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A VOICE-ACTUATED WIND TUNNEL MODEL LEAK CHECKING SYSTEM

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SUMMARY

A voice-actuated wind tunnel model leak checking system has been developed. The system uses a voice recognition and response unit to interact with the technician along with a graphics terminal to provide the technician with visual feedback while checking a model for leaks.

INTRODUCTION

When a model is placed in a wind tunnel for testing, it is connected to pressure measuring devices with small diameter plastic tubing and stainless steel tubing. This installation is a tedious task, and errors in plumbing can easily occur as the number of orifices on a model can frequently exceed one thousand. Leaks can be caused by the improper installation of the plastic tubing over the stainless steel tubing. The soldered joints of the stainless steel tubing sometimes leak also. Whatever the source, these leaks must be detected and repaired so that erroneous test results do not occur.

The previous method for leak checking required two or three people. As shown in figure 1, one technician applies pressure to an orifice on the model while another technician in the control room selects, via a control panel, the orifice being tested. Once the pressure has been applied, a third technician, who generally handles the intercom and record keeping duties, requests a decision on the leak rate from the control room technician who can see the pressure displayed on a CRT in the control room. These steps are repeated until all the orifices have been checked.

Due to the number of technicians and the amount of time required to perform this relatively simple task, an effort was undertaken to improve the model leak checking procedure. The result was a computer program that interfaces with the technician via a voice recognition and response unit. This paper will discuss the requirements that led to the development of this leak checking system as well as the capabilities of the system.

THE WIND TUNNEL MODEL LEAK CHECKING SYSTEM

The computer-based Leakcheck system was developed to allow the computer to perform more of the work done in checking a model for leaks with the objective of reducing the manpower and time required to perform the task. To eliminate the need for a control room technician, it was necessary to provide the technician applying the orifice pressure the ability to select the orifice to be tested. An early prototype system considered the use of a portable terminal.

This allowed the technician to select the orifice from a keyboard but did not allow his hands freedom to work on the model. Therefore, a voice recognition system was chosen for this task.

The voice system used is capable of voice recognition and response. The recognizer is a speaker-dependent, isolated command unit that can handle a vocabulary of up to 100 separate commands. A command can be a single word or a phrase with a duration of 1.5 seconds or less. Each technician trains the Leakcheck vocabulary by speaking each command as directed by the program. After all the commands have been trained, their patterns are stored on a disk file for recall when the technician wishes to use the program again. The voice response unit is a speech synthesizer that is capable of speaking any number of words. It uses an algorithm that converts English text strings to speech. With these recognition and response capabilities the technician can issue commands to the computer and get positive response via the spoken word.

To give the technician some visual feedback in the leak checking process, a CRT which displays information about the orifice currently being checked is included in the system. An example of this display is shown in figure 2. The first two columns in the upper left of the screen contain information about the orifice currently selected. The orifice number and the data channel to which the orifice is assigned are displayed in the first column along with the port number of the orifice, if it is connected to a scanivalve (a pressure scanning device that sequentially connects up to 48 pressures onto a single transducer). The second column contains the X, Y, and Z coordinates of the orifice on the model. The upper right portion of the display shows the current pressure on the selected orifice. This pressure is updated three times each second. The bottom half of the screen is dedicated to a graphical display of the data gathered versus time. Each data point taken is plotted, then the best straight line fit of the data is also plotted. The straight line fit gives the technician a good visual cue as to the rate of leakage per second. Using this information, the technician can make a decision about the status of the orifice and tell the program, by voice, what to record in the database. Alternatively, if the automatic mode of operation is selected, the computer will make a decision on the status of an orifice, record it in the database, and report its findings to the technician.

The program maintains a database of the orifices on the model. This database can be created manually or automatically. In the manual configuration mode, the technician specifies the number of scanivalves, their channel numbers, and the number of orifices connected to an Electronically Sensing Pressure (ESP) unit (refs. 1 and 2). If the automatic configuration is chosen, the program accesses a database that was created by a different program for the current model. This database is parsed for the information necessary to create the leak checking program's database. At the end of the configuration the program records the zero-pressure value for each orifice. This pressure is recorded for two important reasons. First, in an effort to speed up the leak checking process, knowing the zero value of each orifice allows a search mode to be incorporated in the program where the technician just applies a pressure to the desired orifice and the program will search all orifices, stopping on the one with the non-zero value. Without a search mode the technician needs to know the number of the orifice he wishes to check so that it can be selected for monitoring by the program. This can cause delays due to the technician having to refer to the drawing to obtain the correct orifice number. The second, and

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perhaps more important reason for recording the zero value, revolves around the data gathering function of the program. When the program is instructed to begin taking data, it first checks to see if there is sufficient pressure on the orifice being checked to perform a leak check. If there is not, it will report this condition to the technician. This is a vitally important error check because an orifice checked with little or no pressure on it would probably appear to be non-leaking even if there was a leak. This could easily lead to incorrect test results.

The system is currently configured as shown in figure 3. The only pieces of equipment that are brought into the tunnel test section are the CRT and the headset that the technician wears. With this arrangement, one technician can accomplish the entire task, reducing the number of man-hours needed to perform leak checking on a model by a factor of three.
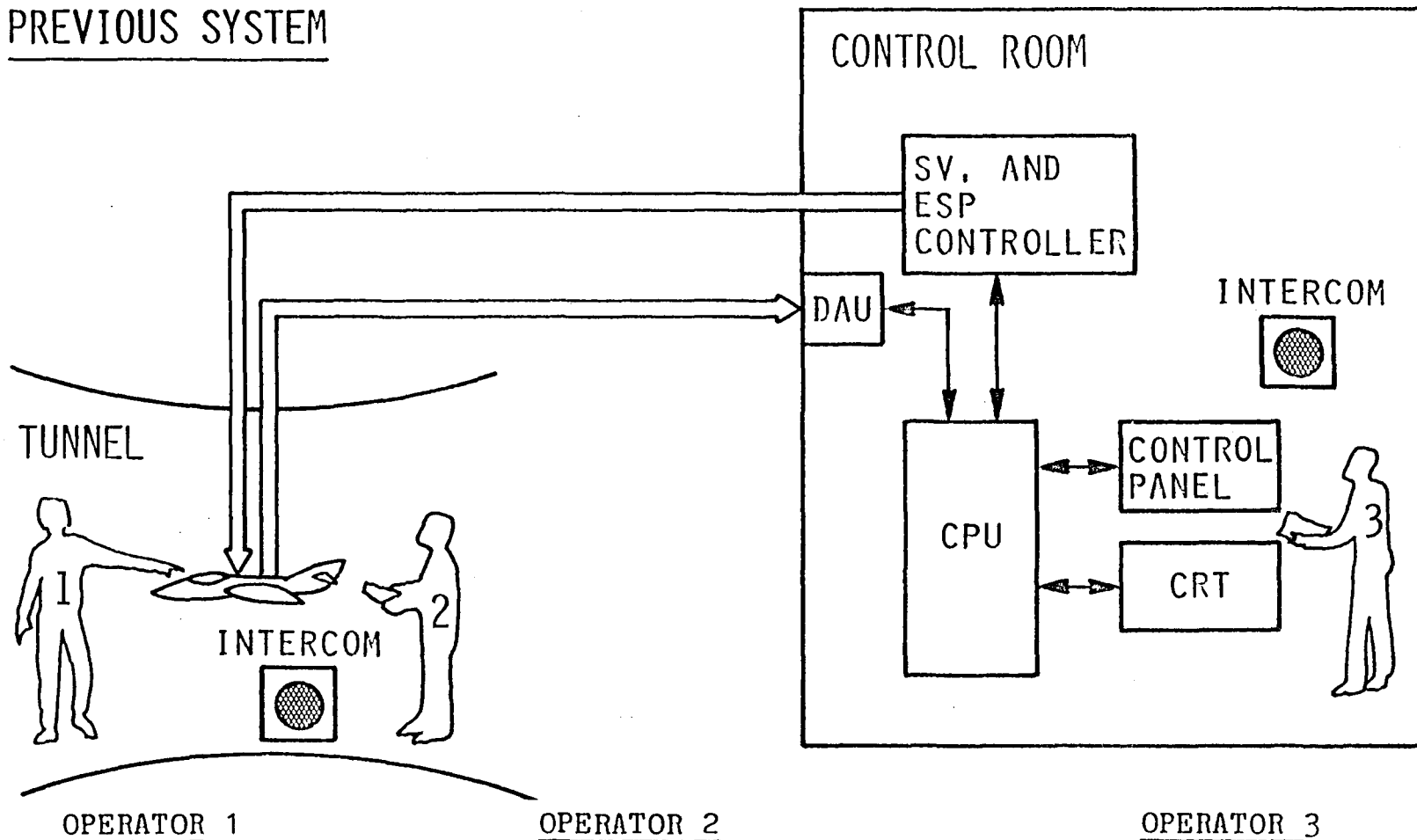
CONCLUDING REMARKS

The leak checking system has been installed and tested successfully at the 16-foot transonic tunnel at Langley Research Center. During the test, a technician was able to perform the entire leak check of a model in the test section without any dependence on other technicians for help. In the near future, after facility dependent changes are made, the leak checking system will be installed at other Langley wind tunnels.

REFERENCES

1. Gross, C. and Juanarena, D. B.: "A Miniature 48-Channel Pressure Sensor Module Capable of In Situ Calibration," ISA 23rd International Instrumentation Symposium, May 1977.

2. Juanarena, D. B.: "A Distributed Processing High Data Rate Multiport Wind Tunnel Pressure Measurement System," ISA 23rd International Instrumentation Symposium, May 1977.

PREVIOUS SYSTEM

FIGURE 1

OPERATOR 1

- APPLIES VACUUM
  OR PRESSURE

- SEALS ORIFICE

- CALLS FOR DECISION
  ON LEAK RATE

OPERATOR 2

- MAINTAINS LOG OF
  ORIFICE STATUS GOOD,
  BAD, OR NOT CHECKED

- PROVIDES X,Y,Z
  COORDINATE OF ORIFICE

OPERATOR 3

- SELECTS DESIRED PORT

- SELECTS CHANNEL FOR
  DISPLAY

- MONITORS READING TO
  DECIDE ON LEAK RATE

MANUAL LEAKCHECK

PORT =   #37   X=1.0

CHANNEL = #35   Y=5.37   PRESSURE= 1748
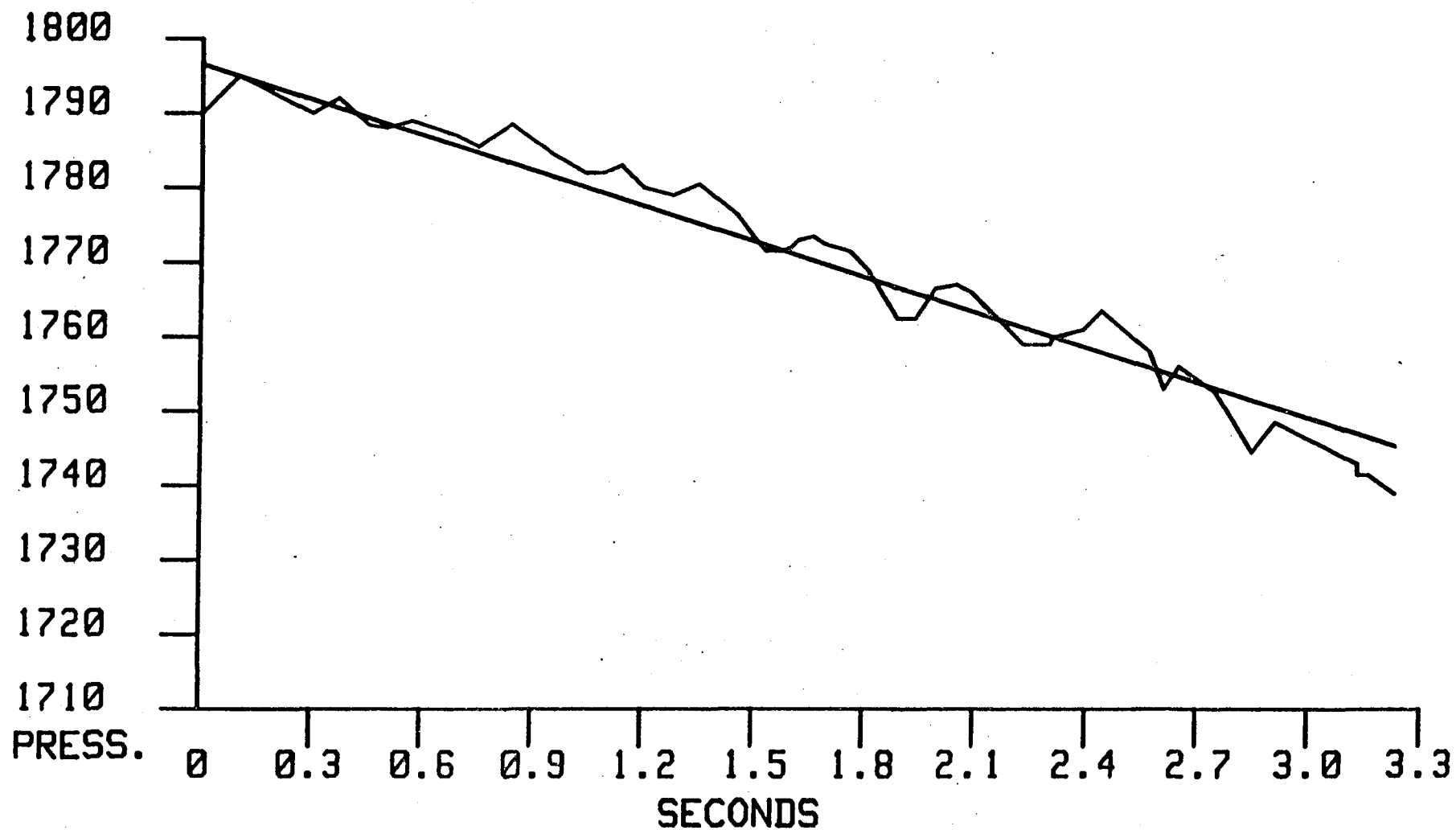
ORIFICE = #149   Z=0

FIGURE 2

AUTOMATED SYSTEM

OPERATOR - "SPEAKS" DESIRED ORIFICE OR COMPUTER AUTO
SEARCHES FOR APPLIED PRESSURE

COMPUTER - DECIDES WHETHER LEAK RATE IS OK, "SPEAKS"
STATUS, OR DISPLAYS ON CRT

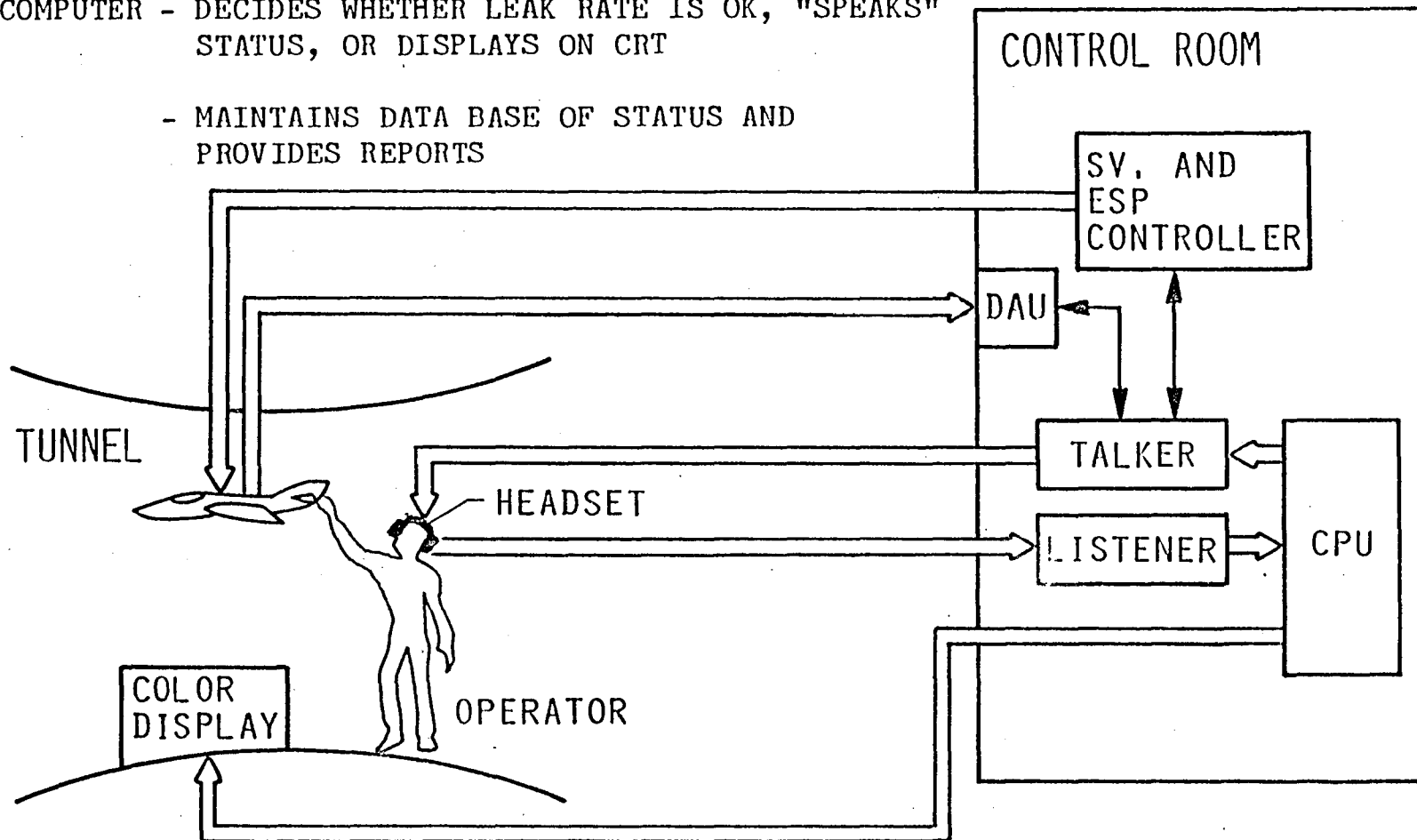   - MAINTAINS DATA BASE OF STATUS AND
PROVIDES REPORTS

FIGURE 3

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15. Supplementary Notes

16. Abstract

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