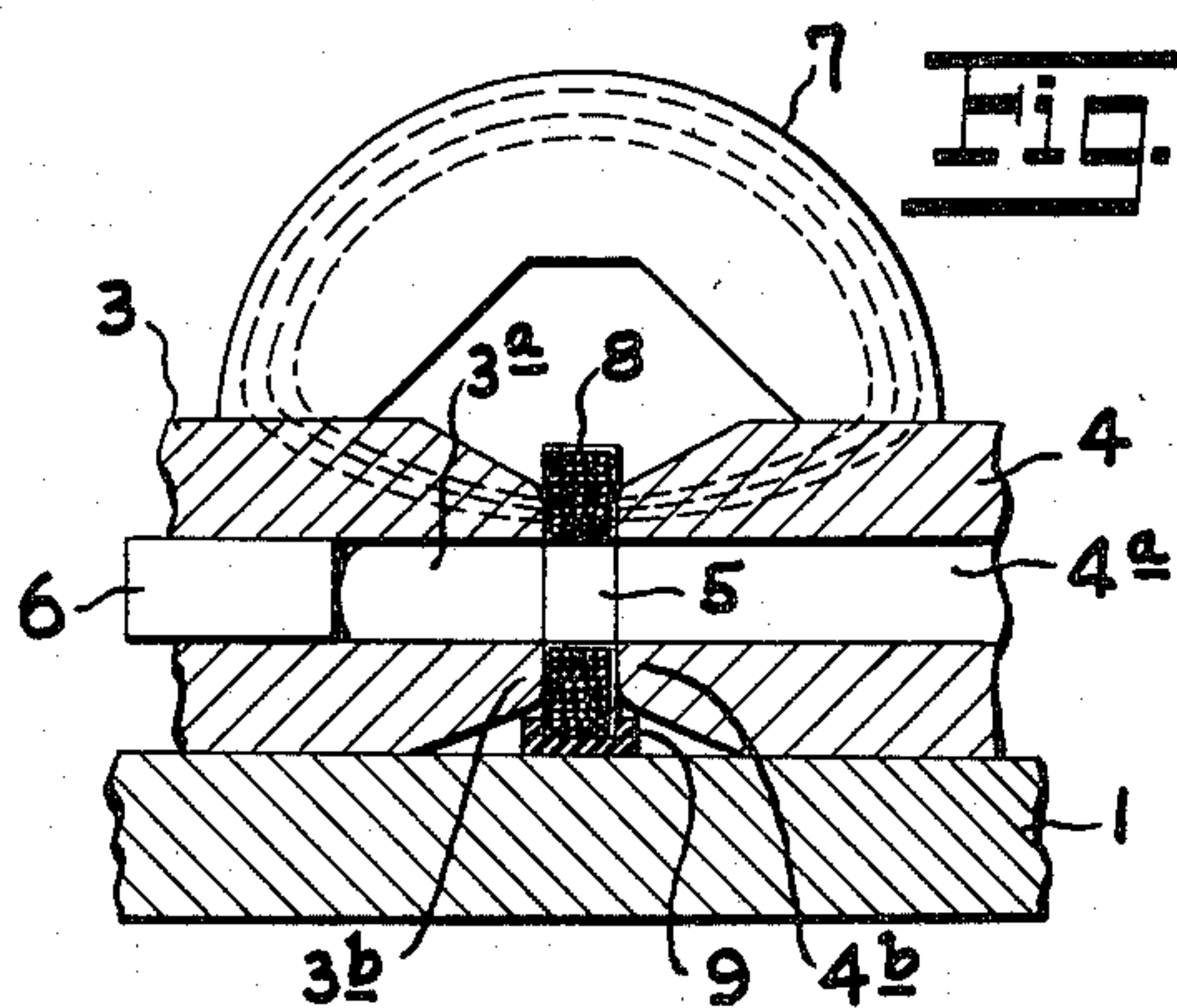
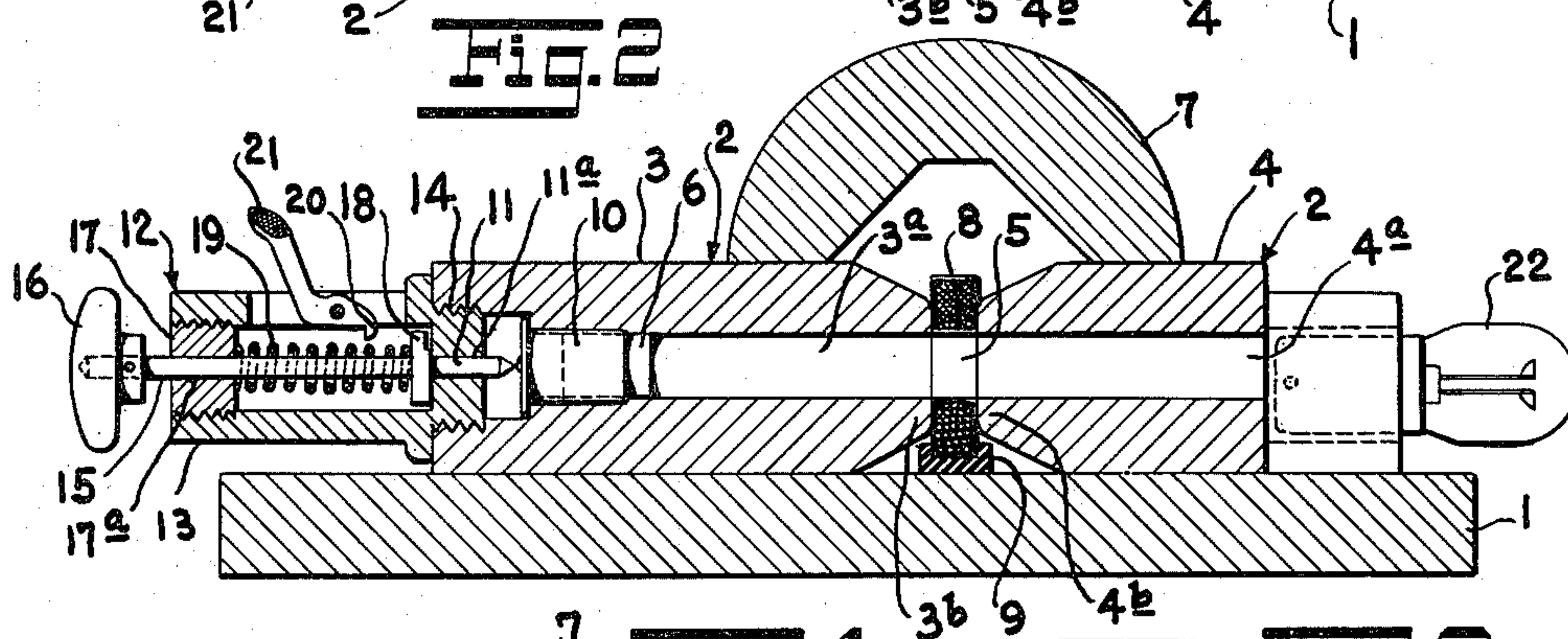
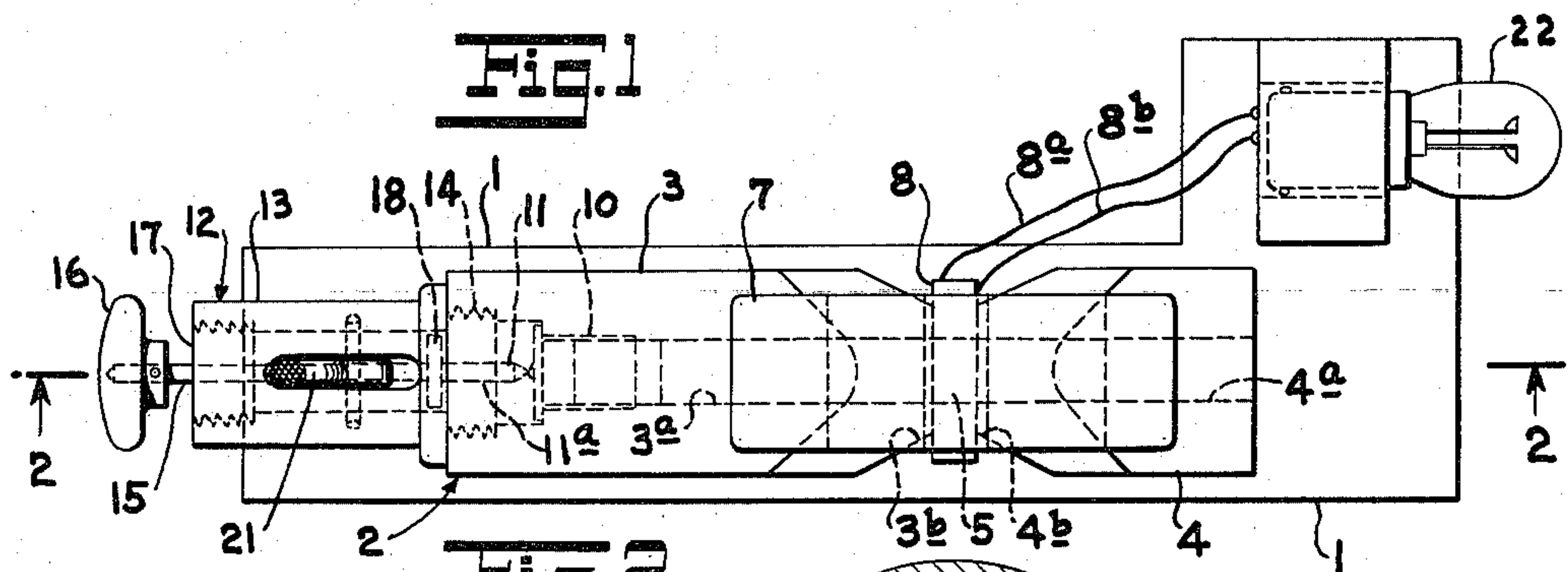
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2,544,077

PROJECTILE-ACTUATED SURGE GENERATOR

Filed July 24, 1948

2 Sheets-Sheet 1



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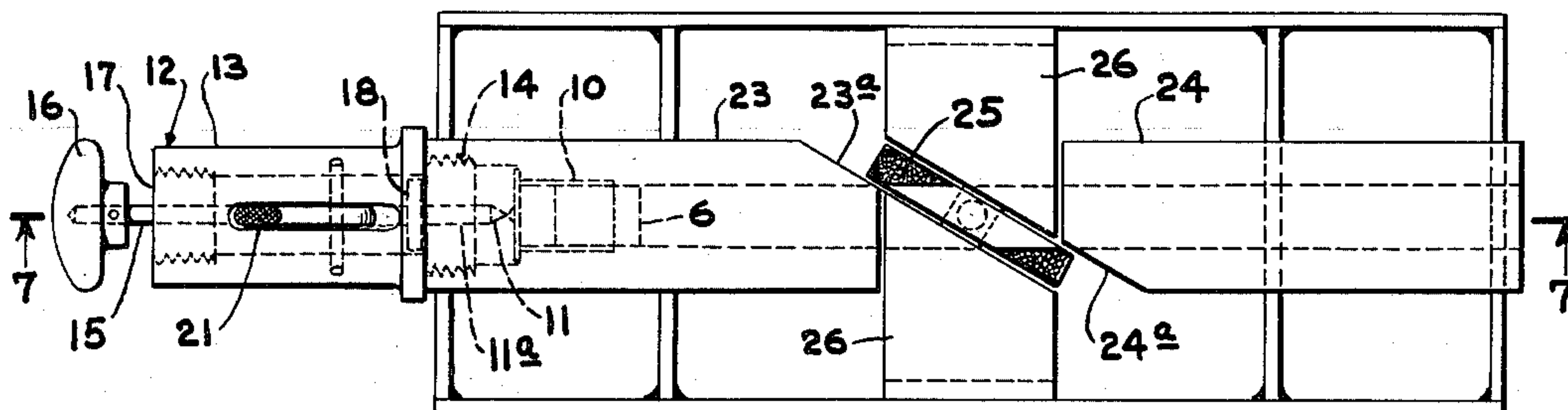
**2,544,077**

# PROJECTILE-ACTUATED SURGE GENERATOR

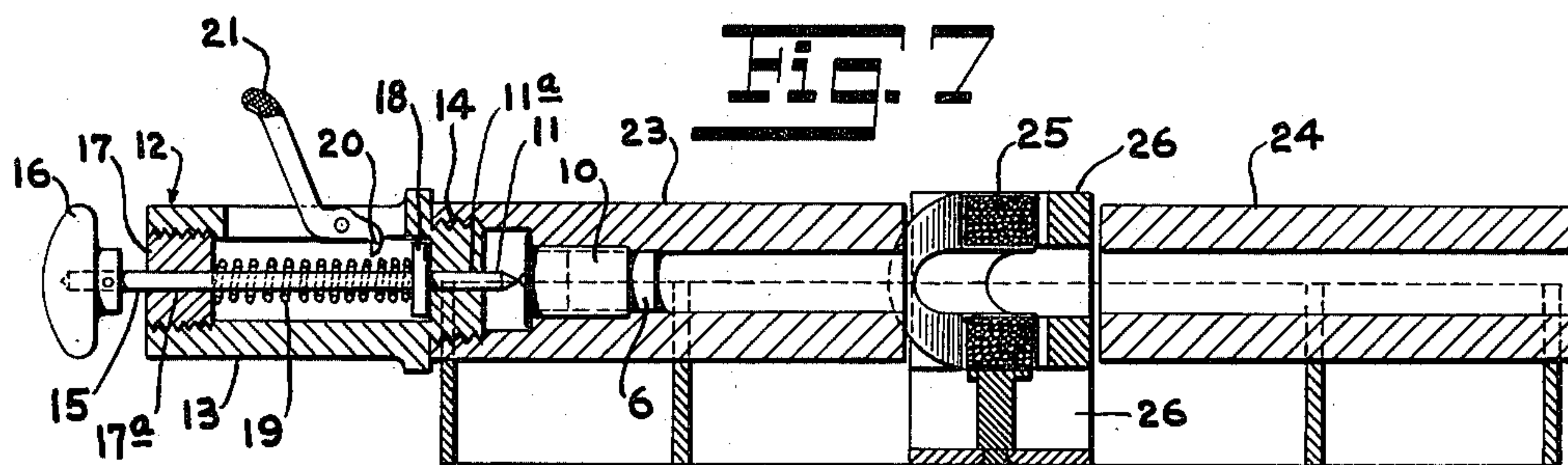
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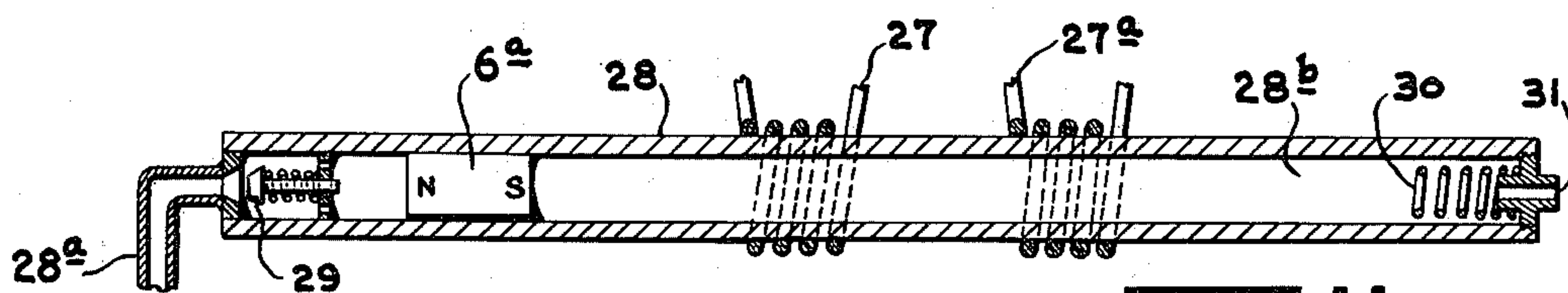
**Fig. 6**



**HAZ**

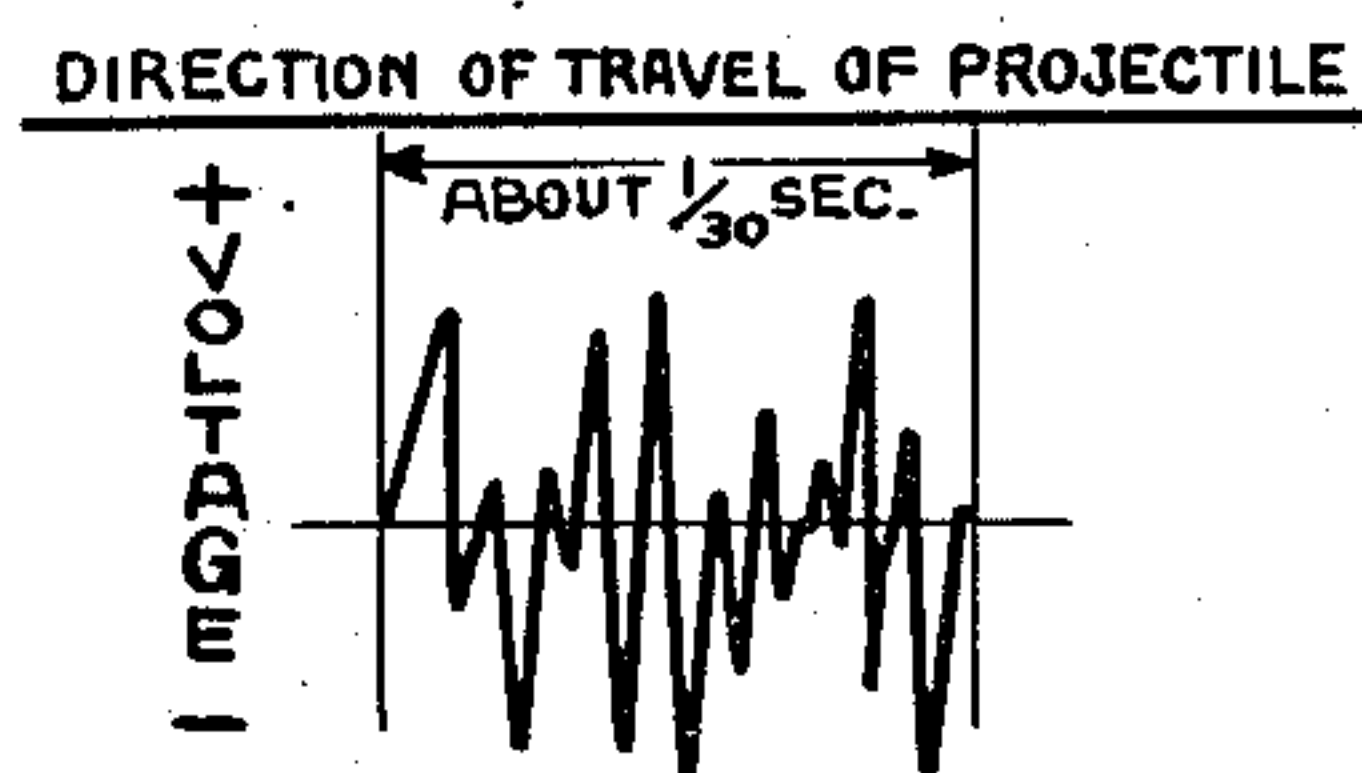
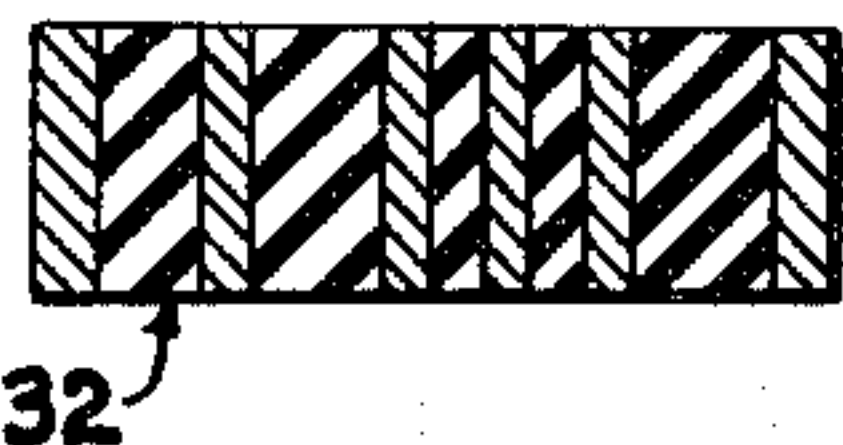


**Fig. 8**



A schematic diagram of a mechanical assembly, likely a pump or engine component. It shows a central vertical shaft with various parts labeled with letters. At the top, there's a horizontal bar labeled 'A'. Below it, a component labeled 'B' is connected to a vertical shaft. This shaft passes through a series of components: 'C' (a horizontal plate), 'D' (a vertical plate), 'E' (a horizontal plate), and 'F' (a vertical plate). The shaft continues down to a component labeled 'G', which is connected to a horizontal bar labeled 'H'. Below 'H' is a component labeled 'I', which is connected to a vertical shaft that passes through a horizontal plate labeled 'J'. The shaft ends at a component labeled 'K'. To the right of the main assembly, there are two vertical bars labeled 'L' and 'M'. The entire diagram is enclosed in a rectangular frame.

**Fig. 9**



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## UNITED STATES PATENT OFFICE

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PROJECTILE-ACTUATED SURGE  
GENERATOR

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Application July 24, 1948, Serial No. 40,558

4 Claims. (Cl. 171—209)

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This invention relates to a projectile-actuated surge generator for producing from a magnet useful electrical impulses of relatively high voltage.

One of the objects of this invention is to produce a surge generator embodying a magnet combined with a surge coil or like element and means for moving these elements relatively to each other at a high speed to generate and to pass through the coil and to suitable terminals an electrical surge or impulse that may be used as light flash in a suitable lamp, and for many other purposes, such as operating devices for a gas discharge tube for photographic flash illumination, a loud speaker for the transmission of audiofrequency signals, a radio signal to transmit information from a remote device, a relay or other means on a device at a distance, a magnet or electrostatic gun to propel a missile at high velocity, and/or operating devices in experimental testing of various electrical devices under transient and/or overload conditions, in a demonstration device for educational purposes, in a toy, and in X-ray work, either for medical or industrial purposes.

Another object of my invention is to produce a surge generator embodying a magnet and a wire coil so arranged as to cause the magnetic lines of force of the magnet to thread the wires of the coil, combined with means for linearly moving a projectile through or in proximity to the coil at a speed which, because of the rapid changes of the magnetic flux threading the surge coil, will generate electric impulses or surges of sufficient voltage to be capable of use in lighting a lamp and for various other purposes hereinabove specified.

Another object of my invention is to produce a gun embodying a magnet mounted on a plurality, and preferably a pair, of spaced gun-barrel members having adjacent ends separated to produce a gap and registering axial bores, said magnet spanning said gap and said spaced gun-barrel portions to cause the latter to form magnetic pole pieces, one of which is positioned at each side of the gap so as to cause the lines of force from the magnet to pass through these poles and across said gap, and thus to provide magnetic induction across said gap, a surge element composed of an electrical conducting element positioned to cause the magnetic lines of force to thread said conducting element thereof and preferably so arranged coaxially that the gun-barrel portions and the registering bores thereof register with the axis of the surge element, a missile or projectile projectable through said gun-barrel bores and through the axis of the

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surge element within said gap, means for projecting the missile, and an electrically-actuated element such as a lamp connected with said coil whereby projection of the missile will provide a pair of electrical impulses, one being produced by the missile upon reaching the gap and the other upon leaving the gap. Upon reaching the gap, because of the difference in reluctance of the materials, there occurs a sudden change in the lines of magnetic force threading the electrical conducting element which will induce in the electrical conducting element an electromotive force or impulse of sufficiently high voltage to cause an electric current to flow in the coil and to actuate the connected electrically-actuatable element or lamp. Upon leaving the gap the lines of force threading the electrical conducting element are again caused to induce in the electrical conducting element an electromotive force of opposite polarity to the first one and cause a reverse current to flow which will again actuate the electrically-actuatable element or lamp. The two impulses are, however, so closely spaced in time that they will be observable in a lamp only as a single flash.

Another object of my invention is to so shape and so position ferromagnetic to non-ferromagnetic parts of a projectile that the rapid movement thereof at a given velocity through or in adjacency to a surge coil or coils will produce in the coil electrical impulse of a given wave form, and of a given frequency when projected between suitable pole pieces.

Another object of my invention is in a magnetic device of the character specified, to utilize an explosion as the force for propelling a projectile or missile to produce an impulse of the type hereinabove specified.

With these and other objects in view, the invention comprises the combination of members and arrangement of parts so combined as to coact and cooperate with each other in the performance of the functions and the accomplishment of the results herein contemplated, and comprises in one of its adaptations the species or preferred form illustrated in the accompanying drawings, in which—

Fig. 1 is a view in plan of a surge generator embodying my invention;

Fig. 2 is a longitudinal section through the middle of the device shown in Fig. 1 substantially on the line 2—2 of Fig. 1 showing the projectile or missile in starting position;

Fig. 3 is an end elevation of the device shown in Figs. 1 and 2;



Fig. 4 is a fragmentary section similar to Fig. 2 showing the missile about to enter the magnetic field and to cross the gap in which a surge coil is located;

Fig. 5 is an illustrative view similar to Fig. 4 showing the missile passing through the magnetic field and across the gap;

Fig. 6 is a plan view similar to Fig. 1 showing a modified form of surge generator in which spaced ends of the gun-barrel portions are bevelled, the surge coil is placed therebetween in inclined position, and the gap traversed by the missile is increased;

Fig. 7 is a section on the line 7—7 of Fig. 6 looking in the direction of the arrows;

Fig. 8 is a sectional view of another modified form of surge generator in which the missile or projectile comprises a magnetic element and a coil is wrapped around the tube through which the projectile or missile is projected.

Fig. 9 is a sectional view of a projectile embodying a plurality of sections or parts of ferromagnetic and non-ferromagnetic materials and adapted to produce an electrical impulse of a given wave form and given frequency;

Fig. 10 is a diagrammatic view of a wave form produced on an oscilloscope screen by the passage of a plain or non-sectioned projectile such as shown in Figs. 1 to 8; and

Fig. 11 is an illustrative view of a wave form produced on an oscilloscope screen by the projection of a missile embodying a plurality of ferromagnetic and non-ferromagnetic parts, such as shown in Fig. 9.

Referring now to these drawings, in accordance with a preferred embodiment of my invention particularly illustrated in Figs. 1 to 5, my surge-generator includes a gun base 1 which is formed of non-magnetic material, such as brass, and has suitably mounted thereon a sectional gun 2 of magnetizable metal and composed of front and rear gun sections 3 and 4 disposed in alignment and having their bores 3<sup>a</sup> and 4<sup>a</sup> in registration. Said sections 3 and 4 are suitably spaced apart to provide between such adjacent gun section-ends 3<sup>b</sup>—4<sup>b</sup> a gap 5. A projectile or missile 6 fitting the bores 3<sup>a</sup> and 4<sup>a</sup> is adapted to be projected through the bores and across said gap 5. The gap 5, as shown, is spanned or bridged by a permanent magnet 7 which is mounted on the adjacent ends 3<sup>b</sup>—4<sup>b</sup>. The lines of force from the magnet pass through these pole pieces and cross said gap so as to produce a constant magnetic induction across the same, and these gun-ends 3<sup>b</sup>—4<sup>b</sup> thus become pole pieces in a magnetic field traversing the gap 5. A surge coil 8 composed of fine wire, preferably of substantially 40 gauge, is positioned between the pole-piece gun-ends 3<sup>b</sup>—4<sup>b</sup> and thus located within the magnetic field to cause the lines of force thereof to thread the wires of said surge coil. Said coil 8 is preferably arranged coaxially of the gun barrel sections and their registering bores so as to enable the missile 6 in its projection through said registering bores to pass through the axis of the coil within said gap. As illustrated more particularly in Fig. 2, the surge coil is supported in position by a shoe member 9 also preferably composed of non-magnetic metal which is in turn supported on the base 1.

In accordance with said preferred form of my invention, I provide suitable means for projecting the projectile or missile 6 at a relatively high speed through the said registering bores across the gap and through said coil, and in said pre-

ferred embodiment of my invention I provide a conventional cartridge 10 in which the missile 6 is mounted and which contains a conventional explosive adapted to be fired by a firing pin 11 mounted in a gun-firing assembly 12 composed, as shown, of a cylinder 13 having a screw-threaded connection at 14 with the front gun section 3. The firing pin 11 is mounted in a pin bore 11<sup>a</sup> at the end of the cylinder 13 and a projecting rod 15 is connected with and preferably integral with said pin 11. The rod 15 slidably extends through a bore 17<sup>a</sup> in a plug 17 and is provided at its outer end with a handle 16. Said rod 15 has disposed thereon between the plug 17 and a cocking-catch member 18 on said rod 15 a coiled expansion spring 19. The firing pin is adapted to be cocked and held in cocked position by the nose 20 of a trigger 21 which is adapted to engage the cocking-catch member 18 so as to hold the firing pin in cocked position and to permit the same to be projected by finger-manipulation of the trigger 21. Obviously when the gun-firing assembly is so cocked the manipulation of the trigger 21 will move the firing pin into firing or explosive engagement with the shell or cartridge 10, an explosive charge therein will be exploded which thereupon will project the missile 6 through the bore 3<sup>a</sup> of the front gun, thence through the axis of the surge coil 8 within the gap 5 and thence through the bore 4<sup>b</sup> of the rear gun section 4 and outwardly therefrom to any suitable target or stopping element not shown.

In operation, the gun-firing assembly 12 is unscrewed, the cartridge and missile are placed in position in the gun-barrel section 3, then the gun-firing assembly 12 is screwed into place, the handle 16 is pulled rearwardly to cause the rear cocking catch member 18 to engage the trigger 21. The gun will now be cocked, and when it is desired to utilize the surge generator for any of the purposes hereinabove specified, such as the sending of a signal, the trigger 21 is manipulated to release the catch member 18, whereupon the spring 19 will move the firing pin forwardly to explode the charge in the cartridge 10 and project the missile 6 through the sectional gun-barrel as hereinabove specified, said missile being in its passage first accelerated through the bore 3<sup>a</sup> of the gun section 3. When the projectile or missile 6 reaches the gap between the pole pieces or adjacent gun section ends 3<sup>b</sup>—4<sup>b</sup> it will short-circuit the magnetic lines of force from the magnet through the said gap and because of the different or lower reluctance over air and the coil materials within the gap, the sudden change thus produced in the number of lines of magnetic force threading the electric surge coil 8 will induce in the surge coil an electromotive force of a relatively high voltage. This voltage will cause an electric current to flow through the wires of the coil and through connecting wires 8<sup>a</sup>—8<sup>b</sup> which may be employed to light a discharge lamp 22 (by sending therefrom a flash of light of short duration) or to perform such other useful work as may be desired. As the projectile or missile 6 leaves the gap between the pole pieces 3<sup>b</sup>—4<sup>b</sup> the lines of magnetic force again thread through the surge coil 8. This is accomplished because the increase in the magnetic field through the said surge coil 8 induces an electromotive force of opposite polarity to the one first induced and hereinabove referred to. Such induction causes a reverse current to flow through the connecting wires to again cause a flash of light in the gas discharge lamp 22. The



projectile or missile 6 now passes to open air or to other suitable absorbing medium through the bore 4<sup>a</sup> of the gun barrel section 4. The two light flashes in the lamp hereinabove referred to are in time spaced very closely together and therefore will be seen or observed only as a single flash.

In Figs. 6 and 7, I have shown a slightly modified form of gun in which the front and rear gun sections 23 and 24 are bevelled at 23<sup>a</sup> and 24<sup>a</sup> and the surge coil 25 is supported in inclined position by a sectional bar magnet 26. This arrangement will increase the width of the gap, subject a greater area of the coil to the field and subjects an increased effective area of the projectile during its passage to produce a change in the rate of magnetic flux, and will therefore increase the duration of the impulses and produce an increased spacing in time of the impulses hereinabove referred to. In other respects, the device is similar to that shown in Figs. 1 to 5.

In Fig. 8 I have shown another modified form of my invention in which, instead of utilizing a permanent magnet such as the magnet 7 to span a gap, I utilize a magnetic missile 6<sup>a</sup> composed of magnetic material and project this magnetic missile 6<sup>a</sup> through coils 27 and 27<sup>a</sup> for the purpose of producing impulses similar to those hereinabove specified.

In the construction shown in Fig. 8, 28 indicates a gun-barrel of non-magnetic material, such as brass, on which surge coils 27 and 27<sup>a</sup> are mounted between the ends of the barrel 28 by winding the wires of said coils on the barrel of the gun. The projectile 6<sup>a</sup> of magnetic material is projected within said gun barrel 28 and through the axis of said surge coils to produce electrical impulses such as hereinabove specified.

In operation, a pipe 28<sup>a</sup> leads to a supply of fluid under pressure, such as a tank of carbon dioxide or air. A valve 29 is set to open at a given pressure. As this valve 29 opens, the released pressure projects the projectile 6<sup>a</sup> through the barrel 28, and thence first through surge coil 27 generating an electric surge. The missile then passes through the surge coil 27<sup>a</sup> and thus generates another or second surge. The projectile is now engaged by the spring 30 and is finally brought to a stop in the long barrel 28 by compressing trapped air in the bore 28<sup>b</sup> thereof. A bleed hole 31 is provided and the gun can be reset by tipping, so that projectile or missile 6<sup>a</sup> may be returned by gravity.

By increasing the length of the projectile and using magnetic and non-magnetic portions or sections therein, which may be varied as desired or required for a given purpose, the time-spacing and number of the flashes produced by one projection or passage of the missile can be varied, and in Fig. 9 I have shown a missile 32 having such characteristics. It will be understood that by the use of a suitable receiver, such as an oscillograph, a receiving signalman can differentiate between signals of varying timings and the varying number of impulses and by coding these timings and/or the number of sections in a given signal it will be obvious that information may be transmitted.

In Fig. 10 I have shown diagrammatically a wave form produced on an oscilloscope screen by the passage of a plain or non-sectioned projectile, such as shown in Figs. 1 to 8, and in Fig. 11 I have illustrated diagrammatically a wave form produced on an oscilloscope screen by the projection of a missile embodying a plurality of fer-

romagnetic and non-ferromagnetic parts, such as shown in Fig. 9. The wave form or oscillograph shown in Fig. 11 was produced by connecting the oscilloscope across a resistance in the electric surge generator circuit. However, the spacing of parts of the projectile shown in Fig. 9 will cause generation of an unsymmetrical wave form as the projectile slows in the gap.

Having described my invention, I claim:

1. A surge generator embodying, in combination, a magnet, a surge coil arranged within the field of the magnet to cause the magnetic lines of force of the magnet to thread the coil, a projectile having ferromagnetic and non-ferromagnetic parts disposed alternately therein and movable through the coil at a speed which, because of the rapid changes of the magnetic flux threading the surge coil, will generate electric impulses or surges of sufficient voltage to be capable of use in actuating an electrically-actuatable element.

2. A surge generator as claimed in claim 1 in which the projectile comprises an elongated body having a series of ferromagnetic and non-ferromagnetic parts positioned in successive relationship to each other and adapted upon the rapid movement thereof at a given velocity through or in adjacency to the surge coil to produce in the coil electrical impulses of a given wave form and of a given frequency when projected between suitable pole pieces.

3. A surge generator embodying, in combination, a magnet mounted on a pair of gun-barrel members having registering bores, said gun-barrel members being positioned with adjacent end-portions separated to produce therebetween a gap, said magnet spanning said spaced gun-barrel and gap to cause said adjacent gun-barrel ends to form magnetic pole pieces, one of which is positioned at each side of the gap so as to cause the lines of force from the magnet to pass through such poles and to provide a magnetic induction across said gap, a surge coil composed of wire positioned in said gap to cause the magnetic lines of force to thread the wires thereof, a projectile projectable through said registering gun-barrel bores across the said gap, means for projecting the projectile, and an electrically-actuatable element connected with said coil whereby projection of the missile will upon reaching the gap, because of the difference in reluctance of the materials and the speed of the missile, produce a sudden change in the lines of magnetic force threading the surge coil and will induce therein an electromotive impulse of sufficiently high voltage to cause an electric current to flow in the coil and to actuate the connected electrically actuatable element, and upon leaving the gap will cause the lines of force threading the surge coil to again induce in the surge coil an electromotive force of opposite polarity and cause a reverse current to flow which will again actuate the electrically-actuatable element.

4. A surge generator embodying, in combination, a permanent magnet mounted on a pair of gun-barrel members having registering bores, said gun-barrel members being positioned with adjacent end-portions separated to produce therebetween a gap, said magnet spanning said spaced gun-barrel end-portions and gap to cause said adjacent gun-barrel ends to form magnetic pole pieces, one of which is positioned at each side of the gap so as to cause the lines of force from the magnet to pass through such poles and to provide a constant magnetic induction across said gap, a surge coil composed of fine wire positioned



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in said gap and having an axial opening arranged coaxially with the registering bores of the gun-barrel portions whereby the magnetic lines of force will thread the wires thereof, a projectile projectable across said gap through said registering gun-barrel bores and through the axial opening of the coil, means for exploding an explosive charge within the sectional gun-barrel for projecting the projectile therethrough, and an electrically-actuatable element connected with said coil whereby the rapid projection of the missile will upon reaching the gap, because of the difference in reluctance of the materials and the speed of the missile, produce a sudden change in the lines of magnetic force threading the surge coil which will induce in the surge coil an electromotive force or impulse of sufficiently high voltage to cause an electric current to flow in the coil and to actuate the connected electrically actuatable element, and upon leaving the gap will cause the lines of force threading the surge coil to again induce in the surge coil an electromotive force of

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opposite polarity and cause a reverse current to flow which will again actuate the electrically-actuatable element, said two impulses being so closely spaced in time that they will be observable in a lamp only as a single flash.

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