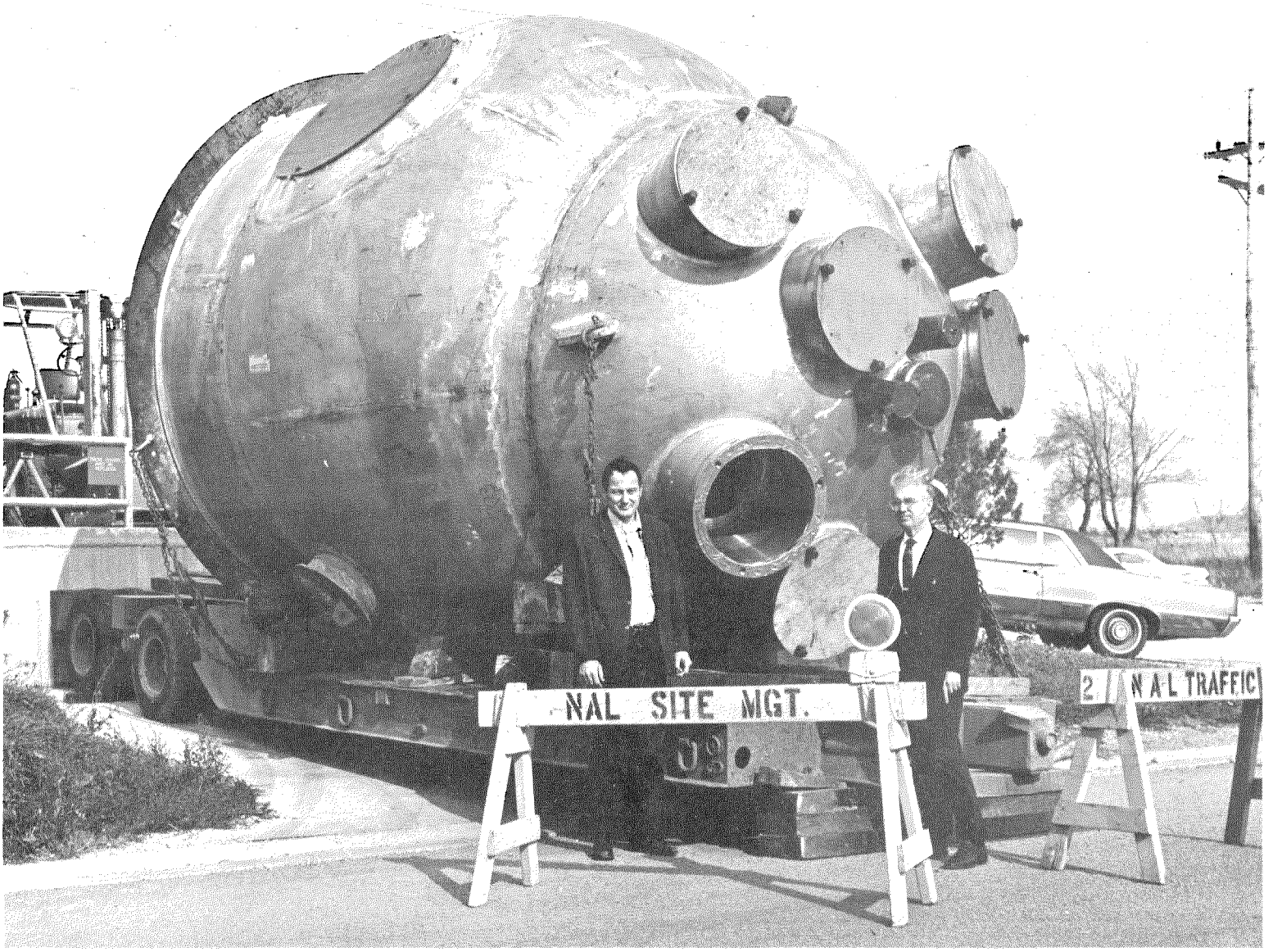
national accelerator laboratory

FERMILAB-NAL-063

0090.01

MONTHLY REPORT OF ACTIVITIES

October 31, 1971



15-FT BUBBLE-CHAMBER VESSEL

Operated by Universities Research Association Inc. Under Contract with the United States Atomic Energy Commission

THE COVER: Chamber vessel for the 15-ft bubble chamber which was delivered to NAL on October 25. Hydrostatic pressure test at the manufacturer's plant was successful, and the inside surface is prepared for "wall-papering" with Scotchlite, the material used for viewing the tracks. The chamber is scheduled to be mounted in its final position in the vacuum tank in Lab B next month. Pictured next to the vessel are F. R. Huson and W. B. Fowler (left to right).

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Abstract: This report summarizes the activities of the National Accelerator Laboratory in October, 1971.

Since the last report a systematic effort is being made to correct the problems that were uncovered during the intensive attempt to accelerate a beam between June and September. All of October was spent on an effort to bring both the magnet system and power-supply system to a point where they would operate reliably above the 100-GeV level. That much has been achieved and injection studies will be started again during the month of November.

All the magnets were "high potted" in place, that is, they were raised successively to a higher and higher dc potential and the current to ground was measured. If the ground current in a particular magnet exceeded several milliamperes, that magnet was replaced by a new magnet or a reconditioned magnet that had good insulating characteristics. By this process an additional 50 magnets have been removed from the ring for reconditioning and then replaced so that by the end of the month magnets in Sections A, B, and C were able to sustain a potential to ground of 500 volts while those in D, E, and F are holding 750 volts (typically the voltage to ground in present operation is about 250 volts). The whole magnet is high-potted each time the power supply is turned on, and since instituting this procedure no magnets have failed by a high current discharge to ground.

Our earlier diagnosis, that moisture (from condensation) that somehow reaches a weak point in the magnet coil and causes failure, appears to be

born out. Two systems of corrective measures have been taken. One has been to dry out the tunnel using air conditioners, heating the air, and stopping the seepage of water. This is a continuing program, of course, and the seasonal cold is now working with us, but we are also preparing for next summer's humid weather. The other measure has been to recondition the magnets which had failed or in which a ground current had indicated the possibility of failure. Depending on circumstances, the faulty coil is replaced and then the whole magnet is vacuum-impregnated with epoxy. Some magnets are still being manufactured, and these are being vacuum-impregnated from the start. We are able to submerge these magnets in water for 24 hours and then high-pot them to several kV upon drying out the lead-in insulators. In reconditioning a magnet, all the copper and iron is reusable.

The power supplies have been an equally serious problem. Part of this has come about because of the magnet breakdowns, and part of it was inherent in the supplies themselves. For example, any failure in the computer control circuit caused the power supplies to turn on at their highest voltage. Closing the vacuum power breakers caused large pulses to appear on the magnets. Neither of these had a salubrious effect on the lifetime of the all too vulnerable magnets, so appropriate corrective measures were taken. Any corrective measure implies changes in some 30 to 60 power supplies and so is not trivial. A temporary measure while bringing the system into operation has been to "cut in half" 30 of the 60 power supplies so that the maximum supply voltage is now 500 volts instead of 1000. Protective devices have now been installed which cause the supplies to trip out in case of excessive temperatures, over-voltage, over-current, or abnormal ground current.

Survey and Alignment. Two complete surveys with the laser have been made, and some points have been measured for the third and fourth times. Complete horizontal and vertical position measurements for the ring have been obtained. A program has been devised, including equipment, for leveling and positioning the magnets. Several weeks will be required to position the magnets well enough to expect a high-field beam to be confined within the vacuum donut.

Vacuum-System and Obstacle Search. To ensure that metal cuttings and other particles do not remain in the vacuum system after cuts are made, an ingenious method was devised by the Bubble-Chamber Section to remove obstacles. A spear was designed to pull a cord through the tube, and it is quite easy to run the spear through 2,650 feet of vacuum tube. The cord is connected to a harness with a permanent magnet which picks up metal slivers and debris. A partially collapsed donut in one of the magnets was discovered in the course of doing this. Figure 1 shows this device.

Corrosion Problem. Some quadrupole magnets have developed vacuum leaks on the manifold end of the magnets. These leaks have occurred in the bellows and also in four magnets in the bottom of the tube near or under the coils. The cause of the leaks is corrosion which in turn is the result of the use of a flux in the soft solder on the manifold which contains fluoride. If the flux is not completely removed, it combines with moisture in the tunnel and runs down the magnet. Corrosion occurs under the position of the static drop. Over 200 corroded bellows have been changed. Corrective measures to eliminate this problem are: all surfaces involved have been thoroughly cleaned and coated with silicone varnish, leaks have been sealed and new bellows are fabricated from a more corrosion-resistant stainless steel.

Fig. 1. Hans Kautzky, engineer in the Bubble-Chamber Section, holds spear used for removing obstacles from the vacuum system.

The Laboratory technical staff has been mobilized, to the extent that this has been practical, in achieving solutions to the problems described above. As a result, work on technical details of some of the experimental facilities has fallen behind schedule. However, conventional construction of facilities has continued on or ahead of schedule due in part to the exceptionally good weather conditions in the area this fall.

Progress on the 15-ft bubble chamber has been substantial in the past months, and the remainder of this month's report is devoted to the 15-ft

bubble chamber. We do this at this time since substantial progress is visible and the project is entering its critical phase of assembly and testing. Barring unforeseen difficulties, the chamber's schedule of first hydrogen operation beginning July 1, 1972, looks valid.

15-Ft Bubble Chamber

A summary report of the progress and status of the 15-ft bubble chamber has been prepared since manufacturing has proceeded to the point where a series of current photographs show the Users a basis for the claim that the project is progressing according to schedule.

From the beginning an attempt was made to place orders so that the equipment would arrive at NAL for assembly and testing over a short span of time rather than spread out, following the belief that if this plan could be achieved the chamber could be constructed in two years. Table I shows the major contracts ordered by total amount of the contract. The date of placement of the order and the delivery are also shown.

Table I. Procurement Contracts for 15-Ft Bubble Chamber of About $100,000 Or Over.

Item	Contract Date	Delivery	Cost
140,000 ft of superconductor	Aug 70	Started July 71	$364,455
Helium cryostat for magnet	April 70	July 71	222,000
Vacuum tank	Aug 70	May 71	221,929
Chamber	Dec 70	Oct 71	220,645
Helium refrigerator	Nov 70	Dec 71	206,000
Neon and deuterium dewars	June 71	March 72	173,490
Copper strips for magnet	Sept 70	Started July 71	118,595
Fisheye windows	Aug 70	Started Oct 71	114,300
Hydrogen refrigerator	Feb 71	Nov 71	100,913
Hydrogen compressor	Feb 71	Oct 71	94,537
Hydrogen dewar	Feb 71	Nov 71	88,300

Figure 2 shows one of the fisheye windows. Blank offs have been made for three of the six windows in case we wish to initiate the first cooldown of the chamber with only three camera ports open.

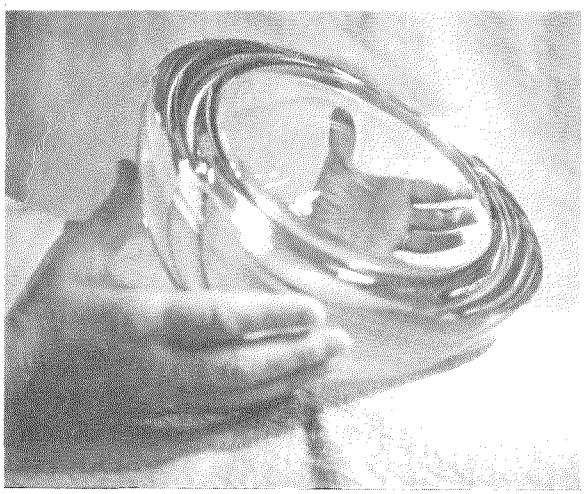

Fig. 2. Fused silica hemispherical window for the 15-ft NAL bubble chamber ready for shipment from the Frank Cooke Optical Company, Brookfield, Mass. This window is the middle one of a set of three for each camera port. (Photo courtesy of Frank Cooke, Inc.)

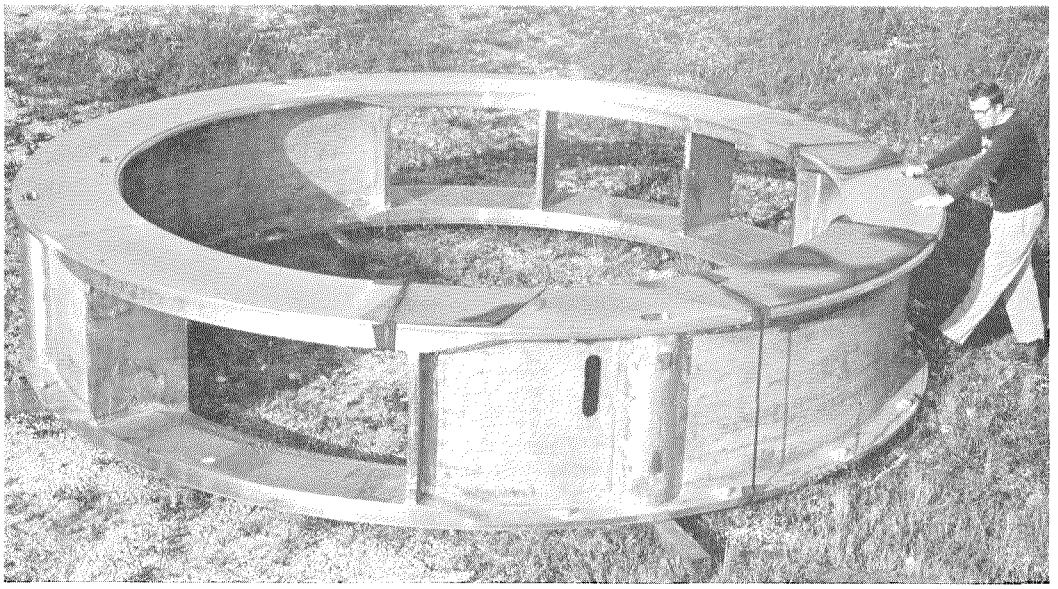

Fig. 3. Bridge section of magnet coil and dewar assembly photographed at ANL. The current plan is to ship the coil pancakes and the dewar pieces to NAL and make the final assembly. Of the required 44 lengths of superconductor, 34 have been produced so far.

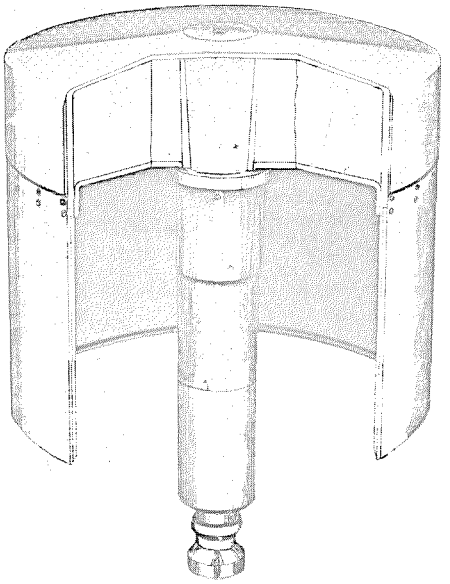

Fig. 4

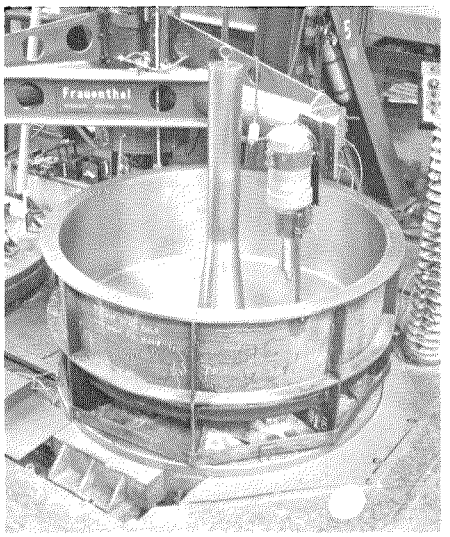

Fig. 5

Fig. 4. is a composite of a cut-away drawing of the 6-ft diameter fiberglass-plastic expansion piston. The form for moulding the piston is shown in the photograph. A stainless-steel coupling is bonded to the shaft. This coupling penetrates the vacuum tank through a shaft seal and connects to the hydraulic drive unit which has been built and tested by the Stanford Linear Accelerator Bubble Chamber Group. The expansion valve and its support stand are shown in Fig. 5 during the valve test at Palo Alto. This equipment is now at NAL ready for installation in Lab B in its final position which is scheduled during November.

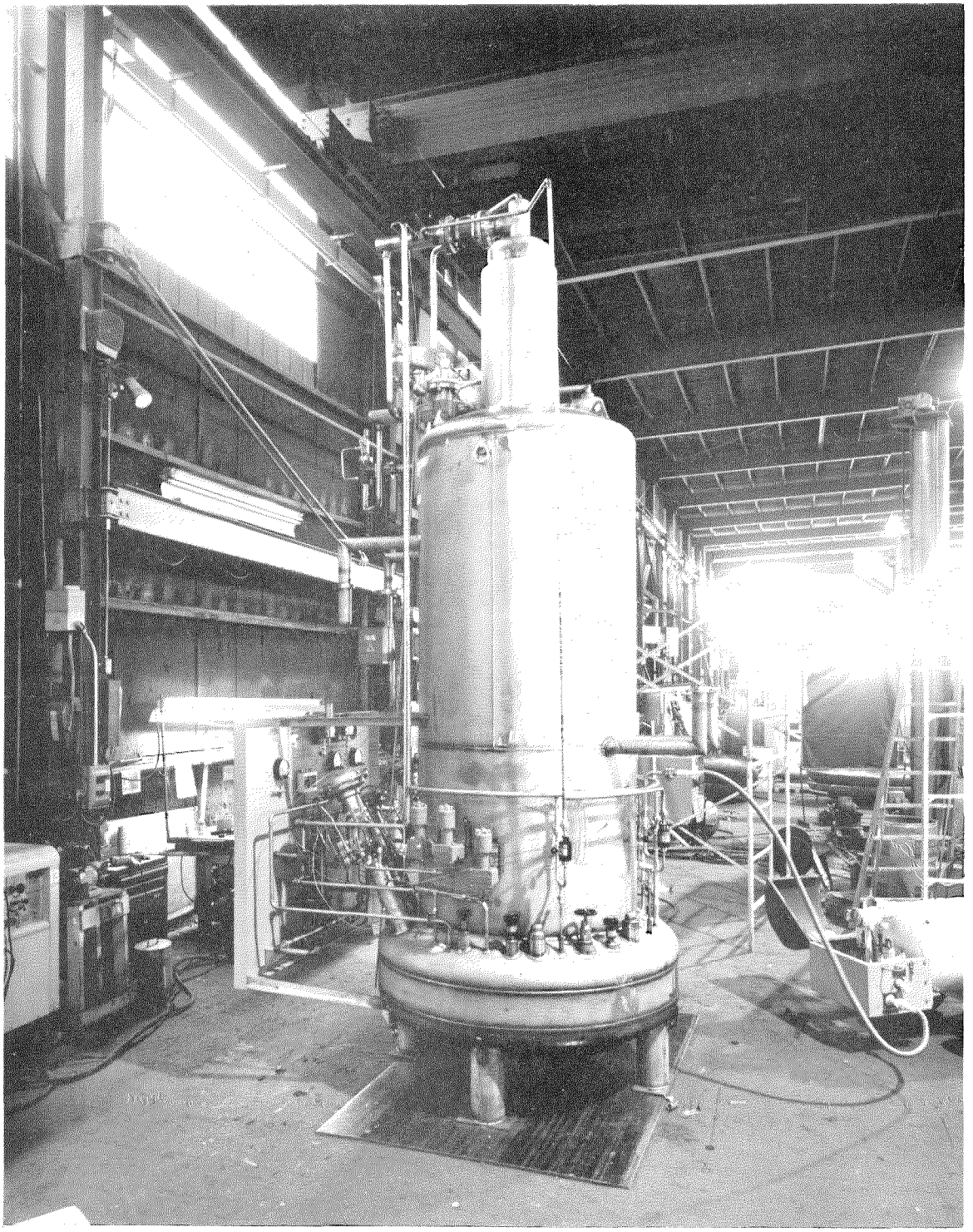

Fig. 6. The 6-kW hydrogen refrigerator at the manufacturer's plant in Denver just prior to shipment. This unit, with the 400-hp hydrogen compressor and the 15,000 gallon hydrogen dewar, is to be used for a complete test of the hydrogen refrigeration system scheduled for December.

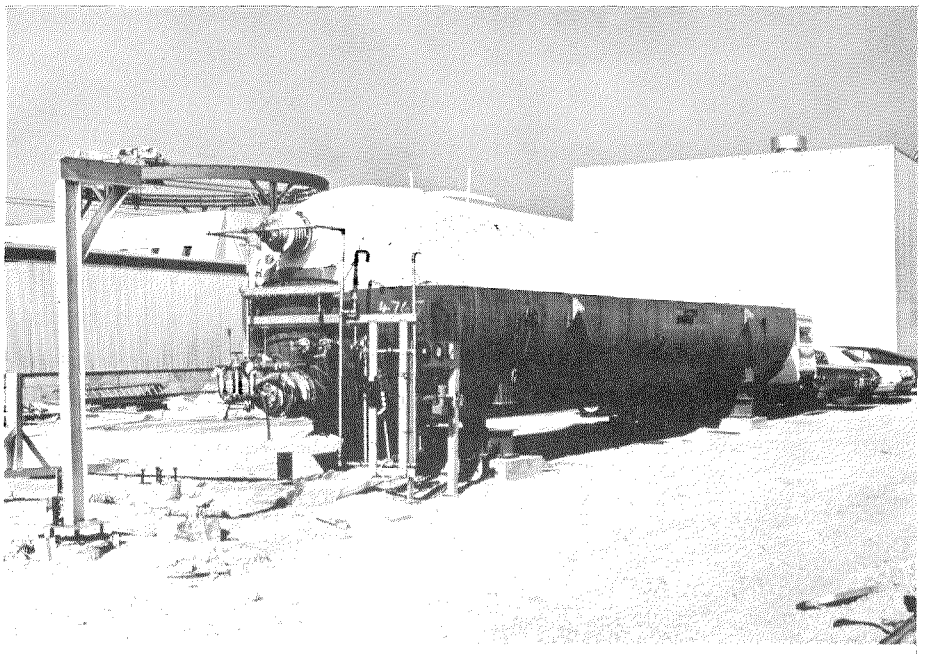

Fig. 7. Liquid nitrogen dewar (12,000 gallon) installed just outside of Lab B. The hydrogen, neon, and deuterium dewars will be positioned parallel and to the left of this dewar. A multitude of piping remains to be installed that interconnects these units and the chamber.

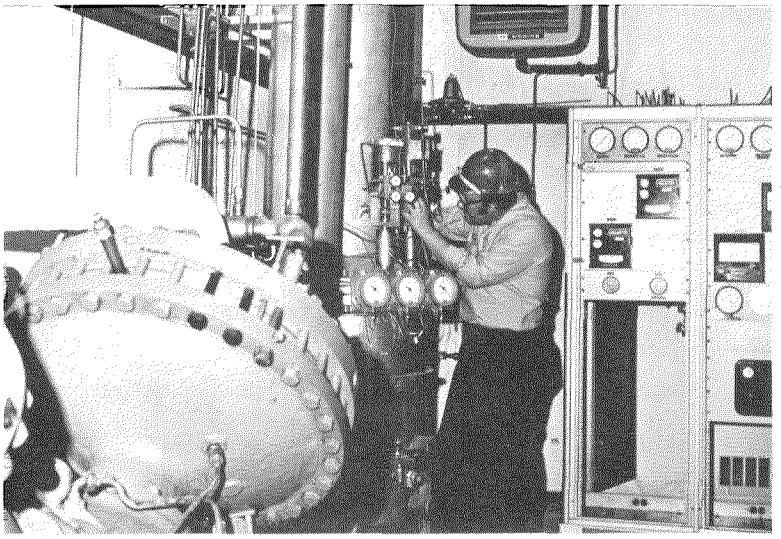

Fig. 8. Neon purification equipment which has been assembled at NAL. The first batch of neon-helium mixtures is scheduled for processing during November. It is hoped that there will be sufficient pure neon by the fall of 1972 to run a test with the 15-ft chamber with 20-30 percent neon mixed with hydrogen. Dick Ahlman of the Bubble-Chamber Section is checking the equipment.

Appendix I. LIST OF APPROVED PROPOSALS*

Experiment Number	Institutions	Scientific Spokesman	Subject
1-A	Wisconsin Pennsylvania Harvard	Cline	NAL Neutrino Proposal
2-I	Michigan State Maryland Iowa State ANL, Duke Notre Dame Toronto, Wisc. Purdue	Smith	Multiparticle Interactions in 30-inch Bubble Chamber and Optical Spark Chamber Hybrid System. 30" b.c. 450K pictures.
3	LBL	Eberhard	Search for Magnetic Monopoles at NAL
4-A	Michigan, ANL	Longo	Neutron Total Cross Sections up to 200 GeV
4-B	Michigan, ANL	Longo	Neutron-Proton Diffraction Scattering
6	Michigan, ANL	Krisch	Proton-Proton Elastic Scattering at High Transverse Momentum
7	Michigan, ANL, NAL	Meyer	Measurement of $\pi^{\pm}p$ and p-p Differential Elastic Scattering Cross Sections from 50 to 170 GeV/c
8	Wisconsin Michigan	Pondrom	Experiments in a Neutral Hyperon Beam
12	Ohio State Michigan State Carleton	Reay	A Study of Neutron-Proton Charge-Exchange Scattering
14	Columbia SUNY Stony Brook	Franzini	Proposal to Study Inelastic Proton-Proton Collisions in the Diffractive Region
19-A	Wyoming	Tompkins	A Search for Monopole Production
21	Caltech NAL	Barish	Neutrino Physics at High Energies
22	VPI, BNL	Collins	Search for Multigamma Events from Magnetic Monopole Pairs
23-A	Washington	Rothberg	Inclusive πp and Kp Scattering

*Emulsion Experiments are not included in this list.

Experiment Number	Institutions	Scientific Spokesman	Subject
25-A	UCSB	Caldwell	Measurement of the Total Photo-Absorption Cross Sections
26	Cornell, UCSD, Michigan State	Hand	High Momentum Transfer Inelastic Muon Scattering and Test of Scale Invariance
27-A	Rochester, NAL Northwestern	Rosen	Study of the Coherent Dissociation of Neutrons
32	Stanford	Hofstadter	Test and Calibrate a Large NaI (Tl) TANC Detector
34	Louisiana State Max-Planck	Huggett	Ionization Spectrometer Test and Development
36-A	Rockefeller Rochester, NAL Dubna, USSR	Cool	Small Angle p-p Scattering
37-A	NAL, UCLA	Malamud	30" b.c. - pp, 50K pictures
48	Yale, BNL NAL	Adair	A Measurement of the Intensity and Polarization of Muons Produced Directly by the Interactions of Protons with Nuclei
61	LBL, Harvard ANL, North-western, Wyoming, Yale, NAL	Chamberlain	Proposal to Measure Polarization in Elastic Scattering at 50, 100, and 150 GeV/c
63	NAL	Walker	Survey of Particle Production in Proton Collisions at NAL
67	Rutgers Upsala College Mississippi State	Maglic	Search for Baryon Resonances up to 10 GeV Mass Produced in $p+p \rightarrow p+MM$
69-A	Yale, NAL	Willis	Elastic Scattering of the Hadron
70	Columbia Rockefeller NAL	Lederman	Study of Lepton Pairs from Proton-Nuclear Interactions
72	BNL, Yale	Leipuner	Quark Search
74	General Elect. NAL	Fleischer	Search for Magnetic Monopoles

Experiment Number	Institutions	Scientific Spokesman	Subject
75	NAL	Yamanouchi	A Proposal to Search for Fractionally Charged Quarks
76	NAL	Carrigan	Search for Magnetic Monopoles
81	ANL, BNL, Chicago Carnegie-Mellon Purdue SUNY (Buffalo)	Butler	Preliminary Survey of 200-GeV Proton Interactions with Complex Nuclei
82	Chicago, SLAC U of California-San Diego, NAL	Telegdi	Investigate Regeneration of Neutral K-Mesons at Very High Energies
86-A	U of Washington Orsay	Lubatti	Study Inelastic Diffractive Processes by Observing Coherent Production of Multi-Pion Final States from He Nuclei
87-A	Columbia Hawaii Cornell, Illinois	Lee	Search for Heavy Leptons and Intermediate Bosons from Photon-Nuclei Collisions
95-A	Johns Hopkins U NAL	Cox	Proposal for Examination of Wide Angle Gamma Rays at NAL
96	Stanford U of Bari Brown, CERN ANL, Cornell MIT, NAL Northeastern	Ritson	Focusing Spectrometer Facility
97	NAL, Yale	Lach	Elastic Scattering of the Hyperons
98	Chicago Harvard Oxford	Mo	Muon-Proton Inelastic Scattering Experiment
100	Chicago Princeton	Cronin	Study Particle Production at High Transfer Momenta
104	BNL, NAL Rockefeller	Kycia	Measurement of Total Cross Sections on Hydrogen and Deuterium
108	NAL	Awschalom	A Beam Dump Experiment
111	Caltech LBL, NAL	Tollestrup	Proposal to Study $\pi^- p \to \pi^0 n$ and $\pi^- p \to \eta n$ at High Energy
115	LBL	Stevenson	Search for Long Lived Particles

Experiment Number	Institutions	Scientific Spokesman	Subject
121-A	UC, Davis	Lander	30" b.c. - π^+p, 50K pictures
125	CERN	Morrison	30" b.c. - π^-p, 50K pictures
137	NAL, LBL, U. of Calif.	Huson	30" b.c. - π^-p, 50K pictures
138-I	Rochester Michigan	Ferbel	30" b.c. - pp, 50K pictures
138-II	Michigan Rochester	VanderVelde	30" b.c. - pp, 50 K pictures
141-A	ANL	Voyvodic	30" b.c. - pp, 50K pictures
143	BNL	Kalbfleisch	30" b.c. - π^-p, 50K pictures
154	MIT, Brown, Ill., IIT Johns Hopkins, Rutgers, Stevens, Yale, NAL, Indiana U of Tenn.- Oak Ridge	Pless	Feasibility Study of Proportional Chamber Hybrid Systems with 30-inch b.c.
155	LBL, Hawaii	Stevenson	Development of a Phase I External Muon Identifier (EMI) for 15' b.c.