Jan. 20, 1953 D. McCARTHY ET AL 2,625,792

FLAME TUBE HAVING TELESCOPING WALLS
WITH FLUTED ENDS TO ADMIT AIR

Filed Sept. 2, 1948 4 Sheets-Sheet 1

Fig. 1.

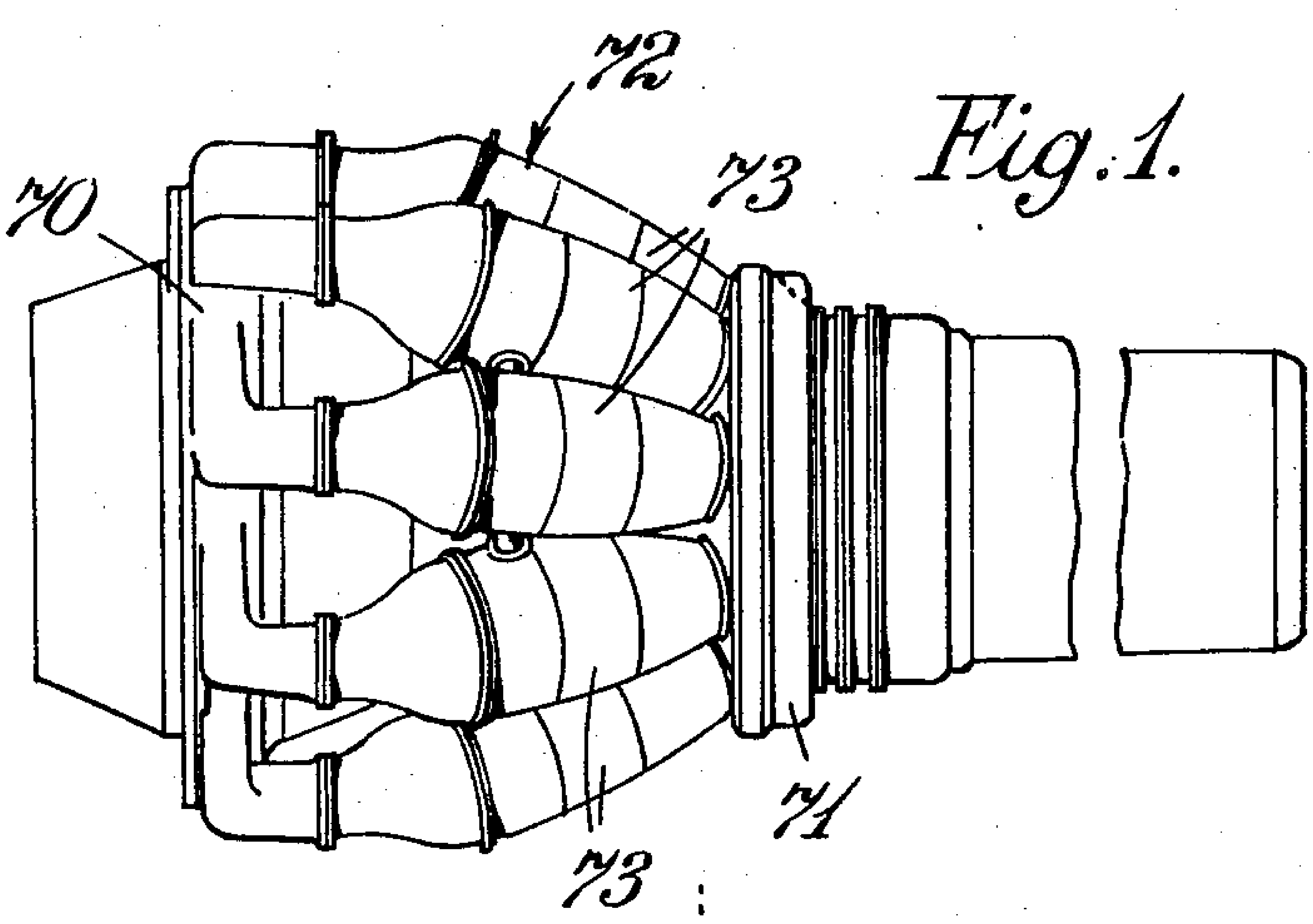
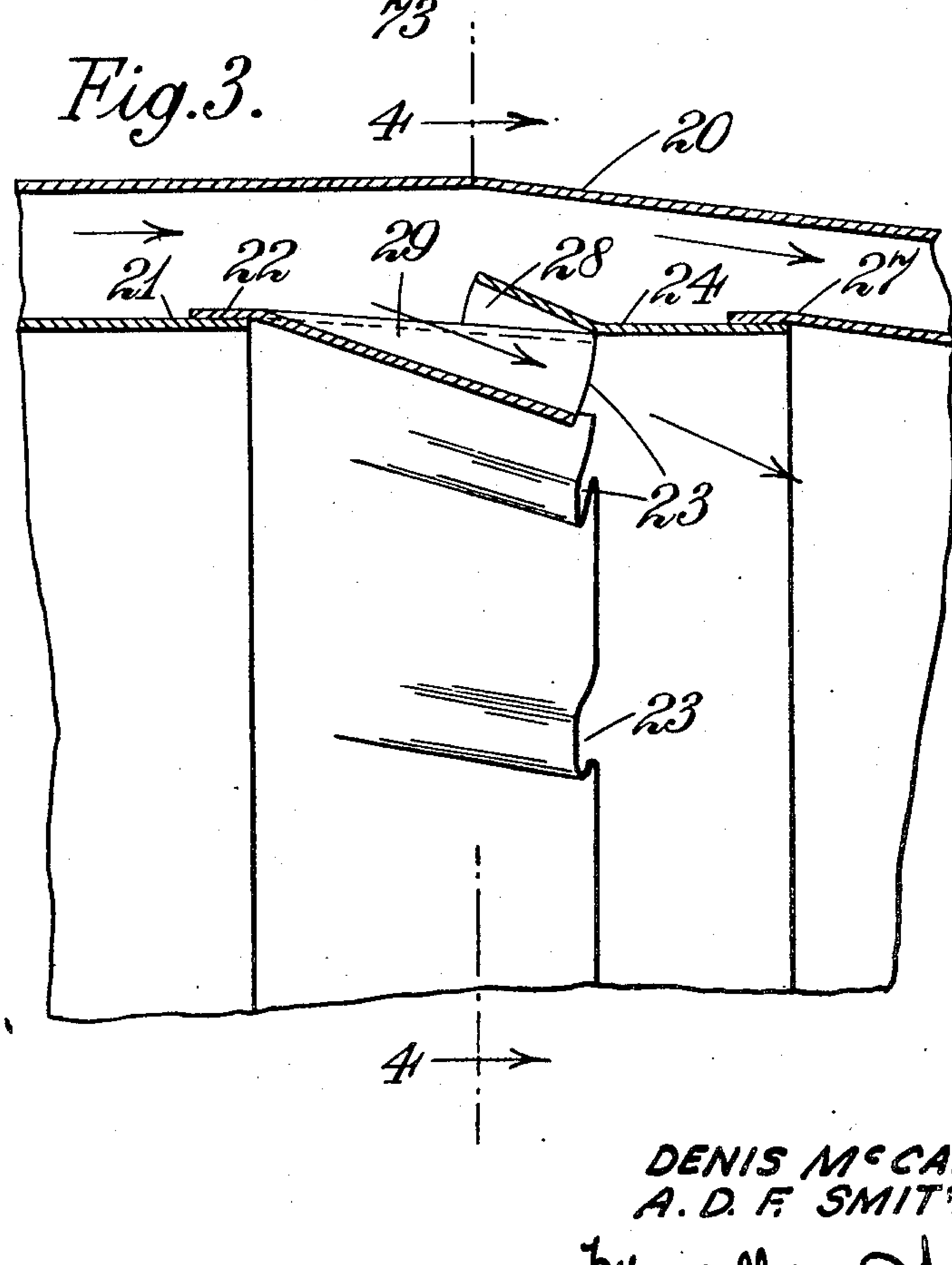


Fig. 3.



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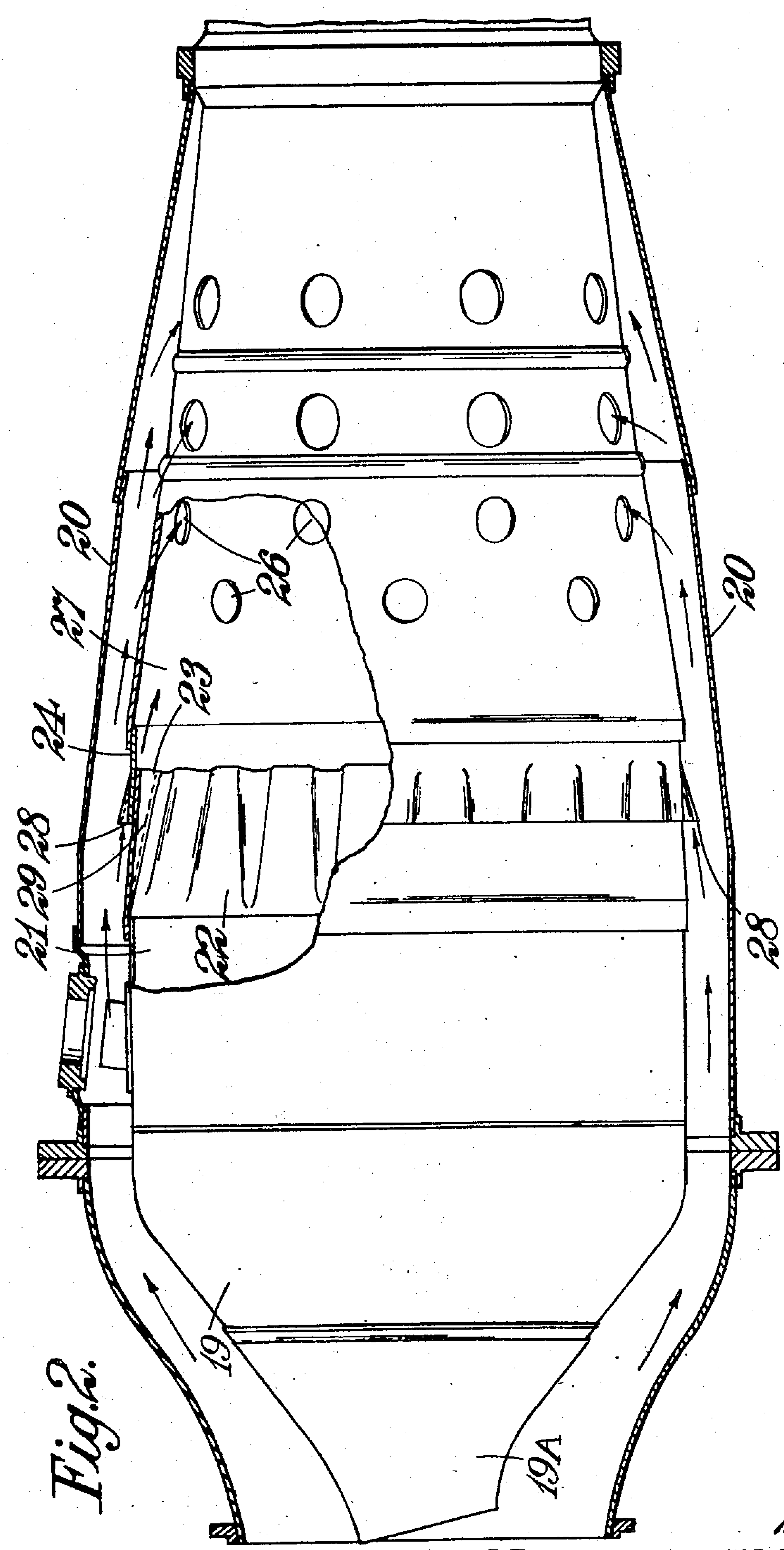

Fig.2.

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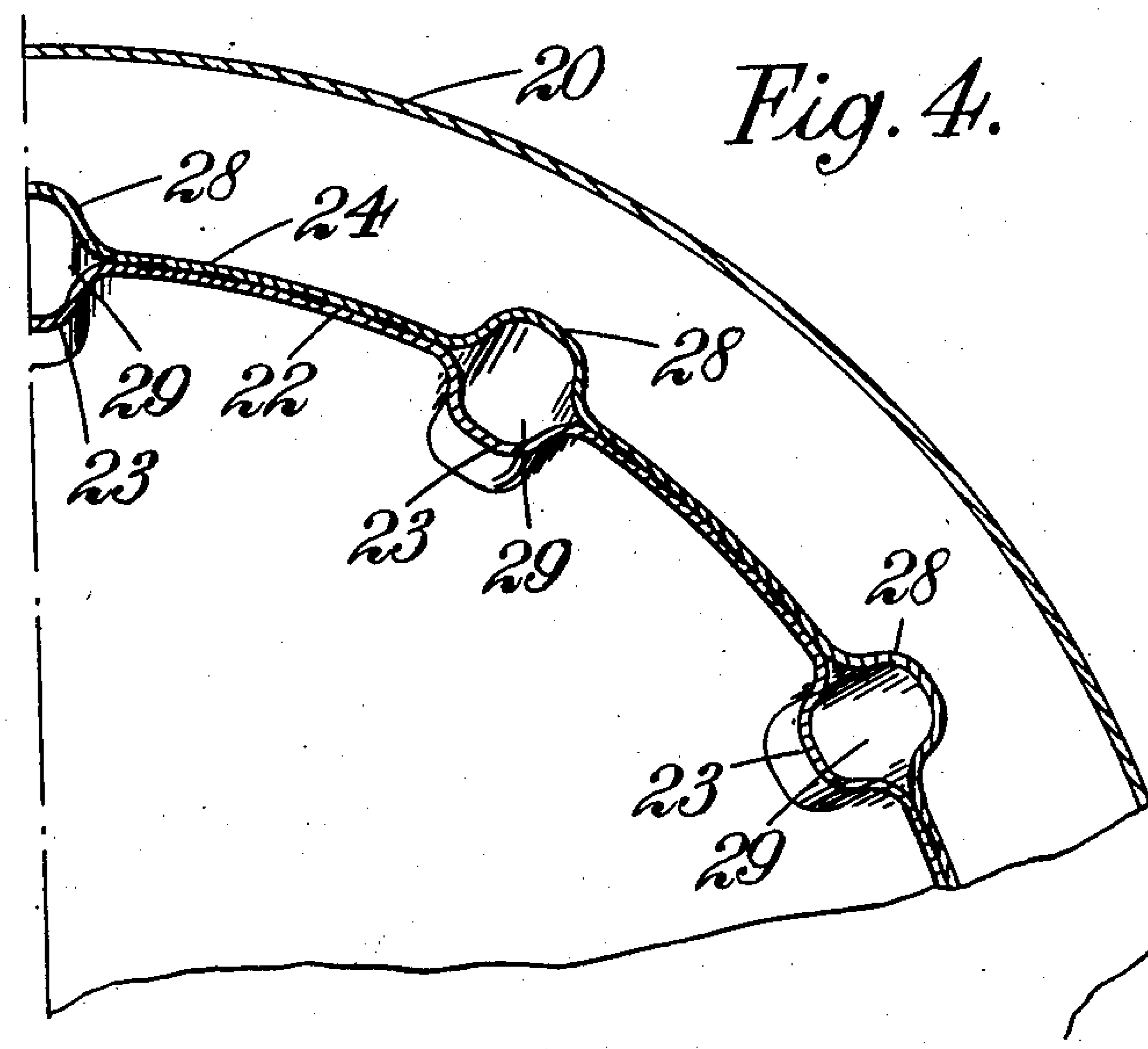
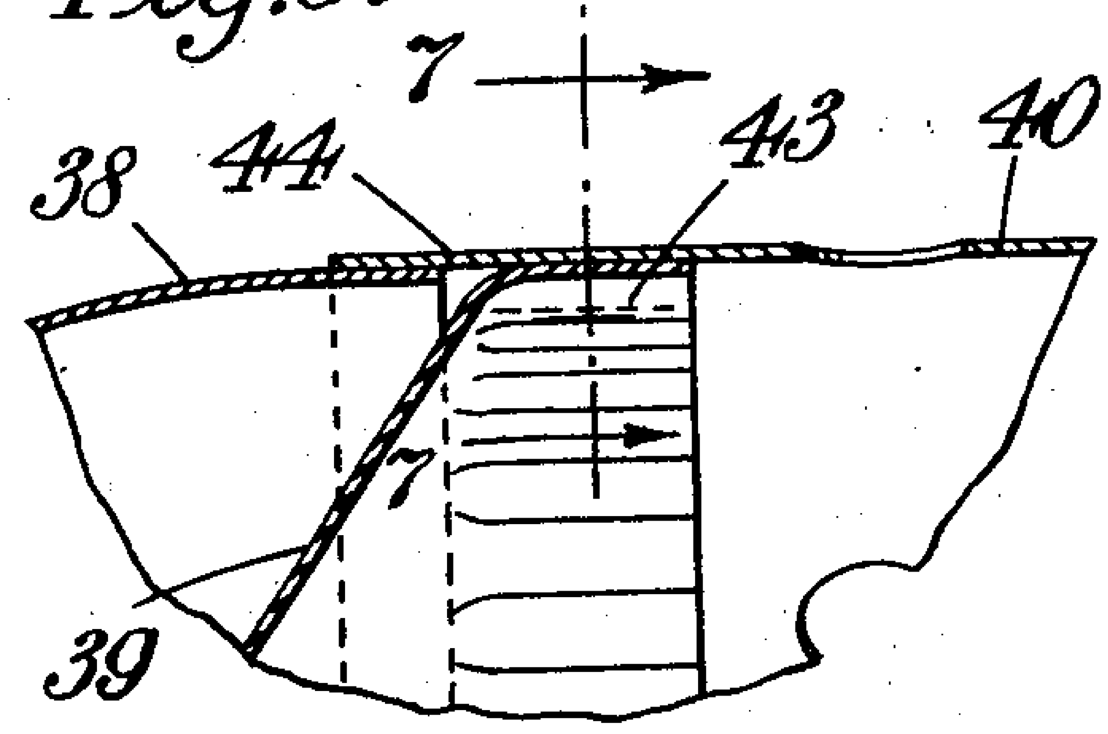


Fig. 4.

Fig. 6.



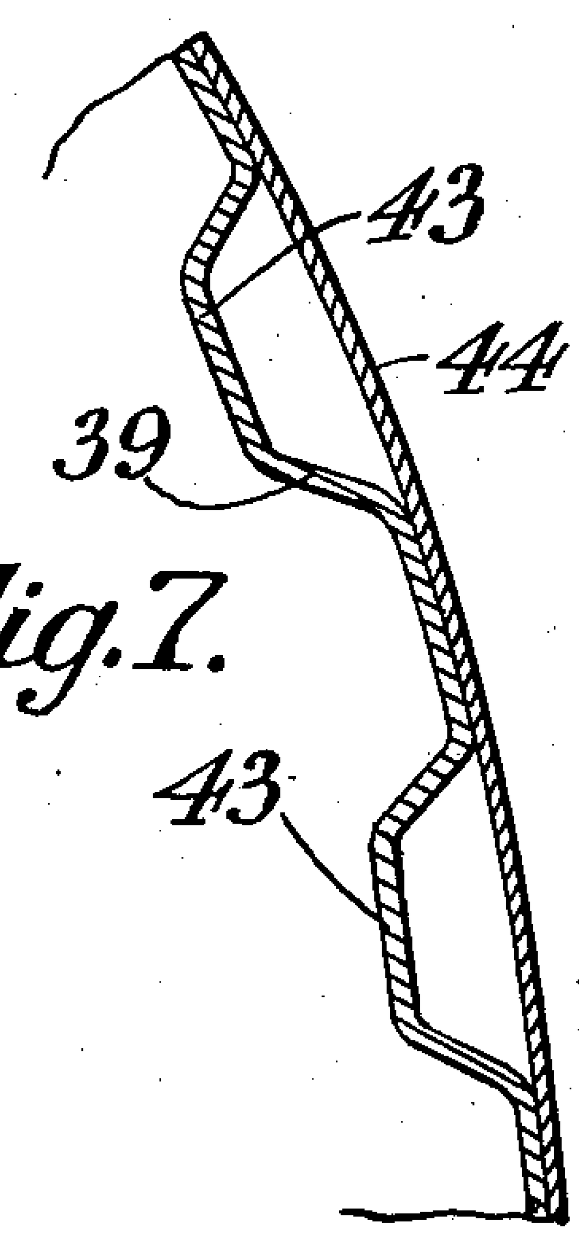


Fig. 7.

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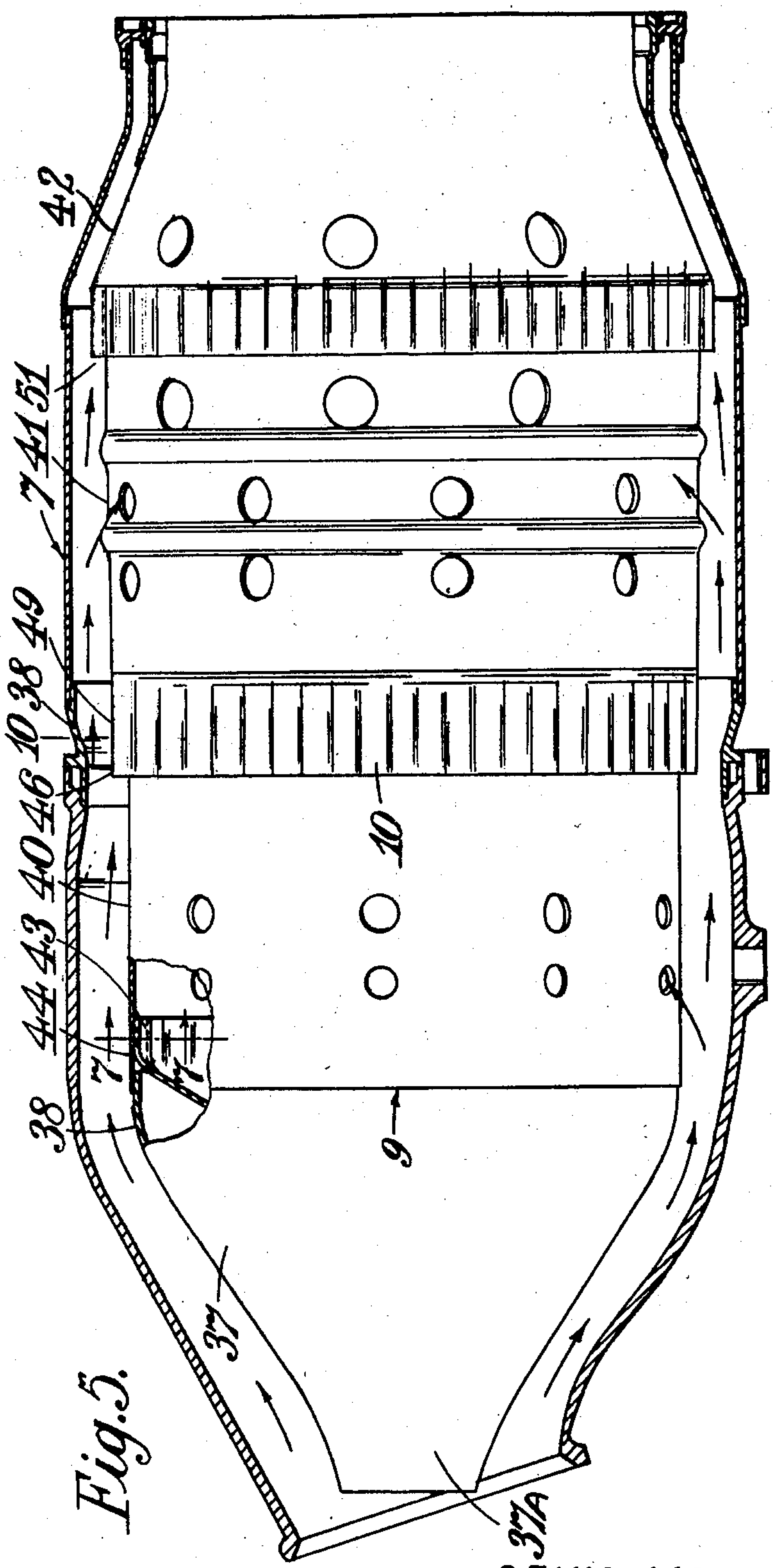

Fig.5.

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Patented Jan. 20, 1953 2,625,792

UNITED STATES PATENT OFFICE

2,625,792

FLAME TUBE HAVING TELESCOPING WALLS WITH FLUTED ENDS TO ADMIT AIR

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Application September 2, 1948, Serial No. 47,398
In Great Britain September 10, 1947

5 Claims. (Cl. 60—39.65)

1

This invention relates to gas-turbine engines and more particularly concerns combustion equipment for said engines.

A typical gas-turbine engine, as illustrated in Figure 1, comprises a compressor 70 driven by a turbine 71 through a shaft connecting them and delivering air to combustion equipment 72 in which fuel is burnt in the air and from which the combustion products pass to the turbine to drive it.

In the embodiment illustrated the combustion equipment comprises a series of combustion chambers 73 disposed in a ring around the shaft connecting the turbine with the compressor and each combustion chamber comprises an outer casing or air casing within which a flame tube of cylindrical or part conical form is positioned so as to be spaced from the air casing. In alternative arrangements of combustion equipment the series of outer casings are replaced by an annular air casing formed by inner and outer substantially cylindrical walls surrounding the shaft interconnecting the turbine and compressor; in such an arrangement a series of flame tubes of cylindrical or part conical form may be accommodated within the annular air casing, or alternatively the flame tube itself may be of annular form being constituted by inner and outer flame tube walls spaced respectively from the inner and outer air casing walls. The present invention is generally applicable to flame tube arrangements, such as those of substantially cylindrical or part conical form or those providing an annular flame tube space.

In combustion equipment comprising an air casing and flame tube arrangement such as outlined, fuel is delivered into the flame tube and the air entering the combustion equipment flow partly as "primary" air directly into the flame tube and partially around it; in addition apertures are usually provided in the wall or walls in the flame tube to allow the air flowing around the flame tubes to pass into them to provide "secondary" or "tertiary" and possibly additional "primary" air supplies thereto.

One known construction of flame-tube comprises two or more substantially frusto-conical elements disposed end to end and connected together by flanges on them so that the flame-tube had a stepped formation. Air inlet apertures are formed in the walls of the frusto-conical sections and in the flanges which extend transversely of the air stream around the flame-tube.

One object of this invention is to provide a flame-tube having rigidity of structure and also

2

giving rise to improved combustion. Another object of the invention is to reduce the pressure loss attributable to the passage of air into the interior of the tube.

Another object of the invention is to provide a flame tube having degree of flexibility, accommodating expansion differences arising from local temperature variations, and thereby reduce the tendency of the flame-tube to buckle.

Another object of the invention is to provide a construction of flame tube which permits flow of the primary and/or secondary and/or tertiary air to enter the interior of the flame tube without undue turbulence.

Constructions of flame-tube embodying the invention will now be described by way of example with reference to Figures 2–7 of the accompanying drawings, of which:

Figure 1 is a side elevational view of a gas-turbine engine constructed in accordance with the present invention.

Figure 2 illustrates one construction of combustion equipment with parts broken away.

Figure 3 is a fragmentary view of part of Fig. 2 to a larger scale.

Figure 4 is a section taken on the line 4—4 in Figure 3.

Figure 5 illustrates another construction of combustion equipment with a part broken away.

Figure 6 is a fragmentary view of part of Figure 5 to a larger scale.

Figure 7 is a section on the line 7—7 in Figures 5 and 6.

The embodiment of the invention illustrated in Figures 2, 3 and 4 of the accompanying drawings comprises a domed end-member 19 of known construction with a snout portion 19A through which primary air enters the flame-tube, and through which a fuel nozzle (not shown) extends to inject fuel into the interior of the flame tube. The flame tube additionally comprises an intermediate tubular member 21 with aperatures for receiving interconnector tubes and a substantially frusto-conical tubular discharge member 27 with apertures 26 for the introduction of tertiary air, these members being secured together in line.

The junction between the intermediate member 21 and the frusto-conical member 27 (Figure 3 and 4) is arranged to be at the desired point for the introduction of secondary air into the flame-tube and they are secured together by tubular, slightly-tapering extensions 22, 24 thereon of a heat-resistant metal, the extension 22 on the intermediate member 21 engaging by its end within the extension 24 on the frusto-conical member 27.

The extension 22 of the intermediate member 21 is formed with a number of circumferentially-spaced longitudinal inwardly-indented flutes or corrugations 23, so that the extension 22 is grooved on its outer surface and ridged on its inner surface. The flutes or corrugations 23 decrease in depth from the end by which it is engaged in the extension 24 of the frusto-conical member 27 to that by which it is secured to the intermediate member 21.

The extension 24 of the frusto-conical member 27 is formed with oppositely-directed flutes or corrugations 28, so that the outer surface thereof is ridged and the inner surface grooved, these flutes or corrugations 28 being likewise circumferentially-spaced and tapered so that when the extensions 22, 24 are interengaged the flutes or corrugations 23, 28 thereon register with one another and form ducts 29 of a cross-section tapering slightly from their inlet ends to their outlet ends. The portions of the extensions 22, 24 between the flutes or corrugations are in contact and are conveniently secured together by welding.

It will be clear that by reason of the flutes or corrugations tapering in depth the ducts 29 will be directed inwardly at an angle to the wall of the flame tube and towards the axis thereof in the direction of flow of gases through the flame-tube. Secondary diluting air passing through these ducts is thus introduced into the interior of the flame-tube in the form of jets which can penetrate the stream of gas flowing through the flame-tube, thus ensuring a more thorough mixing than has been secured hitherto and therefore a more uniform temperature distribution at the flame-tube outlet. Further, on the exterior of the flame tube the ducts present inlet areas facing the flow of air in the passage between the air casing and flame tube walls. This flow of air is shown generally by the arrows of Figs. 2 and 3.

The angle, spacing, length, position and cross-sectional area of the duct-like air-inlets will be selected to give the greatest efficiency of mixing of the air and gases.

The embodiment of the invention shown in Figures 5–7 of the accompanying drawings is illustrative of a number of ways in which the invention can be applied. As shown the flame tube comprises a domed tubular end member 37 of known construction with a snout portion 37A through which primary air enters the flame-tube and through which a fuel nozzle (not shown) extends to spray fuel into the interior of the flame tube. The flame tube additionally comprises two intermediate tubular members 40, 41 and a frusto-conical tubular discharge member 42, these members being secured together in line.

As shown in greater detail in Figs. 6 and 7 the domed end-member 37 comprises two tubular members 38, 39 and compressed air from the compressor of the engine has access between these two members through snout portion 37A.

At the junction of the member 39 and upstream intermediate member 40 (Figures 6 and 7), the end-portion of the member 39, which is received within the end-portion 44 of the upstream intermediate member, is formed with inwardly indented flutes or longitudinal corrugations 43 and the adjacent end-portion 44 of the upstream intermediate member is a cylinder. There are thus provided between the flutes 43 and the cylindrical end-portion 44 duct-like air-passages to introduce cooling air.

The invention is not limited to the details of construction described above and a number of modifications will be apparent to those well skilled in the art, which may be employed without departing from the scope of the invention.

The flutes or corrugations in accordance with the invention may have any suitable cross-section, for example they may be substantially semi-circular to form substantially semi-circular-sectioned, or, when registering with similar flutes on another part, substantially circular-sectioned ducts, or they may be such as to form substantially square or rectangular ducts.

It will be clear moreover, that the fluted or corrugated formation gives mechanical strength to the flame-tube which is relatively simple to manufacture.

Moreover, constructions of flame tube in accordance with the invention can be of the type providing an annular combustion space within an annular air casing structure. Such a flame tube may be constituted by substantially cylindrical or frusto-conical walls respectively of greater and less mean diameter, and one or both of the walls may comprise tubular flame tube wall members secured together in line, with the end portion or one member engaged within the end portion of the other member, either or both of the tubular members being corrugated or fluted in a manner such as described in relation to the substantially cylindrical and part-conical flame tubes described above. In such annular flame tube constructions the duct-like passages associated with the outer flame tube wall may be inclined in the direction of flow towards the axis of the tubular member, whilst the passages associated with the inner flame tube wall may be inclined in the direction of flow away from the axis of the tubular members. In this manner air introduced by the duct passages into the interior of the flame tube space will penetrate towards the mean radius of the annulus of flame tube. Alternatively, the construction may provide air passages substantially parallel to the wall of the flame tube as in the case of the construction illustrated in Fig. 5.

We claim:

1. In a flame tube for use with the combustion equipment of a gas-turbine engine, a first flame tube-wall-member having an integral end portion formed with outwardly indented flutes or longitudinal corrugations, a second flame tube-wall-member arranged in line with said first flame tube-wall-member and having an integral end portion engaged within and secured to said integral end portion of said first wall member, inwardly indented flutes or longitudinal corrugations formed in said integral end portion of said second wall member and registering with said outwardly indented flutes or longitudinal corrugations to provide between them duct-like air-passages to the interior of the flame-tube, which air passages have their inlet ends facing upstream to the air flow exterior to the flame-tube wall.

2. A flame-tube as claimed in claim 1 in which the inner end-portion has inwardly indented flutes or corrugations and the outer end portion has outwardly indented flutes or corrugations.

3. In a flame tube for use with the combustion equipment of a gas turbine engine, a pair of tubular flame tube wall members arranged in

line with the integral end portion of one member engaged within, and secured to, the adjacent integral end portion of the other member, each of which members has its engaging end portion formed with flutes or longitudinal corrugations to co-operate with the end portion of the other tubular member to provide between them duct-like air passages to the interior of the flame tube, which air passages have their inlet ends facing upstream to the air flow exterior to the flame tube wall and have a slightly convergent cross-section throughout their length in the direction of air flow through them.

4. In a flame tube for use with the combustion equipment of a gas-turbine engine, a first tubular flame-tube wall member having an integral end-portion, a second tubular flame-tube wall member arranged in line with said first wall member and having an integral end portion formed with inwardly indented flutes or longitudinal corrugations, which end portion is received within said first mentioned integral end portion, engages therewith and is secured thereto, said flutes or longitudinal corrugations co-operating with said

first mentioned integral end portions to provide between them duct-like air passages to the interior of the flame-tube, which air passages have their inlet ends facing upstream to the air flow externally of the flame-tube-wall.

5. A flame-tube as claimed in claim 4 in which the flutes or longitudinal corrugations are formed so that the duct-like air-passages have a slightly convergent cross-section throughout their length in the direction of air flow therethrough.

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