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VARIABLE AREA NOZZLES FOR JET PROPULSION SYSTEMS

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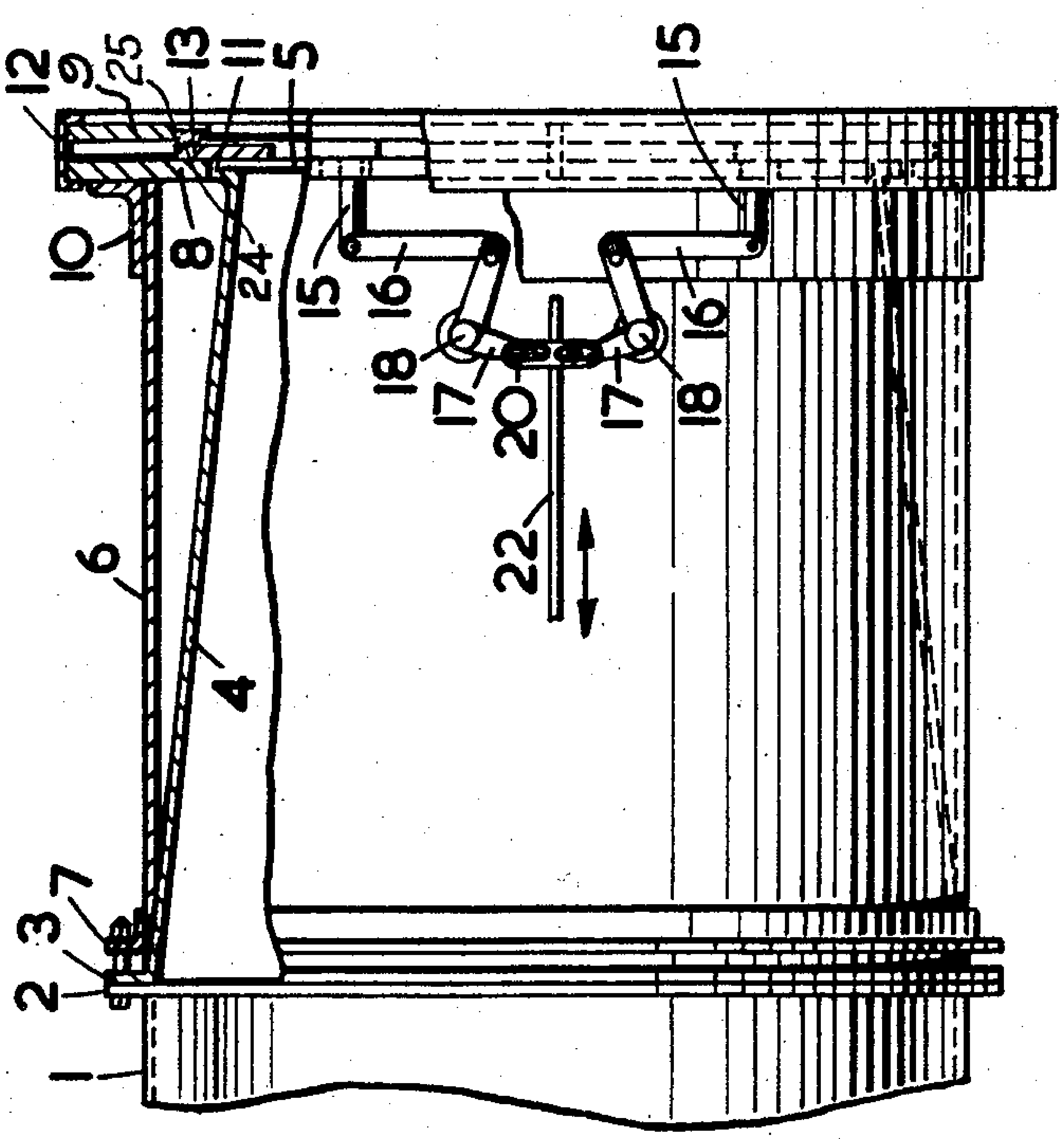

FIG. 1

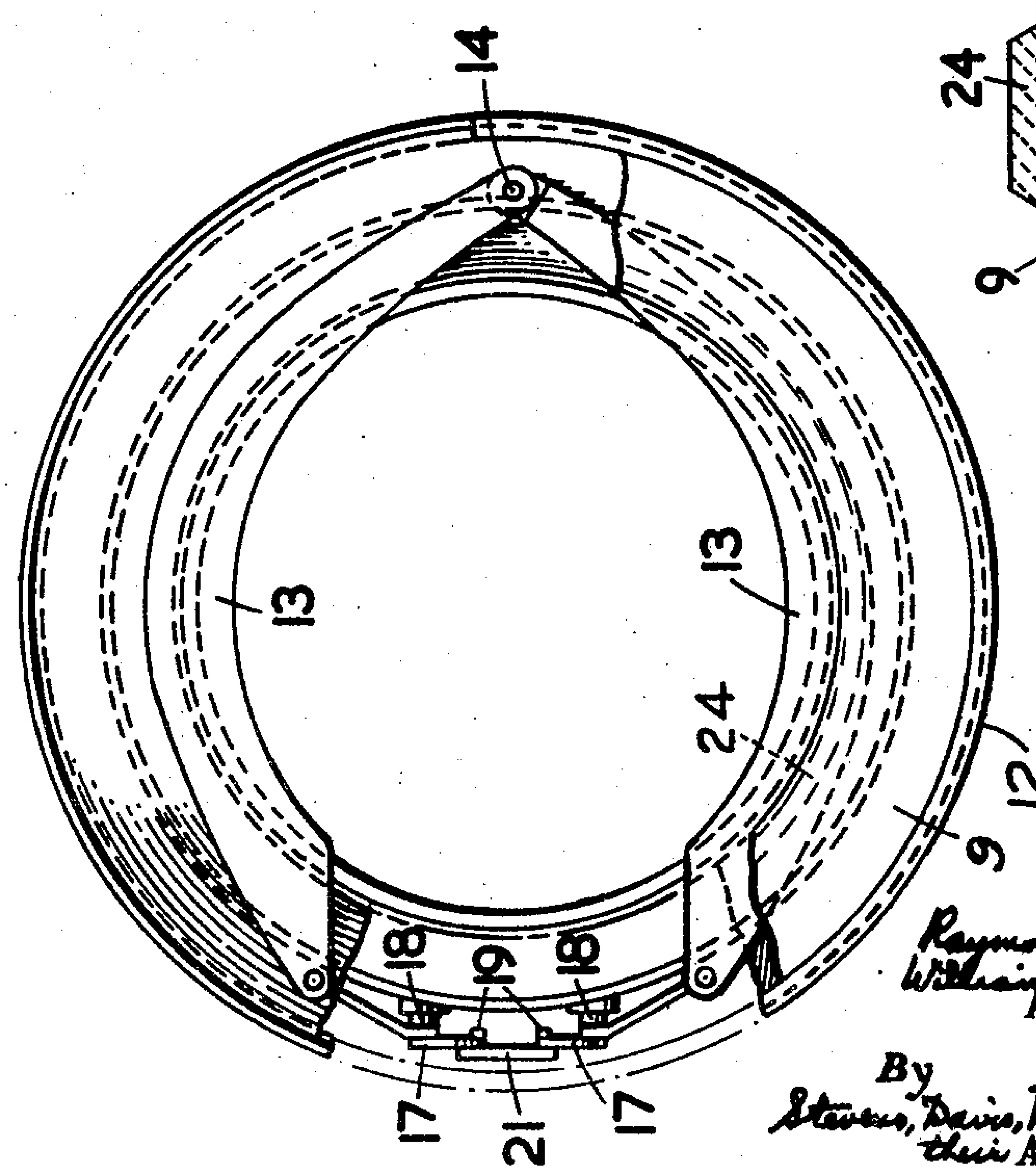

FIG. 2

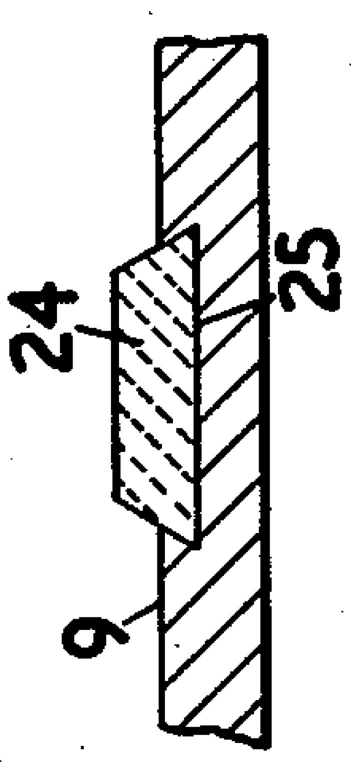

FIG. 3

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VARIABLE AREA NOZZLES FOR JET PROPULSION SYSTEMS

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8 Claims. (Cl. 60—35.6)

This invention is for improvements in or relating to variable area nozzles for a jet propulsion system in which the jet is a stream of hot gaseous fluid.

The invention is concerned with a type of variable area nozzle for jet propulsion in which variation is obtained by the use of obturating means arranged at the boundary of the nozzle at the end of the jet pipe and constructed for movement transversely of the jet stream to constrict it. This type of variable area nozzle has been found to be very effective but difficulty has been experienced in achieving an acceptable degree of operational reliability due to thermal distortion of the parts and to undue leakage losses past the obturating means.

According to the present invention, in a variable area nozzle of the type referred to, the obturator is supported, independently of the outlet end of the nozzle by a supporting structure which leaves the nozzle portion free for thermal expansion and contraction independently of the obturator and its supporting structure. The supporting structure for the obturating means may be a shroud pipe arranged around the nozzle portion of the jet pipe and lying substantially co-extensive therewith, the two forming together a double skin construction in which the outer and cooler shroud pipe carries the obturating means and actuating mechanism whilst the inner and hot nozzle portion is free to expand and contract independently of the outer shroud pipe. The outer shroud pipe may be constructed as a separable unit secured to the jet pipe and the nozzle portion may also be constructed as a separable unit, the two being substantially the same length and joined together to the jet pipe at a common junction point.

A form of the invention will now be described with reference to the accompanying drawing in which:

Figure 1 is a side view of a variable area jet nozzle or orifice partly in section showing the double skin construction of the jet pipe.

Figure 2 is an end view of Figure 1.

Figure 3 is a fragmentary view showing a carbon insert.

A jet pipe 1 is provided with a flange 2 to which is secured a flange 3 of a short separable pipe unit 4 forming a convergent nozzle portion 5 extending axially therefrom.

An outer shroud pipe unit 6 which surrounds the short separable pipe unit 4 is secured by its flange 7 to the flanges 2 and 3. The shroud pipe unit 6 is shown as a continuation of the jet pipe 1 and has substantially the same cross-sectional area. The two pipe units 4 and 6 together form a double skin construction.

A pair of shroud rings 8 and 9 are secured to a flange 10 at the free and unsupported outlet end of the shroud pipe unit 6 to position them with the inner edge of the inner ring 8 adjacent to the free and unsupported end of the nozzle portion 5 leaving an annular gap 11 narrow enough to prevent leakage of jet fluid between the two pipe units 4 and 6 but allowing free expansion and contraction of the pipe unit 4 and the nozzle portion 5.

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At least one pair of constrictor elements 13 of flat plate, shaped like a pair of outside calipers are arranged for movement between the shroud rings 8 and 9 about a pivot 14 so that their inner edges can move into and out of the jet stream issuing from the nozzle 5. The free ends of the constrictor elements 13 are each provided with fixed bosses 15 to each of which is pivotally secured a link 16. A pair of bell crank levers 17 pivoting at 18 are each pivotally connected by one of their lever ends to the link 16 whilst their other lever ends carry pivot bosses 19 engaging slots 20 in a member 21 carried by an actuating rod 22. The actuating mechanism of the constrictor elements 13 is carried on the outer shroud pipe 6 together with the shroud rings 8 and 9. The actuating mechanism is thus carried on a comparatively cool structure whilst the nozzle portion 5, which is subjected to the hot jet fluid, can expand and contract freely and independently of the outer shroud pipe 6.

A sealing ring 12 is arranged around the outer rims of the rings 8 and 9 to seal the gap between them to prevent leakage of the jet fluid passing between them and the elements 13 when the elements 13 are projecting into the stream.

In Figures 1 and 2 the elements 13 are shown in the constricting position. To move them to the open position the rod 22 is pushed to the right as viewed in Figure 1 which moves the member 21 engaging the bosses 19 causing the bell crank levers 17 to pivot on their pivots 18 and push the two links 16 apart and causing the elements 13 to pivot about their pivots 14 and recede between the rings 8 and 9. In an aircraft jet propulsion system the actuating rod 22 may be operated by hand or its operation may be by servo mechanism actuated by movement of the power control lever of the power plant of the system and by movement of the re-heat control of the system if re-heat is used.

To afford satisfactory operation at the high temperatures associated with high thrust when re-heat is used, carbon inserts 24 are inserted in slots 25 formed in the outer ring 9 (see Figure 3) to reduce friction and prevent picking-up between the ring 9 and the caliper elements 13.

When more than one pair of flat plate constrictor elements 13 are used to control the area of the nozzle 5, the other pairs are being spaced appropriately to give a symmetrical jet stream.

What we claim is:

1. A variable outlet jet pipe unit for jet propulsion plant including in combination a nozzle, an obturator comprising a pair of elements wide in one dimension mounted at the outlet end of the nozzle for movement in a plane parallel to said one dimension and across the long axis of the nozzle partially to obstruct said nozzle, and substantially reduce the effective cross-sectional area thereof, and a supporting structure outside the nozzle attached to the unit remotely from the outlet end of the nozzle and supporting said obturator independently of said outlet end, the nozzle being accordingly free for thermal expansion and contraction independently of the said obturator and its supporting structure.

2. A jet pipe according to claim 1 wherein the said supporting structure is a tubular shroud around the nozzle but independent thereof.

3. A variable outlet jet pipe unit for jet propulsion plant including in combination a nozzle, a calliper-type obturator mounted at the outlet end of the nozzle, consisting of a pair of calliper arms movable towards each other across the path of the jet stream in a plane substantially perpendicular to the axial centerline of the nozzle to obstruct said nozzle, and decrease the effective cross-sectional area thereof to constrict the jet, a pair of plates on opposite sides of said obturator located

outside of and free of the nozzle, said plates defining between them a channel in which the calliper arms slide, and a support attached to said plates and attached to the unit remotely from the outlet end of the said nozzle, the nozzle being accordingly free for thermal expansion and contraction independently of the said obturator and its supporting structure.

4. A jet pipe unit according to claim 3 including a sealing ring in the form of a rim around the said plates, making up with these plates an annular channel enclosing the calliper arms.

5. A variable outlet jet pipe unit for jet propulsion plant including in combination a nozzle, a tubular shroud around the nozzle fixed at one end to the unit remotely from the outlet end of the nozzle, an annular channel, radially inwardly directed, mounted on the other end of said tubular shroud at the nozzle outlet, and an obturator for the nozzle outlet in the form of a pair of calliper arms slidably mounted in said channel movable towards each other transversely across said nozzle outlet to partially overlap the inner periphery and effectively restrict the cross-sectional area thereof, in order to constrict the jet, whereby the said tubular shroud, annular, channel, and obturator accordingly leave the nozzle free for thermal expansion and contraction independently of the said obturator with its said associated parts.

6. A jet pipe unit according to claim 5, means wherein the said tubular shroud has its end remote from the outlet end of the nozzle substantially coincident with the other end of the nozzle and including means for adjustably securing those said ends of nozzle and shroud to the rest of the jet pipe.

7. A jet pipe unit according to claim 5 including a flange on the end of the nozzle remote from its outlet, a flange on the same end of the tubular shroud and means for bolting these flanges together to the rest of the jet pipe.

8. A jet pipe unit according to claim 5, including within said annular channel, carbon inserts against which bears the adjacent relatively slidable face of each of the said calliper arms.

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