

Oct. 29, 1968

W. E. WOOLLENWEBER, JR

3,408,046

TURBINE HOUSING FOR TURBOCHARGERS

Filed April 8, 1966

4 Sheets-Sheet 1

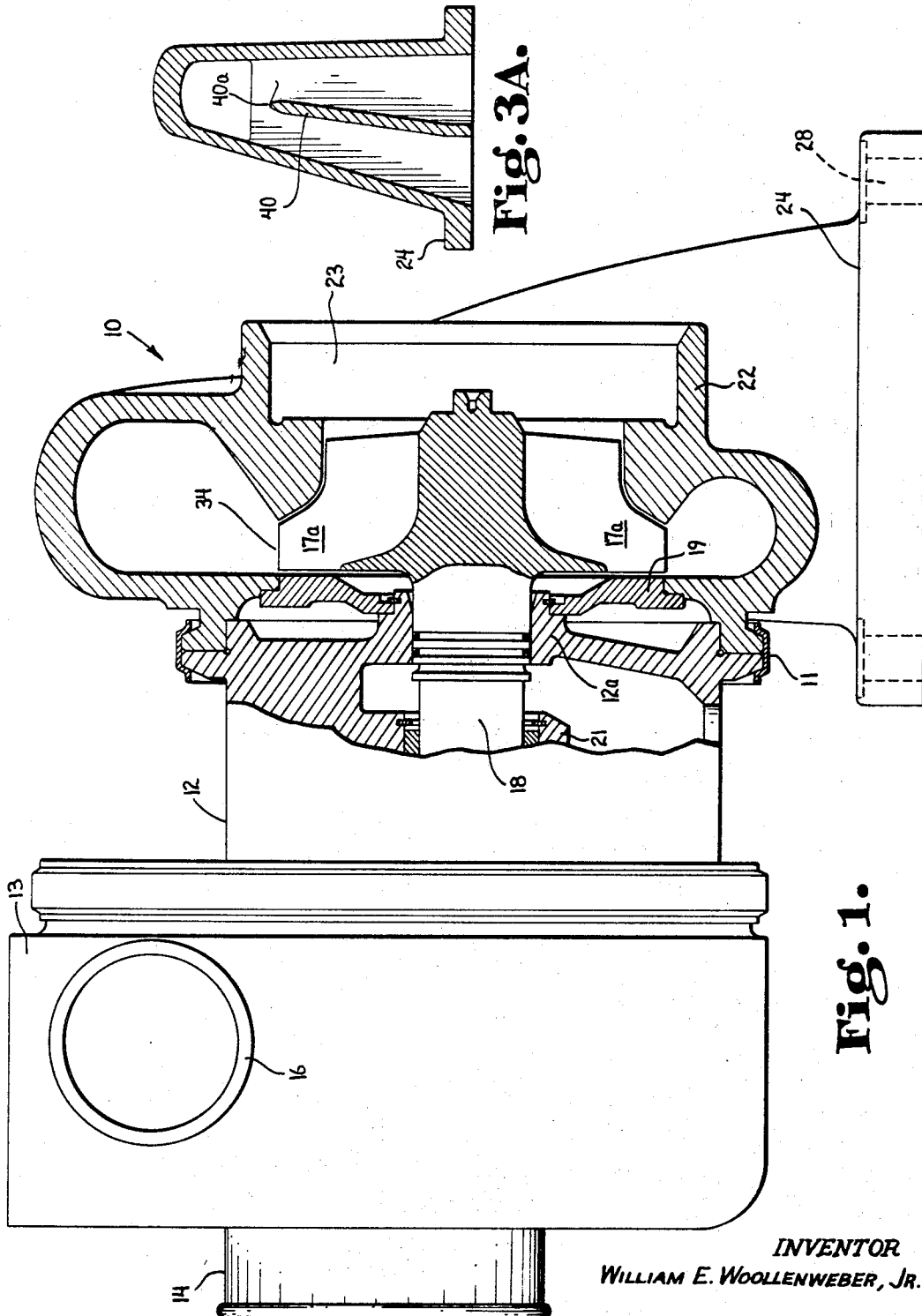


Fig. 3A.

Fig. 1.

INVENTOR
WILLIAM E. WOOLLENWEBER, JR.

BY *Woodard, Wiekert, Emhardt & Haughton*
Attorneys

Oct. 29, 1968

W. E. WOOLLENWEBER, JR

3,408,046

TURBINE HOUSING FOR TURBOCHARGERS

Filed April 8, 1966

4 Sheets-Sheet 2

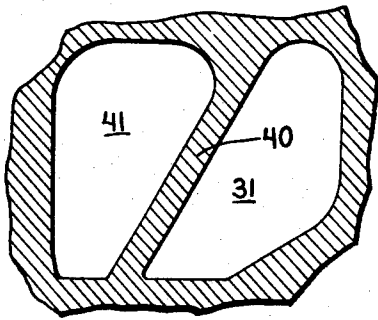


Fig. 4.

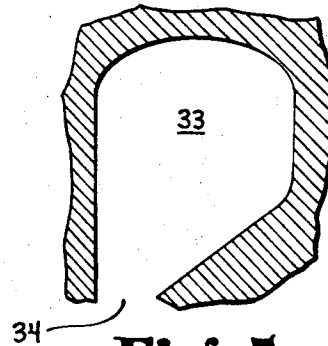


Fig. 5.

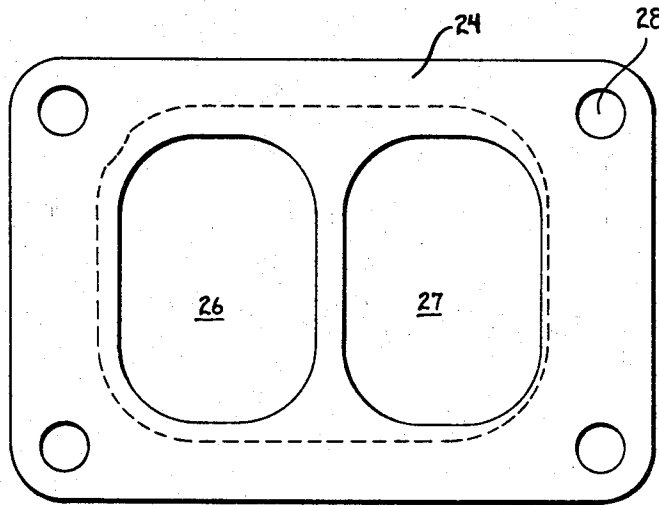


Fig. 2.

INVENTOR.
WILLIAM E. WOOLLENWEBER, JR.

BY
Woodard, Wickert, Emhardt & Naughton
Attorneys

Oct. 29, 1968

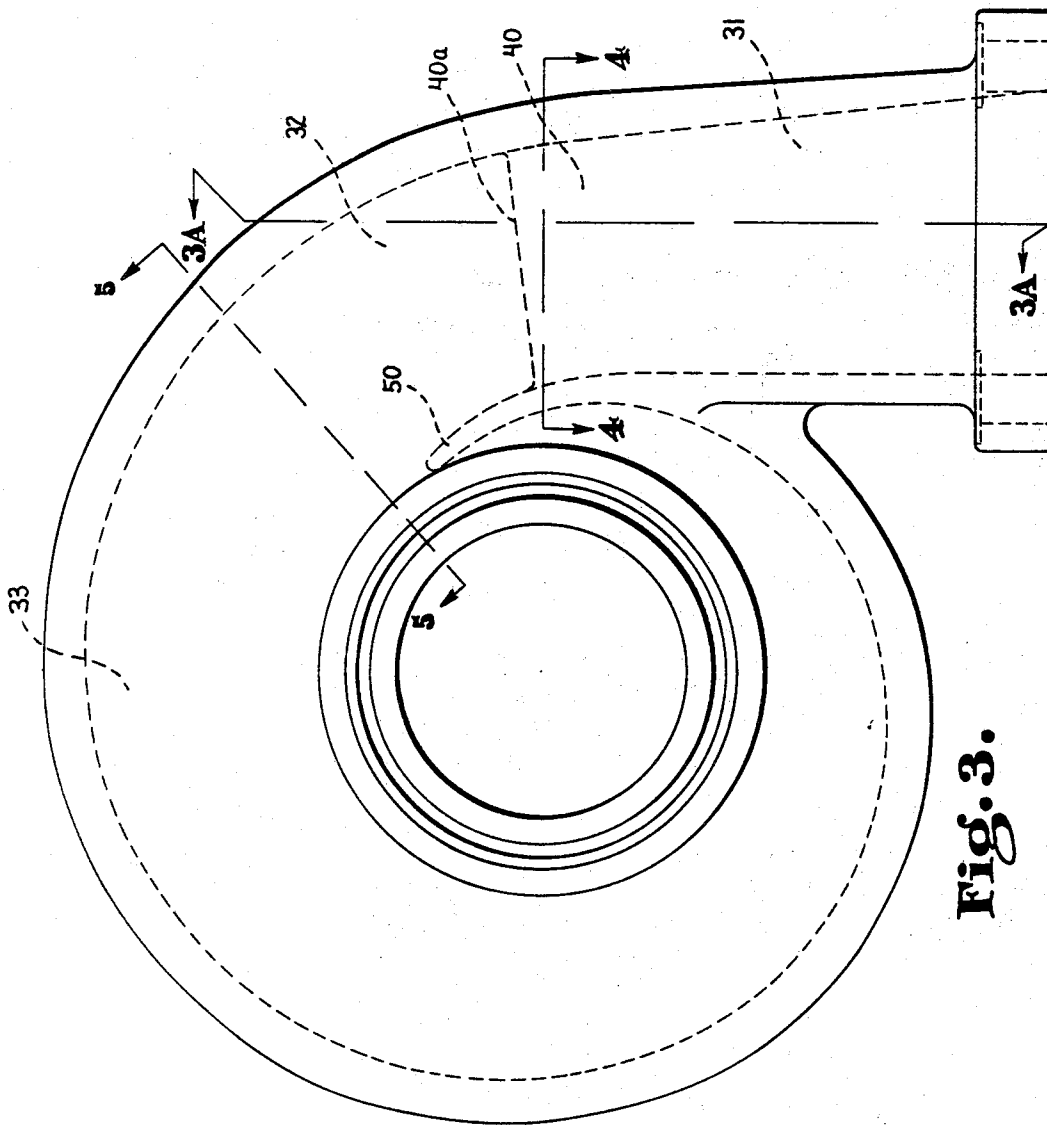
W. E. WOOLLENWEBER, JR

3,408,046

TURBINE HOUSING FOR TURBOCHARGERS

Filed April 8, 1966

4 Sheets-Sheet 3



INVENTOR.

WILLIAM E. WOOLLENWEBER, JR.

BY
Woodard, Wickert, Emhardt & Naughton
Attorneys

Oct. 29, 1968

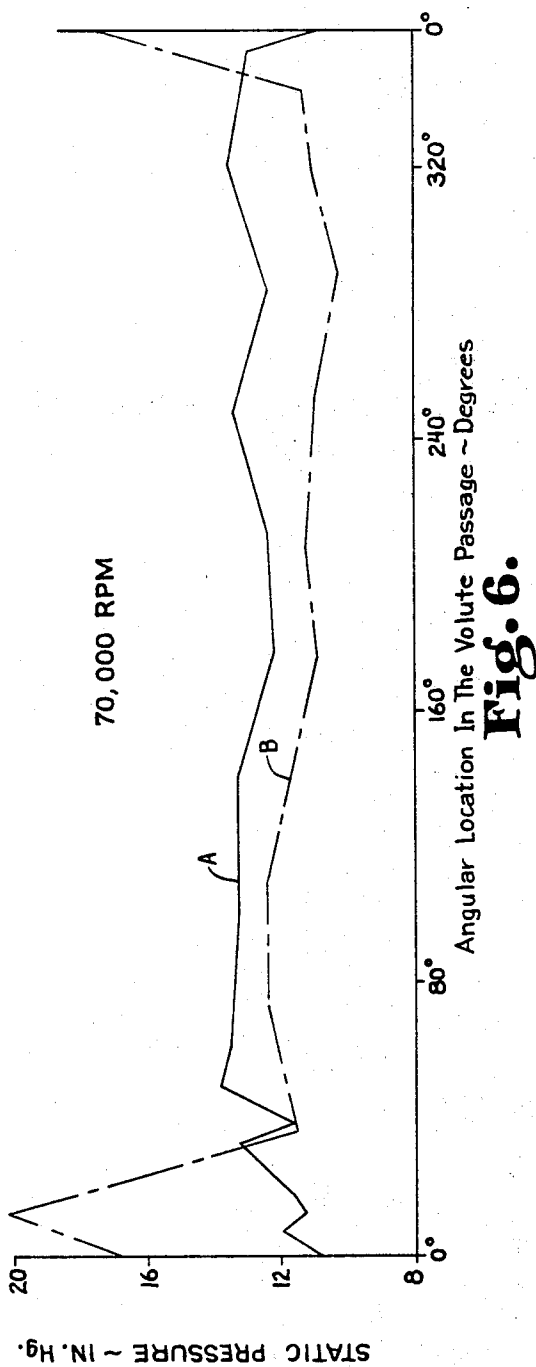
W. E. WOOLLENWEBER, JR

3,408,046

TURBINE HOUSING FOR TURBOCHARGERS

Filed April 8, 1966

4 Sheets-Sheet 4



INVENTOR.

WILLIAM E. WOOLLENWEBER, JR.

BY *Woodard, Wikant, Eshardt & Naughton*
Attorneys

1

3,408,046

TURBINE HOUSING FOR TURBOCHARGERS
William E. Woollenweber, Jr., Columbus, Ind., assignor to
Wallace Murray Corporation, New York, N.Y., a corporation of Delaware

Filed Apr. 8, 1966, Ser. No. 541,185

6 Claims. (Cl. 253-55)

ABSTRACT OF THE DISCLOSURE

A turbine assembly comprising a turbine wheel and a housing enclosing the wheel which includes a single volute passage surrounding the wheel, two inlet apertures, and two passages connecting the inlet apertures with the single volute passage.

This invention relates generally to turbochargers for internal combustion engines and in particular to an improved turbine housing for the exhaust gas turbine component of a turbocharger.

A wide variety of turbine designs have been utilized in the past in applying turbochargers to internal combustion engines. In land vehicle applications, among others, a persistent problem exists in furnishing enough exhaust gas energy to the turbine under low speed, high torque or load conditions. One solution to the problem has been to use the Buchi type divided exhaust manifold with a divided turbine housing.

One type of conventional divided turbine housing utilizes two volute passages each receiving exhaust gases from separate exhaust manifold passages. Each volute passage distributes gas through a nozzle ring to approximately 180° of the periphery of the turbine wheel. Another conventional type has a volute passage extending around substantially the complete turbine wheel periphery, the passage being split by a divider wall, extending in the direction of gas flow, around the complete turbine periphery. The arrangement provides two separate, side-by-side gas passages, each opening to substantially the entire turbine wheel periphery. While the latter type has its volute passages open to substantially the complete turbine wheel periphery, the divider wall, swept by the exhaust gases on both faces and of relatively thin cross-section, is subject to thermal distortion and cracking.

These conventional turbine types, that is, the 180° distribution type and the median divider wall type, when operating on the pulsating gas flow which is inherent in the divided exhaust manifold (Buchi) system, must operate at reduced turbine efficiency. The 180° distribution type turbine must continually operate on partial gas admission to the turbine wheel since both passages are not filled with gas from the engine manifold simultaneously. The median divider wall type permits the gases to expand from one passage into the other across the divider wall and around the entire turbine wheel periphery before entering the turbine wheel. In contrast, the turbine housing of the present invention permits flow of the exhaust gases to the turbine wheel over substantially all of its periphery and does not require use of a divider wall in the volute passage. The turbine thus operates at improved efficiency on pulsating gas flow in comparison to conventional structures. The divided portion of the housing, extending from the inlet flange substantially to the beginning of the volute passage may receive gases from separate components of a divided engine exhaust manifold. By maintaining the ratio of passage area just downstream of the divider wall to passage area of either one of the two divided passages within certain limits, the turbine has excellent performance characteristics when used

2

with divided, Buchi type engine exhaust manifolds. At the transition area where the initial, divided passage portion terminates and the volute passage, open to the turbine wheel periphery, begins, a tongue extends a short distance into the volute passage closing the adjacent portion of the turbine wheel periphery to gases moving into the volute passage. Extension of this closing tongue, referred to above, eliminates the sudden expansion of area which would otherwise be caused by the immediate exposure to the turbine wheel periphery, of gases leaving the divided portion of the turbine housing inlet passage. This provides a more uniform distribution of static pressure along the length of the volute passage, that is, around the turbine wheel, leading to improved performance and a beneficial lowering of turbine vane vibratory strain. Expansion of the gases, in the structure of the present invention, takes place only where the divided passage portion terminates. The expansion at this area is minimized by the converging of the passage walls, and, furthermore, is localized at the throat of the nozzle section and confined to only a very small arcuate portion of the turbine housing. Once expansion in this limited area is completed, the gases then feed substantially the entire 360° of the turbine wheel uniformly and evenly across the width of the passage. The turbine wheel thus operates more nearly as though it were running on steady gas flow rather than intermittent flow and turbine efficiency is thus at a maximum.

The primary object of the present invention is to provide a housing for the turbine component of an internal combustion engine turbocharger which presents engine exhaust gases to substantially the entire 360° of the turbine wheel periphery and can accommodate exhaust gas inputs from divided manifold engines without utilizing divider walls in the volute, turbine wheel entry passage and, hence, operates at improved efficiency.

A further object is to provide a turbine housing characterized, in operation, by a relatively uniform static pressure distribution around the volute passage overlying the turbine wheel periphery.

These and other objects will become apparent as the description proceeds with reference to the accompanying drawings in which:

FIG. 1 is a side view of a turbocharger embodying the present invention with portions broken away to more clearly show the turbine component of the assembly.

FIG. 2 is a plan view of the inlet flange showing the inlet apertures in the structure of FIG. 1.

FIG. 3 is an end view, taken from the right hand end of FIG. 1, of the structure shown in FIG. 1.

FIG. 3A is a sectional view taken generally along the line 3A-3A of FIG. 3.

FIG. 4 is a sectional view of a portion of the turbine housing taken generally along the line 4-4 of FIG. 3.

FIG. 5 is a sectional view similar to FIG. 4 but taken generally along the line 5-5 of FIG. 3.

FIG. 6 is a graphic illustration of the variation in static pressure along the length of the volute passage portion of the turbine housing and illustrating the difference in static pressure variation for turbine housings with and without the extending tongue to be described below.

Referring initially to FIGS. 1, 2 and 3, there is illustrated an exhaust gas driven turbocharger which includes a turbine housing 10 attached by means of a clamp ring 11 to an intermediate casting and bearing housing 12. The casting 12 is attached to a compressor housing 13 which has an inlet fitting 14 and an outlet fitting 16.

The compressor component of the turbocharger forms no part of the present invention and is not shown in detail herein. Referring specifically to FIG. 1, the turbine housing 10 encloses a conventional bladed turbine wheel 17,

two of the blades being indicated at 17a. The turbine wheel is adapted to drive the shaft 18 which extends through the casting 12 and carries the compressor component (not shown). A plate 19 carried by the portion 12a of the casting 12 closes the open inner end of the housing 10. The portion 12a of the casting carries a bearing support hub which cooperates with other bearing parts to provide a suitable rotational mounting for the shaft 18. The outer end of the housing 10 is formed to provide an outlet flange 22 which defines the turbine outlet passage 23. The turbine housing is further formed to provide an inlet flange 24 having separate turbine inlet apertures 26 and 27 (FIG. 2) therein. The inlet flange 24 is provided with suitable mounting apertures 28 so that the turbine may be mounted upon the divided engine exhaust manifold, with exhaust gases from certain of the engine cylinders being transmitted to the inlet aperture 26 and gases from other engine cylinders being separately transmitted to the inlet aperture 27 in accord with Buchi principles.

It will be understood that the turbocharger is connected into an internal combustion engine supercharging system with the compressor being driven by the expansion of engine exhaust gases through the turbine and with the compressor operating to supercharge the engine through connection of the compressor outlet 16 to the intake manifold of the engine.

The turbine housing passages which provide the inventive features of the structure will now be described in detail. Immediately downstream of the aperture 27, the housing is formed so as to provide a smoothly convergent passage 31 (FIG. 3) which extends upwardly and merges at the junctional area 32 with a volute passage 33. This volute passage is open to the periphery of the turbine wheel 17, the opening being indicated at 34 in FIGS. 1 and 5. The volute passage 33 extends adjacent and is open to substantially all of the turbine wheel periphery. As will be evident from FIG. 3, the volute passage 33 decreases in cross-sectional area along its length so as to maintain substantially constant velocity of the gases presented to the turbine wheel through the aperture or opening area 34 throughout the length of the volute passage.

The inlet aperture 26 (FIG. 2) opens into a passage 41 (FIG. 4) in the housing which is in generally side-by-side relationship with the passage 31, the passage 41 also being convergent in cross-section as is the passage 31. The passage 41, in the area indicated at 32 in FIG. 3, merges with the volute passage 33. The divider wall which separates the passages 31 and 41 is identified at 40 in FIGS. 3 and 4, and, as may best be seen in FIG. 3 terminates at 40a. At the termination of the divider wall 40a the passages 31 and 41 thus merge and join with the volute passage 33. As will be evident from FIG. 3, a tongue portion 50 of the housing extends beyond the terminal portion 40a of the divider wall and into the transitional area 32. The tongue 50 thus closes the transitional area to the turbine wheel and prevents gases moving beyond the divider wall terminus 40a immediate access to the turbine wheel until after they have entered somewhat further the volute passage 33.

In operation, when engine and exhaust gases are introduced into the inlet apertures 26 and 27, the velocity of these gases is increased by passage through the convergent passages 31 and 41. As long as the ratio of the total passage area just downstream of the divider wall 40 to the area of the separate passages 31 or 41 is within a range bounded by 1.2 and 2.0, the turbine evidences good performance characteristics and operation with divided, Buchi type engine exhaust manifolds.

The importance of the finger 50, which extends into the junctional area 32 between the passages 31, 41 and 33, is illustrated in FIG. 6. In FIG. 6, the static pressure around the length of the volute passage 33 is plotted as an ordinate and the location around the volute passage 33 is the

abscissa. Curve A illustrates the static pressure condition along the length of the volute passage for the structure shown in FIG. 3, that is, a turbine housing with the extending finger portion 50. Curve B illustrates the same condition for a turbine housing having passages the same size as passages 31, 41 and 33 of the turbine of curve A, but without the extending finger portion 50. As will be evident from curve B, as the gases enter the junctional area 32 and are immediately exposed to the turbine wheel periphery, there is a high static pressure rise.

The situation where the tongue 50 extends into the junctional area 32 and prevents entry of gases to the turbine wheel in the junctional area, is illustrated by curve A and, with this structure, the static pressure is substantially constant around the turbine wheel giving relatively constant gas velocity and low vane exciting forces.

While the invention has been disclosed and described in some detail in the drawings and foregoing description, they are to be considered as illustrative and not restrictive in character, as other modifications may readily suggest themselves to persons skilled in this art and within the broad scope of the invention, reference being made to the appended claims.

The invention claimed is:

1. An exhaust gas driven turbine assembly for driving the compressor component of an internal combustion engine turbocharger, said assembly comprising a housing having two inlet apertures, a turbine wheel mounted for rotation within the housing, a single volute passage formed in said housing extending adjacent to the turbine wheel periphery, a first passage in said housing extending between and joining one of said inlet apertures with said volute passage, and a further passage extending between and joining the other of said inlet apertures with said volute passage, and a tongue extending into the junctional transition area between said volute, first and further passages which prevents entry of gases to the turbine wheel in said junctional area, the engine exhaust gases introduced separately into each of said inlet apertures being then introduced to the turbine wheel along the length of said volute passage at a relatively constant static pressure.
2. An exhaust gas driven turbine assembly as claimed in claim 1 wherein both said first and further passages have a converging nozzle configuration to establish the velocity of the gases moving therethrough at the desired value for entry into the turbine wheel.
3. An exhaust gas driven turbine assembly for driving the compressor component of an internal combustion engine turbocharger, said assembly comprising a housing having two inlet apertures, a turbine wheel mounted for rotation within the housing, a single volute passage formed in said housing extending adjacent to the turbine wheel periphery, a first convergent passage in said housing extending between and joining one of said inlet apertures with said volute passage, and a further convergent passage extending between and joining the other of said inlet apertures with said volute passage, whereby engine exhaust gases introduced separately into each of said inlet apertures are immediately increased in velocity by passage through said convergent passages and are then introduced to the turbine wheel through the common volute passage.
4. An exhaust gas driven turbine assembly for driving the compressor component of an internal combustion engine turbocharger, said assembly comprising a housing having two inlet apertures, a turbine wheel mounted for rotation within the housing, a single encircling passage formed in said housing extending adjacent to the turbine wheel periphery, a first passage in said housing extending between and joining one of said inlet apertures with said encircling passage, and a further passage extending between and joining the other of said inlet apertures with said encircling passage, and a tongue extending into the junctional transition area between said encircling, first and further passages which prevents entry of gases to the

5

turbine wheel in said junctional area, the engine exhaust gases introduced separately into each of said inlet apertures being then introduced to the turbine wheel along the length of said encircling passage at a relatively constant static pressure.

5. An exhaust gas driven turbine assembly for driving the compressor component of an internal combustion engine turbocharger, said assembly comprising a housing having two inlet apertures, a turbine wheel mounted for rotation within the housing, a single encircling passage formed in said housing extending adjacent and nozzleed to the turbine wheel periphery, a first convergent passage in said housing extending between and joining one of said inlet apertures with said encircling passage, and a further convergent passage extending between and joining the other of said inlet apertures with said encircling passage, whereby engine exhaust gases introduced separately into each of said inlet apertures are immediately increased in velocity by passage through said convergent passages and are then introduced to the turbine wheel through said common encircling passage.

6. An exhaust gas driven turbine assembly for driving the compressor component of an internal combustion engine turbocharger, the assembly comprising a housing having two inlet apertures, a turbine wheel mounted for

6

rotation within the housing, a single encircling passage formed in the housing extending adjacent to and opening into the turbine wheel periphery, and characterized by a first passage in the housing extending between and joining one of the inlet apertures with the encircling passage, and an additional passage extending between and joining the other of the inlet apertures with the encircling passage at the same junctional area as that of the first passage and the circling passage, the engine exhaust gases introduced separately into each of the inlet apertures being then both introduced to the turbine wheel along the length of the encircling passage.

References Cited

UNITED STATES PATENTS

2,577,179	12/1951	Buchi -----	253—117 X
2,944,786	7/1960	Angell et al. -----	253—52 X
3,218,029	11/1965	Woollenweber -----	253—55
3,292,364	12/1966	Cazier -----	60—13
3,313,518	4/1967	Nancarrow -----	253—124 X

FOREIGN PATENTS

935,231	8/1963	Great Britain.
---------	--------	----------------

EVERETTE A. POWELL, JR., *Primary Examiner*.