Feb. 17, 1953 J. Y. DUNBAR 2,628,471

SYNCHRONOUS AUGMENTER FOR RESOJET MOTORS

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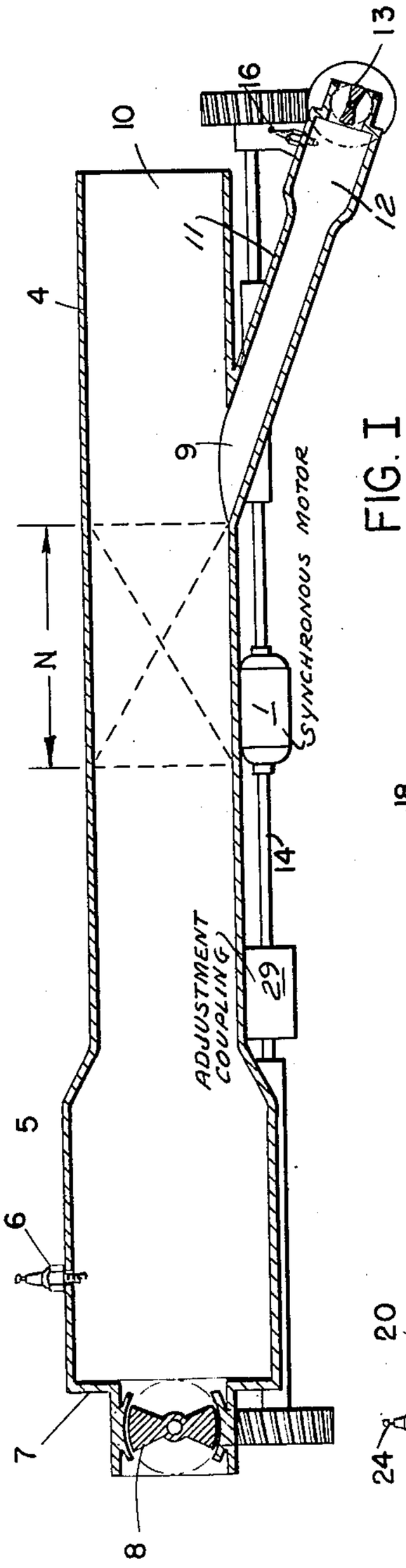

FIG. I

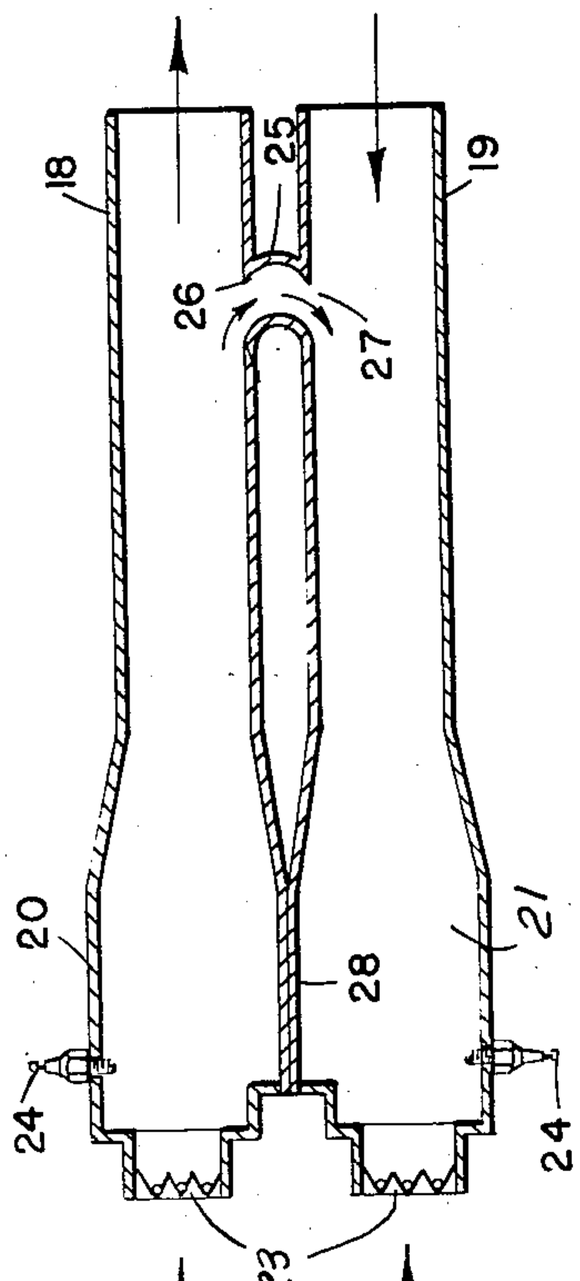

FIG. III

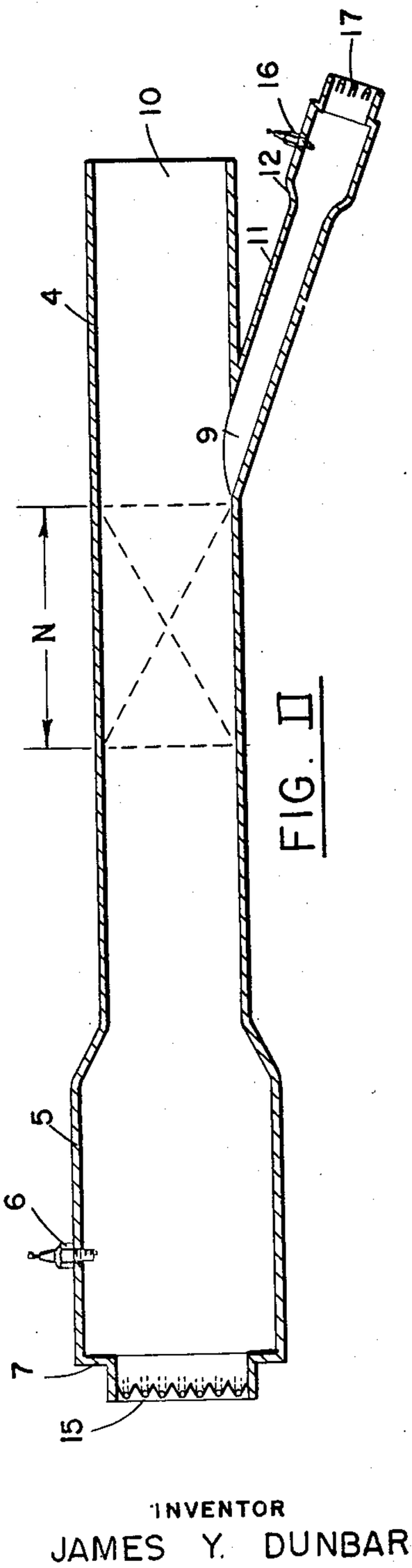

FIG. II

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SYNCHRONOUS AUGMENTER FOR RESOJET MOTORS

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8 Claims. (Cl. 60—35.6)

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This invention relates to an auxiliary synchronous augmenter for jet propulsion devices such as operate cyclically or in resonance.

An object of this invention is to provide an augmenter that increases the compression and consequently the efficiency of jet propulsion devices operating cyclically or in resonance.

A further object of this invention is to provide a device whereby the exhaust of one motor operating cyclically or in resonance augments the compression of another similar operating motor.

Other objects and advantages of this invention will become apparent as the discussion proceeds and is considered in connection with the accompanying claims and drawing wherein like characters of reference designate like parts in the several views and wherein:

Fig. I is a schematic view of a reso-jet motor showing the augmenter embodied in this invention;

Fig. II is a longitudinal section view of a reso-jet motor showing one modification of the augmenter embodied in this invention;

Fig. III is a schematic view of another modification of the augmenter embodied in this invention.

Referring now to the drawing, wherein for the purpose of illustration, are shown preferred embodiments of this invention, the numeral 4 designates the tail pipe or resonant exhaust tube of a conventional reso-jet motor. The numeral 5 designates an explosion chamber communicating with the said tail pipe, having a spark ignition means 6 such as a conventional spark plug. The end of the said explosion chamber 5 is provided with an end plate 7, carrying a rotating valve 8 which meters fuel and air or air only into the said chamber 5. In the modification shown in Fig. I the valve 8 is any conventional type of mechanically operated high speed valve such as a rotating valve driven by a synchronous motor 1. An auxiliary passage opening or hole 9, disposed toward the end of the tail pipe 4, is adapted to receive a tail pipe 11 of a smaller synchronously operated auxiliary reso-jet motor designed for the same operating frequency as the large motor, as shown. The said tail pipe 11 carries a combustion chamber 12 provided with a valve 13 driven also by the synchronous motor. A suitable mechanical linkage 14 connects the synchronous valve 13 to the synchronous valve 8 phased approximately 180 degrees therefrom. The phase angle is susceptible to being varied by relative phase adjustment coupling 29 to provide the optimum efficiency and firing times for the two motors.

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In the modification shown in Fig. II the tail pipe or resonance tube 4, the combustion chamber 5, the electric combustion firing means 6 and end plate 7 are the same as in Fig. I. The valves 15, affixed to the plate 7, are of the vibrating or reed type. A hole 9 disposed near the end 10 of the tail pipe 4, as in Fig. I, has a tail pipe 11, and a much smaller synchronously operated motor affixed thereto, disposed at an angle, substantially as shown. Affixed to the tail pipe 11 is a combustion chamber 12 carrying electric ignition means 16, as shown. Vibrating valves 17 of the reed or resilient type are provided in the end of the combustion chamber 12 to admit air or air and fuel.

In the modification of this invention shown in Fig. III the numerals 18 and 19 designate the tail pipes of two identical reso-jet motors having combustion chambers 20 and 21, respectively, affixed thereto. Air is admitted to the combustion chambers through valves 23, of any conventional design. Conventional spark plugs or other electric firing means 24 are provided in the combustion chambers 20 and 21 to fire the charges. A U tube 25 disposed in the tail pipes 18 and 19, and in open communication therewith, is affixed to the said tail pipe 18 at 26 and to the said tail pipe 19 at 27. It is to be noted that the U is turned towards the combustion chambers 20 and 21. The motors are rigidly affixed together at 28 in any conventional manner, as by welding or the like.

In operation the auxiliary synchronous augmenter as shown in Figs. I and II, consists of a dual resonant jet motor, the larger unit being the propulsion unit and the smaller the compressor unit, each unit augmenting the compression of the other.

If the gas in the motor (due to the explosion in the combustion chamber), is excited into motion, it tends to oscillate at the natural frequency of the unit until brought to rest by damping or friction. If the explosion taking place in the explosion chamber has the same periodicity as the natural frequency of the motor the motion of the gas in the tail pipe will build up to a maximum value limited only by friction or damping or by the constant governing the inertance and compliance of the resonator system. Friction damping may be reduced to a minimum by proper shaping and smoothing the inner surface of the motor parts. But the inertance and compliance of the system, which determines the natural frequency characteristics, are both functions of gas density which varies during the cycle. Should the gas mass in the tail pipe be considered as a

piston N moving outwardly, the maximum restoring force or pressure attainable will be the ambient atmospheric pressure, if a complete vacuum can be created. If the piston moves inwardly, the compression is adiabatic and approaches infinity. Should an explosive charge be introduced into the chamber at the end of the outward stroke, the weak restoring force, drawing the piston (or gas) back into the tail pipe, causes very little pre-compression of the fuel mixture. This results in loss of both power and efficiency. But if an auxiliary compressor be used to provide a high compression of the charge or mixture, the thrust and efficiency is improved.

When this auxiliary compressor is itself a smaller, similar resonating jet motor, its fuel mixture is compressed by the main motor discharge, and the main motor in turn receives its compression from the firing of the auxiliary motor. Thus a concatenation takes place between the two motors to achieve a higher overall efficiency.

These two motors may be kept in proper phase relation to each other by means of mechanically driven valves of any conventional type (specific details of which are not shown here), interconnected to drive at the same frequency, as illustrated in Fig. I, or when using a motor having a vibrating or reed type valve as shown in Fig. II, the two motors are designed so that they have the same natural frequency, using energy from one to complement the operation of the other.

In the modification shown in Fig. III the motors may be arranged to operate in pairs or multiple units (all being prime movers), discharging in the same direction and part of the thrust of each explosion in one motor diverted, through the U tube 25 into the chamber of the other, to charge or compress the other in alternate firing.

It is to be understood that the form of my invention, herewith shown and described, is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, without departing from the spirit of my invention, or the scope of the subjoined claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What I claim is:

1. An augmenter for reso-jet motors comprising a plurality of reso-jet motors each having a combustion chamber with a fluid inlet, an intermittently operable inlet valve upstream of said combustion chamber, a tail pipe having an outlet and in alignment with the combustion chamber, a conduit opening through the wall of the tail pipe of one of said motors downstream of its combustion chamber and having a longitudinal axis disposed at an acute angle and extending rearwardly of the tail pipe, said conduit being connected to the tail pipe of another of said motors, synchronizing means for oppositely phasing said two motors for mutual alternate augmentation of the compression steps in each of said motors by the discharging gases from explosions in the other.

2. A mutual augmentation assembly for reso-jet motors comprising a plurality of reso-jet motors each having an aligned fluid inlet explosion chamber and exhaust tube with an outlet, auxiliary passage means in the wall of at least

one exhaust tube through which exhaust gas from the explosion chambers of at least two reso-jet motors is directed into the exhaust tube and toward the explosion chamber of the other, the exhaust tube of at least one of said reso-jet motors being open at one end for escape of exhaust propulsion gas, and synchronizing means for firing the said two reso-jet motors alternately.

3. The combination set forth in claim 2 further defined in that the auxiliary passage means is shaped to reverse the direction of movement of exhaust gas passing through it.

4. An augmenter for a main reso-jet motor having a combustion chamber, a resonant exhaust tube and a mechanically driven valve communicating with said chamber, comprising a smaller auxiliary reso-jet motor having a combustion chamber and a mechanically driven valve communicating with said chamber, a driving linkage synchronously connecting the first mentioned valve to the said mechanically driven valve, and a resonant exhaust tube affixed to the exhaust tube of the said main motor and in communication therewith.

5. An augmenter for a main reso-jet motor having a combustion chamber, a resonant exhaust tube and a mechanically driven valve communicating with said chamber, comprising a smaller auxiliary reso-jet motor having a combustion chamber and a mechanically driven valve communicating with said chamber, a driving linkage synchronously connecting the first mentioned valve to the said mechanically driven valve, and a resonant exhaust tube affixed to the exhaust tube of the said main motor, said smaller auxiliary motor being timed to fire out of phase with the main motor.

6. In combination, a plurality of reso-jet motors each having a combustion chamber with a fluid inlet upstream thereof, an igniter and an intermittently operable inlet valve for said combustion chamber, and a tail pipe connected to the combustion chamber, the tail pipe of one of said reso-jet motors being open at one end and having an opening along its length downstream of said combustion chamber, said opening forming the entrance of an auxiliary passage to the tail pipe of a second reso-jet motor, and means for firing the two named motors sequentially so that part of the exhaust gas from the explosion in the combustion chamber of the first named motor will move into the tail pipe of the second named motor.

7. In combination, a plurality of reso-jet motors each having a fluid inlet, a combustion chamber, an intermittently operable inlet valve for said combustion chamber, and a tail pipe aligned with the combustion chamber, the tail pipe of one of said reso-jet motors having an open end for the exhaust of propulsion gases and an opening along its length, an auxiliary passage leading from the said opening along the length of the said tail pipe to the tail pipe of a second reso-jet motor, means for synchronizing the inlet valves of both named motors to operate in sequence so that part of the exhaust gas from the explosions in the combustion chamber of the said motor having the open tail pipe will move into the tail pipe of the second motor, and means for firing the second motor after exhaust gas has moved into its tail pipe.

8. In a jet engine, a first reso-jet motor having a combustion chamber, an air inlet opening upstream of said chamber, a tail pipe in alignment

with said combustion chamber to receive and convey products of combustion from said chamber to the atmosphere, and means operatively connected with said chamber for igniting fuel in said chamber, a second reso-jet motor companion to said first reso-jet motor, said second motor including a combustion chamber with a tail pipe connected therewith and a fluid inlet opening upstream of the last-mentioned chamber, said first-mentioned tail pipe having a lateral opening therein downstream of said first-mentioned combustion chamber, and said second motor tail pipe being communicated with said lateral opening, said second motor combustion chamber having ignition means for said second motor timed to operate during the compression stage of actuation of said first reso-jet motor so that exhaust gas from said second motor passes through said lateral opening and into the first motor tail pipe to augment the compression in said first motor.

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