att: B.

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

Gen
BWIP

AUG 3 1984

Mr. F. Robert Cook
Nuclear Regulatory Commission
P. O. Box 1186
Richland, Washington 99352

Dear Mr. Cook:

NRC REQUEST TO ACCESS PNL DOCUMENTS

References are made to 1) the August 2, 1984, telephone conversation between Dr. Michael J. Bell, NRC, and Mr. Thomas B. Hindman, DOE-SR, wherein Dr. Bell requested that you be allowed access to PNL documents relating to the MCC-D2 Data Package in order to support MRB review of the Data Package; and 2) the August 2, 1984, follow-on telephone conversation between Mr. Hindman and Mrs. Elizabeth A. Bracken, DOE-RL, wherein Mr. Hindman concurred with Dr. Bell's request. We hereby honor the request for limited access to PNL documents which relate directly to the MCC-D2 Data Package. You may contact Mr. John E. Mendel, PNL, to arrange a mutually agreeable time.

Please provide SR and RL with copies of any written material produced from your review of the PNL documents.

Very truly yours,

Jerry D. White

Jerry D. White, Director
Waste Management Division

WMD:EAB

cc: M. J. Bell, NRC
T. B. Hindman, SR
J. L. McElroy, PNL
J. E. Mendel, PNL
J. C. Haugen, CH

ad A.

DOE Form GC-213
(2-78)
DOE PR-9-9

U.S. DEPARTMENT OF ENERGY
OFFICE OF ASSISTANT GENERAL COUNSEL FOR PATENTS

RECORD OF INVENTION

This Record of Invention is an important legal document and proper care in its early and complete preparation will save important time and inconvenience in the future. The Instructions* on the back should be read carefully before filling in the data.

DOE Case No.

A. Inventor: 1. Name(s): FRANK ROBERT COOK

2. Title or Position: SR. ON SITE LICENSING REP., BWIP

3. Employed by: US. NUCLEAR REGULATORY COMMISSION

4. Permanent Address: 2552 HARRIS AVE., RICHLAND, WA., 99352

B. Title of Invention (1*): SONIC MONITORING DEVICE FOR PIEZOMETER WATER COLUMNS USED IN HYDROLOGIC INVESTIGATIONS

C. Description of Invention (2*): The device uses existing sonic sounding systems, including those with Doppler frequency shift measurement capabilities to measure the velocity of sonic pulses of various frequencies in water columns (piezometers) to deduce average water column densities given knowledge of the length of the water column. Doppler shift measurement allows the remote monitoring of the velocity of artifacts in the water column, including test vehicles whose design is such as to change velocity with varying local water column parameters. (The use of sounding and Doppler shift techniques in hydrology is new.) (SEE ATTACHMENTS)

D. Dates and Places of Inventions:

1. Conception by Inventor (3*) 4:30 PM June 29, 1984 At Richland, Wa.
2. First Sketch or Drawing July 2, 1984 At Richland, WA. In Workbook Note book Page 1
3. First Written Description July 5, 1984 At Richland, Wa. In Workbook DFT. Record Page 1-9
4. Disclosure to Others (4*) July, 3, 1984 At Richland, Wa. DOE legal Dept.
   a. July 5, 1984 19 At Richland, Wa. BWIB/RHO hydrology dpt
   b. July 9, 1984 19 At Silver Sp, Md, NRC/WM/Geotechnical Br
5. Completion of Model or Full Size Device n/a At n/a
6. First Test or Operation of Invention n/a At n/a

E. Results of Tests and Extent of Use of Invention (5*): n/a

F. Names of all Persons Having Knowledge of Facts Stated Under D. and E.: R. Southworth (DOE) E. W. Nypaver (DOE); D. J. Squires (DOE); L. S. Leonhart, (RHO); M. Gordon, (NRC); A. Brown (NRC consultant)

G. Pertinent Reports (6*): none

H. Other Closely Related Publications, Patents, and Patent Applications (7*): Use of sonar and Doppler effects in oceanograghy and underwater Navy detection

I. Rights of U.S. Government: To be determined

J. Licenses or Assignments: None

K. Contracts Involved: None

Contract No.: n/a

Date: n/a

Contractor and Address: n/a

Type of Contract: Unclassified | Restricted | Confidential | Secret

L. Signature of Witness: Edward W. Nypaver; Robert Southworth

Date: July 10, 1984; July 10, 1984

Signature of Inventor(s): Frank R. Cook

Date: 7/5/84

Forwarded by (8*):

Date:

(OVER)

ATTACHMENT TO RECORD OF INVENTION (FRANK R. COOK, 7/9/84)

SUMMARY

The device uses existing sonic sounding systems including those with Doppler frequency shift measurement capabilities to measure the velocity of sonic pulses of various frequencies in water columns (piezometers) and to hence deduce average water column densities given knowledge of the length of the water column. Doppler shift capabilities allows the remote monitoring of the velocity of artifacts in the water column including test vehicles whose design is such as to change velocity with varying local water column parameters. (The use of sounding and Doppler shift techniques in the geotechnical field of hydrology is new).

BACKGROUND

A piezometer per Webster's Seventh New Collegiate Dictionary is a instrument for measuring pressure or compressibility. In the geologic sciencies speciality area of Hydrology, which deals with the properties, distribution and circulation of water in the Earth's crust and atmosphere, hydrologists use what they call piezometers to infer water pressures at depth in various geologic media. (Different pressures between two locations are important in predicting ground water flow.) The piezometers are typically long steel tubes (piezometer tubes or sometimes referred to as piezometers themselves) which are open at the bottom so as to communicate with water bearing zones at depth. Typically piezometers are intended to be sealed leak tight at other depths, but may be open at the upper end to the Earth's atmosphere. As a result of water pressures at depth and atmospheric pressure at the top of the tube, ground water flows into the piezometer and fills it to some level, sometimes referred to as a "head". This water level is influenced by various conditions of the water column such as temperature, salinity, and dissolved gas content. Measurement of these and other parameters which affect the density of the water column is a difficult task, particularly in piezometers which are several kilometers in length.

DESCRIPTYION OF INVENTION

The subject invention is intended to allow investigators to determine average piezometer water column density through knowledge of water column heights and the measurement of the velocity of sound in the water column, this being a known function of density available in one of several texts on underwater acoustics, for example the text by Urich. Sketch #1 illustrates the system which is the subject of this invention. This sketch also includes the description of commerically available sonar or sounding devices with Doppler frequency shift measurement capability to allow the determinition of the velocity of objects at any depth in a piezometer tube water column.

This invention will allow an investigator to ascertain the combined

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DISCLOSED AND UNDERSTOOD BY ME THIS 10th day of July 1984 (S) [signature] effects of several properties on the average density. These effects are identified in Table 1. The parameters, volume fraction of dissolved gas and suspended solids can complicate the problem if these parameters are a large fraction of the water column's volume, i.e., >0.001 for suspended solids and 0.0001 for suspended gas bubbles. However, with training it should be possible to reliably deduce the presence of gas bubbles or suspended solids in a piezometer in much the same way oceanographers and sonar operators can identify plants, plankton, fish, gas bubbles, or other artifacts on sonar scopes and head phones using various frequencies in their sonar investigations.

DESCRIPTION OF POSSIBLE USES AND ALTERNATIVE SYSTEM CHARACTERISTICS

The sounding device (the transducer or crystal) may be attached to an extended shielded cable and lowered any desirable distance into the water column up to the length of the available cable so as to allow investigation of selected segments of the water column for density. If sonic echo markers are installed in the piezometer tubes at known depths, (See sketch #2), differences in density along the tube can be determined. The shape of the markers in this invention is such as to tend to echo sound waves incident from above, rather than sound waves traveling up the tube from below.

The sounding apparatus described above may also be adapted to serve other purposes in the field of hydrology and geophysical investigations, for example, measuring the length of piezometer tubes or drill strings, listening for natural flow noises and noises from rock movements as well as instrument designed noises. These might include noises emitted by flow meters designed to "click" or emit noise at a frequency related to a spinning propeller, and Doppler frequency shifts related to motions of objects emitting the sounds. The use of active sound wave frequency shifts to determine the velocity of specific objects is also envisioned. For example, the use of Doppler shift measurements to identify and characterize rising bubbles and groups of bubbles and the determination of varing descent rates of test vehicles (see sketch #3) introduced into the piezometer to evaluate the existence of potential convective cells or variations in density which would alter the descent rate of those vehicles, such changes in velocities being determined by the Doppler shifts.

Special test vehicles are also depicted in sketch #3 which when coupled with Doppler shift sonar allow REMOTE sensing of various local water column parameters. This use of Doppler shift sonar is also useful in boreholes for remote geophysical logging applications where cable rigs are not practical or too expensive to use. Specially designed, battery powered test vehicles, which incorporate specific geophysical instruments designed to produce variations in a DC electric current, which powers a DC electric motor/propeller, which in turn controls the vehicles velocity in a predictable manner relative to the local intensity of the geophysical parameter being monitored and the respective electrical current, are envisioned in this application.

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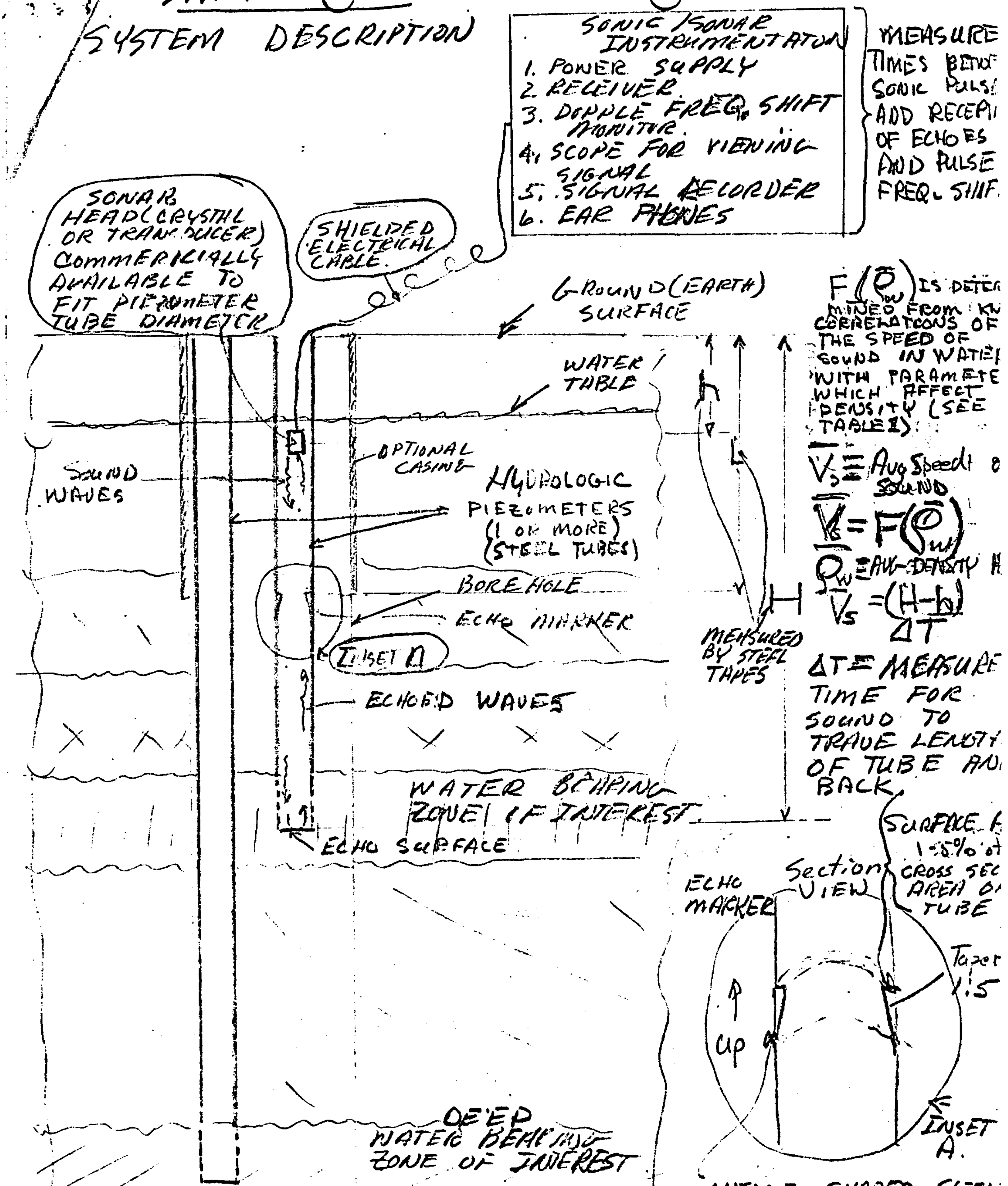
SKETCH #1



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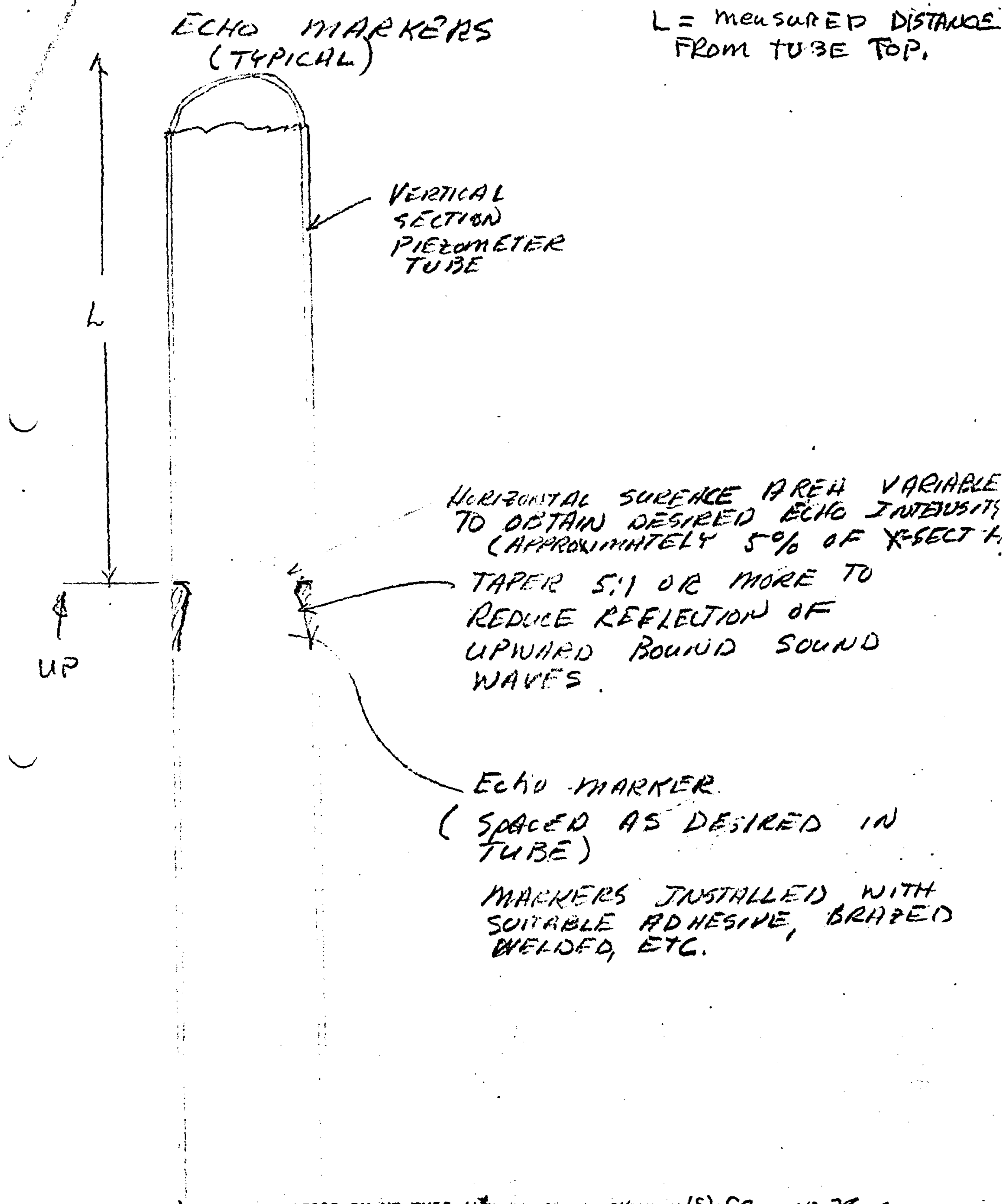
SKETCH 62 (SEE INSET A SKETCH #1)



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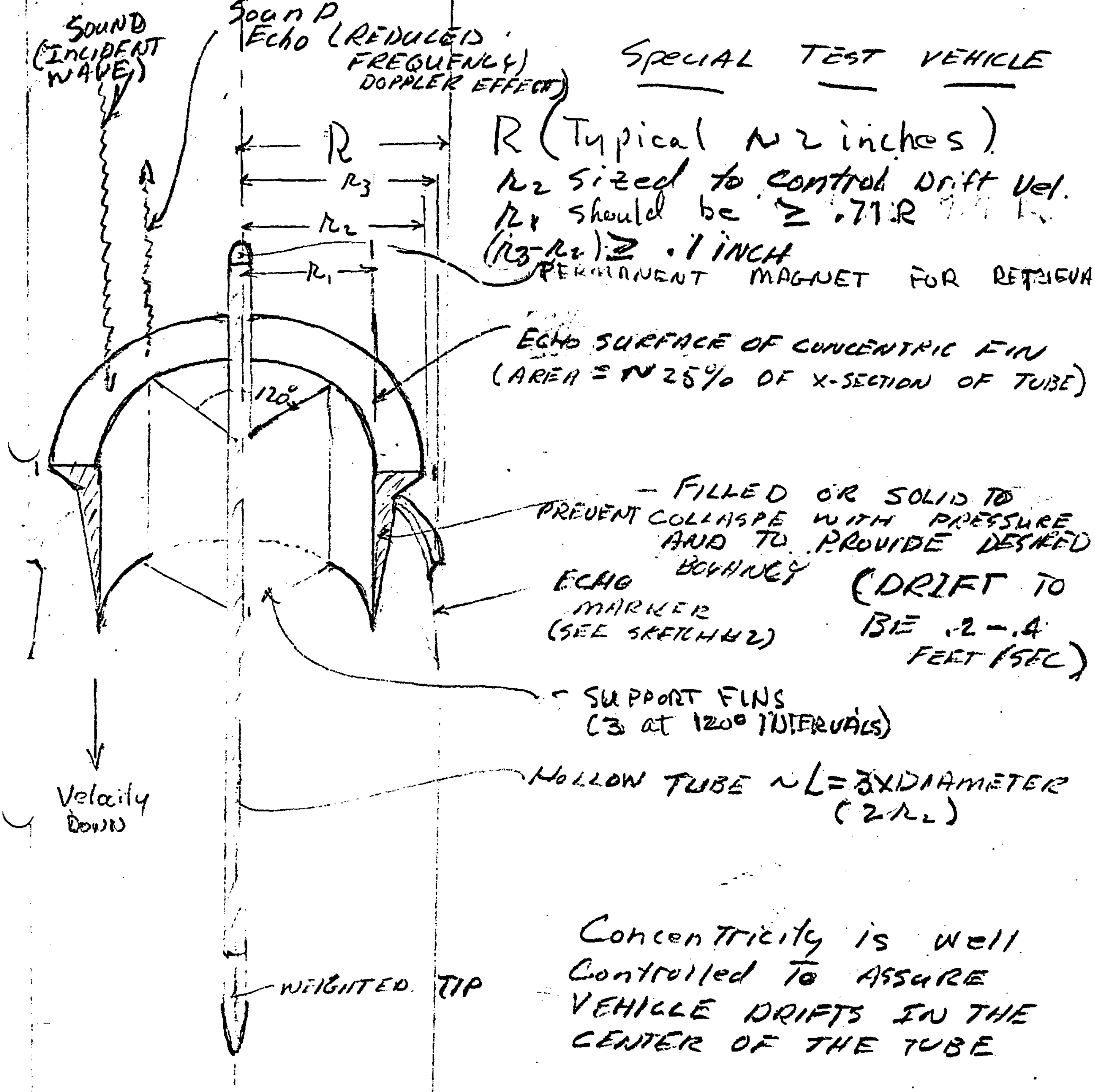
SKETCH #3

Special Test Vehicle



Concentricity is well controlled to assure vehicle drifts in the center of the tube

VEHICLE WILL BE SELF-CENTERING CONSIDERING FLAIR ON CONCENTRIC FIN

VERTICAL SECTION

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TABLE 1

PARAMETERS AFFECTING THE DENSITY OF WATER

PARAMETER	RELATIVE IMPORTANCE OF EFFECT	QUALITATIVE EFFECT
temperature	large	decreases density with temperature
pressure	small	increases density with pressure
concentration of dissolved solids	large	generally increases density with conc.
concentration of dissolved gases	medium	may increase or decrease density depending on the nature and molecular weight of the dissolved gas
volume fraction of suspended solids	large	increases or decreases depending on the density of the solids relative to the solution density
volume fraction of suspended gas (bubbles)	large	decreases density at common pressures with increasing bubble volume fraction

Correlations of the speed of sound in water as a function of the various parameters in this table can be found in standard texts on underwater acoustics or determined experimentally for the range of conditions of water columns of interest.

DISCLOSED AND UNDERSTOOD BY ME THIS 18th day of July, 1984. (S) Edward W. Kuyken

DISCLOSED AND UNDERSTOOD BY ME THIS July 18, 1984. (S) Phil Southworth