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APPENDIX

The apparatus shown in Fig. 3 was designed to produce swirl-free, incompressible turbulent flow with either a thin ($\delta < 0.05d$) or fully developed ($\delta = d/2$) boundary layer at the inlet to the diffuser.

The flow passed through a deep-cell honeycomb which helped to eliminate any swirl, contracted at a bleed valve for volumetric flow control, and then passed down a 2-in-dia tube for 14 ft before entering the diffuser.

The radial channel was formed by a 0.437-in-thick machined steel back disk, through which the flow entered, and a front disk of 0.375-in-thick plate glass which allowed the use of flow-visualization techniques. Two diameters of the disk were used, $D = 12$ in. and $D = 18$ in. The steel disk was mounted rigidly on a heavy steel framework by three studs, and the glass disk moved on three threaded rods. Three dial gauges with 0.001-in. graduations were mounted on the rigid frame and rode against the glass disk, so that the channel width could be adjusted accurately. The steel disks were ground within 0.0005 in. tolerance and then chromium-plated. The glass plate was found to be within 0.0001 in. tolerance over its entire surface and proved to be very satisfactory.

All disks were pressure-tapped at 0.5-in. radial increments along two alternating azimuthal coordinates, thus providing a continuous check on the angular symmetry; as an additional check, the disks were pressure-tapped every 90 deg at two radial positions. The static-pressure taps were 0.015 in. dia and were drilled directly into the steel disk. With the glass plate, it was first necessary to drill 0.125-in-dia holes with a carbide-tipped drill and then insert brass plugs in which the 0.015-in-dia tap hole had been drilled; the plugs were glued into place with epoxy resin. To insure a smooth surface, the plugs were mounted slightly proud and hand-scraped flush with the glass surface. The inlet pipe was joined to the steel channel wall by the diffuser-inlet bend, which was machined from plexiglass and pressure-tapped at 0.25-in. increments along its surface in the direction of the flow. The center body was also machined from plexiglass and the upstream point rounded to stabilize the stagnation point, Fig. 2.

To reduce the apparent thickness of the boundary layer at the pipe outlet, bronze screens (23×24 mesh 0.011 in. wire diameter and $K \approx 1$) with greater effective porosity near the wall were installed. This was accomplished by superimposing at 45 deg a 1.50-in-dia screen on a 2-in-dia screen. This composite screen was then mounted near the supply-pipe outlet, and velocity-profile traverses were taken in order to determine the effective boundary-layer thickness.

The radial diffuser was found to be quite sensitive to any disturbance near the channel inlet where the diffusion rate is very high. In order to traverse the flow at the exit of the 90-deg inlet bend, the stem of a pitot tube was mounted downstream of the traversing section with its nose extending the required distance upstream. The static pressure at the traversing section was taken as the mean between the wall static pressure on the front and back disks since the variation across the channel was small (less than 2 percent).

DISCUSSION

W. G. Cornell[2]

The author is to be congratulated on an interesting and useful paper. In the design of the radial-channel inlet bend shown in Fig. 1 of the paper, the meridional section of the wall contour was approximated by a circular arc, drawn tangent to an axial wall at inlet and a radial wall at exit. Although the approximation is close to the experimental jet boundary and the result of the axisymmetric theory shown in Fig. 1, the use of line-circle-arc-line as an approximation gives rise to abrupt changes in wall curvature at the tangent points. The boundary layer is bound to be adversely affected by the curvature discontinuities. It would be preferable to fair the wall near the tangent points, adding little to manufacturing difficulty.

Author's Closure

The author wishes to thank Mr. W. G. Cornell for his pertinent remarks regarding the inlet boundary shape. In reply, the author agrees that fairing the wall should improve the boundary layer conditions. It is probable that the inlet bend used in the present study had at least some fairing at the tangent points as an unavoidable result of the fabrication process.

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