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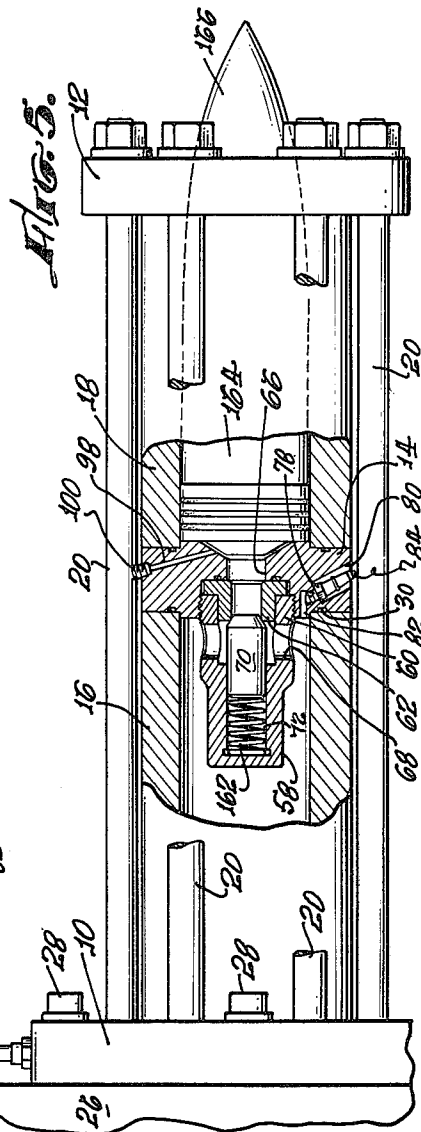
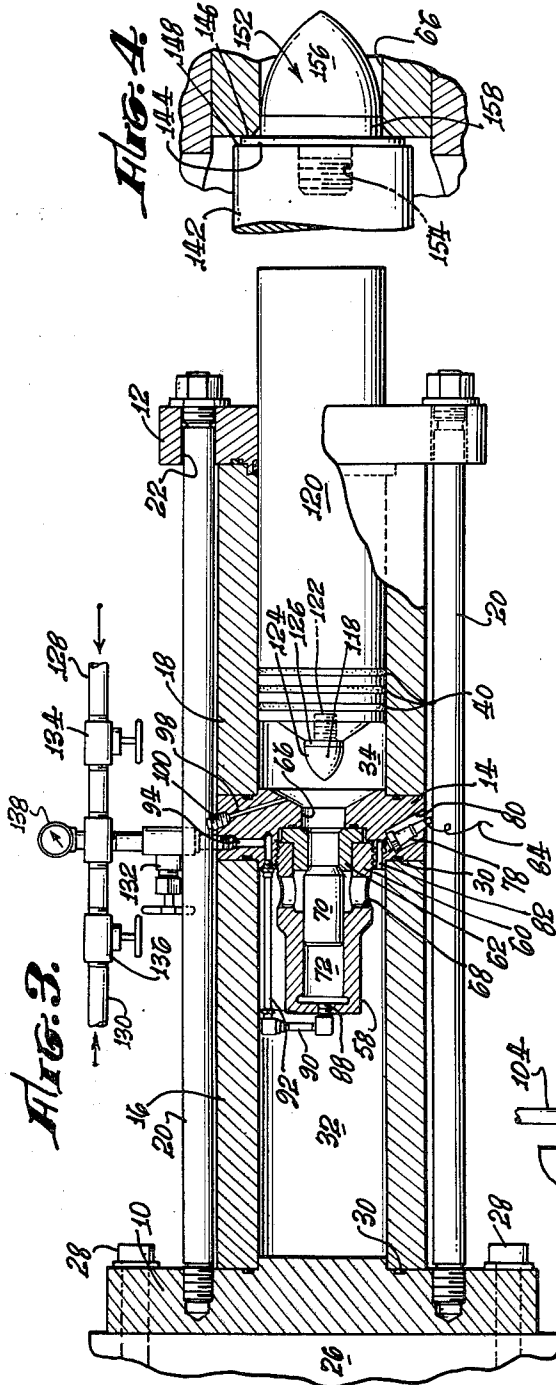
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INTERNAL COMBUSTION ACTUATOR

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2 Sheets-Sheet 2



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INTERNAL COMBUSTION ACTUATOR

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7 Claims. (Cl. 60—39.6)

The present invention relates generally to actuators; more particularly, it relates to an internal combustion actuator for controlled high rate energy application.

The device of the present invention provides accurately controlled high energy rate output. It is generally related to the invention described and claimed in the copending application of Jack B. Ottestad, Serial No. 780,774, filed December 16, 1958, now U.S. Patent No. 2,925,803, for "Actuating Pressure Release System," and the objects and advantages of the prior invention are generally achieved by the present invention.

The invention of the prior application utilizes a novel actuating pressure release system wherein a release piston confronts one side of an orifice wall and an actuator piston is positioned on the opposite side of the wall. The release piston and the wall are adapted to cooperate to provide a pressure seal about the orifice, and the release piston is urged by a set force or set pressure into engagement with the orifice wall to establish this pressure seal. An actuating pressure acts on an area of the release piston outside this seal to oppose and balance the set force. The release piston is then impelled from the orifice wall to release the actuating pressure through the orifice upon the actuator piston. This is done either by increasing the actuating pressure to overbalance the set force and eliminate the pressure seal to expose the release piston area within the seal to the actuating pressure, or by utilizing a separate triggering force to overbalance the set force and release the actuating pressure upon the release piston area within the seal.

The actuator of the present invention provides controlled release of the energy generated by internal combustion. A release plunger confronts one side of an orifice wall within the actuator and an output thrust member confronts the opposite side of the wall. An end portion of the release plunger is adapted for cooperation with the orifice wall to provide a pressure seal about the orifice. A combustion chamber communicates with an area of this end portion outside the pressure seal. In a preferred form of the actuator, the plunger is slidable in a casing which cooperates with the opposite end of the release plunger to define a set pressure chamber. A combustible mixture is introduced into both the combustion chamber and the set pressure chamber, by establishing it in one of the chambers and by leakage into the other chamber through a restricted leakage area defined between the release plunger and the casing. The pressure of the combustible mixture acts on the release plunger to urge it against the orifice wall with a predetermined set force. The combustible mixture in the combustion chamber is ignited and a dynamic pressure differential is rapidly produced across the restricted leakage area between the set pressure and combustion chambers. The internal combustion pressure acts upon the release plunger end portion area outside the pressure seal to overbalance the set force exerted oppositely on the plunger. When the internal combustion pressure attains a predetermined actuating pressure required to overbalance the predetermined set force by acting on the plunger end area outside the seal, the pressure seal is rapidly eliminated and the plunger is impelled from the orifice wall, suddenly releasing the internal combustion pressure through the orifice onto the output thrust member. Precise control of the pressure initially released through the orifice is there-

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by effected. The thrust-time pattern produced on the output member may be predetermined by governing the burning rate and pattern of the combustible mixture in the combustion chamber during and after the release of pressure into the orifice by means known in the art such as selection of the quantity of combustible gas utilized, the fuel-oxygen ratio, and proper additives.

In certain forms of the invention a metering pin is utilized on the release plunger or on the output thrust member to govern the output thrust-time pattern. The metering pin extends into the orifice and cooperates with the orifice wall to regulate the release of pressure through the orifice in the manner described in detail in the copending application of Jack Benton Ottestad and Samuel Arthur Skeen, Serial No. 683,855, filed September 13, 1957, now U.S. Patent No. 2,949,096, for "Pneumatic Actuator."

It is therefore an object of the present invention to provide novel apparatus for the controlled high rate application of internal combustion energy.

An object of this invention is the provision of an actuator wherein an accurately controlled output thrust-time pattern is produced by novel means for releasing pressure.

It is an object of the present invention to provide an internal combustion actuator wherein the combustion rate and pattern may be controlled to predetermine the output thrust-time pattern.

An object of the present invention is the provision of an internal combustion actuator according to the foregoing object wherein controlled high output thrust is sustained by maintaining combustion during movement of an output thrust member.

It is an object of the invention to provide a novel pressure release system wherein an area of a release plunger is rapidly exposed to internal combustion pressure by the rapid elimination of a pressure seal to impel the plunger from an orifice wall to release the pressure through the orifice upon an output thrust member.

An object of this invention is the provision of an internal combustion actuator which effects controlled high rate application of pressure by producing a dynamic pressure differential to impel a release plunger from an orifice wall to release internal combustion pressure through an orifice at a predetermined intensity and in a predetermined pressure-time pattern.

It is an object of the present invention to provide an internal combustion actuator according to the foregoing object wherein a combustible mixture is established in a combustion chamber and in a set pressure chamber by the introduction thereof into one chamber and the leakage thereof into the other chamber through a restricted leakage area across which the dynamic pressure differential is produced.

An object of the invention is the provision of an actuator according to the foregoing objects wherein a thrust-time pattern is controlled by utilizing a contoured metering member to govern release of pressure.

Another object of this invention is to provide an actuator wherein output thrust member movement is substantially unopposed by internal pressures or forces.

Other objects and features of the present invention, as well as many advantages thereof, will become apparent to those skilled in the art from a consideration of the following description, the appended claims and the accompanying drawings, in which:

FIGURE 1 is an elevational sectional view of a preferred embodiment of the internal combustion actuator of the present invention;

FIGURE 2 is a fragmentary view showing elements of the actuator of FIGURE 1 on an enlarged scale during operation;

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FIGURE 3 is an elevational sectional view of another embodiment of the internal combustion actuator of the present invention;

FIGURE 4 is a fragmentary view, partially in section, showing a modified form of release plunger utilized with the present invention; and

FIGURE 5 is an elevational sectional view of another embodiment of the actuator of the invention.

Referring to the drawings and particularly to FIGURES 1 and 2, there is shown a preferred embodiment of the internal combustion actuator of the present invention. The actuator assembly includes a base member 10, an end member 12, an orifice wall or plate 14, and cylindrical sections 16, 18. These components are secured in clamped relation by tie bolts 20 which extend through openings 22 in end member 12 and are secured in threaded openings 24 in the base member. The actuator is attached to a foundation or wall 26 by a plurality of bolts 28 extending through appropriate openings in base member 10, as shown. Pressure sealing is provided by seal rings 30 in appropriate grooves adjacent to the ends of cylindrical sections 16, 18 in base member 10, in the orifice wall 14, and in the end member 12. The cylindrical actuator housing is divided by the orifice wall 14 into a combustion chamber 32 and a thrust member chamber 34.

An output thrust member 36 is slidably positioned in the chamber 34. An enlarged piston portion 38 of the thrust member carries rings 40 in peripheral grooves to provide pressure sealing and to maintain alignment between piston portion 38 and cylindrical section 18. The thrust member extends through an axial opening 42 in end member 12, as shown. A bearing 44 and packing material 46 are disposed in enlarged portions of the opening 42. The packing material is retained by a flanged packing gland 48 which is secured to end member 12 by bolts 50. The outer end of the thrust member confronts a workpiece 52 mounted on an anvil 54 secured to a base 56 on a wall.

A release casing 58 is attached to one side of the orifice wall by threaded engagement of its end portion 60 in an enlarged axial opening in the orifice wall. The casing secures a seat element 62 to the orifice wall, and pressure sealing between these components is provided by a resilient seal ring 64. The orifice wall and the seat element together constitute wall means defining an orifice 66. Ports 68 are provided in the casing near the orifice wall for a purpose hereinafter described.

A release plunger 70 is slidable in the casing 58 and cooperates with the casing to define a set pressure chamber 72, as shown. Restricted communication is provided between the set pressure chamber and the combustion chamber 32, for a purpose hereinafter explained. This is preferably provided by means of a restricted leakage area between the casing and the plunger. For example, the plunger diameter might be three thousandths of an inch (0.003 inch) smaller than the interior diameter of the release casing to define a substantially annular leakage area.

A frusto-conical end portion 74 of the plunger and a mating surface of the seat element 62 about the orifice are provided with accurately defined surfaces which adapt them for cooperation to effect a pressure seal about the orifice when the plunger is urged against the wall means. As indicated in FIGURES 1 and 2, an area 76 of end portion 74 of the release plunger is radially outside this pressure seal.

A spark plug 78 is threadedly secured in a reduced portion of an appropriate opening 80 in the orifice wall 14. The spark plug communicates with combustion chamber 32 through a short passage 82. Appropriate wiring 84 connects the spark plug with a source of electrical potential (not shown).

The set pressure chamber 72 in casing 58 is connected with a source of set pressure (not shown) through a port 88 in the casing, fluid couplings 90, 92, passage 94 in the orifice wall and an external conduit 96. A passage 98

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in the orifice wall communicates between chamber 34 and the exterior atmosphere when plug 100 is not in place, for a purpose which is hereinafter indicated. Combustion chamber 32 is interconnected with sources of air pressure and combustible gas (not shown) by a passage 102 in base member 10 and by fluid couplings 104, 106, 108. Valves 110, 112 and a pressure gauge 114 are provided for controlling input in a manner hereinafter described. A coupling 116 interconnects chamber 34 with a source of relatively low pressure (not shown).

In operation, the internal combustion actuator effects controlled high rate application of internal combustion energy and it imparts high level controlled output thrust to the output thrust member 36. In preparing the actuator of FIGURE 1 for operation, the first step is preferably the positioning of piston portion 38 of thrust member 36 against the orifice wall 14. This may be accomplished manually, mechanically or by other convenient means, such as the introduction through coupling 116 into chamber 34 of air pressure sufficient to move thrust member 36 into contact with the orifice wall. This pressure may be relieved in order to minimize decelerating effects on later rightward movement of the thrust member.

A seating pressure is next introduced into set pressure chamber 72 through port 88 in casing 58, fluid couplings 90, 92, passage 94 and external conduit 96. This seating pressure acts on release plunger 70 and urges its frusto-conical end portion 74 against seat element 62 to close the orifice 66 to prevent leakage from combustion chamber 32. Trapping of pressure within the orifice 66 is prevented by temporary removal of plug 100 to allow release of pressure through passage 98, after which the plug is replaced.

A combustible mixture under a selected pressure is introduced into the combustion chamber 32 through valves 110, 112, fluid couplings 106, 108, 104 and passage 102. An exact quantity of a combustible gas such as propane is first introduced through valve 110 by metering a predetermined specific gas pressure differential by means of the gauge 114. The volume of chamber 32 being constant, this specific gas pressure differential at a particular temperature establishes an exact weight of gas charge in the chamber. Air is next admitted to chamber 32 through valve 112, couplings 108, 104 and passage 102 to a selected pressure metered by gauge 114. This pressure is selected in accordance with the temperature and the volume of combustion chamber 32 to provide a predetermined exact quantity of oxygen.

The pressure of the combustible mixture established in the combustion chamber is introduced into set pressure chamber 72 by leakage through the above-described restricted leakage area defined between the release plunger 70 and the release system casing 58, the pressures in the two chambers being equalized by this restricted communication. The combustible mixture pressure is selected to constitute a set pressure which acts upon the cross-sectional area of release plunger 70 to urge its end portion 74 against seat element 62 of the wall means with a predetermined set force. A pressure seal is thereby effected about the orifice 66 between the mating accurately finished frusto-conical surfaces of the plunger end portion 74 and the seat element.

From the foregoing, it will be understood that a combustible mixture of ingredients in selected quantities and proportions is introduced into combustion chamber 32; it will be understood that the pressure of this mixture in set pressure chamber 72 urges the release plunger 70 against the wall means with a predetermined set force.

With the combustible mixture established in the combustion and set pressure chambers, the spark plug 78 is energized to initiate combustion which rapidly produces a great dynamic pressure differential across the restricted leakage area between the combustion chamber 32 and the set pressure chamber 72 defined by the release plunger 70 and the release casing 58. The high and increasing

internal combustion pressure in chamber 32 acts through ports 68 in casing 58 on the plunger end portion area 76 which is outside the pressure seal between the plunger and the orifice wall, as hereinbefore described. The dynamic pressure differential therefore acts on the release plunger. Upon the attaining of a predetermined actuating pressure, which is sufficient in acting on the plunger area 76 outside the seal to overbalance the opposing set force on the release plunger, the plunger is moved and unseated from the orifice wall. This rapidly eliminates the pressure seal and suddenly exposes the area of plunger end portion 74 confronting the orifice to the high actuating pressure. The release plunger is thereby impelled from the orifice wall extremely rapidly, as indicated in FIGURE 2. The high combustion pressure is thereby released substantially instantaneously through the orifice to act upon the cross-sectional area of the piston portion 38 of the output thrust member 36. Great force is thereby suddenly applied to the thrust member to impel it rightward, as indicated in FIGURE 2, with extreme force and acceleration.

It will be understood that the dynamic pressure differential is produced so rapidly and the release plunger is impelled from the orifice wall so rapidly that the dynamic leak rate through the restricted leakage area between the plunger and the casing is negligible. There is insufficient time for the pressure in set pressure chamber 72 to be increased by leakage of high pressure through the restricted leakage area, so the operative set pressure and actuating pressure are therefore accurately predetermined. The intensity of the pressure released through the orifice is therefore precisely controllable.

From the foregoing, it will be appreciated that the intensity of the initial pressure released through the orifice is accurately predetermined by providing an appropriate set pressure and an appropriate ratio of plunger cross-sectional area to the plunger end area 76 outside the pressure seal. Accurate control of the initial actuator output force or pressure is therefore provided. Premature pressure release before the attaining of a desired combustion pressure cannot occur, and pressure within the actuator cannot increase beyond a selected pressure.

The combustion rate and pattern may be governed to produce a predetermined output thrust-time pattern on the output thrust member 36. Combustion is controllable through the provision of appropriate combustion chamber configuration and the utilization of a combustible mixture of appropriate composition, as is well known in the art. The quantity of combustible gas, the fuel-oxygen ratio of the combustible mixture, and the additives utilized may be varied. The combustion rate and pattern may be so controlled that the combustible mixture will continue to burn and to produce increased pressure in chamber 34 during the output stroke of the thrust member, thereby maintaining or increasing the force on the output member during the output stroke.

The embodiment of the invention shown in FIGURE 3 differs from that of FIGURE 1 essentially in the provision of a metering pin and in the utilization of different means for introducing the combustible mixture into the combustion and set pressure chambers. A metering pin 118 extends axially from the end of an output thrust member 120 and is secured by threaded engagement of its shank portion 122 in an axial opening in the thrust member. The metering pin has a contoured section 124 and a section 126 closely fitting the orifice 66. Set pressure chamber 72 is connected with sources of air pressure and combustible gas (not shown) by fluid couplings 128, 130, which communicate with a valve 132 and passage 94 through valves 134, 136, respectively. A pressure gauge 138 is provided for metering the input of gas and air.

In the operation of the actuator of FIGURE 3, the combustible mixture is introduced into set pressure cham-

ber 72 through port 88 in casing 58, couplings 90, 92 and passage 94 in orifice wall 14. The mixture is introduced into combustion chamber 32 by leakage through the restricted leakage area between release plunger 70 and casing 58, hereinbefore described in connection with the actuator shown in FIGURE 1. In admitting the gas and air, a low air pressure is first introduced into chamber 72 through coupling 128 and valve 134 to exert a seating force on the plunger 70 to move the plunger into engagement with seat element 62, as in the operation of the embodiment shown in FIGURE 1. An accurately controlled weight or quantity of combustible gas is then introduced by means of coupling 130 valve 136 and pressure gauge 138, and air is admitted to a selected pressure to provide a predetermined quantity of oxygen, by means of coupling 128, valve 134 and gauge 138, in the manner described herein relative to the actuator of FIGURE 1.

With the combustible mixture and the set pressure thus established, the operation of the actuator is the same as that of the actuator of FIGURE 1, except for the coaction of the metering pin 118 and the orifice 66. The metering pin is contoured to govern the initial portion of the output thrust-time pattern on the output thrust member 120, in the manner described in detail in the copending application, Serial No. 683,855, hereinbefore identified. When the plunger 70 releases the actuating pressure into orifice 66, it initially acts on the cross-sectional area of the metering pin to move the output thrust member. After section 126 of the metering pin clears the end of the wall of orifice 66, the pressure is released upon the thrust member 120 through a net orifice area defined by the metering pin. The pressure drop across the orifice varies in accordance with the variation of this net effective orifice area with movement of the metering pin, and the force on the thrust member therefore varies accordingly. A predetermined thrust-time or acceleration-time pattern may be produced by an appropriately contoured metering pin. The manner of contouring pins to produce selected output patterns is discussed in the above-mentioned copending application.

In FIGURE 4 is shown a modified release plunger which may be utilized with the actuators shown in FIGURES 1 and 3. Release plunger 142 has an end portion 144 of reduced diameter, the end surface of which is accurately finished for cooperation with the mating surface of the orifice wall 14 to effect a pressure seal about the orifice 66 when the plunger is seated against the orifice wall, as indicated at 146. A transverse annular area 148 outside the pressure seal is defined between the reduced end portion 144 and the body portion of the plunger. A metering pin 152 has its threaded shank portion 154 threadedly secured in an axial opening in the plunger 142. A cylindrical section 158 of the metering pin closely fits the orifice and a contoured section 156 extends into the orifice. Metering pin 152 has the same function as the metering pin 118 of FIGURE 3 and it may be utilized with the actuators of FIGURES 1 and 3 to control the initial portion of the output thrust-time pattern produced on the thrust member. After the plunger 142 is unseated by the action of the internal combustion pressure on the annular area 148 outside the pressure seal, the pressure is released through orifice 66 upon the thrust member through a net orifice area defined by the metering pin. The actuator output is thereby governed in the manner described herein relative to metering pin 118 of FIGURE 3.

From the foregoing, it will be understood that a metering member may be utilized on either the release plunger or on the output thrust member for governing the initial portion of the output time-thrust pattern of the actuator of the present invention.

In FIGURE 5 is shown an embodiment of the invention which differs from those hereinbefore described in

that a projectile type of thrust member is utilized and in that spring means are provided within the casing 58. The projectile 164 has a streamlined end portion 166 which adapts it for flight. A combustible mixture is introduced into chamber 32 and a set pressure is introduced into chamber 72 in the manner in which they are introduced in the actuator of FIGURE 1.

A helical spring 162 in the release system casing 58 exerts a seating force on the plunger and no seating pressure is required in chamber 72. The operation of the actuator of FIGURE 5 is otherwise similar to that described for the other embodiments of the present invention.

Although specific embodiments of the present invention have been described and illustrated in detail, it is to be clearly understood that the same are by way illustration and example only; it is to be understood that the invention is not limited thereto, as many variations will be readily apparent to those versed in the art and the invention is to be given its broadest possible interpretation within the terms of the appended claims:

The inventor claims:

1. An internal combustion actuator comprising wall means defining an orifice within the actuator, a release plunger having an end portion confronting one side of the wall means and adapted for cooperation therewith to provide a pressure seal about said orifice, means defining a combustion chamber communicating with an area of said plunger end portion outside said pressure seal, means cooperating with the release plunger to define a set pressure chamber, means for introducing a combustible mixture under a set pressure into said set pressure chamber, means defining a leakage area whereby said chambers are in restricted communication to permit leakage to establish said combustible mixture in the other of said chambers, the set pressure in said set pressure chamber exerting a set force to urge the release plunger against the wall means to effect said pressure seal, and means for igniting the combustible mixture in the combustion chamber to generate a combustion pressure to produce a dynamic pressure differential across said leakage area between said chambers, said internal combustion pressure acting on said plunger end portion area outside said pressure seal to overbalance said set force, thereby rapidly eliminating said pressure seal to expose an increased area of the plunger end portion to the combustion pressure, whereby the release plunger is impelled from said wall means to release the combustion pressure through the orifice at a predetermined intensity to act on an output member.

2. An internal combustion actuator comprising wall means defining an orifice within the actuator, a release plunger having an end portion confronting one side of the wall means and adapted for cooperation therewith to provide a pressure seal about said orifice, means defining a combustion chamber communicating with a relatively small area of said plunger end portion outside said pressure seal, casing means slidably receiving the release plunger, said casing means cooperating with the plunger to define a set pressure chamber and to define a restricted leakage area between the combustion chamber and the set pressure chamber, means for introducing a combustible mixture under a set pressure into said set pressure chamber to establish it in the other chamber by leakage through said restricted leakage area, the set pressure in said set pressure chamber exerting a set force to urge the release plunger against the wall means to effect said pressure seal, and means for igniting the combustible mixture in the combustion chamber to generate a combustion pressure to produce a dynamic pressure differential across said leakage area between said chambers, said internal combustion pressure acting on said plunger end portion area outside said pressure seal to overbalance said set force, thereby rapidly eliminating said pressure seal to expose an increased area of the plunger end portion to the combustion pressure, whereby the release plunger is

impelled from said wall means to release the combustion pressure through the orifice at a predetermined intensity to act on an output member.

3. An internal combustion actuator comprising wall means defining an orifice within the actuator, a release plunger having an end portion confronting one side of the wall means and adapted for cooperation therewith to provide a pressure seal about said orifice, means defining a combustion chamber of predetermined configuration communicating with an area of said plunger end portion outside said pressure seal, means cooperating with the release plunger to define a set pressure chamber, means for introducing a combustible mixture under a set pressure into said set pressure chamber, means defining a leakage area about the release plunger to provide restricted communication to permit leakage to establish said combustible mixture in the other of said chambers, means for metering the respective ingredients of said combustible mixture, said combustion chamber configuration and said mixture ingredients being adapted to produce a selected combustion rate and pattern, the set pressure in said set pressure chamber exerting a set force to urge the release plunger against the wall means to effect said pressure seal, and means for igniting the combustible mixture in the combustion chamber to generate a combustion pressure to produce a dynamic pressure differential across said leakage area between said chambers, said combustion pressure acting on said plunger end portion area outside said pressure seal to overbalance said set force and eliminate said pressure seal, thereby rapidly exposing an increased area of the plunger end portion to the combustion pressure to impel the release plunger from the wall, whereby the combustion pressure is released through the orifice onto an output member in a predetermined pressure-time pattern governed by said selected combustion rate and pattern.

4. An internal combustion actuator comprising a wall defining an orifice within the actuator, means defining a combustion chamber on one side of the wall, a release casing attached to said wall about the orifice and disposed in the combustion chamber, a release plunger slidable in the casing, said release plunger having an end portion confronting said side of the wall and adapted for cooperation therewith to provide a pressure seal about said orifice, said release casing having ports defined therein near the wall for communication between the combustion chamber and an area of said plunger end portion outside said pressure seal, said casing means cooperating with the plunger to define a set pressure chamber and a restricted leakage area between the combustion chamber and the set pressure chamber, means for introducing a combustible mixture under a set pressure into said set pressure chamber to establish it in the other chamber by leakage through said restricted leakage area, the set pressure in said set pressure chamber exerting a set force to urge the release plunger against the wall means to effect said pressure seal, and means for igniting the combustible mixture in the combustion chamber to generate a combustion pressure to produce a dynamic pressure differential across said leakage area between said chambers, said internal combustion pressure acting on said plunger end portion area outside said pressure seal, thereby overbalancing said set force and eliminating said pressure seal rapidly to expose an additional area of the plunger end portion to the combustion pressure, whereby the release plunger is impelled from said wall to release the combustion pressure through the orifice at a predetermined intensity to act on an output member.

5. An internal combustion actuator comprising wall means defining an orifice within the actuator, a slidably mounted output thrust member confronting a first side of the wall means and extending outside the actuator, a casing positioned on a second side of the wall means, a release plunger slidable in the casing and having an end portion confronting said second side of the wall means, said plunger end portion and the wall means having accu-

ately defined mating surfaces for cooperation to provide a pressure seal about said orifice, means defining a combustion chamber communicating through ports in said casing with an area of the plunger end portion outside said pressure seal, said casing means cooperating with the plunger to define a set pressure chamber and a restricted leakage area between the combustion chamber and the set pressure chamber, means for introducing a combustible mixture under a set pressure into the set pressure chamber to establish it in the combustion chamber by leakage through said restricted leakage area, the set pressure in said setting pressure chamber exerting a set force to urge the release plunger against the wall means to effect said pressure seal, and means for igniting the combustible mixture in the combustion chamber to generate a combustion pressure to produce a dynamic pressure differential across said leakage area between said chambers, said internal combustion pressure acting on said plunger end portion area outside said pressure seal, thereby overbalancing said setting force and eliminating said pressure seal to expose an increased area of the plunger end portion to the combustion pressure, whereby the release plunger is impelled from said second side of the wall

means to release the combustion pressure through the orifice at a predetermined intensity upon said thrust member to produce output thrust.

6. An internal combustion actuator according to claim 5 and further including a contoured metering pin carried by said thrust member for extension into the orifice for cooperation with the wall means to regulate release of pressure onto the thrust member to produce a predetermined thrust-time output pattern.

7. An internal combustion actuator according to claim 5 and further including a contoured metering pin carried by the release plunger for extension into the orifice for cooperation with the wall means to regulate release of pressure through the orifice onto the thrust member to produce a predetermined thrust-time pattern.

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