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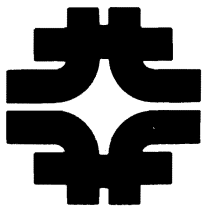

national accelerator laboratory

MONTHLY REPORT OF ACTIVITIES

F. T. Cole

February 1, 1969

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Abstract: This report covers the activities of the National Accelerator Laboratory for the month of January 1969.

General

1. First Accelerated Protons. A proton beam accelerated to 60 keV was achieved in the ion-source test stand on January 20. This is the first accelerated proton beam at NAL. Figures 1 and 2 show experimental results and views of the ion-source test stand and its proprietors.

The maximum measured beam current has been 300 milliamperes. Preliminary measurements indicate that the emittance will be well within the value specified in the Design Report, unless there is unexpectedly large blowup in the accelerating column.

2. President's Budget. The President's budget for fiscal-year 1970 contains requests for authorization of the full $250 million for construction of the National Accelerator Laboratory (we are now authorized up to $32.333 million) and for a construction-fund appropriation of $102 million (we were appropriated $7.333 million in FY 1968 and $12.074 million in FY 1969, the current year).

*This work done under the auspices of the United States Atomic Energy Commission.

3. Construction Progress. Construction is proceeding at satisfactory rates on the various projects under way: Linac Building, Rough Roads and Grading, Construction Power, Main-Ring and Beam-Transfer Laboratories, temporary shop, Main-Ring Enclosure Prototype, and Booster-Enclosure Prototype and Laboratory. Figures 3 through 6 of this report are photographs of these projects. In particular, the Linac-Building excavation is almost complete.

Bids were received January 30 on the Booster Enclosure and are now being evaluated. Construction is scheduled to begin during February.

4. Control-Computer Prototype Development. The Radio-Frequency and Booster Sections have taken delivery on Sigma II computers. These will be connected to the Linac-Section Sigma II, for which some new peripheral equipment has been received. All these sections are beginning development of programs for monitoring and control.

5. Work Space for Visitors. The Experimental-Facilities Section has equipped a house as office space to be used by visitors to the Laboratory.

Theory

1. Long Straight-Section Design. The lattice of the main-ring long straight section is being reexamined, because of possible difficulties in holding fabrication tolerances in the extra-long quadrupoles of the straight-section insertion. Two modified quadrupole arrangements have been developed; both preserve matching and the ring geometry with very small reduction in the length of the central drift space. The first arrangement requires four different quadrupole lengths, while the second requires three. The work

is continuing with the aim of reducing the number of different quadrupole lengths to two.

2. Longitudinal Space-Charge Effects at Transition. It has been pointed out at CERN[1] that space-charge forces can excite bunch-shape oscillations starting at transition energy. For the booster, at full intensity, the amplitude of these oscillations is calculated to be 3 to 4 times larger than the unperturbed amplitude, which will give rise to an increased energy spread of the beam injected into the main ring.

The effect can be compensated by a "triple-switch" scheme suggested at CERN.[1] F. C. Shoemaker has suggested an alternative scheme in which a feedback loop is used to modulate the accelerating voltage by an amount proportional to the time derivative of the instantaneous bunch width. Preliminary computations indicate that this scheme can reduce bunch-shape oscillations to a very small amplitude within some milliseconds after transition with a maximum accelerating-voltage modulation of the order of 15%. The same scheme can be applied to the main ring.

Linac

1. Preaccelerator. The Argonne high-voltage supply has been installed in the Linac Laboratory and operated for short periods up to 750 kV. Improvements are being made to increase the voltage to 800 kV. The assembly of the accelerating column is nearly complete and voltage conditioning will begin early in February. (See page 1 for progress on the ion source.)

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[1] A. Sørennsen, CERN Report MPS/Int. MU/EP 67-2.

2. Prototype 10-MeV Cavity. Final machining and vacuum checking were completed at the fabricators during January. It will be shipped in the first week of February.

3. RF System. Difficulties with grid emission are still present in the modulator tube. Several corrections are being worked on at the fabricators.

Booster

1. Magnet-Cycle Second Harmonic. Detailed study of the introduction of a second-harmonic component into the magnet cycle has led to the conclusion that the scheme gives considerably greater complexity and little or no net cost reduction. As a result, this feature will not be included in the booster design.

2. Vacuum Tests. The full-length vacuum model discussed in last month's report has been baked out at temperatures up to 200°F and has achieved an average pressure less than 4×10^{-7} torr.

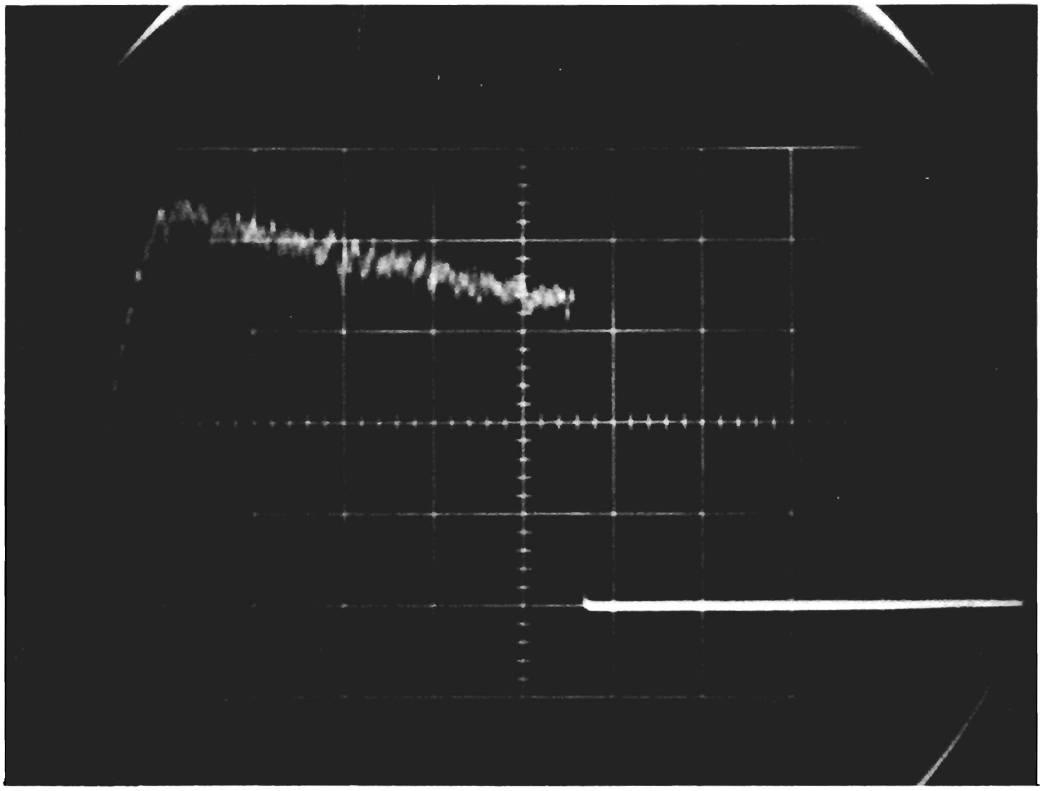
Main Ring

1. Data-Acquisition System. The automatic data-acquisition system for magnetic measurements is now in use by both the Main-Ring and Booster Sections. It has turned out to be both useful and popular; work on the system is tightly scheduled from 8:30 a.m. to 10:00 p. m. six days a week.

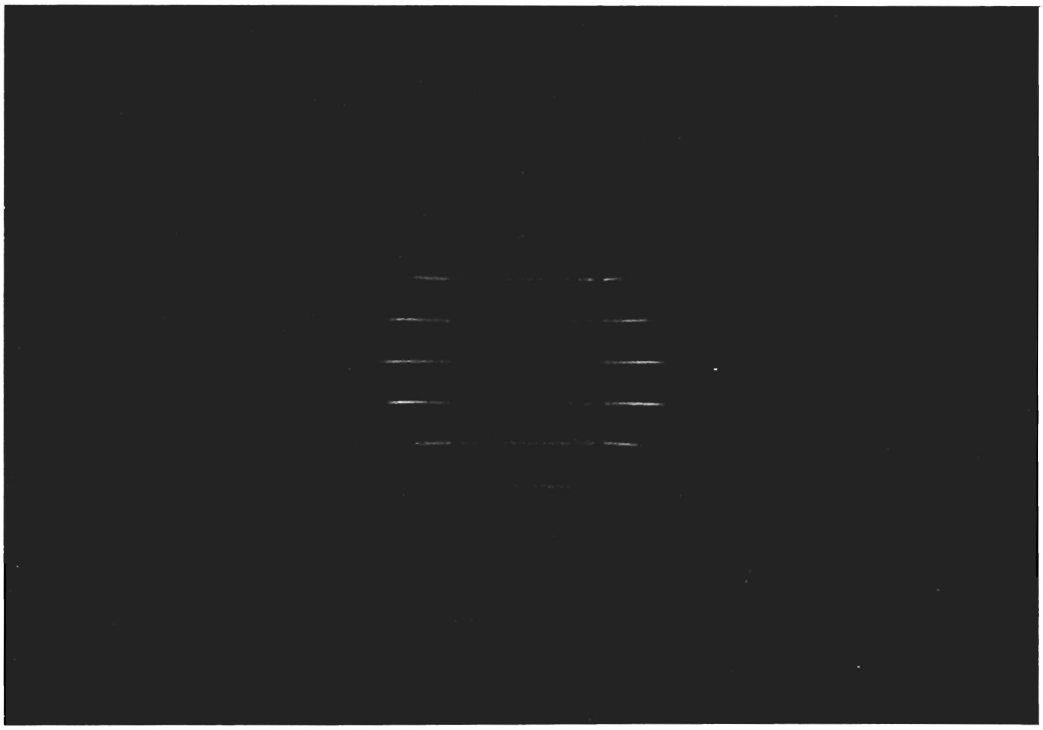
2. Structural Model. The latest 20-foot structural model has been assembled. It is shown in Fig. 7. The twist was within acceptable limits, but the sag slightly exceeded the precamber. The reasons for this sag are not yet fully understood.

Radio Frequency

1. Prototype. The power supply, modulator, and copper for the prototype booster cavity have been ordered. The ceramic insulators will be ordered in February.

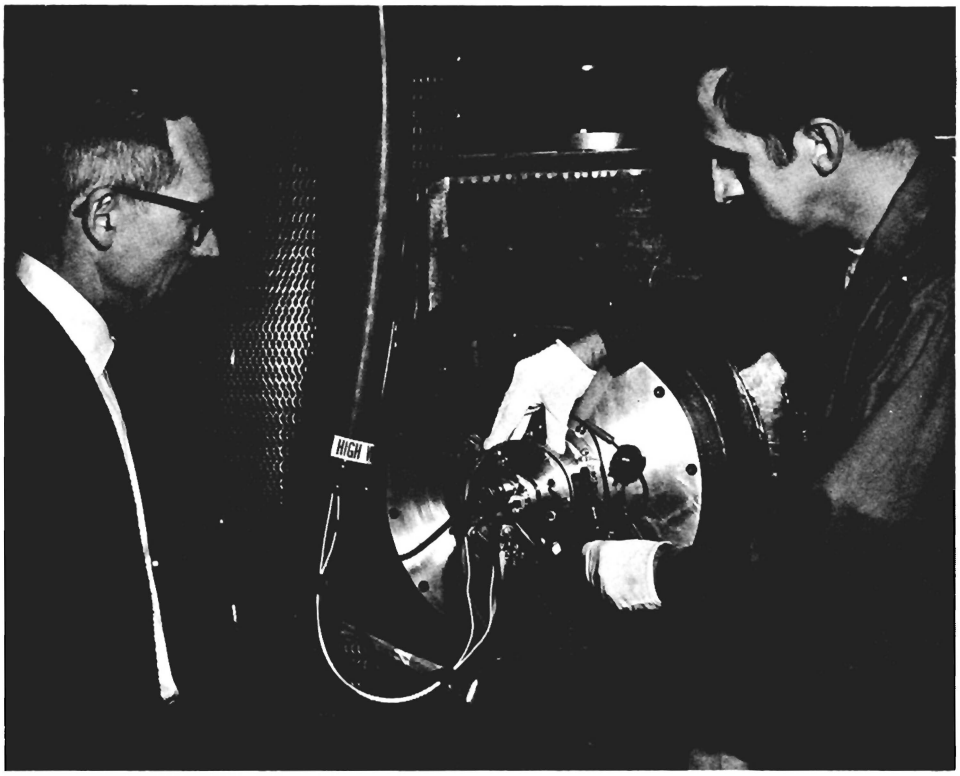


a. Oscilloscope trace of the accelerator proton beam. The ordinate is current, with one large division representing 50 milliamperes. The abscissa is time, with one large division representing 20 microseconds

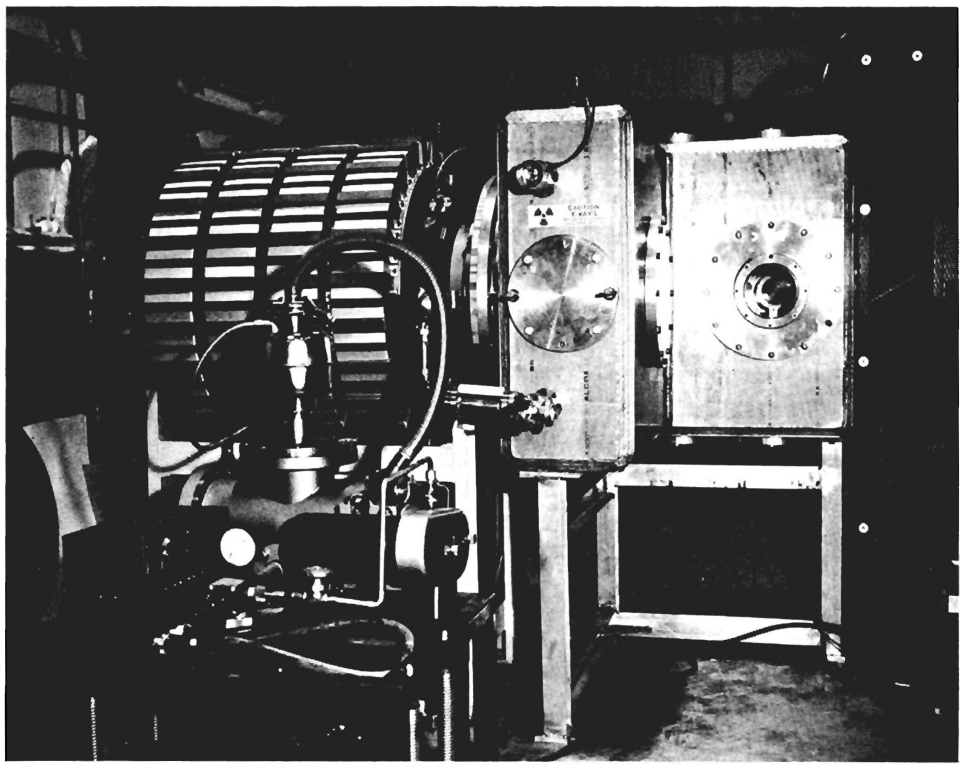


b. The accelerated proton beam (70 keV, 250 mA) striking a set of slits for preliminary emittance measurements. The vertical separation of slits is approximately 0.2 inches.

Fig. 1.



a. Cyril Curtis and Glenn Lee working on the source.



b. Another view of the ion-source test stand (from the side opposite to that shown in a.). The slits of Fig. 1b are mounted in the port at the right.

Fig. 2.

Fig. 3. The Linac Enclosure excavation on January 20. In spite of poor weather, excavation work is virtually complete and forms are being placed.

Fig. 4. Rough roads and grading (January 20). This photograph shows the road along the future external-beam line.

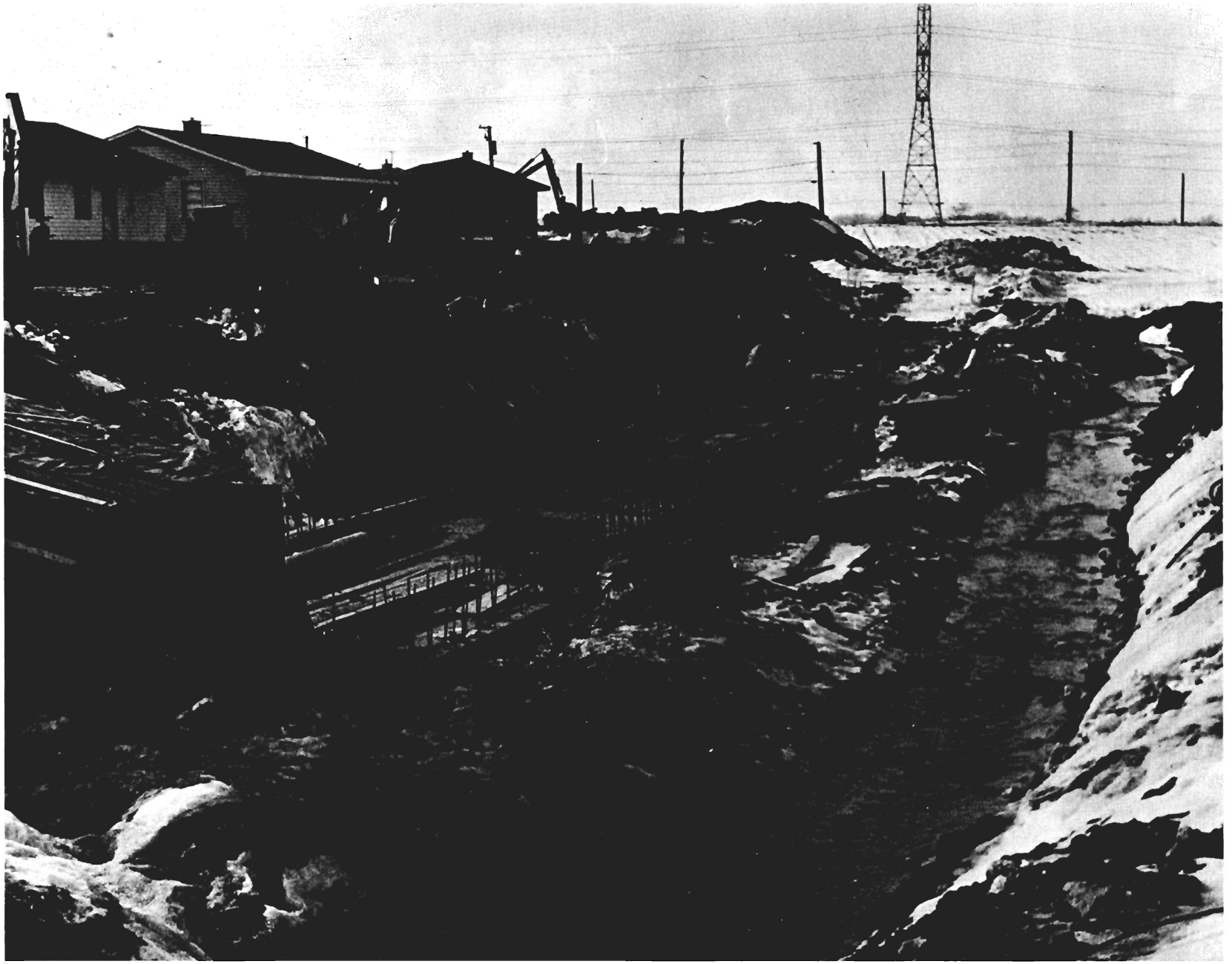


Fig. 5. Booster-Enclosure Prototype(taken January 20). Since this photograph was taken, most of the steel framing of the Booster Laboratory has been erected.

Fig. 6. An aerial view taken January 31. Director's office is in the foreground, Main-Ring Laboratory behind the houses across the street, Main-Ring Enclosure Prototype in front of the Inflatable Building and Shop behind it.

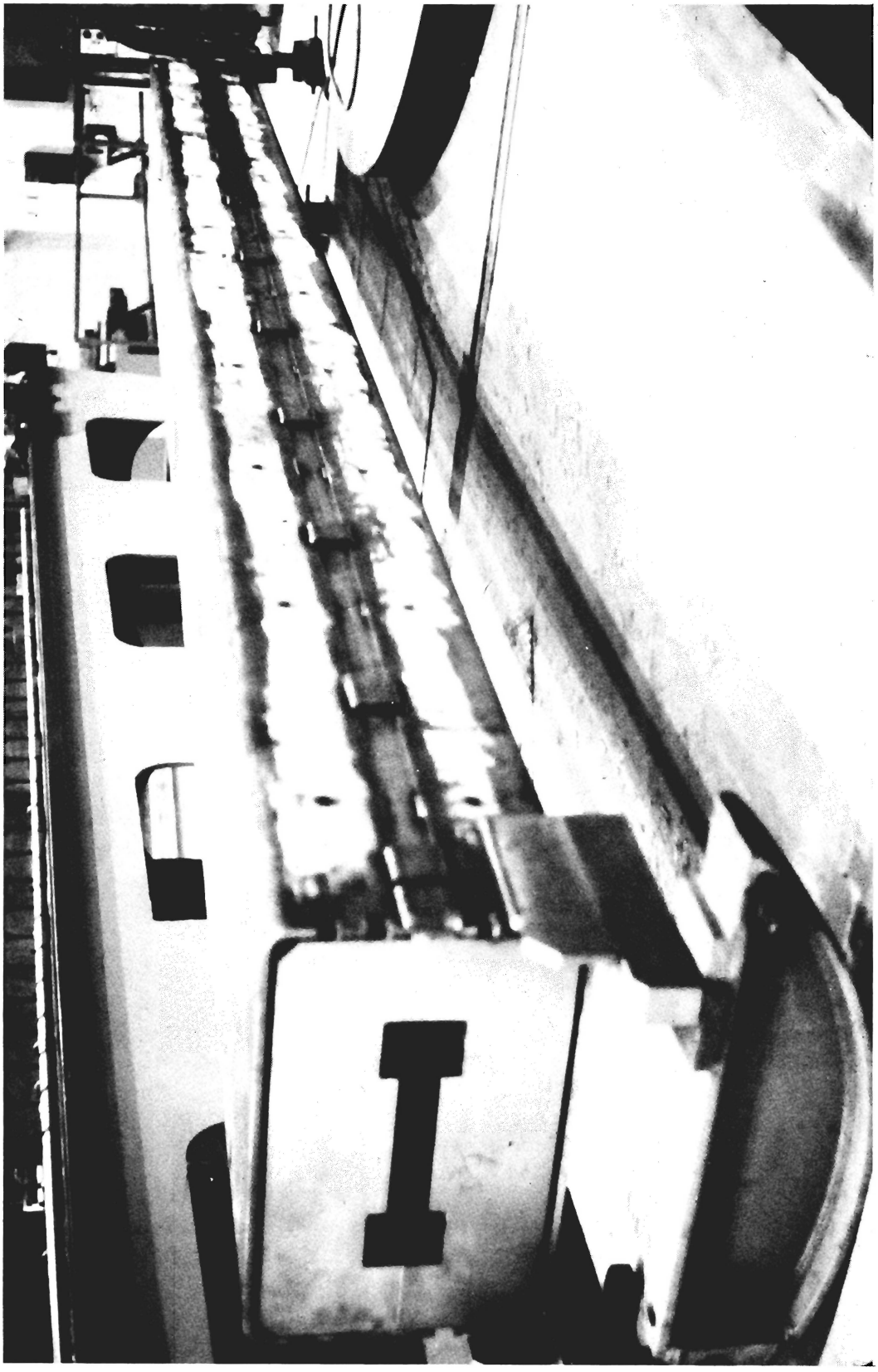


Fig. 7. The main-ring 20-foot structural model.