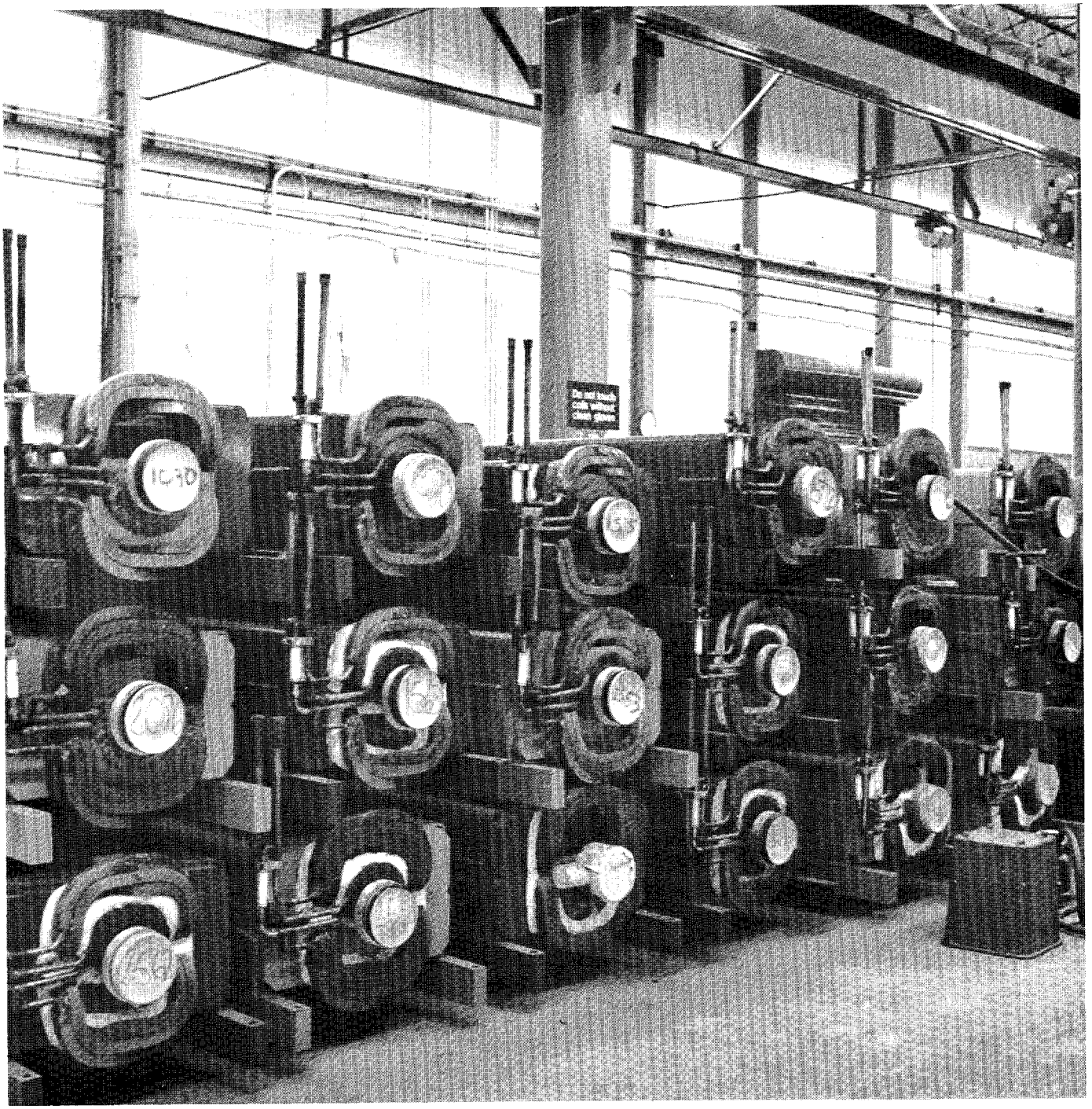
national accelerator laboratory FERMILAB-NAL-049

MONTHLY REPORT OF ACTIVITIES

October 31, 1970



COMPLETED BENDING MAGNETS

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

FORTHCOMING MEETINGS AT THE LABORATORY

November 13. Rapid-cycling bubble-chamber meeting, W. D. Walker, chairman.

December 11 and 12. Program Advisory Committee

THE COVER: The cover photograph shows a part of the inventory of completed main-accelerator bending magnets awaiting installation.

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MONTHLY REPORT OF ACTIVITIES

F. T. Cole

October 31, 1970

Abstract: This report summarizes the activities of the National Accelerator Laboratory in October, 1970.

General

1. Appropriation. On October 7, the President signed into law the Public Works Bill (PL 91-439) with an appropriation of $60 million for the National Accelerator Laboratory for fiscal year 1971. Apportionment of these funds is now under review by the Office of Management and Budget.

2. Training Program. Ten members of the second NAL class who attended the Training and Technology (TAT) course at Oak Ridge National Laboratory have returned and joined technical sections of the Laboratory after completing their training. Eighteen members of the first NAL class are working at the Laboratory.

Main Accelerator

1. Oktoberfest. Early in the morning of October 9, the 139-MeV proton beam from the linac was transported around the booster, extracted, and injected into the main accelerator and transported through eight magnets to Station A1. The beam was of very low intensity. Because of this and because of its low energy, we failed to carry out beam tests on main-accelerator components or to measure beam properties. One goal of the Oktoberfest, injection of beam into the main ring, was achieved, if only barely.

In addition, there was an opportunity to exercise a number of the main-accelerator systems. The magnet power supply was pulsed to high field levels, limited only by the temporary power available. That is, the entire super-period was pulsed to 100-BeV field levels and half of it to 200-BeV levels. Figure 1 shows one of the rectifier assemblies of that supply. Considerable work was done on use of the control system. Remote control of many systems through the computer and from the main control system was carried out.

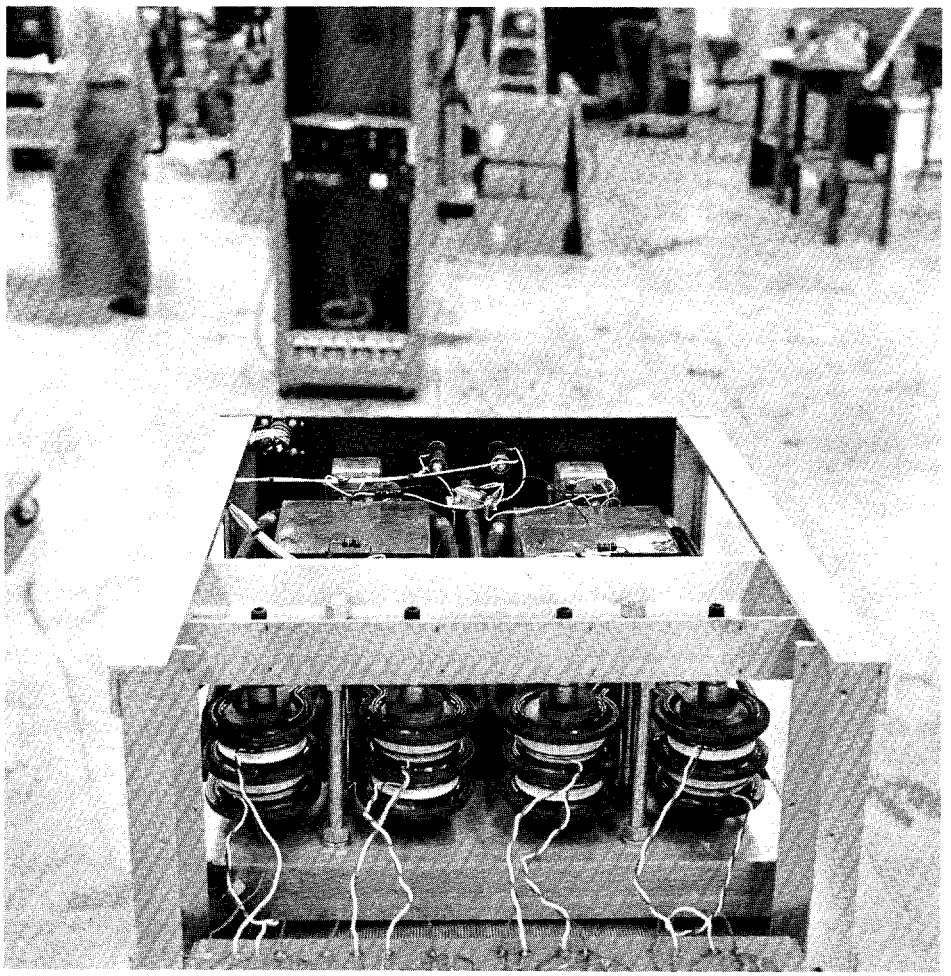

Fig. 1. A rectifier module of the main-accelerator magnet power supply. Four of the eight thyristors in the module are visible at the front.

2. Construction. Production of magnets is now up to 30 per week, with a record production of 8 magnets in one day. The production rate of the West Chicago coil factory has been increased to keep pace with the magnet assembly. A total of 389 magnets has now been assembled; 216 of these have been placed in the tunnel. The cover photograph shows part of the inventory of completed magnets in one of the Industrial Buildings.

Work is also proceeding on other components. Figure 2 shows a beam detector and correction magnets installed in a short straight section.

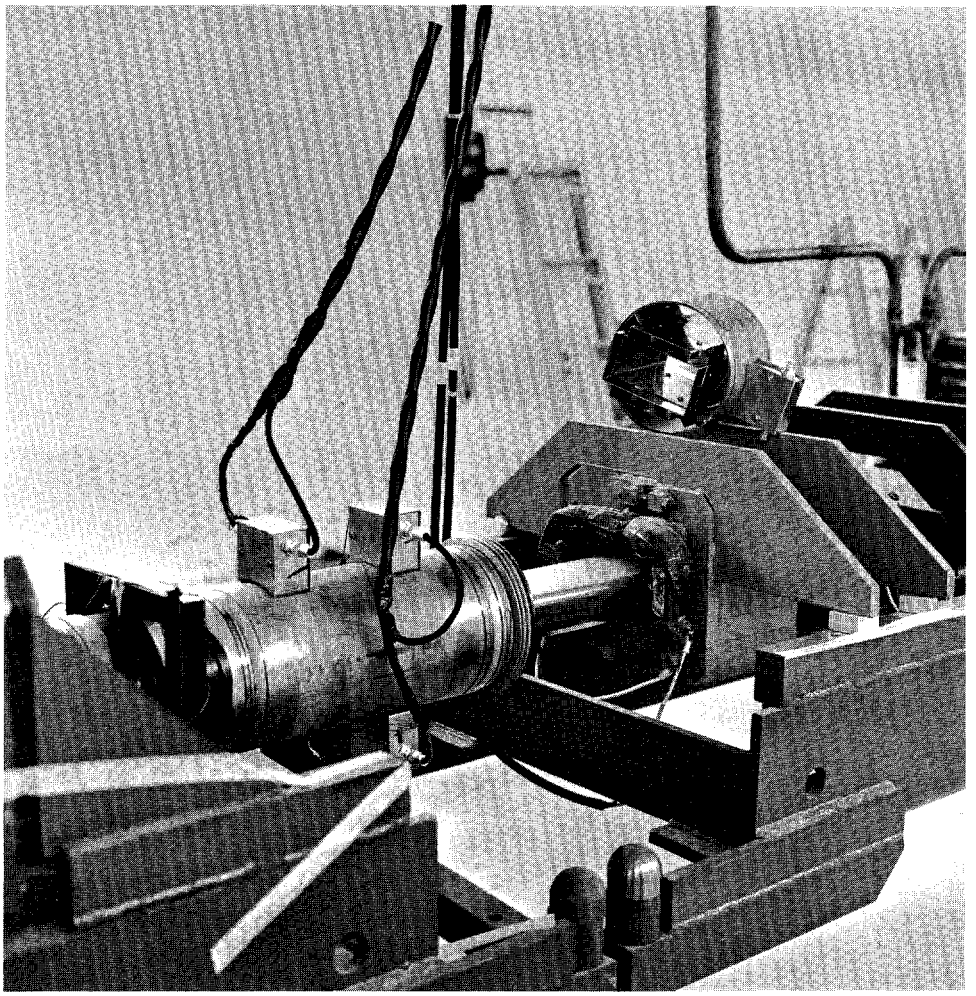

Fig. 2. Auxiliary equipment in a 7-foot straight section of the main accelerator. The cylinder at the left contains beam monitors (with temporary connections). The inside of a beam monitor can be seen in the spare at the right, which is resting on top of one of the small auxiliary magnets.

Figure 3 shows a transformer for the main-accelerator power supply being placed outside a service building. Installation of power bus, water piping, and magnet bases is approximately halfway through Superperiod C. Work is also going on in Superperiods D and F.

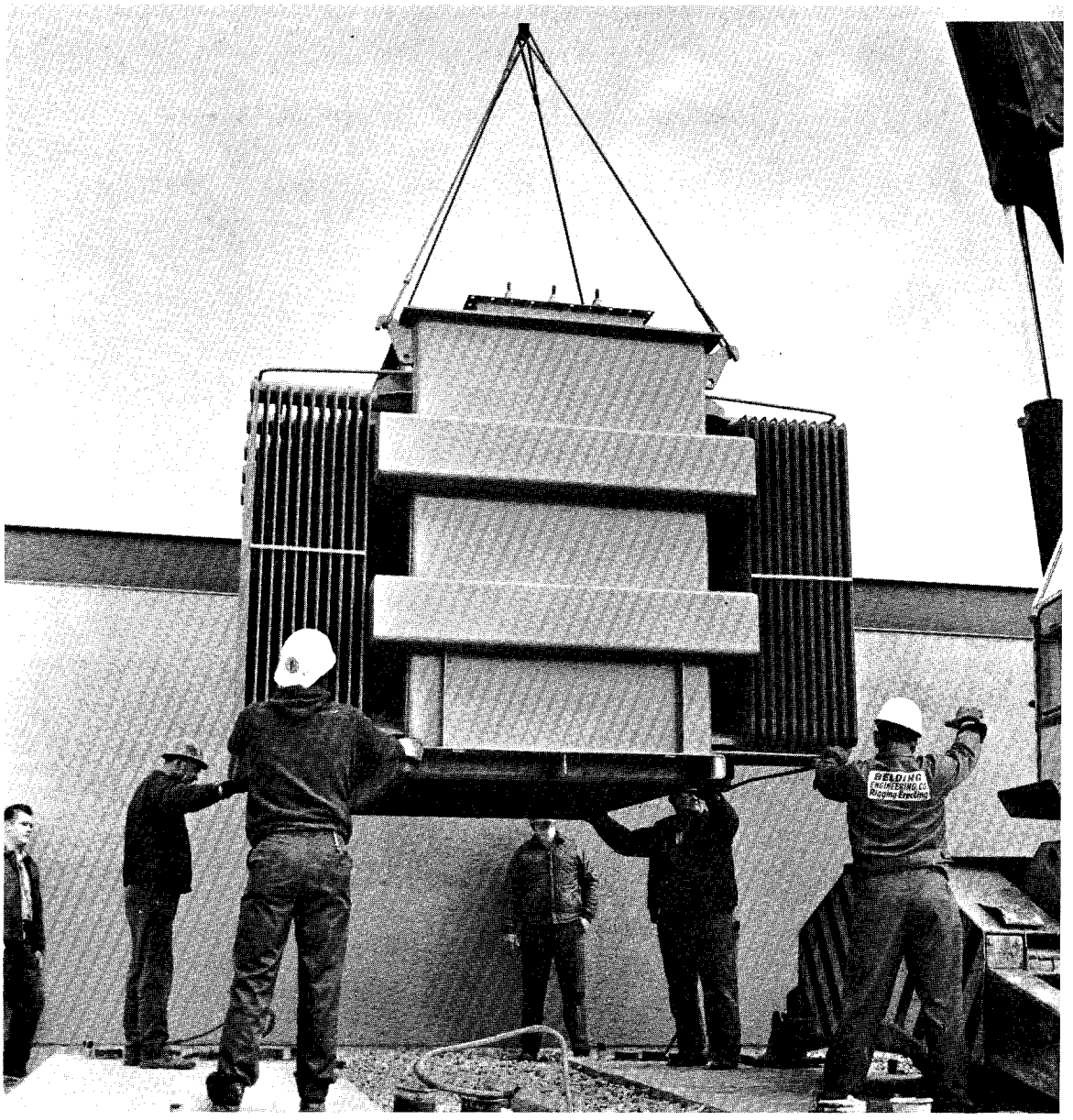

Fig. 3. Riggers installing a power-supply transformer just outside one of the service buildings of the main accelerator.

Linac

1. Oktoberfest. The first six tanks were operated from October 1 to October 9 to produce a 139-MeV beam for booster injection as part of the Oktoberfest. The operation was reasonably stable, with some difficulties arising because the servo system to control rf phase and amplitude between tanks had not yet been installed. No detailed measurements of beam properties were made.

2. Construction. Tanks 7 and 8 have been moved to the beam line. All components have been installed in tank 7 and most in tank 8. Alignment is now in progress. Tank 9, the last tank, has been moved from the Village to the permanent building. The move is shown in Fig. 4. The large access door through which the tanks are brought in will now be permanently closed and shielded.

Fig. 4. The last tank of the linac as it left the Village. The laboratory building is now being used for work on the 15-foot bubble chamber.

The fabrication of all 295 drift tubes for the linac was completed on October 21.

RF systems 7 and 9 have been operated into the dummy load. System 8 is complete except for a few minor parts and will be similarly tested in November.

Acceleration of protons to 200 MeV is expected to be achieved at the beginning of December.

Fabrication of a second accelerating column has also been started. This new column will be used as a spare, should the first column need repair, and for ion-source tests.

Booster

1. Oktoberfest. On October 2, the 139-MeV beam was brought halfway around the booster to the extraction system in straight-section 13. Some beam losses were observed, particularly in the injection transport system. These losses were not serious from the radioactivation standpoint, because beam currents were kept at small values (a few milliamperes) for these tests, but enough was learned from them to suggest better arrangements of the focusing elements in the transport system. In the time available, it was not possible to carry out any studies of beam properties, but it is believed that the losses were primarily caused by poor beam matching into the booster and by the lack of energy stability of the linac beam (which arose from the lack of the linac servo system).

2. Construction. During the operating period, a large part of the control system was put into operation. Beam detectors were used and controlled through the computer. Correction coils in the first half of the ring were

installed and used. All these elements and the ring magnet power supply was controlled from the main control room.

Since the end of the Oktoberfest, another quarter of the ring magnets have been installed, and it is expected that the magnet ring will be complete early in December. About one fourth of the ring is already under vacuum with its permanent ion-pumping station. Transport and injection studies of the 200-MeV beam will start about the middle of December.

Beam Transfer

Major parts of the booster extraction system were temporary for the Oktoberfest, but the beam line from the booster to the main accelerator is permanent. Exercising of the beam-transfer system during the Oktoberfest provided valuable information, particularly on control of the system from the main control room.

Radio Frequency

Booster. All cavities have been delivered. Assembly of modules, which include two cavities, two power amplifiers, ferrite tuners, vacuum pump, and support girder, is proceeding on schedule. Five of the total of 8 booster rf modules have been delivered to the booster ring.

Main Accelerator. Tests on the prototype cavity are still going on. There are still problems associated with the damping ferrite. A contract for fabrication of all main-accelerator cavities will be let in the first week of November. The power amplifiers and modulators, which are identical to those of the booster, are already being fabricated.

Radiation Physics

The Oktoberfest provided valuable operational experience with the dosimeters built at the Laboratory and with the interlock system. Some actual radiation doses (well within legal limits) have been recorded. Radiation-safety training programs are continuing (perhaps with better audience attention).

Construction

1. Electrical Substation. The contract is 94% complete. The major bottleneck has been slowness in the delivery of the first of the 345-kV transformer. This transformer is now undergoing tests at the manufacturers and is expected to be delivered in November.

2. Transmission Line. All but two of the power poles have been erected and cabling work is beginning. Figure 5 shows the line of power poles. The

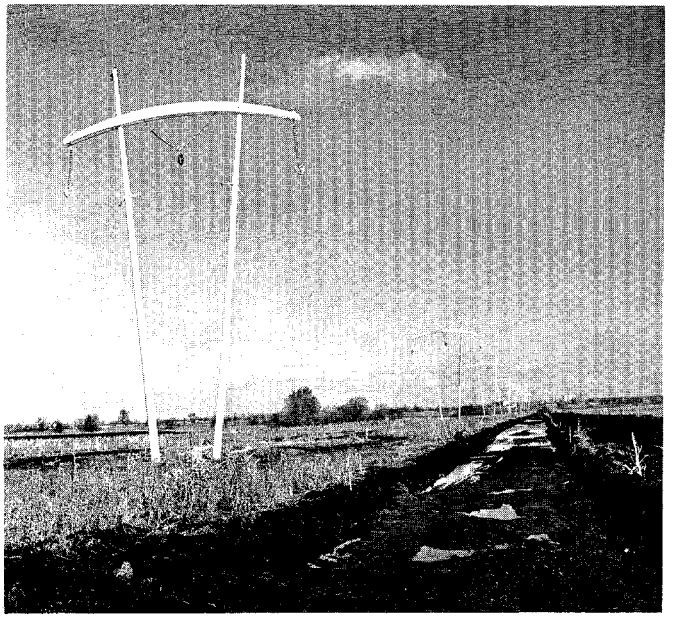

Fig. 5. Power poles of the 345-kV transmission line. The view is northeast. At the right is the site of the extension of "Road A," which will now run parallel to the Neutrino Laboratory beam line all the way to the northeast corner of the site.

contract as a whole is 60% complete and is scheduled to bring power to the electrical substation by December 1.

3. Central Utility Plant. Installation and checking of the mechanical and electrical systems is now the major part of the work, which is 93% complete. The first boiler has been tested successfully, and heat will be provided (none too soon) to the Linac, Booster, and Cross Gallery in the early part of November.

4. Main Accelerator. The first phase is 97% complete, with only a few items remaining to be corrected. The second phase, which is 77% complete, is moving well in most aspects. The excavation and floor slab of the tunnel are complete and less than 3,000 feet of the precast tunnel sections remain to be placed. The second major access, in Superperiod C, is complete, and Fig. 6 shows the first magnet being ceremonially lowered into it.

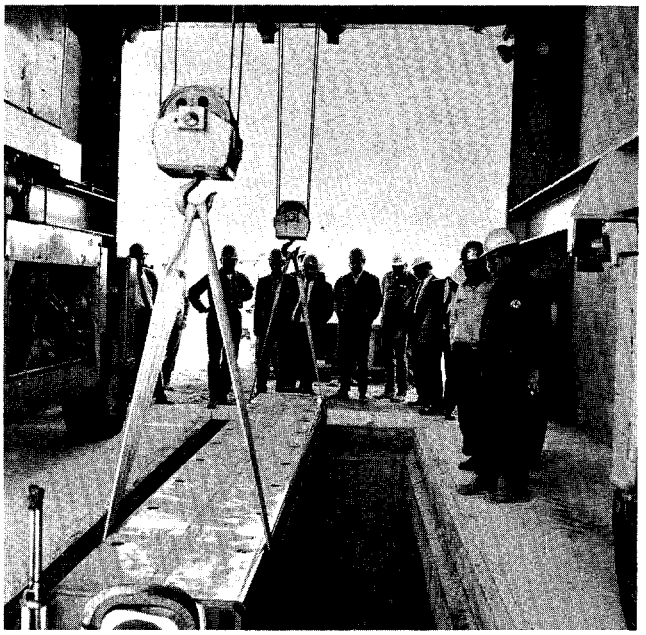

Fig. 6. First use of the second Major Vehicle Access in Superperiod C. Watching are Thomas Collins, Henry Hinterberger, Robert Wilson, and Anthony Glowacki of the Laboratory and Norman Christensen and Parke Rohrer of DUSAF, and several contractor employees.

Fig. 7. Construction work on the RF Building. The cable penetrations between the upper and lower tunnel levels can be seen. The inside of the main ring is to the left.

Figure 7 shows the current status of the RF Building, whose progress has not been all we hoped for. It is now expected to be completed and ready for our occupancy on December 1.

5. Proton Beam Enclosure. All the additive options have been exercised to date. The work is proceeding very well, with considerable progress north of the substation. The contract as a whole is 30% complete.

6. Central Laboratory. Approximately half the caissons were finished by the end of October and excavation will begin shortly. This contract is 4% complete. The courtyard of the Linac, Cross Gallery, and Transfer Gallery is a scene of highly visible activity, with both the Central Laboratory and a large utility tunnel under way. Figure 8 is a recent view of this work.

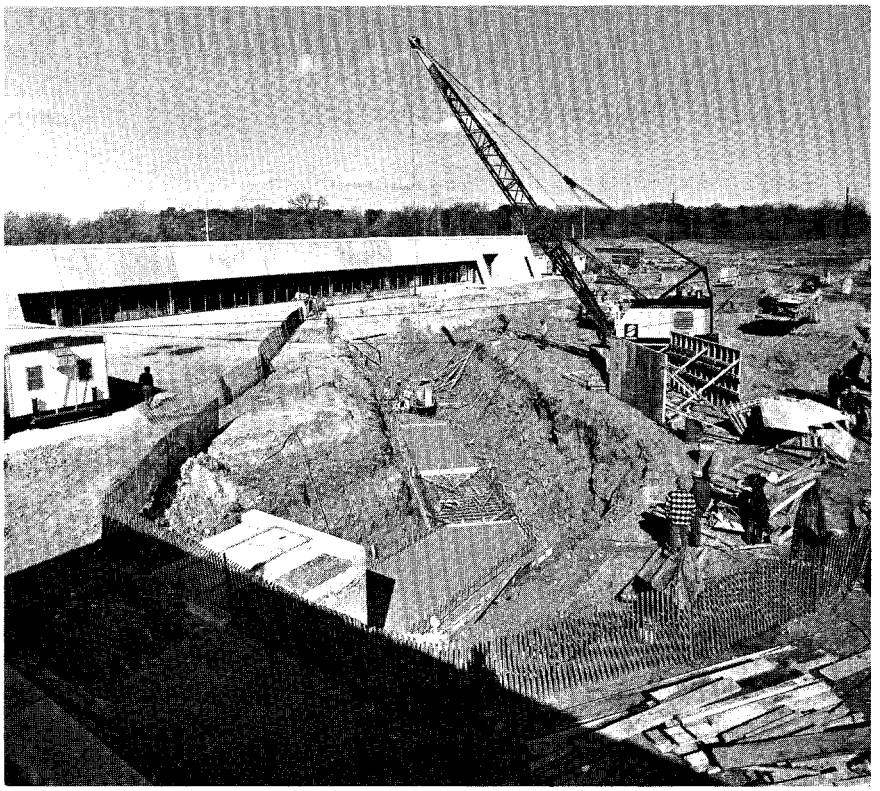

Fig. 8. Utility-tunnel work, looking from the Cross Gallery toward the Linac Building. Caisson work on Phase I of the Central Laboratory is beyond the crane.

7. Meson Laboratory. Notice to proceed was issued on October 27 to the Herlihy Midcontinent Co. of Chicago (who built the Booster Enclosure and are now finishing the Central Utility Plant) for Phase I of the Meson Laboratory. This contract, for approximately $1.5 million, will be for construction of the Target Area. Phase II, which will be for construction of the secondary-beam enclosures to the Detector Building, will go out for bid early in November.

Experimental Facilities

Design. Phase I of the Neutrino Laboratory, including the target area, has been completed and is out for bids. The design of the hadron beam was

modified to accommodate a branch to the 30-inch bubble chamber, which will be moved from Argonne National Laboratory. This chamber will be located adjacent to the downstream end of the neutrino shield.

Main-accelerator dipole and quadrupole magnets will be utilized in many of the secondary-beam lines. An additional 55 bending magnets and 68 quadrupoles will be fabricated for this use. Design work is also in progress on special quadrupoles for the high-resolution 180-BeV secondary beam in the Meson Laboratory.

Experiments. Meetings were held at the Laboratory to further technical and organizational work on a number of proposed experiments. These discussions may be summarized as follows:

(i) Double-arm spectrometer. Two proposals (7 and 61) are approved. The purpose of the meeting was to explore the possibility of using common equipment. The groups concerned have organized themselves to work toward that end.

(ii) Muon-Scattering Experiments. Proposal 26 has been tentatively approved as a first experiment in this field. It will be done subject to the conditions that if can be mounted at low cost and completed by July, 1972. The groups involved in proposals 5, 29, and 33 will arrange a collaboration for the design and construction of a facility with which more detailed muon-scattering experiments can be done. L. W. Mo is currently serving as coordinator of this work.

(iii) Neutrino-Counter Experiments. The experiment of proposal 21, which utilizes a narrow-band neutrino beam, was approved to run as soon as possible in an area located about halfway down the muon shield

of the Neutrino Laboratory. The experiment of proposal 1, which utilizes a wide-band neutrino beam, has been approved to run in the previously designated counter-neutrino area at the end of the muon shield.

(iv) Single-Arm Spectrometer. The groups submitting proposals 23, 52, 64, and 73 will collaborate on the design and construction of a high-resolution spectrometer. David Ritson has agreed to serve as coordinator of this work. The groups plan to collaborate on an initial experiment using this facility, then to submit separate independent proposals for its subsequent use. These proposals will have to compete with others that might be submitted in the interim.

(v) Multiparticle Spectrometer. The groups submitting proposals 35, 51, and 54 will collaborate on the design and construction of this apparatus. They were able at the meeting to move toward agreement on common parameters for the target magnet. Jerome Pine has agreed to serve as coordinator for this work. The groups plan to submit separate proposals for experiments.

A list of new proposals received is appended to this report.

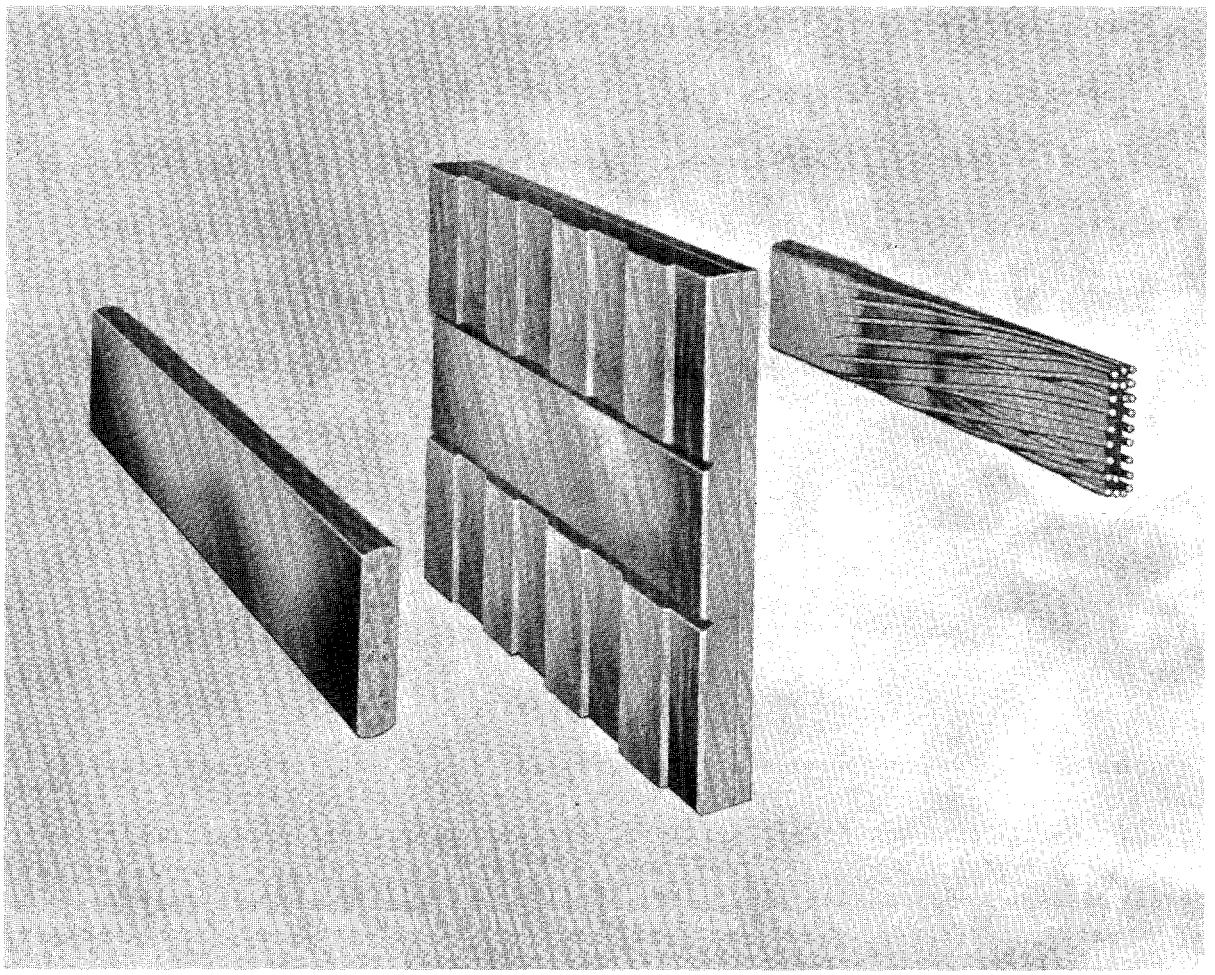

Fig. 9. A sample of superconducting wire for the 15-foot bubble chamber. The Argonne National Laboratory has taken responsibility for the design of the magnet for the chamber, under an agreement with NAL, and Argonne has let the contract for the superconducting wire. Supercon Division of the Norton Company will produce 140,000 feet of the wire, with delivery beginning in February, 1971.

On the left, the end of a sample section has been polished to show 24 niobium-titanium filaments metallurgically bonded into copper. In the final conductor, 60 filaments will be used to carry 5,000 amperes at 60 kilogauss. These wires must be twisted; on the right-hand piece, the twist can be seen because the copper has been partially etched away. The finished conductor is shown in the center. Here the center strip carries the superconducting wire. The top and bottom copper strips carry cooling channels for the liquid helium used to cool the conductor to 4.4° K. The three strips are soldered together with a thin copper carrier strip to form the 1.5-inch high by 0.15-inch thick conductor.

(This elegant photograph, as well as all the others in our Monthly Reports, was done by Anthony Frelo of the Laboratory.)

APPENDIX. ADDITIONAL PROPOSALS RECEIVED

90. Cracow Nuclear Emulsion Exposures

Institute of Nuclear Research, Cracow, Poland

91. Proposal for an Emulsion Experiment to Measure the Energy Dependence of Total Cross Sections and Multiplicities Up to 500 GeV/c

C.-Y. Chien, B. Cox, D. Denegri, L. Ettlinger, L. Madansky, A. Pevsner, R. Zdanis, R. Mobley, and T. Toohig

92. A Neutrino Experiment in the NAL 30 m^3 Bubble Chamber Using "Monoenergetic" Neutrinos

B. Barish, F. Sciulli, and A. Maschke

93. Small-Angle Charge Exchange Reactions $\pi^- + p \rightarrow \pi^o + n$ and $\pi^- + p \rightarrow \eta + n$ From 50 to 200 GeV/c

M. Wahlig, A. Skuja, M. Pripstein, J. Nelson, I. Linscott, R. Kenny, O. Dahl, and R. Chaffee

94. 100 GeV Pion Interactions in Photographic Emulsion (A Parasitic Experiment)

E. R. Goza

95. Proposal for Examination of Wide Angle Gamma Rays at NAL

C.-Y. Chien, B. Cox, D. Denegri, L. Ettlinger, L. Madansky, A. Pevsner, R. Zdanis, R. Carrigan, and T. Toohig