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UNIVERSITY OF MICHIGAN

ATMOSPHERIC PHENOMENA AT HIGH ALTITUDES

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ATMOSPHERIC PHENOMENA AT HIGH ALTITUDES

Department of Aeronautical Engineering

1. INTRODUCTION

This is the sixth in a series of quarterly reports on Contract No. DA-36-039 SC-15443 describing high-altitude meteorological experiments being carried out by the University of Michigan for the Meteorological Branch of the Signal Corps. This program is a continuation of one which was carried out between July 1946 and August 1950 on Contract No. W-36-039 sc-32307 and from August 1950 to December 1951 on Contract No. DA-36-039 sc-125. For background material the reader is referred to the final reports on these contracts and the previous ones of this series.

2. SUMMARY

The work during the quarter was devoted to the reduction of data from sphere Aerobee SC-29, the firing of sphere Aerobee SC-30, and planning for further sphere firings. The study of possible causes of separation in the sampling or analysis techniques continued. The design of sampling Aerobee SC-31 and the development and testing of a two-inch sealer were completed.

3. SPHERE EXPERIMENT

3.1 SC-29

The firing of SC-29 on 11 December 1952 was described in Progress Report No. 4. The completed tabulated DOVAP count was received from BRL and corrections for spin carried out. A typical complete correction for spin proceeds as follows:

a) Plot counts per half second as a function of time for all receivers.

b) Difference tabulated counts from two receivers at one station whose antennas are oppositely polarized.

c) Divide differences by 2 and add or subtract to raw counts as required by antenna phase condition indicated in plot.

d) Plot results of step 3.

Fig. 1 is a plot of counts per half second of two receivers at each of two stations for SC-29. Since each doppler count is a distance equal to one wave length, the ordinate of the plot is the velocity, and the slope the acceleration of the transmitter-sphere-receiver distance. Steps (a) to (d) usually provide good spin correction for regions of the plot between cross-over points. The cross-overs seen in Fig. 1 result from "tumbling" or rotation of one or both of the antennas about a transverse axis. Corrections for tumbling are made by a skill technique which is partially explicit and and partially cut-and-try as follows:

e) The DOVAP film is examined in the region of cross-over points and the nature of the phase changes due to tumbling noted. Depending on the types of antennas, the geometry of the transmitter-sphere-receiver combination, and the spin and tumble rates, the phase change due to tumble will be 1/2, 2/2, or 3/2 cycle occurring at varying rates and distributed in time linearly or nonlinearly. The counts are corrected at the cross-over points on the basis of a judgment of the above factors.

f) In general, the totalized corrected count should agree with the totalized raw count and further adjustments, usually minor, are made to meet this condition. For example, in SC-29 the deviation of the corrected count did not exceed 5 cycles for stations B, F, and G, and 12 cycles for station K.

The preceding steps represent actual corrections to the count data and constitute the major modification made in the raw data. A lesser amount of smoothing may also be applied, either graphically or to the tabulated count, as follows:

g) The count data (positions) are differenced in increasing order until the differences are nearly constant over an interval of about 5 seconds. Where the curvature is large, differences as high as the fifth may be taken. All differences of the highest order are then adjusted to be equal to the mean for the interval being considered. The adjustments are then propagated through the decreasing-order differences to the count or position data. Readjustments may be necessary to adhere to the condition of step (f) that the total corrected count be approximately equal to the total raw count. The smoothing process described here corresponds approximately to fitting curves of various orders (depending on the order of the differences taken) to the data by a least squares method.

h) The final step in the trajectory reduction is to introduce the corrected count data and the parameters of the geometry of the DOVAP stations into the ORDVAC computer at BRL. Data from three stations are required to solve for the position of the sphere. The computer gives a least squares solution for each position point using the data from four stations taken three at a time. The trajectory is given in terms of x, y, z coordinates of position as a function of time.

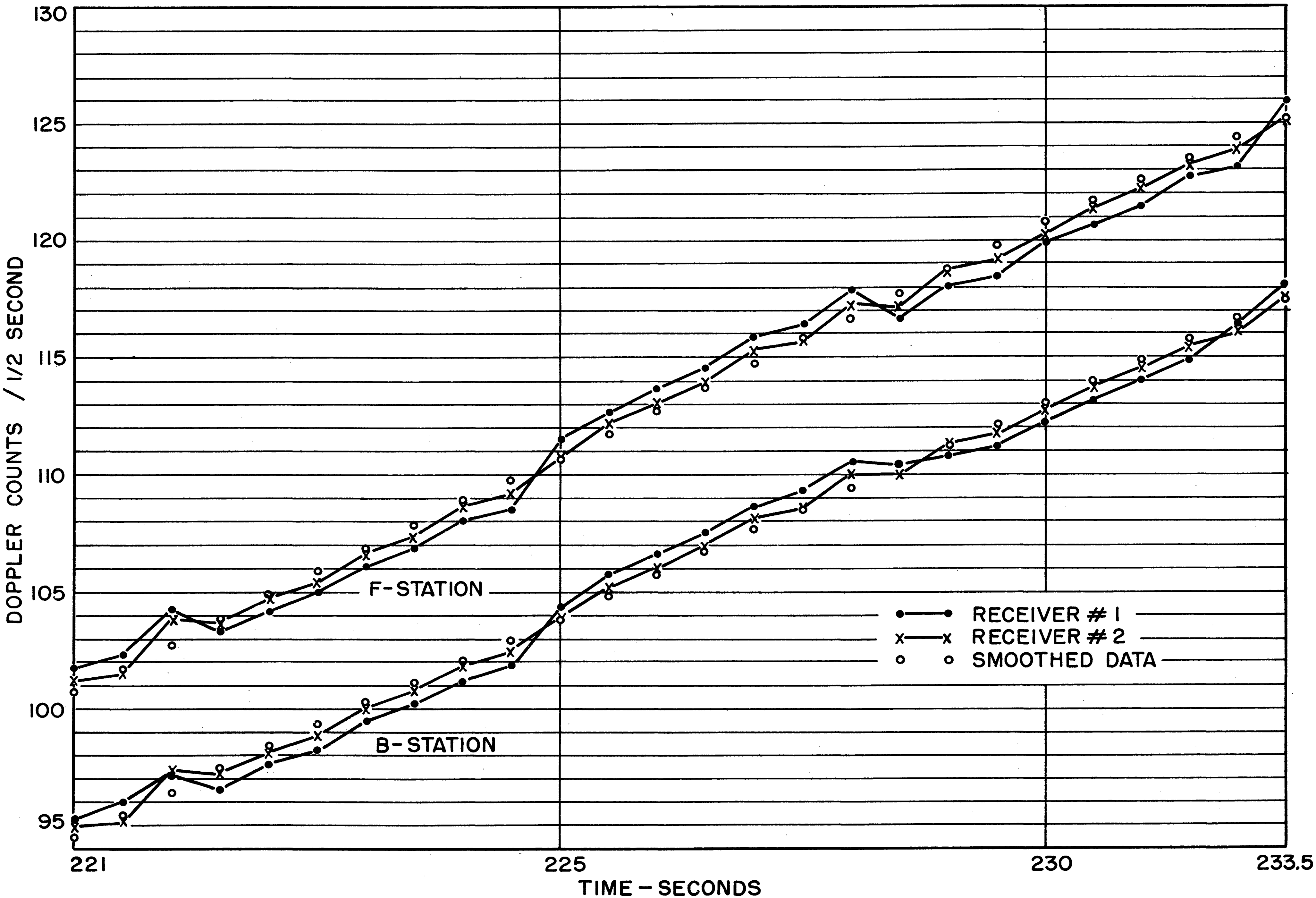


Fig. 1. DOVAP Cycle Counts vs. Time, SC-29.

It can be seen that for a 300-second trajectory of a spinning, tumbling sphere steps (a) to (g), particularly (e), would take considerable time to carry out. The entire process was employed by BRL in the reduction of SC-23. In an attempt to shorten the process for SC-29, two variations were tried and compared. At Michigan the entire process was carried out with the exception that in step (e), spin and tumble effects were deduced from the count plots without reference to the film. At BRL steps (b) and (c) were done on a computer and the results plotted. Smoothing was then done graphically on the plots. Some idea of the relative quality of the corrected and smoothed data may be gained from the magnitudes of the difference between position points obtained using just enough stations (three) and the least squares point of four stations taken three at a time, i.e., the maximum residuals:

Process	Maximum Residuals
Complete process as in SC-23	8 feet
Simplified manual spin correction as in SC-29 (Mich.)	12 feet
Computer spin correction as in SC-29 (BRL)	25 feet

An unknown part of the superiority of the SC-23 reduction may be attributed to the more favorable position which this sphere had with respect to the DOVAP stations than did the one in SC-29.

Various possibilities exist for reducing the spin error and the reduction time. In Progress Report No. 5 it is shown that a single antenna in the sphere for transmitting and receiving reduces the spin correction ambiguity. Antenna configurations which introduce spin cycles instaneously or as a linear function of time may be possible. A considerable saving in time in the counting of the doppler cycles which precedes step (a) above may be realized from the use of electronic counters counting cycles recorded on magnetic tape during the flight. See Section 3.5.

3.2 SC-30

The design of the instrumentation for the third sphere Aerobee SC-30, originally scheduled for 7 April 1953, was described in Progress Report No. 5. The firing date was changed to 22 April so that the flight would take place on the same date as a Signal Corps grenade Aerobee for measuring temperatures. No particular difficulties were encountered in preparing the missile and instrumentation for flight at White Sands although trouble with communications from the DOVAP stations to the recorder station once again caused a one-day delay. The launching took place at 1232 hours MST on 23 April in rain and with the sky completely overcast. Trajectory information will not be available until the DOVAP data have been reduced because the missile radar beacon transponder failed shortly after take-off.

From the DOVAP frequency record it was determined that peak time was at 185 seconds which indicates, by comparison with other Aerobees, a peak altitude of about 365,000 feet MSL. The payload weight was 127 pounds, and the missile was pressurized with helium.

The sphere apparatus apparently functioned perfectly with the exception that the single channel telemeter commutator stuck on the 0-volt calibration point from x+35 to x+330 seconds. The telemeter channel was used to transmit sphere pressure as in previous spheres. The record, shown in Fig. 2, shows the pressure descending in the early part of the flight and drifting downward slowly through the design value of 3 psia. It is thought that the sphere was properly inflated throughout the flight. The pressure decrease may be due to cooling in the low-velocity portion of the trajectory. At 470 seconds the pressure rise due to increasing ambient pressure commences. The altitude at which the ambient pressure is 2.6 psi is about 41,000 feet.

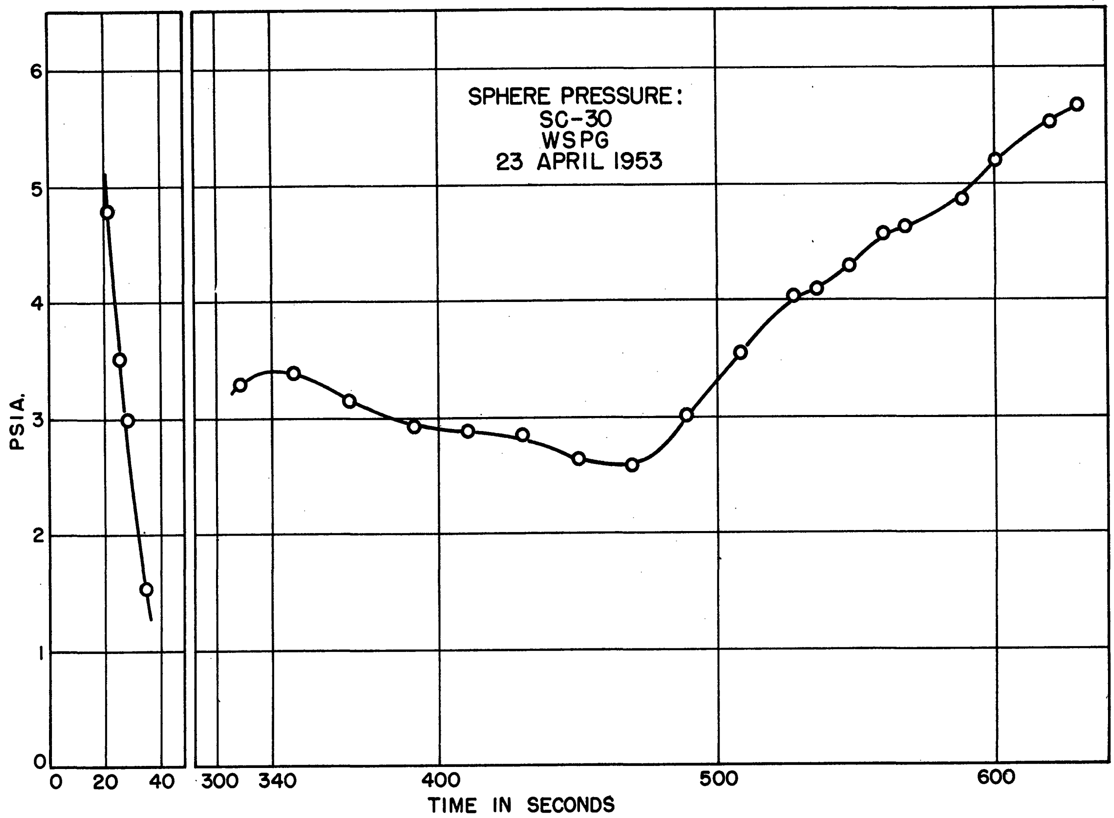


Fig. 2. Flight Sphere-Pressure Record, SC-30.

The DOVAP transponder in the sphere operated throughout the flight. All DOVAP receivers also operated throughout the flight. However, from x+250 seconds until x+374 seconds recording at the central camp recorder station failed because of a failure of the local power source within the laboratory building. The transmitter and four receivers at B station and a single receiver at station D-4 near Holloman Air Force Base continued to operate and record throughout the flight. Unfortunately, the interval x+250 to x+374 seconds is almost exactly the measuring interval of the sphere drop. Thus the calculations must be based on a two-station trajectory reduction. Since three stations are required to solve for position, it will be necessary to solve for the projection of the trajectory on a horizontal plane from the data from x+0 to x+250 seconds and extrapolate this direction to x+374 seconds. It is thought that a solution can be made, but the precision will be reduced.

Fig. 3 shows a DOVAP field-strength record for the B3 receiver. The spin rates of the missile and sphere are indicated by the periodic fluctuations. The DOVAP command signals for ejection are seen at about x+170 seconds. The impact coordinates for the missile and sphere with respect to the launcher were, respectively: 92,944 feet north, 39,004 feet west and 83,541 feet north, and 28,601 feet west.

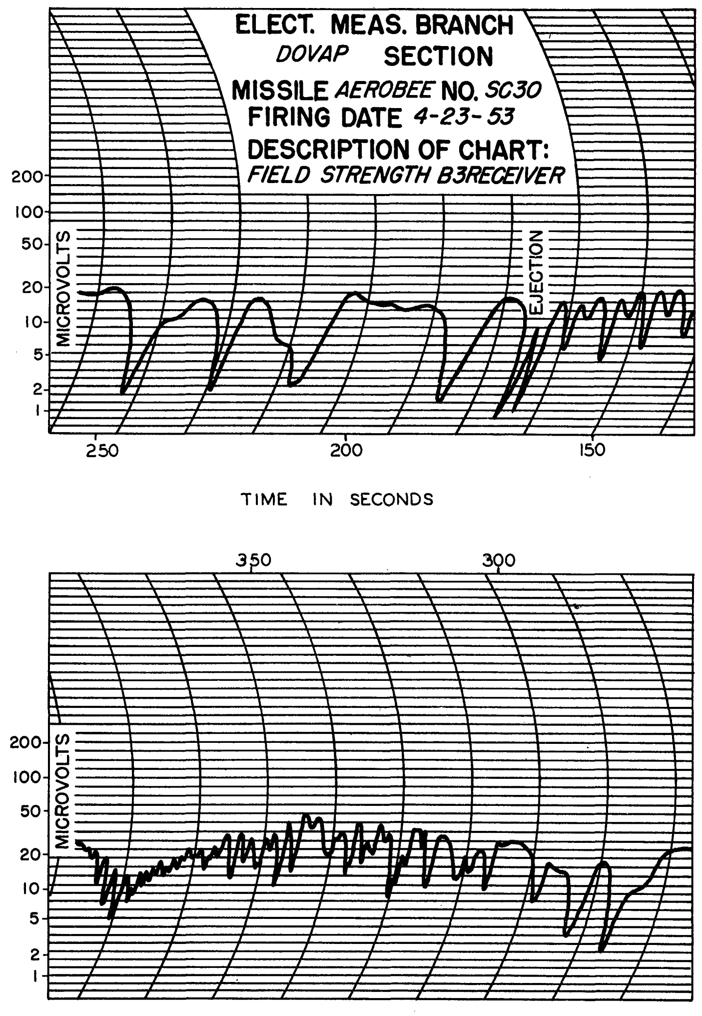


Fig. 3. DOVAP Field-Strength Record, SC-30.

3.3 Further Sphere Firings

Planning for a series of high-latitude firings of the sphere experiment in the summer of 1954 was started. The general features of the operation were to be as follows: A land-based transportable DOVAP system consisting of a transmitter and recording station and three or four receiver stations would be established in advance at a suitable location. The launchings would take place on a ship operating in a favorable position with respect to the DOVAP array. Because of the relatively high cost of the Aerobee and the Aerobee shipboard launching operation, the redesign of the experiment for the Deacon rocket-balloon combination was undertaken. In order to reduce the data reduction time, the possibility of using magnetic recording and electronic counters for counting DOVAP cycles was investigated.

It appears now that the high-latitude firing program will be postponed and that the next step in the sphere program will be an Aerobee firing at White Sands in September, 1953. The work accomplished on such improvements as a lighter sphere packing in a smaller space and automatic counting equipment, which were contemplated for the high-latitude operation and which have application in a White Sands firing, is described in Sections 3.4 and 3.5. Work on the following problems peculiar to the high-latitude operation was started but will be temporarily suspended.

Tracking - Minimum requirements of a transportable DOVAP system, optimum DOVAP geometry, measurement of initial point of sphere trajectory, radar tracking during balloon ascent, power requirements during balloon ascent.

Rocket - Deacon performance: peak altitude, stability, trajectory. Deacon launching: vertical take-off, antifouling, acceleration loads. Operation: firing command, sphere ejection command.

Other - Balloons, winds (preflight sonde runs), personnel requirements, costs, etc.

3.4 Light-Weight Sphere

The original predictions of the performance of the sphere experiment were based on a sphere 6 feet in diameter, weighing 20 pounds, and dropped from 400,000 feet. The latest actual version in SC-30 was 4 feet in diameter, weighed 50 pounds, and was dropped from 365,000 feet, the engineering compromises resulting in a lower altitude at which densities and temperatures could be measured with useful precision. In order to accommodate the sphere in the Deacon rocket, the internal structure of the sphere was redesigned. Using a 4-foot diameter nylon sphere as before, the predicted weight is 20 pounds. To take advantage of the higher altitude limit and the relative simplicity of the new design, it will be completed and used for the next White Sands flight. The new sphere design is shown in Fig. 4.

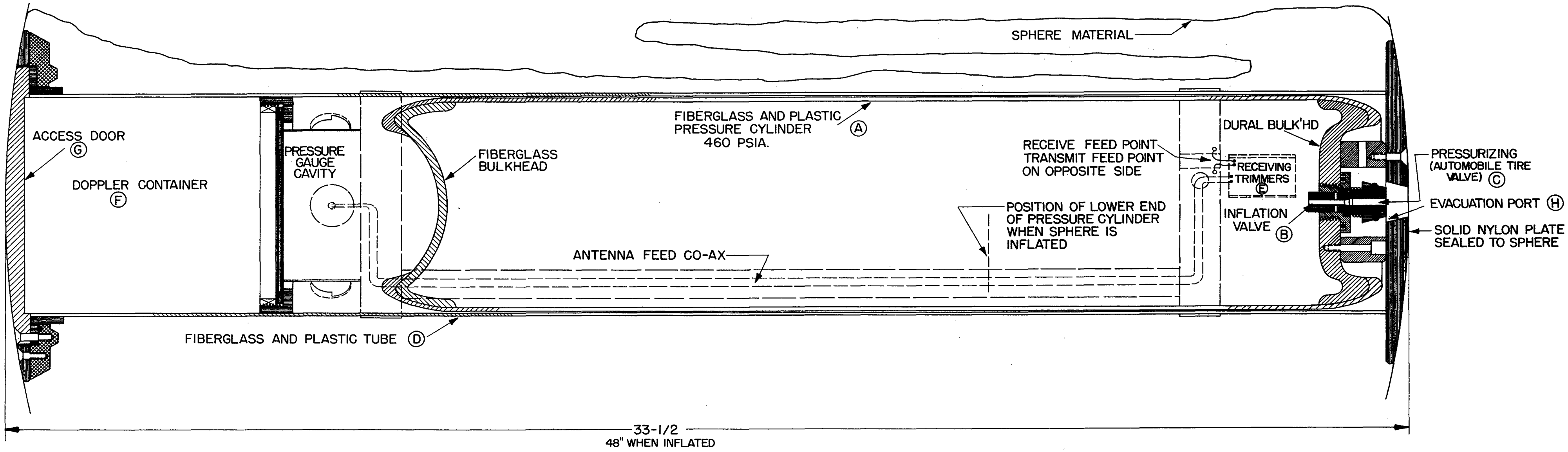


Fig. 4. New Light-Weight Sphere.

The pressurizing air is contained in a glass pressure cylinder A at 460 psia. An inflation valve B, similar to previous ones, is opened upon ejection of the sphere. The pressure cylinder is filled through a pressurizing valve C located in the inflation valve B. During ascent the sphere is maintained at ambient pressure by port H, which closes on ejection. The pressure cylinder A slides in glass tube D, thus permitting a small packing size and allowing the sphere to assume its free diameter on inflation. The single DOVAP antenna is mounted on the outside of tube D. The antenna is fed at the upper (right) end through matching networks and wave traps mounted at E. The DOVAP transponder F, weighing three pounds complete with one-shot batteries, is mounted on the access door G at the bottom. There is no upper access door. This design separates the pressurizing and DOVAP functions of the sphere. The ejection system and rocket auxiliary circuits will be similar to those of SC-30 described in the previous report.

3.5 Data Reduction

The following memo summarizes the results of a preliminary study made of a method of speeding up DOVAP reductions by the use of magnetic recording and electronic cycle counting. Similar systems have been proposed elsewhere and are being developed for other applications. The specifications below were chosen with the high-latitude sphere flights in mind but, with some simplifying modifications, could be used for sphere flights at White Sands in conjunction with the present DOVAP installation there.

"AN ALTERNATE METHOD FOR RECORDING AND REDUCING DOVAP DATA

"In connection with Signal Corps Contract No. DA-36-039 SC-15443, three sphere (Ref. 1) experiments for high-altitude temperature measurements were flown at White Sands Proving Ground, New Mexico. The DOVAP (Ref. 2), a system for surveying high-altitude rocket trajectories, was a necessary and integral part of this experiment.

"On the basis of these experiments an investigation was made of the possibility of conducting this experiment at higher latitudes. The initial approach was to determine whether or not a simpler system could be used for this purpose. The possibility of a single doppler transmitter-receiving station plus a radar was investigated. This proved to be inadequate due to the angular error of the radar. Other single-station systems were considered. One was the Azusa, an interferometer phase comparison system. These systems were all thought to be too elaborate for the purpose. It was decided that DOVAP was the simplest system having the required accuracy.

"A re-evaluation was made of the DOVAP to see what modifications would be required if a new system were to be built. It was thought that the present method of recording and reducing the data could be improved. The present method of recording the data is to place the doppler signals on one set of plates of an oscilloscope and move the film across the screen. The motion of the film forms the time base. There are 4 channels recorded on a 35-mm film.

"The reduction of these data is done with the aid of a special stroboscopic film reader (Ref. 3). This instrument counts the total number of cycles to the nearest tenth of a cycle. The total is recorded at the end of each 1/2-second interval, which intervals are obtained from time signals recorded on the film. These counts are automatically differenced to see that no gross errors are made.

"A great many improvements have been made in magnetic tape recording equipment and electronic counters since the original DOVAP system was set up. In view of these developments it seemed that a system employing these components would have several advantages. The recording would be simpler and the processing of the film eliminated. The counters required in the reduction would be less expensive and more rapid than the special stroboscopic film reader.

"The proposed system would employ a 13-channel magnetic tape recorder. These 13 channels would be recorded on a single tape 1 inch wide. The proposed doppler set-up would consist of one transmitter and four receiving stations with two receivers each. The transmitting antenna would be a helix; one receiver antenna at each station would be a right-hand helix, and the other receiver antenna would be a left-hand helix. Thus, there would be a total of eight channels of doppler frequencies. This information would be communicated to a master station via an FM-FM data transmitter. In addition to these channels, three time signals and the command circuit (voice) would be recorded. The primary time signal would be a 50-kc note recorded on two channels. A 100-cycle note would be recorded on a single channel. The purpose of the latter signal would be for calibration in the low frequency doppler region if the doppler signal had to be examined more carefully, e.g., from a Brush recorder record. The third timing signal to be recorded would be two-per-second pulses.

"The channel line-up across the tape would be as follows:

1. Pulses 2/sec	4. 50 kc	7. 100 cps	10. 50 kc
2. Doppler DC-800 cps	5. Doppler	8. Doppler	11. Doppler
3. Doppler	6. Doppler	9. Doppler	12. Doppler

13. Voice (250-3000 cps)

The proposed line-up is such that no doppler channel is more than two channels away from the primary timing signal. This is done to avoid possible errors due to uneven tape stretch.

"In the process of reducing the data, the initial required information is the total number of doppler cycles at the end of each half second. This information would be obtained with the equipment shown in the block diagram of Fig. 5 below. The operation is as follows: Each doppler channel is counted separately. The doppler signals are fed into the shaping amplifier indicated. The 50-kc signal from the channel closest to the doppler channel being counted is fed into the other shaping amplifier. The shaping amplifiers form pulses at the negative-going cross-overs of the sine wave inputs. These pulses are located on the sine waves to an accuracy of 1/10 of a wave length. The 50-kc pulses are totaled in the eight-decade counter, and the doppler pulses are totaled in the five-decade counter. The 1/2-second pulses from the recording are used as read-out pulses. The read-out pulses are sent to the five-decade counter where they activate the read-out circuit so that when the next doppler pulse is counted, the total count is read out and stored in the storage register. At the same time the total count in the eight-decade register is read out into the storage register. During the next 1/2-second interval the count in the storage register is transferred to magnetic tape for permanent storage in coded form. This process empties the storage register so that it is set up to receive a new set of data from the counters 1/2 second later.

"The doppler channel being counted would be continuously monitored and when the doppler signal dropped to zero, the five-decade counter would be reset to zero. The reason for doing this is that the zero occurs at the peak of the trajectory, and the doppler signals should have a negative sign after this point. A trajectory solution could be made up to this point and then a new solution started on the computing machine, which would be programed to subtract cycles beyond this point and continue with the same solution.

"After counting all the doppler channels and storing the information on magnetic tape, the information would be fed into an IBM or high-speed digital computer. The rate at which this was done would depend on the type of computing machine used.

"The information at this point is a recording of an integral number of doppler cycles and the corresponding times at intervals of approximately 1/2 second. A linear interpolation would be made to determine the fractional number of doppler cycles for exact 1/2-second intervals. The determination would be made to the nearest 1/10 of a doppler cycle. The procedure from this point on is the same as that now employed by BRL.

References

1. Atmospheric Phenomena at High Altitudes, University of Michigan, Engineering Research Institute, Progress Report No. 5, Final Report, Signal Corps Contract No. W-36-039 sc-32307, January 31, 1952; and Progress Report No. 5, Quarterly Report, Signal Corps Contract No. DA-36-039 SC-15443, April 30, 1953.

2. Scientific Monthly, 68 (1949), p. 172.

3. The Stroboscopic Film Reader, BRL Technical Note No. 5, March, 1949.

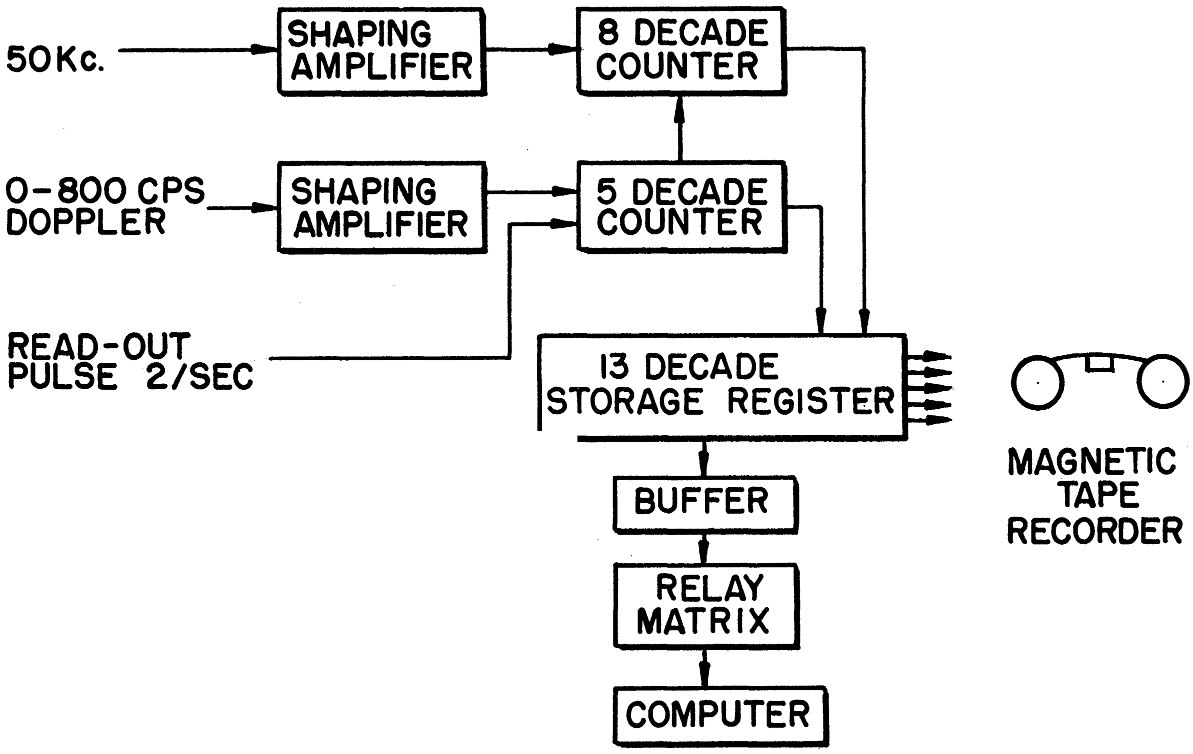


Fig. 5. Counter Block Diagram.

"Counter Specifications

1. Timing Counter
   a. Input - 50-kc sine wave
   b. Counting rate - 50 kcs
   c. Maximum count - 8 decades
   d. Input level and impedance - to be determined
      In general, 1 volt at 600 ohms
   e. Read out - each 1/2 second without effecting the count

2. Doppler Counter
   a. Input - 0-800 cycle sine wave
   b. Counting rate - 800 cps
   c. Maximum count - 5 decades
   d. Input level and impedance - same as 1d
   e. Read out - same as 1e

3. Storage Register for Above Information

4. Recording and Coding Medium

5. Input to IBM Equipment or High-Speed Digital Computer"

L. W. Chaney
June 1953

"Recorder Specifications

1. Number of Channels - 13 (minimum).

2. Signal Frequencies:

Channel	Frequency
1	Pulses (2 per second)
2	DC - 800 cycles
3	DC - 800 cycles
4	50 kc
5	DC - 800 cycles
6	DC - 800 cycles
7	100 cycles
8	DC - 800 cycles
9	DC - 800 cycles
10	50 kc
11	DC - 800 cycles
12	DC - 800 cycles
13	Voice 200-3000 cycles

3. Adjacent Channel Crosstalk - 40 db below maximum signal level.

4. Phase Shift - The phase shift (record through playback) of channels 2, 3, 5, 6, and 7 relative to channel 4 shall be less than 15 degrees of the modulation frequency; a similar specification shall apply for channels 7, 8, 9, 11, and 12 relative to channel 10. The above specification covers all sources of phase shift such as electronic, mechanical alignment, tape stretch, etc.

5. Recording Time - 15 minutes (minimum).

6. Dynamic Range - 40 db (minimum).

7. Input Signal Amplitudes - To be determined.
   In general, approximately 1 volt RMS.

8. Input Impedances - To be determined; in general, 100 k (min.).

9. Erase - No erase heads to be incorporated in tape recorder.

10. Wow and Flutter - Consistant with Spec. #4.

11. Rewind - Fast forward and reverse rewind to be provided. Maximum rewind time 20 percent of recording time.

12. Monitor - Continuous monitor of channels 1, 4, 7, and 10 to be provided. Monitor of channels 2, 3, 5, 6, 8, 9, 11, 12, and 13 to be available singly by switching. All monitoring to be available from separate monitoring playback heads during recording. Phase shift during monitoring need not conform to Spec. #4. Monitoring outputs to conform to Spec. #13.

13. Output Impedance and Amplitude - To be determined.
In general, approximately 1 volt at 600 ohms.

14. Distortion - Total harmonic distortion of playback signals to be less than 10 percent.

15. Power Source - 115 VAC, 60 cycles portable motor-generator set.

16. Playback - Continuous playback of channels 1, 4, 7, and 10 to be provided. Playback of channels 2, 3, 5, 6, 8, 9, 11, 12, and 13 available singly by switching.

The total number of channels could be reduced and the phase shift requirements eased if a technique is available whereby the 50-kc timing signal could be used as the carrier for the DC 800-cycle channels. In the event that such a technique were used, it would be necessary to provide means for recovering the 50-kc and the modulating frequency without frequency or phase distortion to either signal."

E. J. Schaefer
June 1953

4. SAMPLING

4.1 Sample Analysis

The preparation of four control bottles containing ground air has been described in previous reports. The analysis on one "vial" type and one "chamber" type by Professor Paneth showed no separation, and it was tentatively concluded that sorption in the bottles and "static orifice selection" were not causes of the measured separation in upper-air samples. During the quarter the results of the analysis of the remaining two bottles (both "vial" types) were received from Professor Paneth. These samples showed an appreciable increase in helium and neon and a decrease in argon with respect to nitrogen over the accepted values for ground air. The results from the four control bottles are shown below:

Bottle	Type	Date of 1st Analysis	Bottle Pressure mm Hg (Mich.)	Bottle Pressure mm Hg (Durham)	Amount Sample cc NTP (Durham)	Analysis* (Durham) O_2	He	Ne	A
B-17-P	chamber	12-17-52	.0185	.0189	0.151	0	0.994	1.001	1.00
B-18-P	vial	12-19-52	.0165	.0165	0.134	0	0.997	1.003	0.99
B-20-P	vial	12-29-52	.0202	.0150	0.12	0	1.25	1.03	0.92
B-21-P	vial	12-30-52	.0174	.0162	0.13	0	1.36	1.08	0.92

$$* \quad \frac{\text{Volume ratio to } N_2 \text{ in sample}}{\text{Volume ratio to } N_2 \text{ in ground air}} .$$

The fact that separation due to an unknown cause has been detected in ground air samples throws doubt on the previous conclusion reached--that diffusive separation occurs in the upper atmosphere starting at 60 km. The possibility that separation in upper air samples resulted from some supersonic flow phenomenon was considered earlier. Aerobee SC-31, designed to sample at a subsonic velocity and with large (2-inch) intake tubes, was planned to eliminate such a phenomenon. Now, however, further work on SC-31 will be suspended until the cause of separation in the ground air samples is determined.

Selective adsorption and selection by a small orifice are the most likely processes suggested which could account for the control bottle results. Attempts to formulate a simple picture consisting of adsorption and/or orifice selection have been unsuccessful. For instance, if one proposes nitrogen adsorption as the cause of the apparent increase in helium, the pressure loss in B-20-P is sufficient; in B-21-P, on the other hand, it is not, and desorption or effusion of helium must be supposed. A selective leak in the analyzer is a possibility but is presumed to be eliminated by the analysis of Durham ground air samples interspersed with the control bottle runs.

4.2 Control Experiments

Two experiments have been undertaken which, it is hoped, will narrow the field of possibilities and suggest further experiments leading to a detailed explanation. At Durham an analysis of an upper air sample is being carried out as follows:

a) Attach sample bottle to the analyzer.

b) Transfer sample to a storage vial attached to the analyzer.

c) Transfer portion from the vial to the analysis section and analyze.

d) Bake and evacuate bottle in the same way as it was before flight.

e) Transfer sample back to the bottle and allow it to stand until pressure equilibrium is reached.

f) Extract and analyze sample again for comparison with the first analysis.

By this process the upper-air bottle and sample are both used in a control experiment for adsorption or selection caused by some process occurring during the manipulation of the sample.

At Michigan a study of total adsorption in the bottles (without analysis) is being made. A sample bottle was attached to an experimental gas-handling system. An oven was built around the bottle to permit baking during evacuation just as is done on the system used to prepare flight bottles. The experimental system was also provided with a storage vial and stopcock arrangement for admitting small known quantities of air to the bottle and a McLeod gage to measure the bottle pressure. The experiment then proceeded as follows:

a) Bake and evacuate bottle as for flight. Final pressure < 0.01 μ Hg.

b) Close off pumps from system with Hg valve.

c) Admit small slug of air. Amount is sufficient to increase bottle pressure by a little less than 1 μ Hg. Bottle volume is 8200 cc.

d) Monitor bottle pressure. In 6 days pressure increased from 0.8 μ Hg to 1.1 μ Hg.

e) Admit second slug of air. Read bottle pressure.

f) Admit subsequent slugs of air at 10-minute intervals and read bottle pressure.

Fig. 6 is a plot of the expected and measured bottle pressures plotted against the number of the slug admitted. It is to be noted that the pressure is slightly higher than expected for the first few slugs and then becomes lower. This may represent a change from net desorption to net adsorption as a result of increasing pressure. Time lapses of 20 hours occurred between the 11th and 12th slugs and 15 hours between the 31st and 32nd slugs. At the lowest point of the 31st slug, the pressure is 18 percent lower than expected.

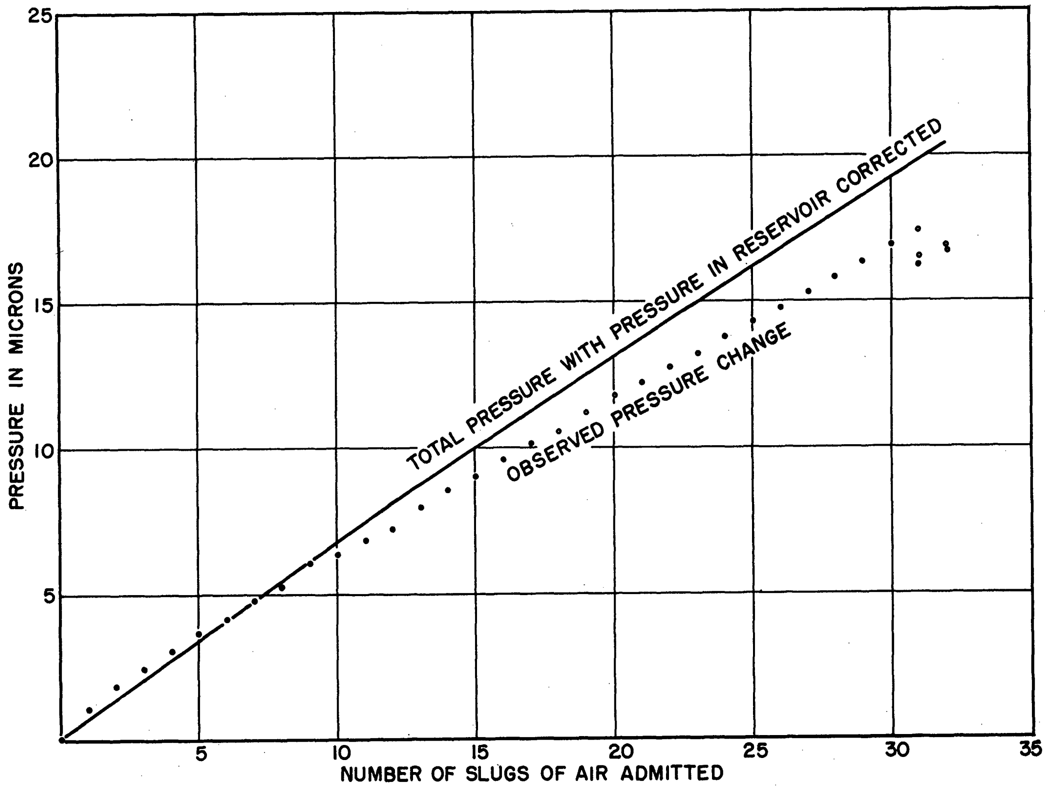


Fig. 6. Plot of Control-Bottle Pressures.

It is thought that a great deal may be learned from this type of experiment. The adsorption of pure gases and known blends as a function of time and pressure may be investigated without analysis. In order to permit manipulating the samples more easily, a rebuilt system with a new oven was planned and construction begun. A schematic of the apparatus is shown in Fig. 7.

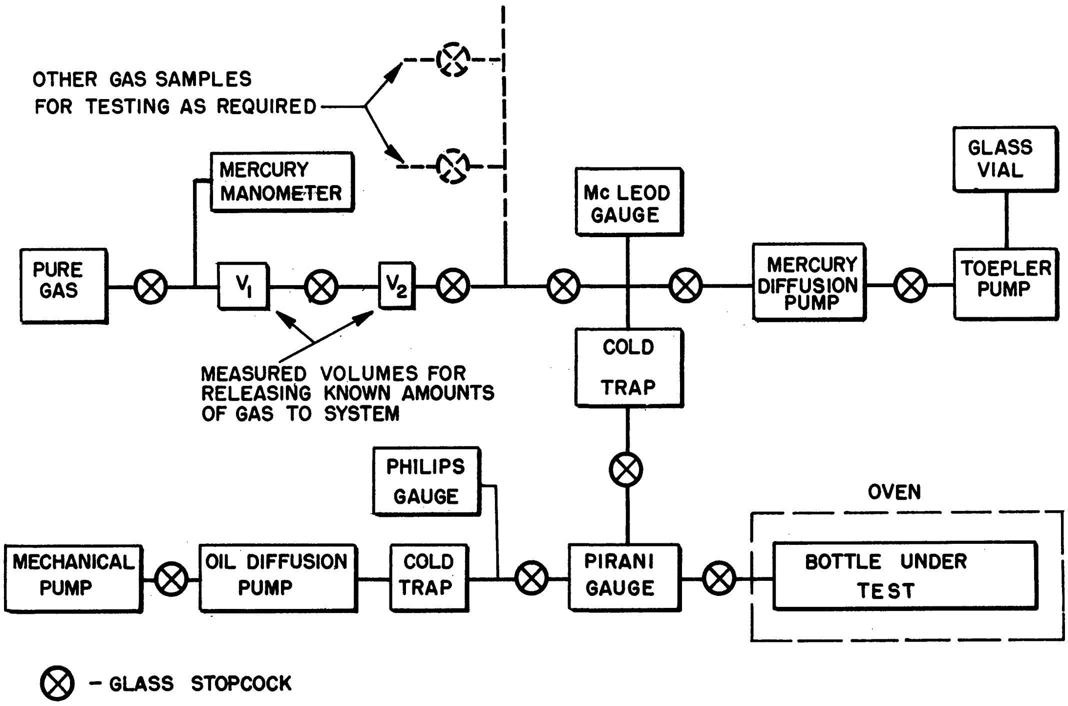


Fig. 7. Schematic of Adsorption Apparatus.

4.3 Control Samples for O^{34}/O^{32} Measurements

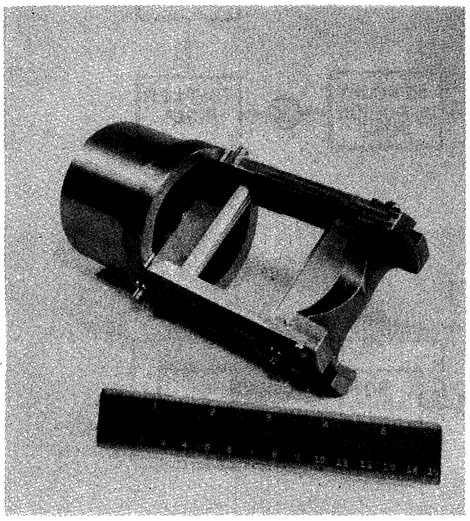
The increase in the O^{34}/O^{32} ratio, measured mass spectrometrically in two upper air samples by Dr. M. Dole of Northwestern University, was reported in Progress Report No. 3. We have received the results of the analysis of the contents of three vials containing ground air from a steel sample bottle prepared as a control for Dr. Dole:

Ground-Air Sample	Result
Pyrex vial (#232)	≈ 0.4 percent oxygen No change in O^{34}/O^{32} ratio from accepted ground-air value
Pyrex vial (#233)	≈ 2 percent oxygen
Lime Glass vial	Apparent leak

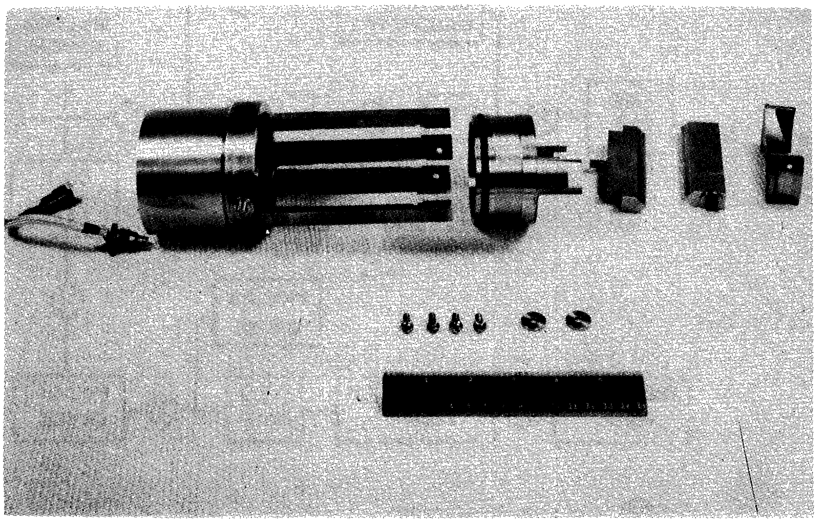
Since all three vials were filled simultaneously from the same control bottle, the difference in the amount of O_2 in the first two is anomalous. In view of this and the loss of the third vial, new controls will be prepared.

4.4 Two-Inch Cold-Weld Sealer

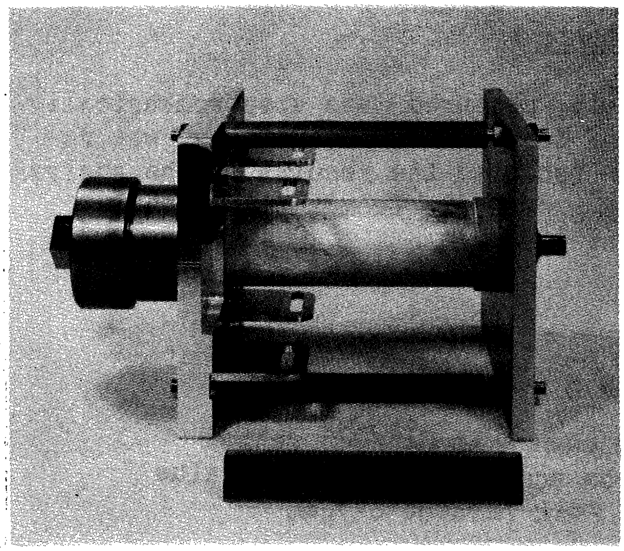
The construction of a prototype cold-weld sealer for sealing 2-inch copper tubing was completed and testing begun. The sealer, described in the previous report, will be used on sampling Aerobee SC-31. Figs. 8a and 8b show the assembled and disassembled sealer. Fig. 8c is the testing jig with a test piece of 2-inch tube in place. Fig. 8d shows the sealer mounted around the tube. Several successful seals have been made although further investigation of the amount of powder will be necessary. Too much powder causes flattening of the jaws, which results in a poor seal.



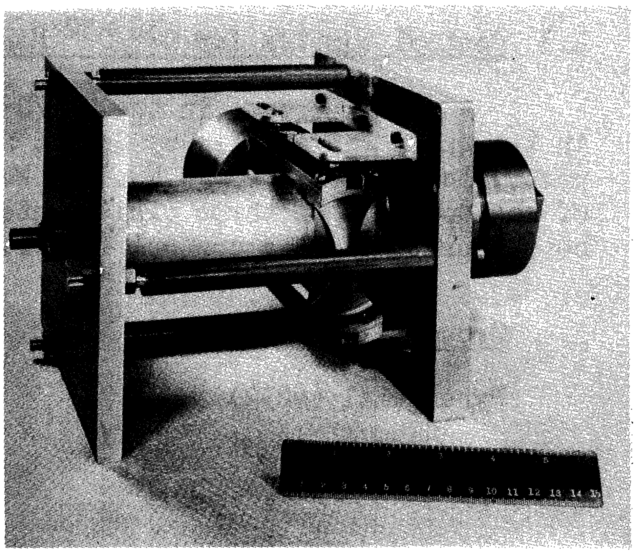
8a



8b



8c



8d

Fig. 8. Sealer for 2-Inch Tubing.

5. REPORTS ISSUED AND LABORATORIES VISITED

Technical Memorandum No. 6, A Technique for Rendering Solutions to the Problem of Ambient Temperature Measurements in the Upper Atmosphere by V. C. Liu, originally issued in December, 1952, was reissued with corrections.

The following places were visited during the course of the work:

Ballistic Research Laboratories
Evans Signal Laboratory
Goodyear Tire and Rubber Company
Potter Instrument Company
State University of Iowa
White Sands Proving Ground

6. FUTURE PROGRAM

Reduction of data from sphere Aerobee SC-29 and SC-30 will continue. Preparation of the fourth sphere Aerobee will continue. The investigation of possible sources of separation in upper-air samples other than upper-air phenomena will continue.

7. ACKNOWLEDGMENT

Thanks are due the Meteorological Branch of the Signal Corps for cooperation and support and to Ballistic Research Laboratories for continued cooperation in the sphere experiment. We are also indebted to personnel at White Sands Proving Ground for help in the preparation of Aerobee SC-30, and to Dr. J. A. Van Allen of the State University of Iowa for valuable information concerning his technique of launching Deacon rockets from balloons.