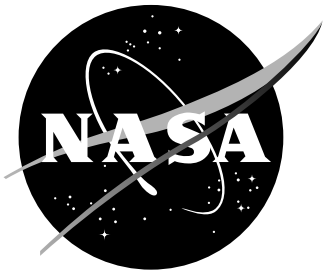
John F. Kennedy Space Center
Kennedy Space Center, Florida 32899

Technical Support Package

Flow-Concentrating Supersonic Gas/Liquid Nozzles

NASA Tech Briefs
KSC-11883



National Aeronautics and
Space Administration

Technical Support Package

for

FLOW-CONCENTRATING SUPERSONIC GAS/LIQUID NOZZLES KSC-11883

NASA Tech Briefs

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Flow-Concentrating Supersonic Gas/Liquid Nozzles

The purpose of this invention is to clean and verify the cleanliness level of tanks, pipes, tubes, machine parts, and structures.

The previous methods for performing this task are flushing with solvents, spraying with high-pressure liquid nozzles, and supersonic DeLaval nozzles. Solvent flush methods require large volumes of chemicals to dissolve the contaminants. High-pressure liquid sprays require less solvent than solvent flush methods, but the volumes are still substantial. Supersonic DeLaval nozzles are the best of these methods listed, but can be improved upon.

This invention consists of a supply tube, a straight precision-bored tubular section, and a flow-directing insert. The insert is placed inside the precision-bored tubular section. The supply tube is attached by some suitable means to the tubular section. The two-phase gas-liquid mixture flows through the supply tube and into the precision-bored tubular section where it is directed outward by the insert. The flow is compressed and converged by the insert until it reaches the largest diameter of the insert. There it achieves sonic (the speed of sound) velocity. As the flow continues, it is allowed to expand and accelerate to supersonic (greater than the speed of sound) velocity. The flow leaves the nozzle directed inward, back upon itself by the insert. This concentration of the flow path greatly improves the ability of the nozzle to remove contaminants in the cleaning embodiment of the invention. A drawing of the new design is depicted in Figures 1 and 2.

Alternate embodiments of the invention are many multiple nozzle arrangements for tank cleaning, pipe cleaning, etc. They could be manual, automatic, rotating, or stationary. Banks of nozzles could be used to clean wide, flat surfaces. The nozzles may be attached radially outward from a small pipe to clean larger pipes from the inside.

The invention uses much lower volumes of solvent than high-pressure liquid sprays, and does not require a powerful solvent like the solvent flush methods. The cleaning process relies on the mechanical action of the jet, which is dramatically improved over the DeLaval design for removing the contaminate. The flow in traditional nozzle designs, including supersonic nozzle designs, spreads out and is weakened after it leaves the nozzle exit. The concentrating nozzle directs the flow into a tight stream. The tight stream increases the intensity of the jet above that of DeLaval nozzles using the same inlet flows and pressures. This design eliminates the very difficult internal machining required to produce a DeLaval nozzle.

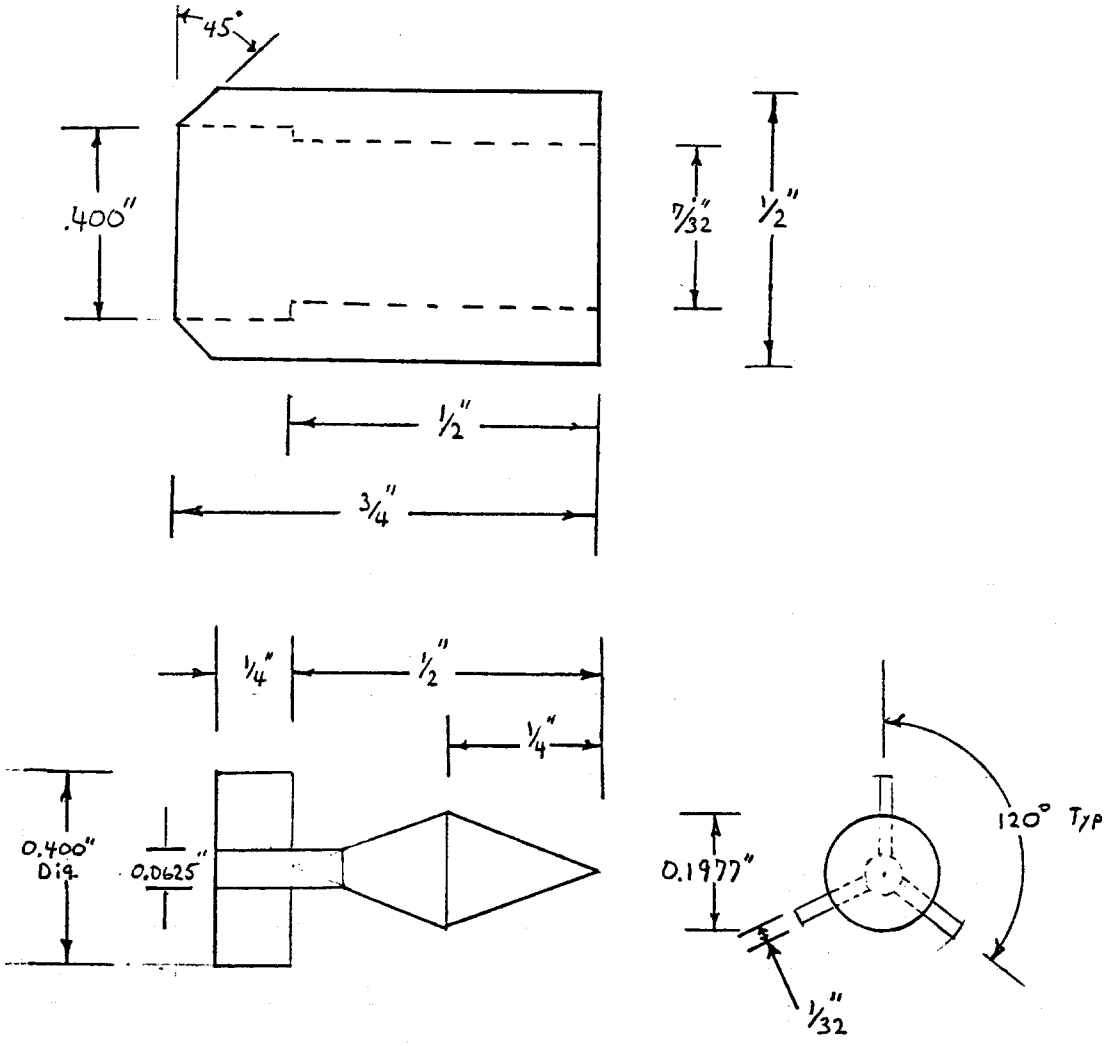

Figure 1

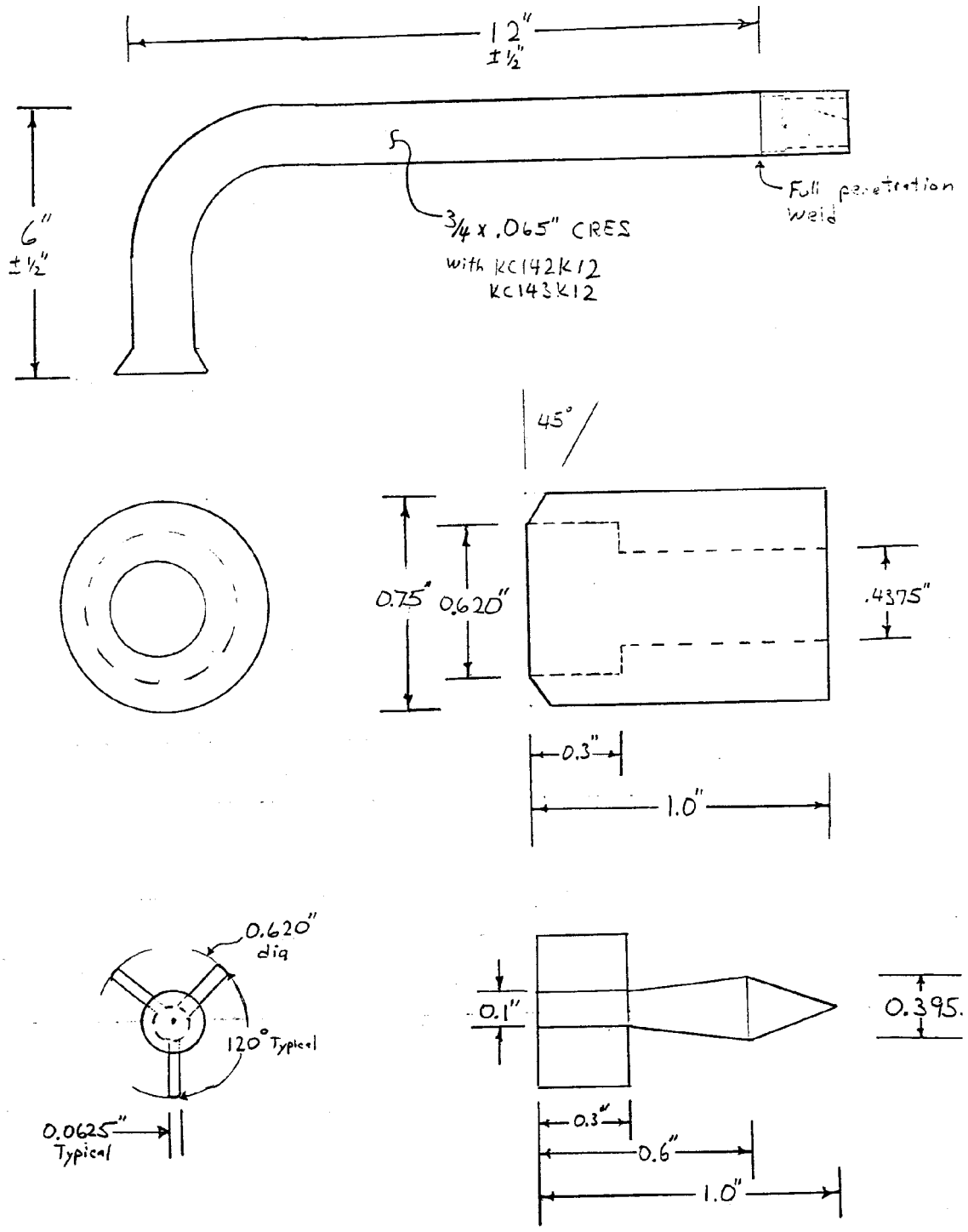

Figure 2

The new parts of the invention are the use of a two-phase (gas-liquid) supersonic nozzle with converging flow paths to concentrate the cleaning action in a cleaning application.