March 29, 1966 E. D. LATULIPPE 3,243,125

SILENCER FOR REACTION ENGINES

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FIG. 3

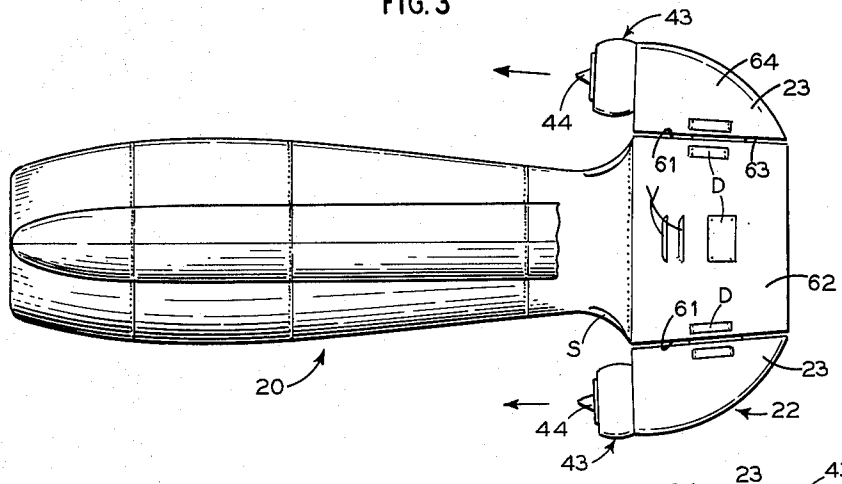


FIG. 2

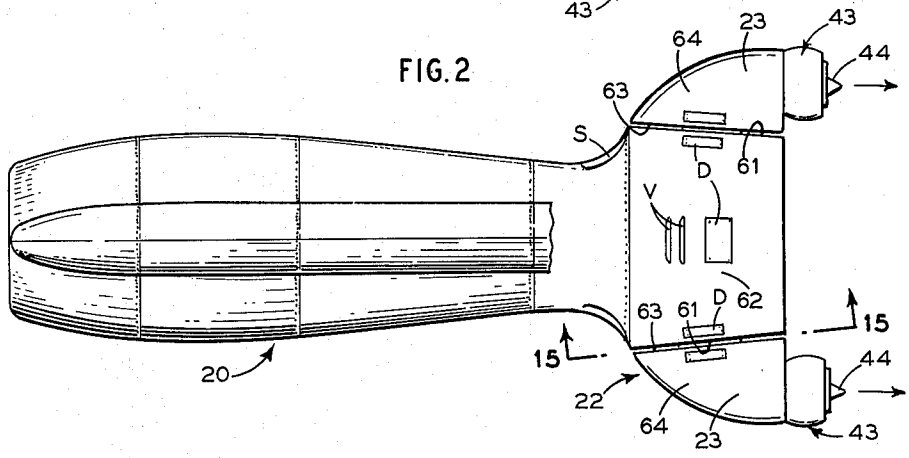
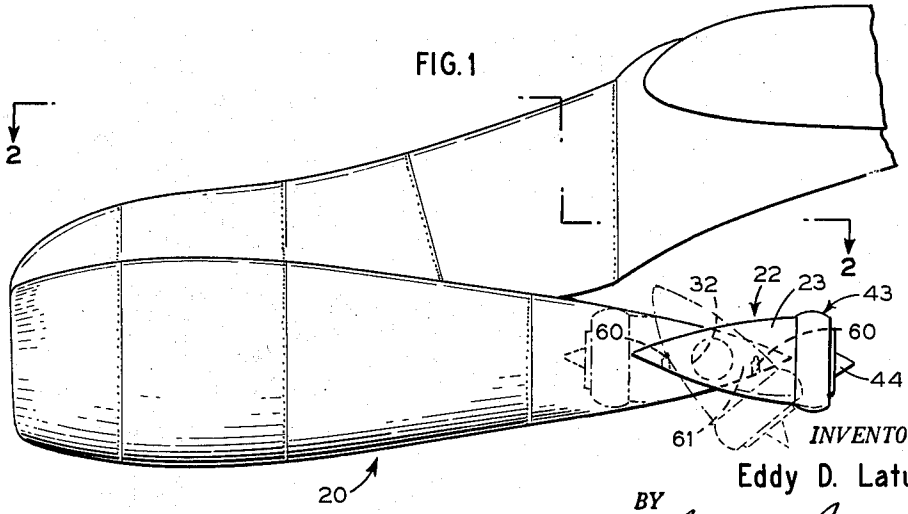


FIG. 1



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FIG. 4

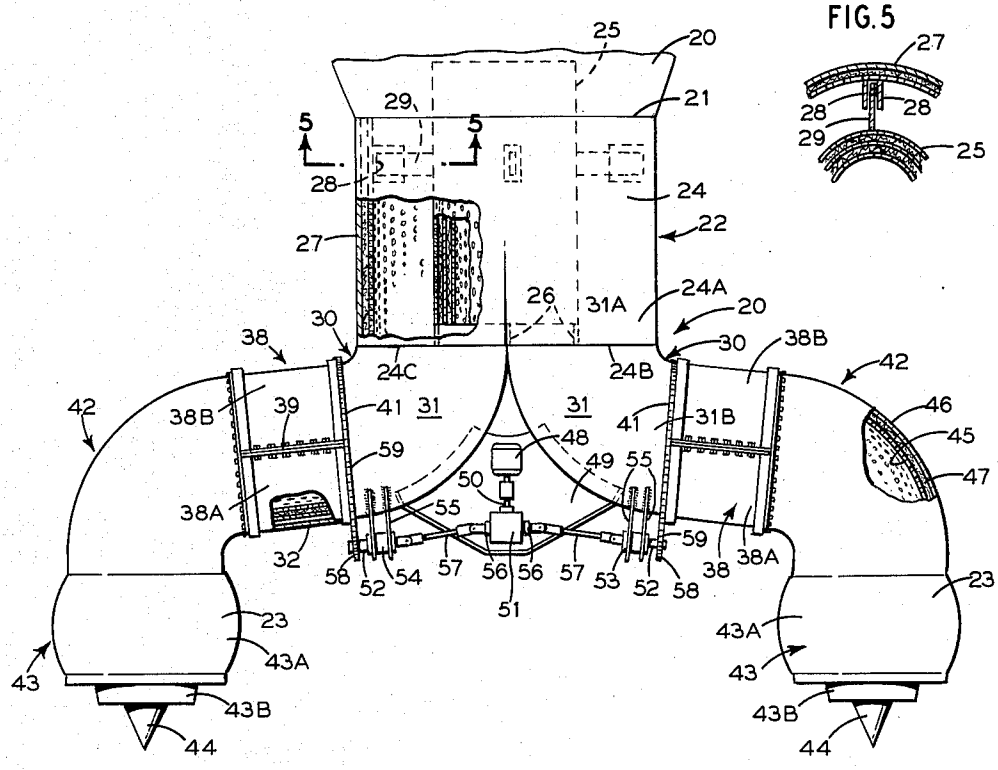


FIG. 5

FIG. 8

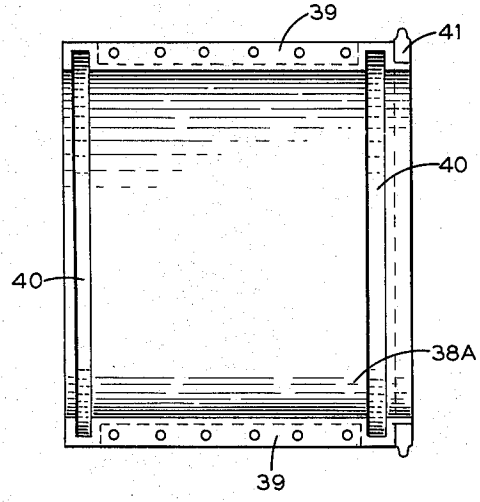
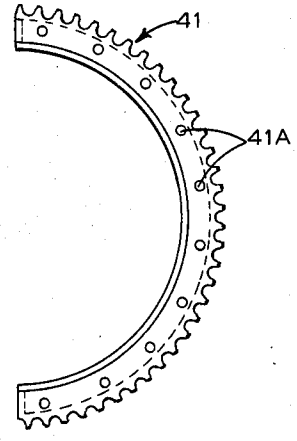


FIG. 9



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FIG. 6

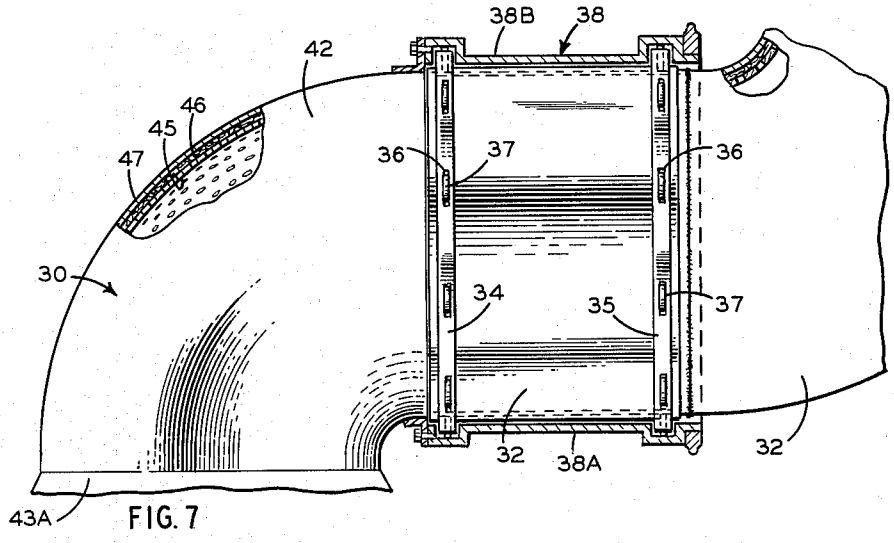


FIG. 7

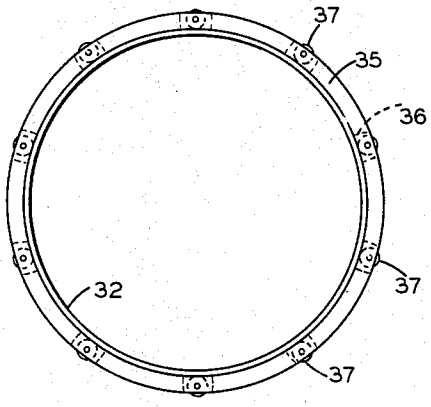


FIG. 10

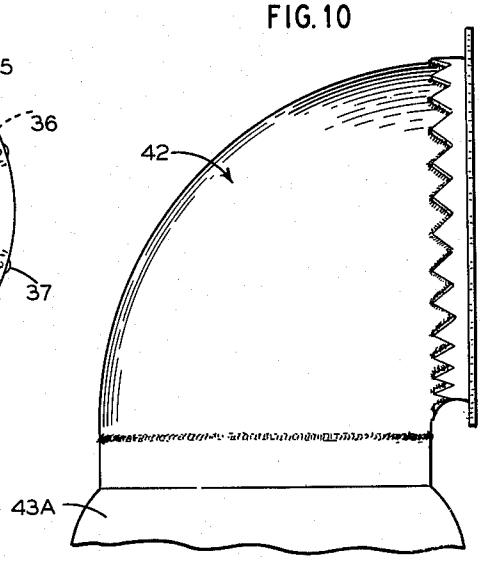


FIG. 15

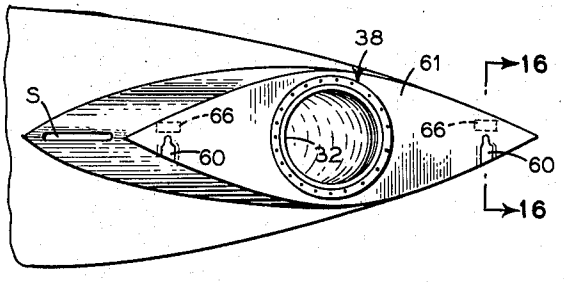
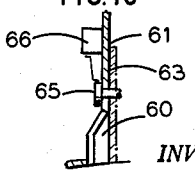


FIG. 16



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FIG. 13

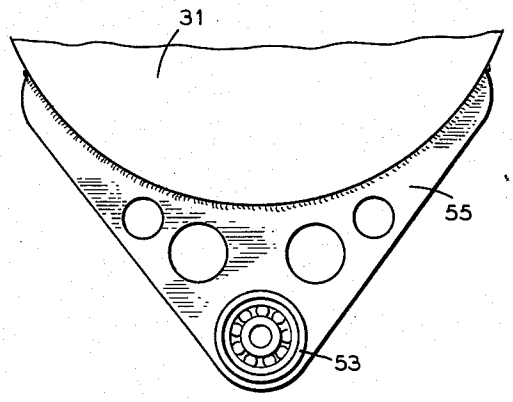


FIG. 14

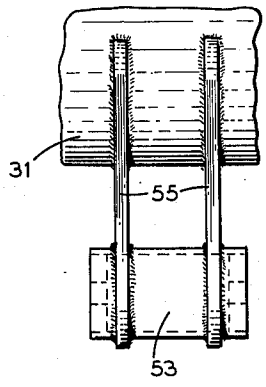


FIG. 11

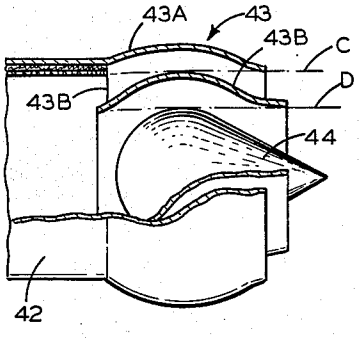
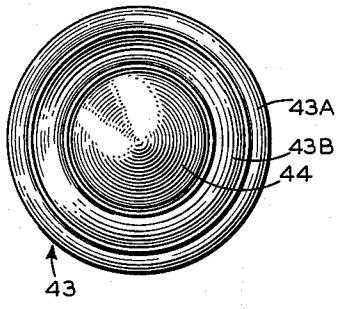


FIG. 12



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3,243,125

SILENCER FOR REACTION ENGINES

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Continuation of application Ser. No. 99,519, Mar. 30, 1961. This application Mar. 15, 1965, Ser. No. 445,826

6 Claims. (Cl. 239—265.25)

This is a continuation application of application S.N. 99,519, filed March 30, 1961, and now abandoned.

This invention relates in general to a reaction engine, and more particularly to an attachment for connection to the exhaust end of a reaction engine for changing the thrust angle of the exhaust gases and also for enhancing the muffling of the reaction engine noises to minimize its noise disturbance. The invention herein described constitutes, further, an improvement over the muffler construction disclosed in my United States Patent No. 2,543,461, granted February 27, 1951.

Two of the major problems plaguing the operation of aircraft powered by jet engines are (1) the requirement of very long runways necessary for landing and takeoff, and (2) the noise disturbances produced by the jet engines of such aircraft. Therefore, for either one or both of the above reasons, many of the larger aircraft so powered are restricted to operate from only a limited number of airports. Further, because of these reasons the airports which are operational for such aircraft must necessarily be located at relative great distances from the urban areas which these aircrafts are expected to serve. Therefore, much of the time saved in flight is lost on the ground in going to and from the urban areas and the airports that serve them. Further, the present long runway requirements for the large jet aircraft is of considerable concern to military and naval aviation.

Therefore, an object of this invention is to alleviate these problems by providing an attachment that can be readily fitted to the exhaust end of a reaction engine which will permit the pilot to reverse the full thrust of a reaction engine upon landing to more quickly bring the aircraft, so powered, to a halt and thereby reduce the length of runway otherwise required.

Another object resides in the provision whereby the attachment in accordance with this invention may be positioned on take-off to produce a lift component as well as thrust component, and thus minimize the runway length otherwise required for takeoff.

Another object is to provide a reverse thrust attachment that is constructed and arranged to further reduce engine noises for more quiet operation.

Still another object is to provide an arrangement in which the back pressure of the reaction engine may be reduced and thereby enhance its thrust producing qualities.

A feature of this invention resides in the provision that the engine attachment of this invention is relatively simple in construction, relatively inexpensive to fabricate and positive in operation.

Another feature resides in the provision that the attachment of this invention is readily adapted for use on existing reaction type aircraft engines of all types.

Other features and advantages will become readily apparent when considered in view of the description and drawings in which:

FIGURE 1 is a side elevation view of a jet engine in which the attachment of the invention is incorporated; the dot dash line illustrating other thrust positions of the attachment.

FIGURE 2 is a plan view, taken along line 2—2, of FIGURE 1 illustrating the jet engine as it appears in flight.

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FIGURE 3 is a plan view, taken along line 2—2, of FIGURE 1 illustrating the reverse thrust position of the engine attachment.

FIGURE 4 is an enlarged fragmentary plan view of the engine illustrated in FIGURES 1 to 3, with the streamlined shrouding removed and with parts shown in section.

FIGURE 5 is a section view taken along line 5—5 of FIGURE 4 on an enlarged scale with respect to FIGURE 4.

FIGURE 6 is a detailed view on an enlarged scale and partly in section, of a portion of the attachment of the present invention.

FIGURE 7 is an end view of the hub construction of this invention.

FIGURE 8 is a detail view of the bearing shell of the invention.

FIGURE 9 is a detail view of the gear ring.

FIGURE 10 is a detail view of the outlet elbow section of the instant attachment.

FIGURE 11 is a detail view shown partly in section of the tail piece or gas discharge end of the attachment.

FIGURE 12 is an end view of FIGURE 11.

FIGURE 13 is a fragmentary end view of a bearing mount or support of the drive means for reversing the thrust of the instant attachment.

FIGURE 14 is a plan view of FIGURE 13.

FIGURE 15 is an enlarged section view taken along line 15—15 of FIGURE 2.

FIGURE 16 is an enlarged sectional view taken along line 16—16 of FIGURE 15.

Heretofor many attempts have been made in an effort to reverse the thrust of a reaction engine, e.g. a jet type aircraft engine. However, the known constructions have been only partially successful because only a component portion of the engine thrust was reversed. Before this invention full reverse thrust of the jet engine was not possible. Also the prior known reverse thrust constructions did little, if any, muffling of the engine noises.

In accordance with this invention an improved reaction engine attachment is disclosed which permits full reverse thrust to be achieved while at the same time greatly improving the muffling effect of engine noise by 100% over any known muffler construction. Referring to the drawing, FIGURES 1 to 4 illustrate the general assembly of a reaction type or jet engine **20** embodying the instant invention. Connected to the exhaust or discharge end **21** of the engine **20** is the instant attachment **22**. In accordance with this invention the discharge end portion **23** of the attachment is rendered readily reversible, and as shown in FIGURES 1 to 3, the thrust producing forward motion can be fully reversed.

Referring to FIGURE 4, the instant attachment **22** comprises a muffler section **24** which is adapted to be connected to the discharge end **21** of the jet engine for receiving the thrust producing gases. Generally the muffler construction is of the type disclosed in my U.S. Patent No. 2,543,461. The instant muffler **24** differs from the patented construction in the support of the inner sleeve or casing **25** within the outer sleeve or casing **27**. In the instant case the inner casing **25** is rigidly connected at its rear end to the transition section of the muffler by spider members **26** circumferentially spaced about the rear end of the casing **25**. The forward end of the casing **25** is supported for relative movement with respect to the outer casing **27** of the muffler **24** to accommodate for thermal expansion and contraction. As shown in FIGURE 5, the front supports of the inner casing **25** consist of circumferentially spaced pairs of plates **28** which are connected to the outer casing **27** and extend radially inwardly therefrom.

As shown the plates **28** of each pair are spaced apart for snugly receiving therebetween a radially extending plate **29** which is connected to the inner casing **25**. Accordingly, plates **28** are of sufficient width so as to accommodate the relative movement of plate **29** sandwiched therebetween during expansion and contraction of the inner casing **25** relative to the outer casing **27** of the muffler **24**.

In accordance with this invention the discharge end **24A** of the muffler is flared to define a pair of discharge openings **24B** and **24C**, each having connected thereto laterally extending and oppositely disposed tubular extensions **30** for receiving a divided portion of the gases discharging through the muffler section **24**. Each of the tubular extensions **30** are similarly constructed but opposite in hand. Therefore, a description of one need only be discussed.

As shown, each of the tubular extensions **30** for receiving the divided portion of the engine reaction gases comprises an inlet elbow section **31** having its inlet end **31A** rigidly secured to one of the muffler discharge openings and having its outlet end **31B** disposed laterally therefrom. Connected to the outlet end **31B** of the inlet elbow **31** is a hub section **32**.

Referring to FIGURES 6 and 7, the hub section **32** consists of a tubular conduit having a pair of spaced laterally extending external flanges **34** and **35**. Each of the flanges **34, 35** is provided with a series of circumferentially spaced recesses **36** in which there is housed a roller **37** rotatably mounted therein. As seen in FIGURE 7, the periphery of the individual rollers projects slightly beyond the outer circumference of the respective flanges.

Rotatably connected relative to the hub **32** is the bearing shell **38**. Actually the bearing shell **38** consists of two sections **38A, 38B** which are bolted together about the hub **32**. As shown in FIGURE 8, each half section **38A, 38B** of bearing shell **38** is provided with a bolting flange **39** by which the two sections **38A, 38B** are fastened together onto the hub **32**. Each section **38A, 38B** is further provided with lateral offset portions to define an internal groove **40** which is adapted to accommodate the flanges **34** and **35** of the hub **32**. The arrangement is such that the bearing sections **38A, 38B** riding on rollers **37** are thus rendered readily rotatable relative to the hub **32**.

Rigidly secured to one end of the bearing shell **38** is a gear ring **41**. If desired the gear ring **41** may be made in two halves, as shown in FIGURE 9, that can be readily secured to the bearing sections **38A, 38B**, as in FIGURE 8, by suitable fasteners extending through apertures **41A** in gear ring **41**.

Connected to the outlet end of the bearing shell **38** for rotating movement therewith is the outlet elbow **42** of the extension **30**. As shown, the discharge elbow **42** in normal flight is arranged to discharge the reaction gases to the rear to provide the forward thrust. Upon landing the discharge elbows **42** are reversed a full 180° so that the full thrust of the reaction gases is directed forwardly to slow down the aircraft.

To further enhance the thrust of the engine, a tail section **43** capable of reducing the back pressure on the engine is connected to the linkage end of the outlet elbow **42**. As shown in FIGURES 11 and 12 the tail section **43** comprises an outer sheet metal shell **43A** which is connected to the discharge end **42B** of the outlet elbow **42**. The outer shell **43A** is outwardly curved in longitudinal section. Concentrically disposed within the shell **43A** is a tear drop shell **44**, and intermediate the tear drop shell **44** and outer shell **43A** is an annular shell **43B**. As shown in FIGURE 11, the inner and outer shells **43A** and **43B** are substantially similar in shape and the spacing therebetween is such that the maximum diameter of the intermediate shell **43B** is substantially equal to the minor diameter of the outer shell **43A**. In other words the maximum bulge of the inner shell **43B** is tangent to the cord C. Likewise the maximum bulge of the tear drop **44** is tangent to cord D, as shown in FIGURE 11. Thus

the function of the tail section **43** due to its particular configuration is to reduce the pressure of the gases passing therethrough by increasing their velocities. In this manner the back pressure on the engine is reduced and the engine rendered more efficient.

In accordance with the invention the inlet elbow **31**, hub section **32** and discharge elbow **42** of each extension **30** are each formed of an inner and outer membraned shells **45, 46** mutually spaced. As shown in FIGURE 4 the inner membrane shell **45** of members **31, 32,** and **42** is perforated while the outer membrane shell **46** of these members is rendered gas tight. The space between the shells **45, 46** of these sections **31, 32,** and **42**, is filled with a sound absorbent material **47**. Thus in effect the sections **31, 32,** and **42** are formed of the same construction as the outer casing **27** of the muffler section **24** and thus cooperate therewith to further deaden the engine noises in any position of the discharge elbow **42**. For a more detailed description of the muffler casing **27** reference is made to my U.S. Patent No. 2,543,461.

Means by which the elbows **42** may be simultaneously changed from in-flight position, FIGURE 2, to full reverse thrust position, FIGURE 3, or any position therebetween, includes a motor **48** mounted on a suitable platform bracket **49** disposed between inlet elbows **31**. The arrangement is such that the center line of the motor **48** coincides with the center line of the engine **20**. The motor shaft **50** connects to a reduction gear ratio **51** which in turn drives a pair of oppositely disposed drive shafts **52** journaled in similar bearings **53** and **54** respectively. A pair of braces **55** support the respective bearings **53, 54** on elbows **31**. As shown in FIGURE 4, the gear ratio shafts **56** are connected to the respective drive shafts **52** through a suitable universal connection and coupling **57**. Connected to the drive shafts **52** is a sprocket **58** which is connected in driving relationship with the gear ring **41** by a chain drive **59**. Thus actuation of the motor **48** effects rotation of the bearing shell **38** and connected discharge elbow **41** accordingly.

Means for cooling the bearings **38A, 38B** include slots "S" formed in the leading edge of shrouding, as shown in FIGURES 2, 3, and 15. Thus cool air is permitted to circulate over the ebarings **38A, 38B**, motor **48** and gear box **51** to maintain the same cool. Cooling air then escapes through vent openings "V" in shroud **62**. Suitable access doors "D" are provided in the shrouding.

Means for locking the outlet elbows **42** at either of their limits of movement are provided. The locking means include a keyhole slot **60** having its narrow portion projecting outwardly in the face **61** of the shroud **62** covering the hub section, a keyhole slot being disposed on either side of the hub section **32**. The face **63** of the shrouding **64** surrounding the discharge elbow **42** is provided with a lug **65** having a projecting head which is adapted to engage wtih either of the keyhole slots **60**, as the discharge elbow **42** approaches the limit of travel. If desired, limit switches **66** are disposed adjacent the keyhole retainers **60** so that as the lug **65** is received therein, the lug actuates the limit switch **66** which in turn de-energizes the circuit control motor **48**. Thus in either the in-flight position or full reverse thrust position, the discharge elbow **42** is firmly locked in position.

With the construction described it will be noted that the angle of thrust may assume any angle between 0 and 180°. Thus on takeoff, the discharge outlets or elbows **42** may be angularly disposed so as to produce a lift component as well as a forward thrust component. By properly angling the discharge outlets **42**, the attachments of this invention may be used much in the same manner as flaps are used to increase the lift of the aircraft and thereby permit takeoff on a much shorter runway.

A feature of this invention and one which further enhances the forward thrust of the engine is that the lateral extending sections **30** permits the reaction gases to be discharged outwardly of the turbulent slipstream flowing

over the engine nacelle **20**. Thus the reaction gases are discharged into the more quiet and solid air outboard of the engine **20** where the reactive forces of the gases are more enhanced.

While the instant invention has been disclosed with reference to a particular embodiment thereof, it is to be appreciated that the invention is not to be taken as limited to all of the details thereof as modifications and variations thereof may be made without departing from the spirit or scope of the invention.

What is claimed is:

1. An attachment for use on a reaction engine for changing the thrust angle of the reaction gases comprising a tubular extension adapted to connect to the exhaust end of a reaction engine for receiving the thrust producing gases, said extension having a laterally extending tubular hub section forming a continuation thereof, a tubular discharge elbow rotatably connected to said laterally extending tubular hub section, and means connected to said discharge elbow for rotating said discharge elbow relative to said lateral tubular section for fully reversing the full thrust of the reaction gases, a tubular tail piece connected to the discharge end of said elbow, said tail piece being outwardly curved in longitudinal cross section, a tear drop shell concentrically disposed in spaced relationship within said tail piece, and an intermediate annular member conforming substantially to the curvature of said tail piece concentrically disposed between said shell and said tail piece and said annular member having the major diameter that is substantially equal to the minor diameter of said tail piece.

2. An attachment for muffling the noise of a reaction engine and for changing the forward thrust component of reaction gases of said engine substantially 180° comprising a muffler adapted for connection to the exhaust end of a reaction engine, a laterally extending substantially right angled tubular section connected to the discharge end of said muffler to form a continuation thereof, a tubular hub connected to said laterally extending section, a bearing shell connected to said hub for relative rotation therewith, a substantially right angled tubular elbow connected to said bearing shell so as to be rendered rotatable therewith, and drive means operatively connected with said bearing shell for rotating said bearing shell and connected tubular elbow relative to said hub for changing the forward thrust component of the exhaust gases discharging from said elbow between 0 and 180°, said hub being provided with a pair of spaced laterally extending flanges, each of said flanges having a plurality of circumferentially spaced recesses formed therein, a wheel roller mounted in each of said recesses so that the periphery of said wheel rollers project slightly beyond the periphery of said flanges, and asid bearing shell having cooperating grooves for receiving said flanges and arranged to ride on said wheel rollers.

3. The invention as defined by claim **2** wherein said drive means includes a motor, a gear reduction ratio means connected to the armature of said motor, a driving sprocket connected in driving relationship with the shaft of said gear reduction ratio means, a gear ring connected to said bearing shell, and a chain drive connecting said gear ring in driving relationship with said sprocket so that actuation of said motor effects rotation of said bearing shell and connected elbow to change the direction of thrust of said exhaust gases accordingly.

4. A tail section adapted to connect to the discharge end of a reaction engine to enhance its thrust comprising a tubular outer shell adapted to be connected to the discharge end of a reaction engine, said outer shell being outwardly curved in longitudinal cross section, a tear drop shell concentrically disposed in spaced relationship in said outer shell, and an intermediate annular shell conforming substantially to the curvature of said outer shell concentrically disposed between said tear drop shell and said outer shell, whereby the major diameter of said intermediate shell is substantially equal to the minor diameter of said outer shell.

5. An attachment for muffling the noise of a reaction engine and for reversing the thrust of the reaction engine between forward thrust and 180° reverse thrust, said attachment comprising a muffler having concentric and spatial disposed inner and outer sleeves connected to the exhaust end of a reaction engine, means for mounting the inner sleeve for relative movement to said outer sleeve to compensate for relative thermal expansion therebetween, and said muffler having a discharge end, a pair of oppositely disposed, laterally extending tubular sections connected in communication with the discharge end of said muffler, each of said pair of tubular sections adapted to receive a divided portion of the reaction gases flowing through said muffler, a stationary tubular hub rigidly connected to the outlet end of each of said lateraly extending tubular sections, said hub having a pair of spaced flanges, each of said flanges having a plurality of recesses circumferentially spaced therearound, a wheel type roller mounted in each of said recesses so that the periphery of each of the wheel type rollers projects slightly beyond the periphery of said flange, a bearing shell having a groove adapted to receive said flange and connected to said hub for relative rotation therewith, a tubular substantially right angled elbow connected to the discharge end of each of said bearing shells to rotate therewith, means connected to the discharge ends of said elbows to enhance the thrust of the reaction gases, and means for simultaneously rotating each of said bearing shells and connected elbow for varying the angle of thrust of the reaction gases discharging therefrom, said latter means including motor means connected between said tubular sections, and a drive means connected between said motor means and said bearing shells whereby said drive means are rendered operative upon actuation of said motor means to rotate said bearing shells accordingly.

6. The invention as defined in claim **5** including means for cooling said bearing shells.

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MARK NEWMAN, *Primary Examiner.*