

April 5, 1955

A. L. BOYCE ET AL
MULTIPLE PULSE JET ENGINE

2,705,396

Filed Feb. 18, 1953

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Fig. 3

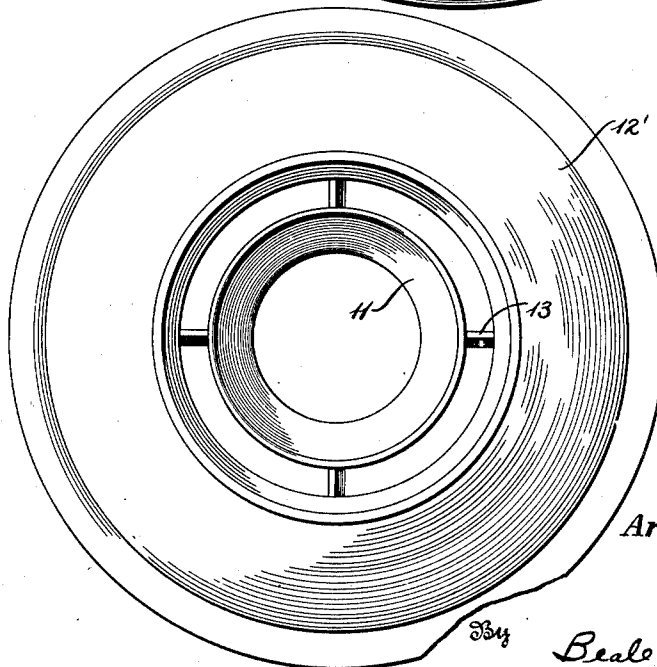
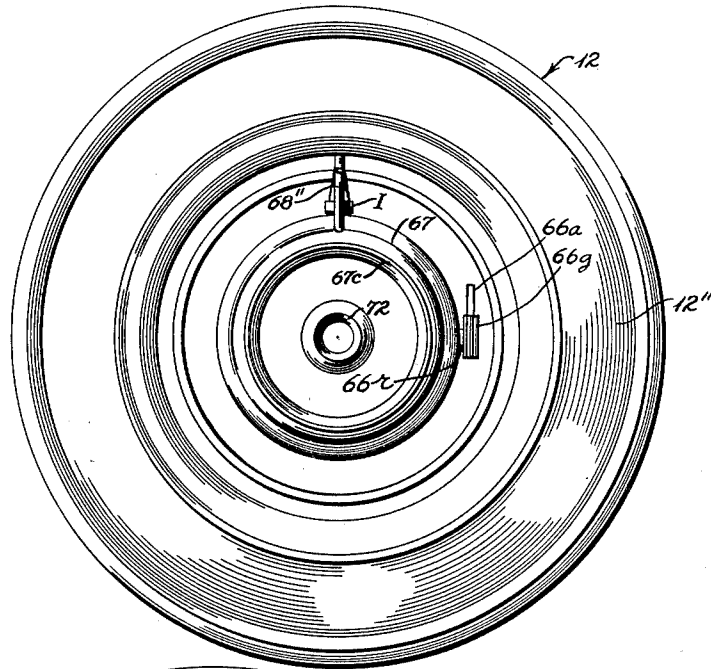


Fig. 4

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Fig. 5

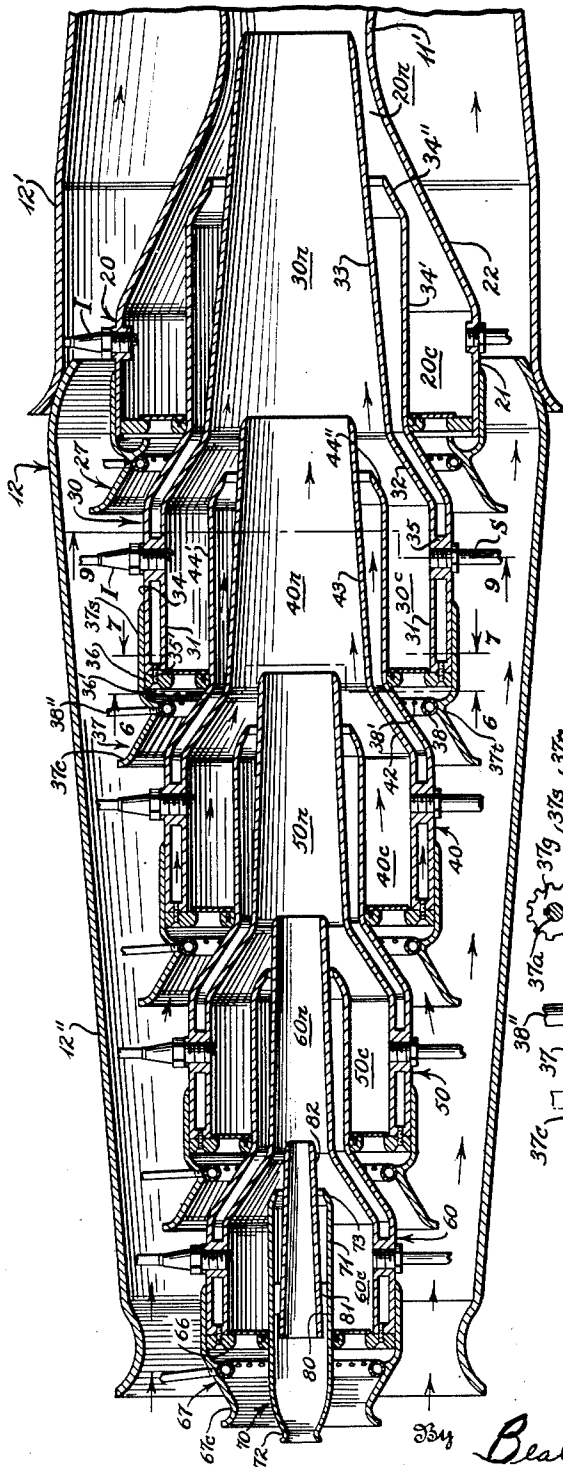
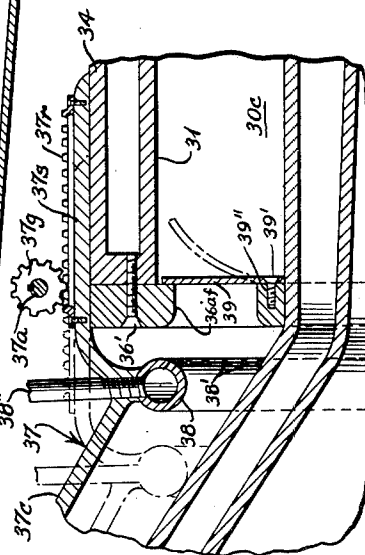


Fig. 8



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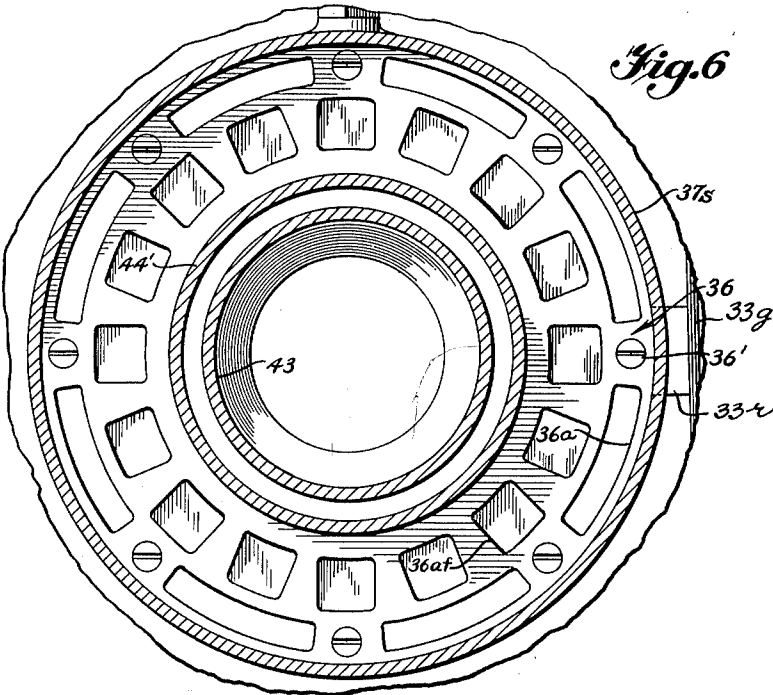


Fig. 6

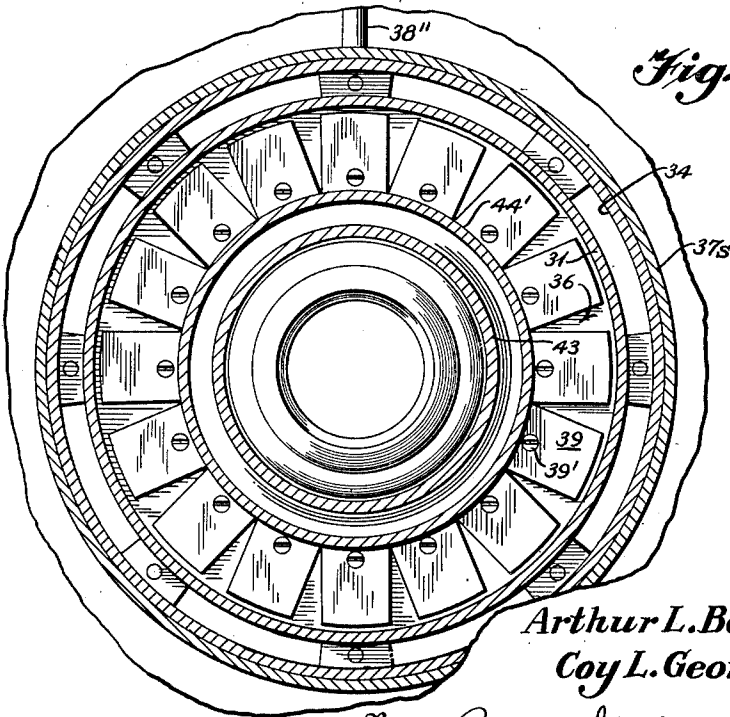


Fig. 7

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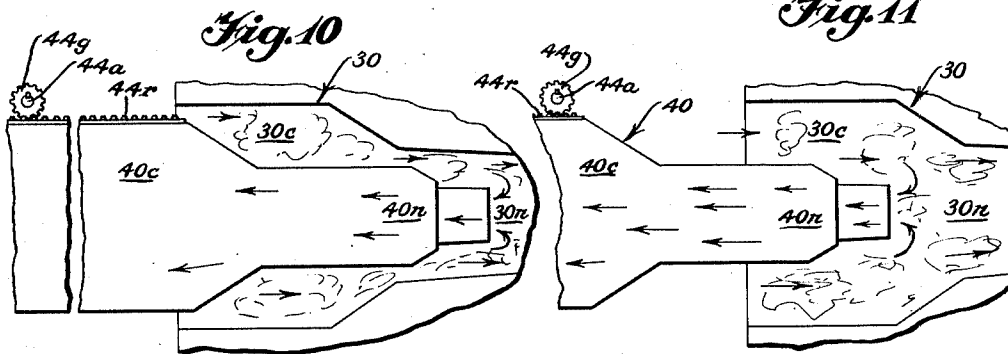
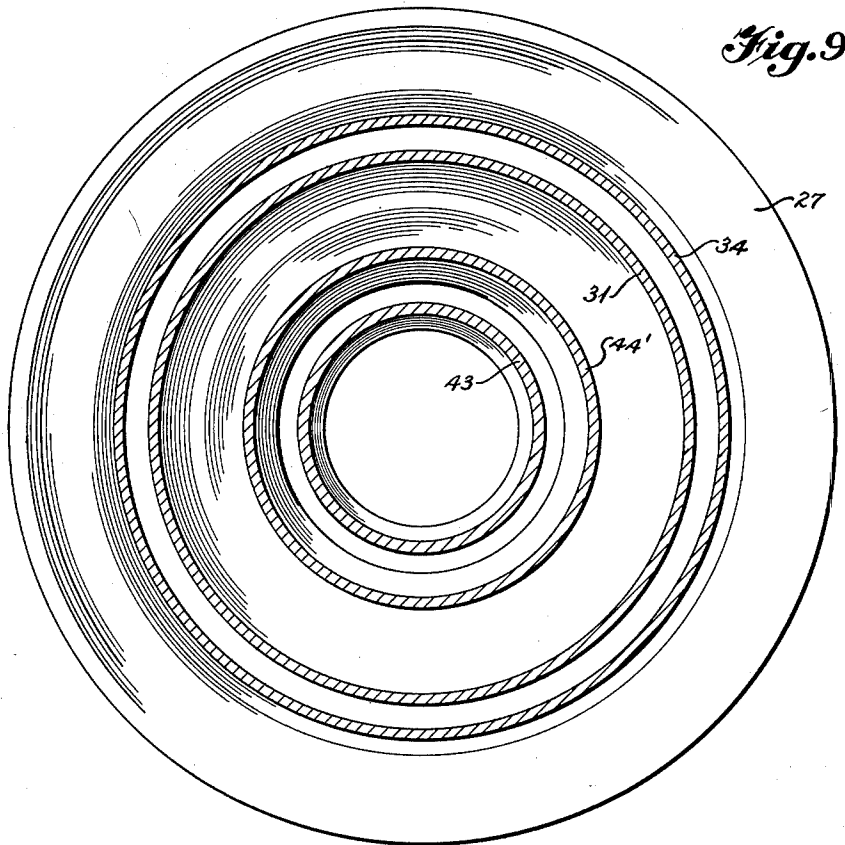
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2,705,396

MULTIPLE PULSE JET ENGINE

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Application February 18, 1953, Serial No. 337,634

15 Claims. (Cl. 60—35.6)

Our invention relates to improvements in direct jet engines and more particularly to successive axially aligned engines where each engine assists the next adjacent engine.

An object of the invention is to provide a power producing device consisting of a plurality of axially aligned jet engines having the exhaust of one engine discharging into the adjacent engine so that a part of the exhaust gases of one engine compresses the air and fuel mixture of the adjacent engine.

Another object of our invention is to provide for an exhaust nozzle arrangement in successively arranged jet engines such that gases passing from one exhaust nozzle increase the velocity of the exhaust gases discharging from adjacent exhaust nozzles.

A further object of the invention is to provide in a plurality of successive axially arranged jet engines the induction of cooling air into the mass of discharged gases such that the mass of the discharged gases will be increased without retarding the velocity of the gases.

A still further object of our invention is to provide in direct jet engines for maximum intake area for air without increasing the size and head resistance of such engines for airplane power plant use.

Another object of the invention is to provide a power producing device consisting of a plurality of successive axially arranged jet engines which cooperate with each other such that the firing of one engine assists the charging and discharging of the adjacent engine with a frequency which permits a substantially constant discharge of gases from the power producing device without the use of rotary compressor or turbine.

Another object of the invention is to provide in a direct jet engine air cooling chambers about the combustion chamber and exhaust nozzle in successive axially arranged jet engine such that the exhaust nozzle and air jacket therearound on one engine is disposed within the combustion chamber and exhaust nozzle of the adjacent engine and air is drawn through the air chamber by the suction created by the discharge of flowing gases of the adjacent engine.

A still further object of the invention is to provide an arrangement of axially aligned successive jet engines wherein the exhaust nozzle of one engine projects into the combustion chamber and exhaust nozzle of the adjacent engine such that the exhausting of one engine augments the exhausting of the adjacent engine.

Another object of our invention is to provide in a direct jet engine relatively large air induction openings to the combustion chamber of the engine as compared with the cubic displacement of the combustion chamber.

A yet still further object of the invention is to provide a power producing device of the jet type that is relatively simple to construct and repair, produces a large amount of power for its weight and has a relatively small head resistance.

Still further objects and the entire scope of the applicability of the present invention will become apparent from the detailed description given hereinafter; it should be understood, however, that the detailed description and specific example is given by way of illustration only and, while indicating the preferred embodiment of the invention, is not given by way of limitation, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

For a more complete understanding of the nature and

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scope of our invention, reference may be had to the drawings and description in which:

Fig. 1 is a side elevational view of the power producing device according to our invention;

Fig. 2 is a side elevational view of the power producing device with the outer casing in section depicting the assembled tail pipe and the successive axially aligned jet engines;

Fig. 3 is a view of the leading end of the power producing device along line 3—3 of Fig. 1;

Fig. 4 is a view of the trailing end of the power producing device along line 4—4 of Fig. 1;

Fig. 5 is a fragmentary enlarged cross sectional view along line 5—5 of Fig. 1 of the power producing device with the tail section omitted and showing the successive axially aligned jet engines arranged for cooperation with each other;

Fig. 6 is an enlarged cross sectional view along line 6—6 of Fig. 5 showing the fuel and air induction openings of one of the engines;

Fig. 7 is an enlarged cross sectional view along line 7—7 of Fig. 5 depicting the air and fuel induction valves of one of the engines as viewed from within the combustion chamber;

Fig. 8 is an enlarged fragmentary cross sectional view showing portions of two adjacent engines, an air and fuel induction valve and the associated fuel manifold within a movably mounted air cowling on one of the engines;

Fig. 9 is an enlarged cross sectional view along line 9—9 of Fig. 5 showing the relationship of an air cowling of one engine, the jacketed combustion chamber of the next adjacent engine and the jacketed exhaust nozzle of a further engine;

Fig. 10 is a schematic fragmentary view showing the relationship of an exhaust nozzle of one engine discharging into the trailing end of the combustion chamber of the next adjacent engine permitting part of the combustion gases of the firing engine to temporarily enter the next adjacent engine to compress the air and fuel mixture therein; and

Fig. 11 is a schematic view similar to Fig. 10 but showing an exhaust nozzle of the next adjacent engine discharging into the middle portion of the combustion chamber of an engine wherein a greater portion of the exhaust gases from the combustion chamber shown enter the exhaust nozzle of the next adjacent engine to compress the air and fuel mixture therein to a greater degree than shown in Fig. 10.

Throughout the various figures and the description, like reference numerals refer to similar parts.

In Figures 1 and 2 the power producing device is generally indicated at 10 and as shown in Fig. 2 is made up of a plurality of jet engines axially disposed about the axis X—X' in a successive arrangement. Disposed in the trailing end of the power producing device is a tail pipe 11 which is of frusto-conical shape gradually increasing in size from its leading end 11' to its trailing end 11". Surrounding the tail pipe 11 in spaced relationship thereto is an outer housing generally indicated at 12 made up of two sections, the trailing section 12' and the leading section 12". Trailing section 12' of the outer housing 12 is connected to the tail pipe 11 at its trailing end 11" by suitable struts 13. A first engine 20 is disposed within the outer housing 12 as by means of supporting struts 14 such that the axis of engine 12 coincides with the longitudinal axis X—X' of the power producing device.

Engine 20 is formed with a cylindrical wall section 21 and an integral section 22 of frusto-conical form which is integrally connected with the leading end 11' of the tail pipe 11.

Referring to Fig. 5 engine 30, which is next adjacent to the first engine 20 will be described, engine 30 includes a combustion chamber 30c at the leading end and an exhaust nozzle 30n at the trailing end.

Combustion chamber 30c is formed by a cylindrical wall 31 and a mid-section 32 which is of frusto-conical shape and is integrally connected with a wall 33 which is also of a frusto-conical shape but of greater convergence toward the trailing end than the wall mid-section 32. The longitudinal axis of this engine as do the others,

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coincides with the longitudinal axis X—X'. Exhaust nozzle 30n projects into the combustion chamber 20c and exhaust nozzle section 20n of engine 20. A second wall 34 surrounds the engine 30 in spaced relationship thereto and is connected to wall 31 as by spaced webs 35 and leading end spacing web 35'. Outer spaced wall 34 extends toward the tail end of the engine 30 over the exhaust nozzle wall 33 as at 34' where it is of cylindrical shape and finally tapers into a frusto-conical section 34'' at its extreme end which is in spaced relation to the end of the wall 33 of exhaust nozzle 30n. The wall sections 34' and 34'' form an air nozzle about the exhaust nozzle 30n. Mounted over the leading end of the engine 30 is an annular air and fuel induction plate 36 which is apertured to receive screws 36' which are secured in suitable threaded apertures in webs 35'. The annular plate 36 is formed with a large aperture at its center through which extends the air and exhaust nozzles of the engine next preceding toward the leading end of the power producing device. Annular plate 36 has formed therein a plurality of spaced apart air and fuel induction apertures 36af which pass air and fuel to the combustion chamber 30c. Outwardly spaced from apertures 36af are a plurality of spaced apertures 36a which are in alignment with the air jacket formed between walls 31 and 34 so as to permit cooling air to flow over the combustion chamber and exhaust nozzle of engine 30. Further, there is movably mounted on the leading end of engine 30 an air induction cowl 37 which is formed with a cylindrical sleeve 37s that is slidably received over the leading end of outer wall 34. Cowl 37 narrows down to a throat 37t at its mid-section while its leading end is further formed with an outwardly flaring end 37c which extends substantially parallel to and surrounds the mid-section of the next preceding engine 40. Mounted within and attached to the throat 37t of cowl 37 is an annular tubular fuel ring or manifold 38 which is positioned in the air stream formed between the cowl portion 37c and the mid-section of the next preceding adjacent engine. The manifold 38 has spaced orifices 38' therein at the trailing face through which fuel is discharged. A fuel line 38'' connects with manifold 38 and leads to a fuel supply (not shown) exterior of the engine.

Referring to Figures 5, 7 and 8 on the combustion chamber side of air and fuel induction plate 36 there is mounted over each aperture 36af valve plates 39 as by screws 39' which are threadedly received in suitable threaded apertures 39'' in annular fuel and air induction plate 36. These valves 39 are in the form of leaf springs which permit entrance of fuel and air in one direction, see Fig. 8, into the combustion chamber 30c of the engine but seal off the entrance of fuel and air as the charge is compressed for firing in the combustion chamber 30c. It will be observed that a relatively large area of fuel and air entrance is provided in the plurality of openings 36af and the total area of these openings as respects the cubic volume of combustion chamber 30c is large. In Fig. 5, there is shown, as for engine 30, an ignition plug I, which is mounted in a threaded aperture formed in one of the spacing webs 35 so that the ignition plug extends into the combustion chamber 30c. These ignition plugs I are continuously being fired or caused to spark by external conventional means (not shown). Also formed in one of the spacer webs 35 between walls 31 and 34 is a threaded aperture to receive the starting fuel and compressed air line S through which compressed air and fuel are introduced into combustion chamber 30c for starting the engine.

Referring to Fig. 8 there is shown an enlarged detail section of engine 30 and particularly a moveable mounting for the air induction cowl 37 which is typically described as equally as well applying to the other engines. Sleeve 37s has mounted thereon a gear rack 37r which is engaged by a gear 37g made fast on a shaft 37a which is mounted in suitable bearings (not shown) in the power producing device and through which the cowl 37 is slid back and forth on wall 34, as shown by the broken and full line positions. It will be observed that in the broken line position, the fuel manifold 38 abuts the adjacent mid-section outer wall of engine 40 and totally closes off any air induction to engine 30. The cowl 37 through the rack 37r and gear 37g may be positioned to control the size of the air induction opening and thus govern the amount of air permitted to enter engine 30 and its air jacket.

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Each of the other engines 40, 50 and 60 are of similar construction to engine 30 which has just been described but each is of decreasing size as they extend toward the leading end of the power producing device. Engine 20, the first engine, at the trailing end of the power producing device does not have an outer spaced wall about its combustion chamber 20c and exhaust nozzle 20n as the air flowing thereover and within the outer housing 12 adequately cools that engine.

Referring to Figures 3 and 5 the leading engine 60 is shown have the air cowl 67 projecting forwardly therefrom but instead of the leading end portion 67c flaring outwardly, it converges inwardly and then flares outwardly at the extreme end. Mounted in the central aperture in the annular air and fuel induction plate 66 on engine 60 is an air nozzle generally indicated at 70 which through its main section 71 is cylindrical in shape and is formed with a converging throat 72 at its leading end and a converging trailing end 73. Mounted concentrically in spaced relationship within air nozzle 70 is a converging nozzle 80 which is supported by spaced webs 81 extending from wall 71 of nozzle 70. Nozzle 80 has a trailing end 82 which projects beyond the end 73 of nozzle 70 and into the exhaust nozzle 60n of engine 60. These nozzles 70 and 80 permit the introduction of air along the common longitudinal axis of the exhaust nozzles of the engines. This air is heated as it passes through the engines to the tail pipe 11 and thus its velocity is progressively increased.

In Figures 10 and 11 there is depicted the compression effect that the exhaust gases of one engine have on the charge of fuel and air in the next preceding engine. Typical engines 30 and 40 of the power producing device are depicted in schematic representation. Engine 40 in Fig. 10 is shown provided with its combustion chamber 40c and exhaust nozzle 40n which nozzle is projecting through the combustion chamber 30c of engine 30 and into the exhaust nozzle 30n of engine 30. Engine 40 has a gear rack 44r secured to a portion of the wall about the combustion chamber 40c such that the rack 44r extends in the axial direction of the engine. Meshing with this rack 44r is a gear 44g fast on shaft 44a which is in turn, suitably supported in bearings (not shown) and adapted to be rotated so that gear 44g in turn will be rotated. Thus by rotating gear 44g the rack 44r attached to engine 40 is moved and engine 40 and its exhaust nozzle may be positioned relative to engine 30 and its combustion chamber 30c and exhaust nozzle 30n. Reference to Figures 2, 3 and 6 shows that the engines 30, 40, 50 and 60 are equipped with racks 33r, 44r 55r and 66r respectively meshing with gears 33g, 44g, 55g and 66g which gears are rotated by control shafts 33a, 44a, 55a and 66a respectively. These control shafts 33a, 44a, 55a, and 66a lead to control means (not shown) for rotating the shafts and the gears fixed thereto to adjust the position of the respective engine exhaust nozzles. The purpose of this positioning will now be described.

In Fig. 10 the nozzle 40n of engine 40 is shown projecting into the exhaust nozzle 30n of engine 30. Assuming that engine 30 is firing and engine 40 is having its fuel and air charge compressed just prior to its firing. A portion of the gases of combustion at high pressure from combustion chamber 30c pass into the exhaust nozzle 40n of engine 40 and temporarily act on the combustion mixture of air and fuel in combustion chamber 40c of engine 40 thereby compressing the charge in combustion chamber 40c. In the arrangement shown in Fig. 10 with the exhaust nozzle 40n projecting into exhaust nozzle 30n, a relatively small amount of combustion gases from engine 30 will act to compress the charge in engine 40. However, by changing the position of nozzle 40n so as to subject it to greater exhaust gases from engine 30, a greater degree of compression of the charge in engine 40 may be effected.

Reference in Fig. 11 shows that through the rotation of gear 44g, engine 40 has been positioned with respect to engine 30 such that exhaust nozzle 40n of engine 40 projects into the central part of combustion chamber 30c of engine 30. Thus, a greater amount of gases of combustion at high pressure enters nozzle 40n and the charge of fuel and air in combustion chamber 40c of engine 40 is subjected to a greater compression effect which will tend to increase the power developed by engine 40.

With respect to the successive firing of engines 30 and 40, it will be observed that when engine 40 fires, the

exhaust gases therefrom passing through exhaust nozzle 40n will tend to draw out spent combustion gases from combustion chamber 30c and induce a new charge of air and fuel into combustion chamber 30c. This action of firing, compressing, and recharging of engines occurs very rapidly.

It will also be noted, particularly from Fig. 5, that the firing of an engine and the high velocity travel of exhaust gases from the engines exhaust nozzle will not only tend to draw out the exhaust gases from the engines combustion chamber but in addition will induce a fresh charge of fuel and air into the combustion chamber as well as induce cooling air through the surrounding air jacket about the engine combustion chamber and exhaust nozzle. This cooling air will take up heat from the combustion chamber and exhaust nozzle over which it passes and its temperature being raised will increase its velocity as it enters the respective next trailing exhaust nozzles and passes rearwardly to and through the tail pipe 11. As the progressive charging, compressing and firing takes place from trailing engine to leading engine, higher compression will take place in the successive engines from trailing end to leading end of the power producing device.

It is contemplated within the scope of our invention that adjustable positioning of the air induction cowlings of each engine may be accomplished either individually or in unison either by hand adjustment or by means (not shown). So also the positioning of one exhaust nozzle with respect to the next adjacent engine may be accomplished individually or in unison. In operation, one or more engines may be entirely cut out of operation. The starting lines S to each combustion chamber supply compressed air and fuel for starting purposes.

With this arrangement of successive acting axially aligned direct jet engines a cumulative power producing effect is accomplished which is relatively high for the size and weight of the engines. So also the head resistance offered when such a power producing device is used for airplane propulsion is a minimum for the amount of air supplied for engine charging and cooling purposes.

The ignition or combustion of each engine unit is thought to be governed by the amount of fuel admitted relative to the air admitted or the fuel-air mixture; the proportioning of the combustion chamber relative to the tail pipe diameter; the length and positioning of the respective engine nozzles; and the frequency of vibration of (1) the valves and (2) the gas column contained in the exhaust nozzles of the engines which two vibrating components must be matched or synchronized. The frequency of vibration of the above two vibrating components is influenced by the weight, size, shape and spring tension of the valves indicated at 36af and 39.

The frequency of vibrating reciprocation of the gas columns contained in the exhaust nozzles 30n-60n is primarily controlled by the length and diameter of the nozzles 20n-60n and the pressure or vacuum that the gas columns are subjected to at each end of the nozzles.

To start the power producing device, air and fuel in the proper ratio are introduced into the respective engine combustion chambers 20c-60c through the starting lines S as heretofore described. The ignition plugs I are energized simultaneously and the engines fire in unison. Combustion occurs in all combustion chambers 20c-60c of the engines of the power producing device for the starting power impulse. This starts a flow of gas at high velocity through the tail pipe 11. The inertia of the high velocity gas passing through the tail pipe 11 causes a vacuum to occur in all of the respective combustion chambers 20c-60c. Fuel and air are drawn into the combustion chambers through the apertures 36af in the fuel and air induction plate 36 of each engine and past the valves 39.

It would appear that the operation after starting might take place in each engine acting as a separate pulse jet engine. However, due to the intimate relation of the respective exhaust nozzles of each engine with the next adjacent engine's combustion chamber and the fact that observed operation of a plurality of such separate engines arranged thusly together developed a rhythm of operation, it is thought that a simultaneous operation of each engine does not take place.

Possibly there is a predetermined sequence of operation wherein the trailing engine 20 affects the operation of preceding engines, et cetera. The sequence may be such that when engine 20 fires, a partial vacuum is cre-

ated in engines 20 and 30 by the rush of the exhausting gases through exhaust nozzle 20n to tail pipe 11. Air rushes into each engine 20 and 30 through the opened inlet 36af and past valve 39 of each engine along with a fuel charge. A return pressure wave from the tail pipe 11 compresses both combustion mixtures in combustion chambers 20c and 30c, which combustion mixtures then fire, causing another rush of exhaust gases out through the exhaust nozzles 30n and 20n of the respective engines, such exhausting gases thereby creating a partial vacuum in combustion chambers 20c, 30c, and also 40c. Air is drawn in as before into each of the combustion chambers along with fuel and the rearward moving pressure wave compresses each of the charges. Each engine 20, 30, and 40 is fired and the cycle is repeated bringing in each time a next adjacent leading engine to the prior group. However, since the return pressure wave reaches the adjacent engines at an appreciable small difference of time there may not be precisely exact simultaneous firing of engines 20, 30, and 40, for example, at the same instant.

The final result, however, is to have either all five engines operating under a condition possibly approaching simultaneous operation or to have a peculiar sequence of operation due to proportioning of the engine, their valves and combustion columns such that there is an interference of the pressure waves of one engine upon another. Thus, due to such cyclic interference, it may be that the steady state of operation has engine 40 firing, then engines 30 and 50, and followed thereafter by engines 20 and 60 or some other peculiar firing order which is not readily determinable.

The modes of operation above described are believed by applicants in good faith to be the mode or modes of operation of their power producing device. However, they may be wrong as to the exact details of operation, and the mode of operation may be different from those stated.

Having described our invention what we claim is:

1. A power producing device having a leading end and a trailing end and comprising in combination an outer elongated housing, a tail pipe mounted within said housing in spaced relation thereto at the trailing end thereof and a plurality of axially aligned and successively associated similar direct jet engines within said housing; the first engine thereof being at the trailing end of the device and communicating with said tail pipe; said first engine having a combustion chamber at one end thereof which extends toward the leading end of the power producing device, an elongated exhaust nozzle in communication with said combustion chamber and extending toward said trailing end of the device and in communication with said tail pipe, an air chamber surrounding the combustion chamber having an air ingress opening at the leading end thereof and an air nozzle in communication therewith having a discharge opening at the trailing end thereof surrounding the exhaust nozzle and in communication with said tail pipe, fuel and air induction openings at the leading end of the combustion chamber, valve means associated with said induction openings permitting ingress of air and fuel therethrough in one direction into said combustion chamber, an air induction cowlings at the leading end of said engine and in spaced relationship within said housing directing air to the air ingress opening of said air chamber and to said fuel and air induction openings in said combustion chamber, fuel supply means adjacent said fuel and air induction openings at the leading end of the combustion chamber and within said cowlings, and ignition plug means in said combustion chamber; each successive engine being in axial alignment and of decreasing size as respects the engine positioned next adjacent toward the trailing end of the power producing device and having its exhaust nozzle and surrounding air nozzle projecting into the combustion chamber of the next adjacent engine, whereby to start said power producing device the combustion chambers of each engine are charged with air and fuel and same are fired in unison and develop a high velocity flow of gas which passes from the engines and through said tail pipe causing a vacuum to occur in all combustion chambers and induction of air and fuel into all combustion chambers and a return pressure wave having a compression effect instigating a sustained cyclic firing and recharging of the engines.

2. A power producing device having a leading end and a trailing end and comprising in combination an outer

elongated housing, a tail pipe mounted within said housing in spaced relation thereto at the trailing end thereof and a plurality of axially aligned and successively associated similar direct jet engines within said housing, the first engine thereof being at the trailing end and communicating with said tail pipe; said first engine having a combustion chamber at one end thereof which extends toward the leading end of the power producing device, an elongated exhaust nozzle in communication with said combustion chamber and extending toward said trailing end of the device and in communication with said tail pipe, fuel and air induction openings at the leading end of the combustion chamber, valve means associated with said induction openings permitting ingress of air and fuel therethrough in one direction into said combustion chamber, an air induction cowling at the leading end of said engine and in spaced relationship within said housing directing air to the fuel and air induction openings in said combustion chamber, fuel supply means adjacent said fuel and air induction openings at the leading end of the combustion chamber and within said cowling, and ignition plug means in said combustion chamber; each successive engine being in axial alignment and of decreasing size as respects the engine positioned next adjacent toward the trailing end of the power producing device and having its exhaust nozzle projecting into the combustion chamber of the next adjacent engine, whereby to start said power producing device the combustion chambers of each engine are charged with air and fuel and same are fired in unison and develop a high velocity flow of gas which passes from the engines and through said tail pipe causing a vacuum to occur in all combustion chambers and induction of air and fuel into all combustion chambers and a return pressure wave having a compression effect instigating a sustained cyclic firing and recharging of the engines.

3. A power producing device having a leading end and a trailing end and comprising in combination a tail pipe at the trailing end thereof and a plurality of axially aligned and successively associated similar direct jet engines, the first engine thereof being at the trailing end and communicating with said tail pipe; said first engine having a combustion chamber at one end thereof which extends toward the leading end of the power producing device, an elongated exhaust nozzle in communication with said combustion chamber and extending toward said trailing end of the device and in communication with said tail pipe, fuel and air induction openings at the leading end of the combustion chamber, valve means associated with said induction openings permitting ingress of air and fuel therethrough in one direction into said combustion chamber, an air induction cowling at the leading end of said engine directing air to the fuel and air induction openings in said combustion chamber, fuel supply means adjacent said fuel and air induction openings at the leading end of the combustion chamber and within said cowling, and an ignition plug means in said combustion chamber; each successive engine being in axial alignment and of decreasing size as respects the engine positioned next adjacent toward the trailing end of the power producing device and having its exhaust nozzle projecting into the combustion chamber of the next adjacent engine, whereby to start said power producing device the combustion chambers of each engine are charged with air and fuel and same are fired in unison and develop a high velocity flow of gas which passes from the engines and through said tail pipe causing a vacuum to occur in all combustion chambers and induction of air and fuel into all combustion chambers and a return pressure wave having a compression effect instigating a sustained cyclic firing and recharging of the engines.

4. A power producing device of the character described in claim 3 including operating means attached to each engine for varying the amount of projection of the exhaust nozzle extending into the combustion chamber of the adjacent engine.

5. A power producing device of the character described in claim 3 including an elongated tubular housing mounted in spaced relationship about said engines thereby providing an annular air passage surrounding said engines from the leading end to the trailing end of said power producing device.

6. A power producing device of the character described in claim 3 wherein said air induction cowling at the leading end of said engine has air cut off means

associated therewith for interrupting the flow of air therethrough and wherein said fuel supply means has fuel cut off means associated therewith for interrupting the flow of fuel.

7. A power producing device of the character described in claim 3 wherein the combustion chamber of each engine is provided with an air and fuel starting supply conduit.

8. A power producing device of the character described in claim 3 wherein each engine has a wall disposed in spaced relation about the combustion chamber and the exhaust nozzle thereof forming an annular air cooling jacket about said engine, said jacket being in communication at the leading end thereof with said engine air cowling and open at the trailing end thereof to discharge cooling air about the trailing end of the exhaust nozzle of the engine.

9. A power producing device of the character described in claim 8 wherein the air induction cowling of each engine is movably mounted so that the air passage between the cowl and the next successive engine may be varied whereby the amount of air supplied to the combustion chamber of the engine may be varied.

10. A power producing device of the character described in claim 8 including operating means attached to each engine for varying the amount of projection of the exhaust nozzle and air nozzle extending into the combustion chamber of the adjacent engine, thereby controlling the amount of combustion gases from one engine that enters the exhaust nozzle of the next preceding engine so as to vary the degree of compression of the air and fuel charge in the combustion chamber of the preceding engine.

11. A power producing device of the character described in claim 10 wherein the air induction cowling of each engine is movably mounted so that the air passage between the cowling of each engine is movably mounted so that the air passage between the cowl and the next successive engine may be varied whereby the amount of air supplied to the combustion chamber of the engine may be varied.

12. A power producing device having a leading end and a trailing end and comprising in combination a tail pipe at the trailing end thereof and a plurality of axially aligned and successively associated similar direct jet engines within said housing, said tail pipe being of circular cross section and gradually increasing in cross sectional area from leading end to trailing end, the first engine of the successively associated engines being at the trailing end of the power producing device and communicating with said tail pipe; said first engine having a combustion chamber at one end thereof which extends toward the leading end of the power producing device, said combustion chamber being cylindrical in shape at its leading end and terminating in a frustum-conical shaped converging trailing end, an elongated frustum-conical shaped exhaust nozzle having the larger end thereof communicating with said trailing end of the combustion chamber and in communication with said tail pipe at its trailing end, fuel and air induction openings at the leading end of the combustion chamber, valve means associated with said induction openings permitting ingress of air and fuel therethrough in one direction into said combustion chamber, an air induction cowling at the leading end of said engine directing air to the fuel and air induction openings in said combustion chamber, fuel supply means adjacent said fuel and air induction openings at the leading end of the combustion chamber and within said cowling, and a plug ignition means in said combustion chamber; each successive engine being in axial alignment and of decreasing size as respects the engine positioned next adjacent toward the trailing end of the power producing device and having its exhaust nozzle projecting into the combustion chamber of the next adjacent engine, whereby to start said power producing device the combustion chambers of each engine are charged with air and fuel and same are fired in unison and develop a high velocity flow of gas which passes from the engines and through said tail pipe causing a vacuum to occur in all combustion chambers and induction of air and fuel into all combustion chambers and a return pressure wave having a compression effect instigating a sustained cyclic firing and recharging of the engines.

13. A power producing device of the character described in claim 12 including an elongated tubular

housing mounted in spaced relationship about said engines thereby providing an annular air passage surrounding said engines from the leading end to the trailing end of said power producing device and each engine has a wall disposed in spaced relation about the combustion chamber and the exhaust nozzle thereof forming an annular air cooling jacket about said engine, said jacket being in communication at the leading end thereof with said engine air cowling and open at the trailing end thereof to discharge cooling air about the trailing end of the exhaust nozzle of the engine.

14. A power producing device of the character described in claim 13 including operating means attached to each engine for varying the amount of projection of the exhaust nozzle and air nozzle extending into the combustion chamber of the adjacent engine, thereby controlling the amount of combustion gases from one engine that enters the exhaust nozzle of the next preceding engine so as to vary the degree of compression of the air and fuel charge in the combustion chamber of the preceding engine.

15. A power producing device of the character de-

scribed in claim 14 wherein the air induction cowling of each engine is movably mounted so that the air passage between the cowling of each engine is movably mounted so that the air passage between the cowl and the next successive engine may be varied whereby the amount of air supplied to the combustion chamber of the engine may be varied.

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