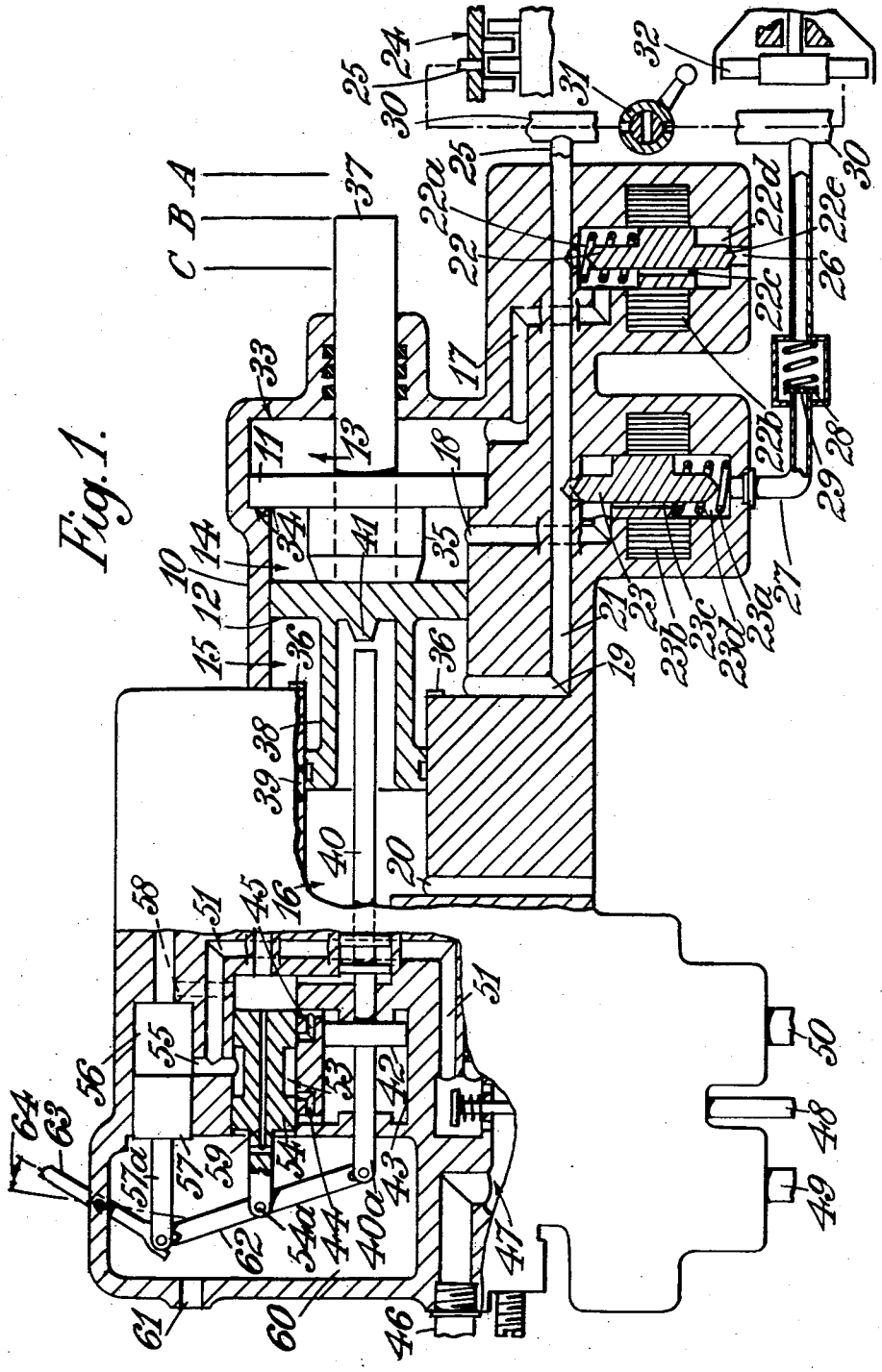
Nov. 28, 1961 R. H. COLLEY 3,010,434

CONTROL MECHANISM INCLUDING VARIABLE-STROKE RAM

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Fig. 1.

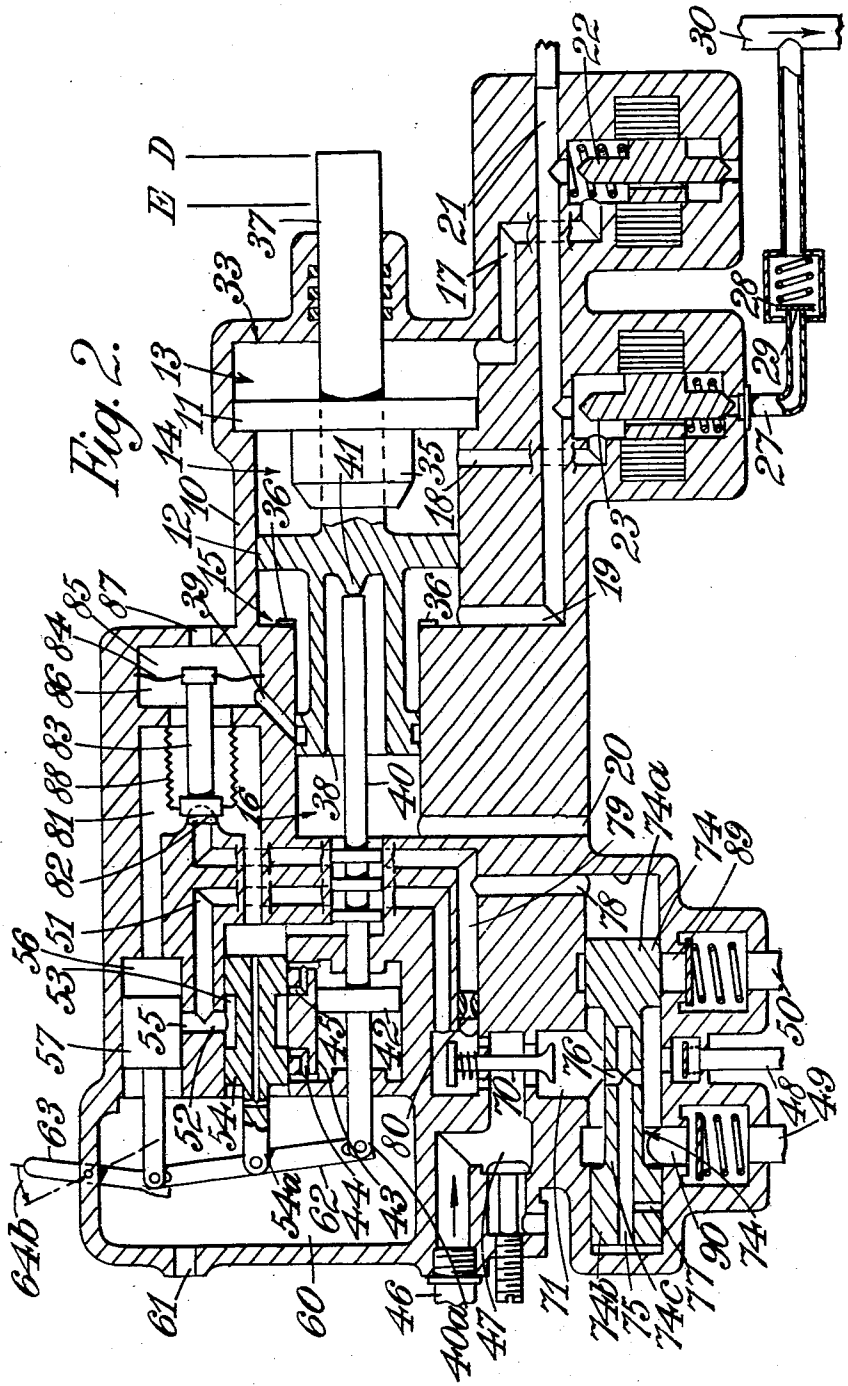


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Fig. 2.



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CONTROL MECHANISM INCLUDING VARIABLE-STROKE RAM

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Fig. 4.

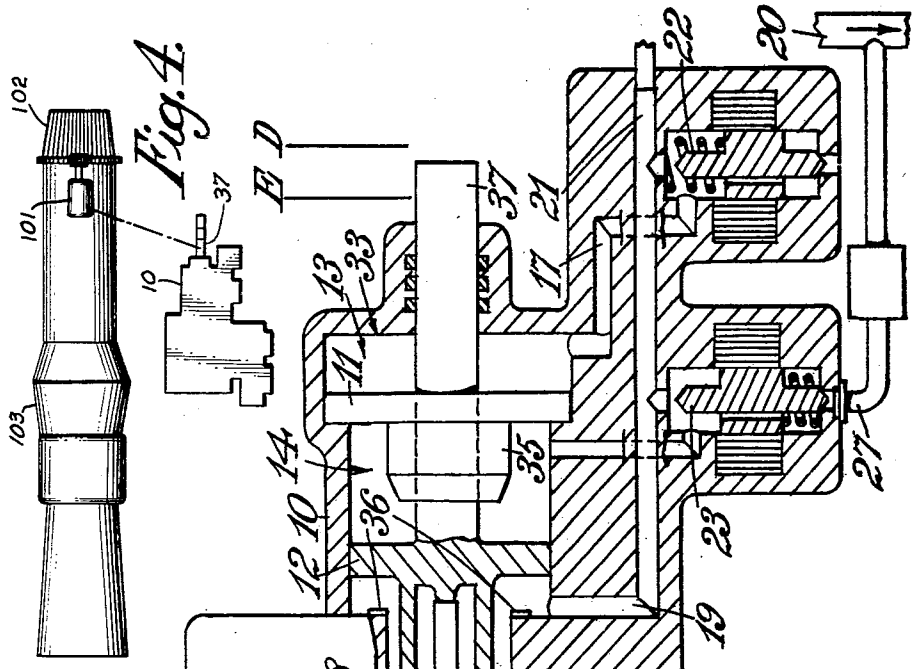
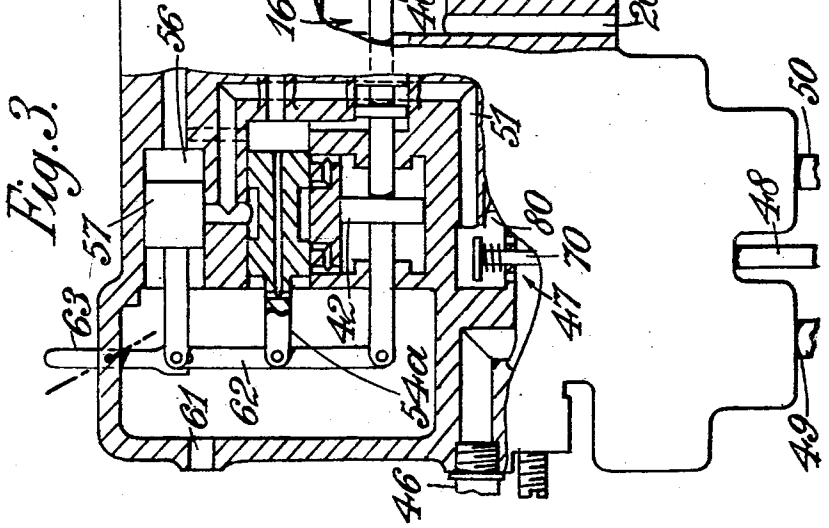


Fig. 3.



United States Patent Office 3,010,434 Patented Nov. 28, 1961

3,010,434

CONTROL MECHANISM INCLUDING VARIABLE-STROKE RAM

Rowan Herbert Colley, Derby, England, assignor to Rolls-Royce Limited, Derby, England, a company of Great Britain

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Claims priority, application Great Britain July 25, 1957
7 Claims. (Cl. 121—38)

This invention comprises improvements in or relating to control mechanisms for moving an adjustable part and to uses of such control mechanisms.

According to the present invention, a control mechanism for moving an adjustable part comprises a ram cylinder, a plurality of pistons dividing the cylinder into a series of fluid spaces, the piston adjacent one end of the cylinder having a travel limited by a pair of fixed abutments and the remaining piston or remaining pistons having each a travel limited by a pair of corresponding abutments at least one of which is on the next adjacent piston towards said end of the cylinder, the piston adjacent the opposite end of the cylinder being the operating piston for the adjustable part, valve means controllable to supply pressure fluid selectively to the pressure spaces whereby the operating piston may be set in any of a number of positions predetermined by the abutments, power-operated adjustable abutment means adapted to be rendered operative and inoperative and, when operative, to cause the operating piston to be set at any desired position in a range of its travel, and selector means operable to render the power-operated adjustable abutment means operative and inoperative and to select the desired position in the range.

The control mechanism of this invention may be used with apparatus comprising the adjustable part which, under some conditions of operation of the apparatus, is required to be set in predetermined positions and, under other conditions of operation, is required to be set in any position within a range of its travel. During operation of the apparatus under the first condition, the power-operated adjustable abutment is inoperative, and during operation under the second conditions the power-operated adjustable abutment is operative, the valve means being set to supply pressure fluid to the ram so that at least the operating piston follows the movements of the adjustable abutment.

The number of predetermined positions obtainable is dependent upon the number of pistons in the ram cylinder and upon the arrangement of the abutments for the pistons, a greater number of positions being obtainable when both abutments for a piston (apart from the first piston) are on the next adjacent piston than when only one abutment is on the next adjacent piston. For instance, when two pistons are employed three or four positions are obtainable according as one only or both abutments for the operating piston are on the first piston.

The range of travel under control of the power-operated adjustable abutment may be arranged to be any proportion of the maximum travel of the operating piston, and the adjustable abutment may co-operate with any of the pistons but preferably co-operates with the operating piston.

In a preferred construction of this invention, a control mechanism for moving an adjustable part comprises a ram cylinder, first and second pistons dividing the cylinder into end fluid spaces and an intermediate fluid space between the pistons, the first piston having a maximum travel limited by fixed abutments, and the second piston having a travel limited by a pair of abutments at least one of which is carried by the first piston, and the second piston being the operating piston for the adjustable part,

valve means controlling the selective supply of pressure fluid to said spaces whereby the operating piston may be set in any of at least three positions predetermined by the abutments, power-operated adjustable abutment means co-operating with one of the pistons and adapted to be rendered operative and inoperative and, when operative, to cause the operating piston to be set at any desired position in a range of its travel, and a selector member adapted to render the power-operated adjustable abutment means operative and inoperative and to select the positions of the adjustable abutment means in said range. In one such arrangement the second piston has one fixed abutment and one abutment on the first piston so that the second piston has three predetermined positions, and the adjustable abutment co-operates directly with the second piston and is arranged to move the second piston in a range of travel between an adjacent pair of the predetermined positions.

According to another preferred feature of this invention, the power-operated adjustable abutment means comprises an abutment member engaging the operating piston, a fluid-operated servo-mechanism which moves the abutment member relative to the ram cylinder, and control valve means operated by the selector member to render the servo-mechanism operative and inoperative and to select the setting of the abutment member, the pressure fluid supply to the ram cylinder spaces being controlled, when the servo-mechanism is operative, to maintain the operating piston in contact with the abutment member. In one particular arrangement according to this feature of the invention, the servo-mechanism comprises a piston working in a cylinder and having a piston rod one end of which projects into the ram cylinder to act as the abutment member, the cylinder of the servo-mechanism having operating fluid supply ports to each end thereof, and the control valve means for the servo-mechanism comprises a first valve controlling the supply of operating fluid through the ports and a second valve controlling the supply to the first valve to render the servo-mechanism operative and inoperative, these valves and the servo-mechanism piston moving in parallel paths, and there is provided a link, the ends of which are pivoted to the servo-mechanism piston and to the second valve respectively and an intermediate point of which is pivoted to the first valve, the position of the end of the link pivoted to the second valve being moved by the selector member. The selector member may be a pivoted lever having a range of angular movement, and it may be arranged for instance that the second valve prevents supply of operating fluid to the servo-mechanism (so that the adjustable abutment is inoperative) in a first portion of the range of angular movement and allows the supply of operating fluid (to render the adjustable abutment operative) in a second portion of the range.

A control mechanism according to the present invention has important uses in connection with gas-turbine engines. In such engines, especially when employed for aircraft propulsion purposes, it is often desirable to position accurately a part of the engine, such as a bleed valve, inlet guide vanes, thrust reversal devices and variable area nozzles, in accordance with some operating condition of the engine, for instance in accordance with compressor delivery pressure, pilot's throttle setting and rate of delivery of reheat fuel.

According to one use of the control mechanisms, the operating piston is connected to adjust area-varying means of a variable-area jet nozzle at the outlet end of a jet pipe of the engine which has a reheat system in the jet pipe, the valve means controlling the selective supply of pressure fluid to the ram is arranged to be operable to provide a number of predetermined nozzle areas when reheat system is not being used and the selector member

is adjusted by a pilot's lever controlling delivery of reheat fuel to the jet pipe so that the nozzle is varied in a desired range in accordance with the rate of reheat fuel supply. In such a use of the control mechanism, the reheat fuel may be employed as operating fluid in the servo-mechanism above described.

One construction of control mechanism of this invention will now be described with reference to the accompanying drawings in which—

FIGURE 1 shows the control mechanism in a first setting,

FIGURE 2 shows the control mechanism for range operation of the mechanism, and other features,

FIGURE 3 shows the control mechanism intermediate the ends of its travel in range operation,

FIGURE 4 is a diagrammatic view on a reduced scale of a gas turbine engine with a variable-area nozzle adjusted by an air motor.

The control mechanism shown in the drawings is suitable for use in connection with a gas-turbine engine having a jet pipe and a variable-area nozzle at the outlet of the jet pipe and also having reheat combustion equipment in the jet pipe. The control mechanism is arranged so that, when the reheat system is inoperative (FIGURE 1), the nozzle can be set to have any of three predetermined areas, viz: a minimum area, a maximum area and an intermediate area, and so that, when the reheat system is operative (FIGURES 2 and 3), the nozzle area is increased in a range of areas between the intermediate area and the maximum area as the rate of delivery of reheat fuel is increased.

The control mechanism comprises a ram cylinder **10** containing two differential-area pistons **11, 12** dividing the cylinder into a number of spaces **13, 14, 15, 16** of which space **13** has a pressure fluid supply connection **17**, the space **14** has a pressure fluid supply connection **18**, the space **15** has a pressure fluid supply connection **19** and the space **16** is open to atmosphere through port **20**. The connections **17, 18** are connected to a supply drilling **21** through solenoid-controlled spring loaded valves **22, 23** respectively and the connection **19** opens directly into the drilling **21**. The drilling **21** is shown as being supplied with pressure air tapped from a compressor **24** of the engine through conduit **25**.

The valve **22** is loaded by its spring **22*a*** so that when the associated solenoid **22*b*** is de-energized (FIGURES 1, 2 and 3), the connection **17** receives pressure air from the drilling **21**. The valve **22** has a bleed drilling **22*c*** through it leading to a space **22*d*** which, when the solenoid is energized, is open to atmosphere through port **26**. Port **26** is closed by a valve extension **22*e*** when the solenoid **22*b*** is a de-energized.

The valve **23** is similar to valve **22** having a spring **23*a*** solenoid **23*b***, drilling **23*c***, space **23*d*** and extension **23*e***. When the solenoid **23*b*** is de-energized, the spring **23*a***, urges the valve **23** to shut off the connection **18** from drilling **21** and to open the space **23*a*** to a conduit **27**. When the solenoid **23*b*** is energized connection **18** is open to drilling **21** and space **23*d*** is cut off from conduit **27**.

The conduit **27** contains spring loaded lift valve **28** having a small bleed orifice **29** and the conduit **27** is joined to a conduit **30** branching from the conduit **25**. A shut-off cock **31** is provided in conduit **30** between its points of connection with conduits **25** and **27**. The conduit **30** conveys pressure air to an air turbine **32** for driving a reheat fuel pump and when the reheat system is inoperative cock **31** is closed.

The piston **11** has its larger effective area facing space **13** and has its travel in the cylinder **10** limited by axially-spaced travel-limiting fixed abutments afforded respectively by the end **33** of the cylinder **10** and by an internal shoulder **34**.

The piston **12** has its larger effective area facing space **14** and has its travel limited by a first travel-limiting abutment **35** carried by the piston **11** and by a second and axially-spaced travel-limiting fixed abutment formed by shoulder **36**. The piston **12** has a piston rod **37** extending through piston **11** to outside the cylinder and the rod **37** is connected in any convenient manner to actuate an adjustable part which in the particular embodiment being described is the variable-area nozzle. For example as shown in FIGURE 4 the rod **37** of the control mechanism may control the operation of an air motor **101** for adjusting a variable area nozzle **102** at the outlet of a gas turbine engine **103**. The piston **12** also has an axial skirt **38** which controls a port **39** the purpose of which will appear below.

In FIGURE 1 of the drawings, line A indicates the minimum area position of the nozzle, B indicates an intermediate area position and C indicates the maximum area position.

The three positions A, B, C are employed during non-reheat operation, and in such operation the cock **31** is closed so that pressure air does not reach air turbine **32** or conduit **27**. The conduit **27** is, however, connected to atmosphere through the air turbine **32**.

Position A.—Solenoid **22*b*** is energized and solenoid **23*b*** is un-energized. Thus pressure air is fed solely to space **15**, spaces **13, 14, 16** being at atmospheric pressure, and the pistons **11, 12** are moved to the right until piston **11** is against abutment **33** and piston **12** is against abutment **35**. This position corresponds to maximum engine r.p.m., minimum nozzle area, no reheat.

Position B.—Solenoids **22*b*, 23*b*** are un-energized. Thus pressure air is fed to spaces **13** and **15**, spaces **14** and **16** being at atmospheric pressure, and piston **11** is moved to the left against abutment **34** carrying with it piston **12** which is against abutment **35**. This position is employed under idling to cruise operation with no reheat and gives an intermediate area setting of the nozzle.

Position C.—Solenoid **23*b*** is energized and solenoid **22*b*** is un-energized. Thus pressure air is fed to spaces **13, 14** and **15** and both pistons **11, 12** are held against their left-hand abutments **34, 36** respectively. This setting gives the maximum nozzle area and is employed during descent of the aircraft.

The control mechanism also comprises a power-operated adjustable abutment, which is employed during operation of the reheat system, to move the piston **12** to a position in a range of its travel dependent on the degree of reheat selected.

The power-operated adjustable abutment comprises an abutment member **40** in the form of a rod projecting into the space **16** to co-operate with a projection **41** on the piston **12**, a servo-mechanism for moving the rod and comprising a piston element **42** on the rod **40** working in a cylinder **43** having inlet and outlet porting **44, 45** to the respective ends of the cylinder, and control valve means for controlling the supply of operating fluid to the porting **44, 45**.

The operating fluid employed is reheat fuel under pressure. The fuel enters the control mechanism through pipe **46** and flows into chamber **47** whence part flows to the servo-mechanism and the bulk flows to outlet pipes **48, 49, 50** leading respectively to pilot injector means, an inner ring injection means and outer ring injector means, the injection means being as usual in the engine jet pipe.

The fuel flows to the servo-mechanism through ducting **51** which has a first outlet **52** to a chamber **53** containing a piston valve **54** controlling the porting **44, 45** and a second outlet **55** to a chamber **56** containing a piston valve **57** which determines by uncovering and covering the outlet **55** whether pressure fuel is supplied to cylinder **43**. When outlet **55** is uncovered pressure fuel cannot reach the cylinder **43** since the chamber **56** is connected via duct **58**, drillings **59** in the valve **54**, and chamber **60** to a drain outlet **61**. When outlet **55** is cov-

ered pressure fuel reaches the cylinder **43** past the piston valve **54** and through porting **44** or **45**.

The rod **40** has an extension **40***a* into chamber **60**, and each of the piston valves **54**, **57** has a stem **54***a*, **57***a* also projecting into chamber **60**, and there is provided a link **62** which is pivoted at its ends to the extension **40***a* and the stem **57***a* and at an intermediate point to stem **54***a*. The end of link **62** which is pivoted to stem **57***a* is engaged by a forked end of a selector lever **63** pivoted in the casing of the control mechanism, and the lever **63** is moved in accordance with movements of the pilot's control lever.

The pilot's control lever has a range of movement in a gate from a position corresponding to idling of the engine to a position corresponding to maximum engine r.p.m. and has a further range of movement beyond the maximum r.p.m. position for reheat operation control. During reheat operation, the engine operates at its maximum r.p.m.

The ranges of angular movement of lever **63** are indicated at **64***a* (FIGURE 1) and **64***b* (FIGURE 2), the range **64***a* corresponding to non-reheat operation, and range **64***b* corresponding to reheat operation. The valve **57** takes up a position in its chamber **56** dependent on the angular setting of the lever **63** and the position of the outlet **55** is such that, when the lever **63** is in a position corresponding to maximum r.p.m. the outlet **55** is just covered and the outlet is also covered throughout the range of movement of valve **57** corresponding to the reheat range of movement **64***b* of the lever **63**.

For reheat operation, cock **31** is open, solenoid **22***b* is un-energized, solenoid **23***b* is energized, and lever **63** is set in its range of travel **64***b* (FIGURE 2). Thus the reheat fuel pump driven by air turbine **32** is operating and pressure fuel is delivered to chamber **47**, and pressure air is fed to spaces **13**, **14** and **15** so that the piston **11** is against shoulder **34** and piston **12** is urged to the left.

With the lever **63** in the minimum reheat setting, i.e. at the right-hand end of its range of travel **64***b*, the parts of the power operated adjustable stop take up the positions shown in FIGURE 2 and the piston **12** is held against the rod **40**. This setting of the parts is obtained as follows:

Pressure fuel from chamber **47** flows through duct **51** and enters chamber **53** via outlet **52** (outlet **55** being covered), and, if the valve **54** is not in its equilibrium position as will normally be the case on selecting reheat operation, the fuel enters one end of the cylinder **43** via porting **44** or **45** to displace the piston **42** until it reaches the illustrated position (FIGURE 2) in which valve **54** covers both porting **44** and porting **45**. Fuel draining from the opposite end of the cylinder **43** during this movement flows into chamber **60**, either through porting **44** or through porting **45** and duct **59**. Also since the piston **12** is urged by the pressure air in space **14** into contact with rod **40** and the end of the rod **37** takes up a position indicated in FIGURE 2 by line D giving a nozzle area suitable for minimum reheat.

It will be clear that on movement of the lever **63** from the position of FIGURE 2 to a new position in the range **64***b*, the piston **42** will be constrained to take up a new position within its cylinder **43**, the operation being first that the valve **57** is moved to the right by the lever **63**, as viewed in the drawings, carrying with it the piston valve **54** to uncover the porting **44**, **45** permitting pressure fuel to enter the cylinder **43** through porting **45**, and second that the piston **42** is moved to the left carrying with it the piston valve **54**, this movement continuing until the porting **44**, **45** is again covered. During this latter movement the valve **57** is stationary in the position set by the selector lever **63**. Since the selector lever **63** has a range of movement **64***b* corresponding to the desired degrees of reheat, the piston **42** will have a corresponding range of movement in its cylinder **43**.

Further since, as has been described above, the piston **12** of the ram is maintained in contact with the rod **40**, the piston **12** will follow the movements of the piston **42** and will take up a position within the cylinder **10** dependent upon the setting of the lever **63**. Consequently the piston rod **37** will be set in a position so that its end is in a predetermined position in the range between the lines D and E, of which line E represents the maximum reheat setting of the nozzle. FIGURE 3 shows the parts set in a position intermediate the ends of the range D, E.

In the event that solenoid-controlled valve **23** fails to operate when its solenoid **23***b* is energized for reheat operation, a supply of pressure air will reach space **14** from conduit **25** through conduits **30** and **27** (cock **31** being open during reheat operation and the valve **28** having a central orifice **29**), space **23***d*, drilling **23***c* and connection **18**. It is thus ensured that even if valve **23** fails to operate, piston **12** will be maintained against rod **40** during reheat operation.

The power-operated adjustable stop does not prevent movement of the piston **12** to the left into position C (FIGURE 1) during non-reheat operation, since when the maximum nozzle area is required in descent of the aircraft, lever **63** will be towards the right-hand end of its range of travel **64***a* and outlet **55** will therefore be uncovered and valve **54** cannot reach the position in which it closes off the porting **44**, **45**, so that piston **42** will be able to move freely to the left.

It will be clear from the foregoing description that there is provided control means by means of which the variable-area nozzle may be set in any of three predetermined positions represented by lines A, B and C in FIGURE 1 or can be set at any position within a range of movement represented by the lines D, E (FIGURES 2 and 3) corresponding to the degree of reheat selected by adjustment of the selector lever **63**.

The control mechanism illustrated is also arranged to secure operation of a valve controlling the distribution of fuel to the various injection means of the reheat fuel system according to the setting of the selector lever **63** in the range **64***b* (FIGURE 2).

As will be seen from FIGURE 2, the fuel flows from chamber **47** past a non-return valve **70** into a chamber **71** containing a shuttle valve **74**. Movement of the shuttle valve controls the distribution of fuel to the pipes **48**, **49**, **50**.

Movement of the shuttle valve **74** is effected as follows. The shuttle valve has a pair of lands **74***a*, **74***b* joined by a reduced diameter portion **74***c* and also has a longitudinal bore **75** opening to its left-hand end, a cross bore **76** at its mid length opening into the bore **75** and a restricted bore **77** extending from the bore **75** to the peripheral surface of the land **74***b*. In all positions of the valve **74**, the cross bore **76** receives fuel entering the chamber **71** past the non-return valve **70**.

The end of the chamber **71** adjacent the land **74***a* is connected by a duct **78** to a further duct **79** one end of which is connected through a restrictor **80** to duct **51** and the opposite end of which leads to a chamber **81** which is connected with the chamber **56** and with the chamber **53** containing the piston valve **54** so that the chamber **81** is open to the drain port **61**. This end of the duct **79** is controlled by a half ball valve element **82** carried on a stem **83** connected to a flexible diaphragm **84** separating two spaces **85**, **86** of which space **85** is open to atmosphere through aperture **87** and of which chamber **86** is connected to port **39**. The chamber **86** also has a wall formed by a flexible bellows **88**, one end of which is fixed to the wall of the casing of the control mechanism and the opposite end of which is secured to the stem **83** adjacent the half ball valve element **82**.

When the piston **12** is in the minimum reheat area position of FIGURE 2, the pressure within the space **86** is atmospheric pressure and thus the flexible bellows **88**

holds the half ball valve element **82** firmly on the outlet from duct **79** preventing any outflow of fuel through the duct. Thus, when pressure fuel is being fed to the chamber **47**, the pressure within the duct **79**, which pressure acts on the right-hand end of the shuttle valve **74**, will be substantially equal to the reheat fuel pressure upstream of the non-return valve **70**, whilst the effective pressure acting on the shuttle valve **74** in the opposite direction will be lower due to the fall of pressure across the non-return valve **70**. Thus the shuttle valve **74** will be maintained in the position shown in FIGURE 2, in which the land **74***a* covers a port **89** leading to pipe **50** and fuel is supplied through the space around the reduced diameter portion **74***c* of the shuttle valve to the pilot fuel supply pipe **48** and through a port **90** to the fuel pipe **49**.

When the piston **12** moves so far to the left that the port **39** is placed in communication with space **15**, pressure air is fed from the space **15** to the chamber **86** so urging the diaphragm **84** to the right and lifting the half ball valve element **82** off the outlet from the duct **79**. This permits fuel to flow to drain through the duct **79** and, due to the restrictor **80**, the pressure within the duct **79** falls to a value below the fuel pressure downstream of the non-return valve **70**. The shuttle valve **74** is therefore moved to the right to a position in which the land **74***a* uncovers the port **89** leading to the fuel pipe **50**, and in which the land **74***b* covers the port **90** leading to the fuel pipe **49** but the restricted bore **77** is opposite the port **90**. In this way a greater proportion of the reheat fuel flows to the pipe **50** and a minor propotrion flows through the cross bore **76** into the longitudinal bore **75** through the restricted bore **77** into the fuel pipe **49**.

In this position of the shuttle valve **74**, the pilot fuel pipe **48** is still supplied from the annulus around the reduced-diameter portion **74***c* of the shuttle valve.

Clearly as the degree of reheat selected by the selector lever **63** is reduced so the piston **12** will be moved to the right and will ultimately again cover the port **39** so that the bellows **88** will again expand closing the half ball valve element **82** onto the outlet from the duct **79** and when this position is reached the shuttle valve **74** will be moved back into the position of FIGURE 2.

I claim:

1. A control mechanism for moving an adjustable part, which mechanism comprises a ram cylinder, a plurality of axially-disposed pistons slidable in the cylinder and dividing the cylinder into a series of fluid spaces, a pair of fixed axially-spaced abutments co-operating with the piston adjacent one end of the cylinder to limit travel of this piston in the cylinder, a pair of axially-spaced travel-limiting abutments for each remaining piston at least one of which is on the next adjacent piston towards said one end of the cylinder, the piston adjacent the opposite end of the cylinder being the operating piston and having a part connectible to the adjustable part, a source of pressure fluid, valve means connected between said source and the said fluid spaces and controlling the supply of pressure fluid selectively to the pressure spaces whereby the operating piston may be set in any of a number of positions predetermined by said pairs of abutments, an adjustable abutment co-operating with the operating piston and settable in any position in a range of movement thereby to set correspondingly the operating piston in position in said range, power-means connected to move the adjustable abutment in said range of movement and selector means controlling the power means, said selector means including a selector member having a setting in which said power-means is rendered inoperative to control the adjustable abutment and a further range of settings in which the power-means is rendered operative and sets the adjustable abutment in a position in said range of movement corresponding to the setting of the selector member.

2. A control mechanism according to claim 1, wherein the adjustable abutment co-operates directly with the operating piston.

3. A control mechanism for moving an adjustable part comprising a ram cylinder, first and second pistons sliding in the cylinder and dividing the cylinder into end fluid spaces and an intermediate fluid space between the pistons, a pair of axially-spaced fixed abutments co-operating with the first piston and limiting the travel of the first piston, a second pair of axially-spaced abutments co-operating with the second piston limiting the travel of the second piston, at least one of said second pair of abutments being carried by the first piston, and the second piston being the operating piston for the adjustable part, a source of pressure fluid, first valve means connected between said source and the said fluid spaces and controlling the selective supply of pressure fluid from said source to said spaces whereby the operating piston is movable into any of at least three positions predetermined by engagement of the pistons with the said abutments, an axially-adjustable abutment cooperating with one of the pistons settable in any position in a range of movement thereby to set the operating piston in a corresponding range of movement, power means connected to move said adjustable abutment in its range of movement, and means controlling the power means including a selector member having a setting in which the power means is rendered inoperative to control the adjustable abutment and having further a range of settings in which the power means is rendered operative and sets the adjustable abutment in a position in said range of movement corresponding to the setting of the selector member.

4. A control mechanism according to claim 3, wherein the second piston has one fixed abutment and one abutment on the first piston so that the second piston has three predetermined positions, and the adjustable abutment co-operates directly with the second piston and is arranged to move the second pitson in a range of travel between an adjacent pair of the predetermined positions.

5. A control mechanism according to claim 3, said adjustable abutment comprising an abutment member engaging the operating piston, and said power-means comprising a fluid-operated servo-mechanism which moves the abutment member relative to the ram cylinder, and control valve means operated according to the setting of the selector member to render the servo-mechanism operative and inoperative and to select the setting of the abutment member, said first valve means controlling the pressure fluid supply to the fluid spaces, when the servo-mechanism is operative, to maintain the operating piston in contact with the abutment member.

6. A control mechanism according to claim 5, said servo-mechanism comprising a servo-piston working in a servo-cylinder and having a piston rod, one end of which projects into the ram cylinder and acts as the abutment member, the servo-cylinder having operating fluid supply ports to each end thereof, and the control valve means comprising a first movable valve element controlling the supply of operating fluid through the ports and a second valve controlling the supply of operating fluid to the first valve element to render the servo-mechanism operative and inoperative, these valves and the servo-piston moving in parallel paths, a link having its ends pivoted to the servo-piston and to the second valve element respectively and having an intermediate point pivoted to the first valve element, the selector member being connected to move the end of the link which is pivoted to the second valve element.

7. A control mechanism according to claim 6, said selector member being a pivoted lever having two ranges of angular movement in the first of which the second valve element is set to prevent supply of operating fluid to the first valve element so that the servo-mechanism and adjustable abutment are inoperative, and in the second of which the second valve element is set to permit operating fluid to the first valve element so that the servo-mechanism and the adjustable abutment are operative, the position of the selector member in the second range determining the setting of the adjustable abutment in its range movement.

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2,630,786	Poore	Mar. 10, 1953
2,893,209	Colley	July 7, 1959
2,908,189	Parker	Oct. 13, 1959