UCRL-18228

Cy. 2

University of California
Ernest O. Lawrence Radiation Laboratory

TWO-WEEK LOAN COPY

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. 5545

BEVATRON OPERATION AND DEVELOPMENT 56

October through December 1967

Kenneth G. Crebbin and Robert Frias

April 1, 1968

RECEIVED
LAWRENCE
RADIATION LABORATORY
JUL 10 1968
LIBRARY AND
DOCUMENTS SECTION

Berkeley, California

UCRL-18228 Cy. 2

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

UCRL-18228
UC-28 Particle Accel. and
High Volt. Mach.
TID-4500 (54th Ed.)

UNIVERSITY OF CALIFORNIA

Lawrence Radiation Laboratory
Berkeley, California

AEC Contract No. W-7405-eng-48

BEVATRON OPERATION AND DEVELOPMENT. 56

October through December 1967

Kenneth C. Crebbin and Robert Frias

April 1, 1968

Printed in the United States of America
Available from
Clearinghouse for Federal Scientific and Technical Information
National Bureau of Standards, U. S. Department of Commerce
Springfield, Virginia 22151
Price: Printed Copy $3.00; Microfiche $0.65

BEVATRON OPERATION AND DEVELOPMENT. 56

October through December 1967

Kenneth C. Crebbin and Robert Frias

Lawrence Radiation Laboratory
University of California
Berkeley, California

April 1, 1968

ABSTRACT

The beam was on for 90.6% of the scheduled operating time. The beam was off 4.6% of the scheduled operating time because of equipment failure and 4.8% of the scheduled operating time for experimental setup, tuning, and routine checks. During the quarter, the Bevatron accelerated 1.45×10^{18} protons.

Fractures were detected in the dovetail area of the main motor generator poles. Monitoring and inspection procedures have been established.

I. MACHINE OPERATION AND EXPERIMENTAL PROGRAM

The Bevatron operation record is shown in Fig. 1. The beam was on for 90.6% of the scheduled operating time. The beam was off 4.6% of the scheduled operating time because of equipment failure and 4.8% of the scheduled operating time for experimental setup, tuning, and routine checks. During this quarter, the Bevatron accelerated 1.45×10^{18} protons.

The Alvarez (Murray) Group's Experiment #39 ended this quarter. This experiment was done using the 25-inch hydrogen bubble chamber.

A new foundation pad for the 25-inch bubble chamber was prepared in the new external proton beam (EPB) hall. A new secondary beam channel will be built for the bubble chamber. The target for this new beam channel will be located at the second focus in Channel II of the EPB facility.

The major mode of operation this quarter was for the Moyer-Helmholz Group's Experiment #47A. They operated on a 800-msec flattop at 5.3 BeV. The remaining experiments this quarter were generally in a tune-up or parasitic mode of operation.

A summary of the experimental program is shown in Table I.

Construction continued through this quarter on the new EPB Hall and two-channel EPB facility. Roof construction was started on the last two bays of the hall, and the remaining part of the heavy-duty concrete floor was poured.

The Third Annual Bevatron User's Meeting was held on December 16, 1967. Current topics in high energy physics were discussed together with the future Bevatron program and schedule of experiments. Ideas were discussed for future accelerators using nonconventional techniques. The ideas covered were the use of superconductivity magnets and acceleration of particles by the coherent field of an electron ring.

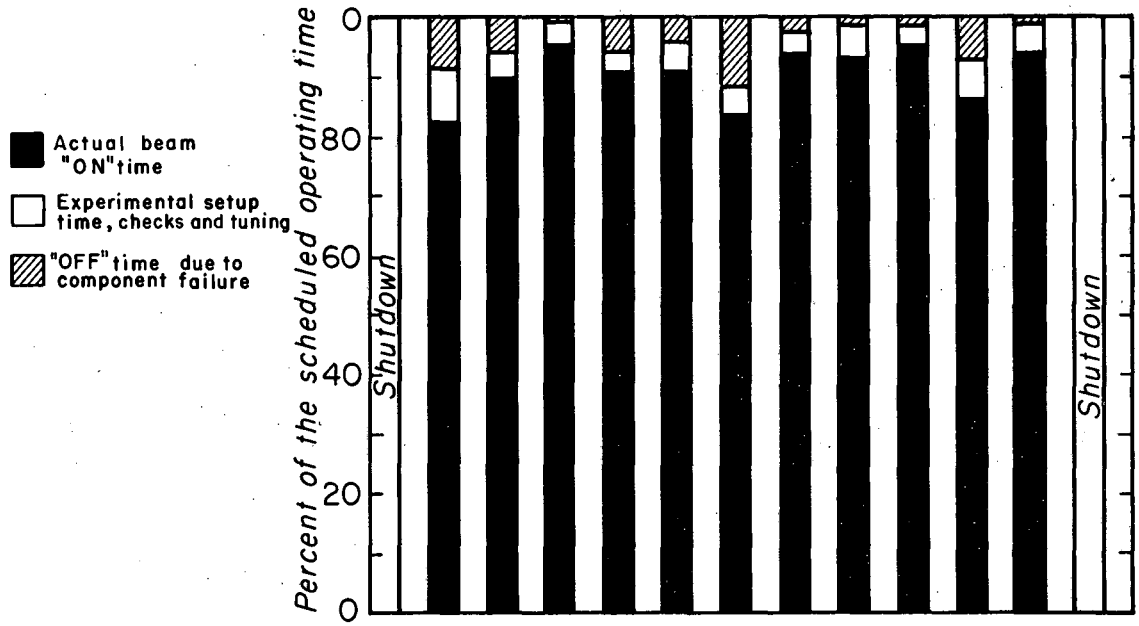
II. SHUTDOWN

The shutdown that started last quarter, on September 25, continued through October 11. The major job was the repair of the main motor generator field pole connectors. The details of this job and the remainder of the shutdown jobs were reported in the preceding quarterly report.

The Bevatron was shut down for 4 days over the Thanksgiving Day week end. No work was scheduled for this period. The Bevatron was shutdown on December 22 for the remainder of the year. There were three work days, December 26, 27, and 28, when routine maintenance and setup work were done. Effort level during the Christmas shutdown was kept low for budgetary reasons.

III. BEVATRON DEVELOPMENT AND STUDIES

The machine study periods this quarter were devoted mainly to the study of resonant extraction of the proton beam. Work continued on the development and testing of diagnostic tools and methods to study the beam behavior. Detailed measurements were made of radial ν value as a function



Week of	10/1	10/8	10/15	10/22	10/29	11/5	11/12	11/19	11/26	12/3	12/10	12/17	12/24
Crew hours	168	168	168	168	169	168	168	96	144	168	168	120	72
Turnon and maintenance time (h)	0	7	9	9	11	10	10	3	21	10	10	12	0
Scheduled operating time (h)	0	69	144	140	143	142	141	87	104	137	142	103	0
Scheduled Bevatron test time (h)	0	8	15	19	15	16	17	6	19	21	16	5	0
Scheduled shutdown time (h)	168	84	0	0	0	0	0	24	40	0	0	0	72
Holiday	0	0	0	0	0	0	0	48	0	0	0	48	48

XBL686-2846

Fig. 1. Bevatron operating schedule.

Table I. Summary of Bevatron experimental research program, October through December 1967

Groups	Dates: Run no.	Dates: Start	Dates: End	Experiment	Beam time: This quarter (Oct.-Dec.) 12-hour periods	Beam time: This quarter (Oct.-Dec.) Hours	Beam time: Start of run through December 1967 12-hour periods	Beam time: Start of run through December 1967 Hours	Pulse schedule	Primary or secondary experiment
Internal Groups										
Alvarez (Murray)	39	8/5/65	10/16/67	K^0-K_2^0 interference using 25-in. bubble chamber	8	79	242	2519	1:1	P
Moyer-Helmholz (Parker)	47A	5/19/66	In progress	Investigation of neutral particles	82 4	908 47	208 71	2283 890	1:1 1:1	P S
Lofgren (Wenzel)	67	6/7/67	In progress	Ke_2 branching ratio	3 30	28 321	7 37	80 448	1:1 1:1	P S
Moyer-Helmholz (Kenney) Alvarez (Pripstein)	84	8/14/67	In progress	Preliminary tests for a future experiment	1	13	1	13	1:1	S
Chemistry-Hyde-Poskanzer	98 (P-13)	9/21/66	In progress	Light-fragment production from interactions of heavy nuclei with protons	16 67	281 655	16 80	281 803	1:1 1:1	P S
Abolins-Smith	P-25	11/2/67	In progress	Counter and spark chamber tests in preparation for Experiment 83	2	47	2	47	1:1	S
Cork-Murthy (for U. of Michigan)	P-26	11/11/67	In progress	Test of relativistic rise $\left(\frac{dE}{dx}\right)$ with proportional counter	7	86	7	86	1:1	S
Health Physics (Lloyd Stephens)	P-27	11/28/67	In progress	Spectral and angular measurements of particles produced by 6.3-BeV protons	1	8	1	8	1:1	S
External Groups										
U. of Washington (Davis)	54	7/21/66	In progress	Ξ^0 decay parameters	4 0	44 32	4 19	44 280	1:1 1:1	P S
Calif. Inst. of Technology (Tollestrup)	80	8/31/67	In progress	Study of K_0 leptonic deacy $\Delta S/\Delta Q$ determination using 2- to 3-BeV/c separated π^- beam	6 67	66 824	7 77	73 957	1:1 1:1	P S
Jet Propulsion Laboratory (Metzger)	P-10	9/21/67	In progress	Lunar γ-ray emission simulation	3	46	4	59	1:1	S

Table I

of radius. Nonlinearities of the radial field shape of the Bevatron were investigated. Tests will continue on resonant extraction.

IV. MOTOR GENERATOR

Robert Frias

A. Detection of Lamination Cracks in New Generator Poles

Installation of fatigue life gages on the generator-pole-end laminations has been in progress since the new poles were installed. The gage is designed to be mounted on a metal structure where an indication of precrack cumulative fatigue damage is desired. The gage resembles a conventional strain gage in appearance. Figures 2 and 3 show the location of installation and an enlarged view of the sensor.

A fatigue life gage changes resistance as a continuous function of the fatigue experience. The nominal gage resistance prior to installation is 100 ohms. Large amplitudes of cyclic stress generate an irreversible resistance change which may reach as much as 10 ohms. This resistance can be measured with a conventional ohmmeter. The gages are monitored once each week during the Bevatron maintenance shutdown.

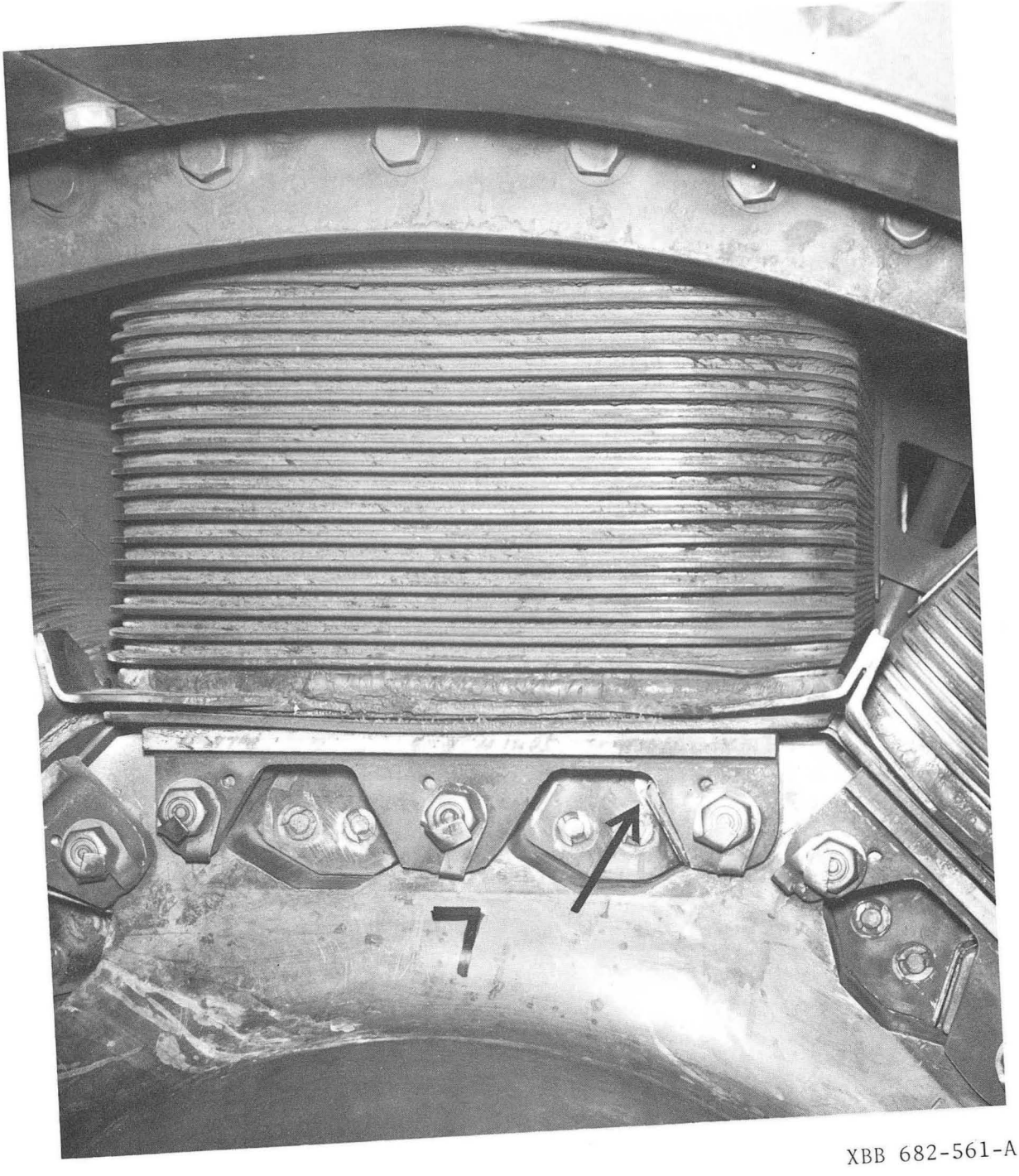
Extreme temperatures, large centrifugal forces, and considerable wind force made it necessary to develop a suitable bonding technique for installation of the fatigue life gages. Roland Krevitt and Hans Krapf of the Strain Gage Instrumentation Group have devised a satisfactory procedure. Four gages can now be installed during the maintenance shutdown. A total of 128 such monitors will be installed.

Two gages were found damaged during this quarter. Small cracks, practically undetectable to the naked eye, had developed in two pole laminations and propagated through the gages. In both cases the continuity of the gage was destroyed. These failures occurred after a small number of gages had been installed. In one case, the crack was found before any resistance increase had been recorded. In the second case, the readings had gone from 100.38 ohms to 101.60 ohms and to failure in a 2-week interval. This indicated that the crack development was fairly rapid, and reinforced the necessity for weekly readings of the gages.

A small hole was drilled at the end of each crack in an attempt to stop their propagation. Figure 4 shows one of the cracks and the stopper hole. A new life gage was installed to record any future cyclic stress or cracking.

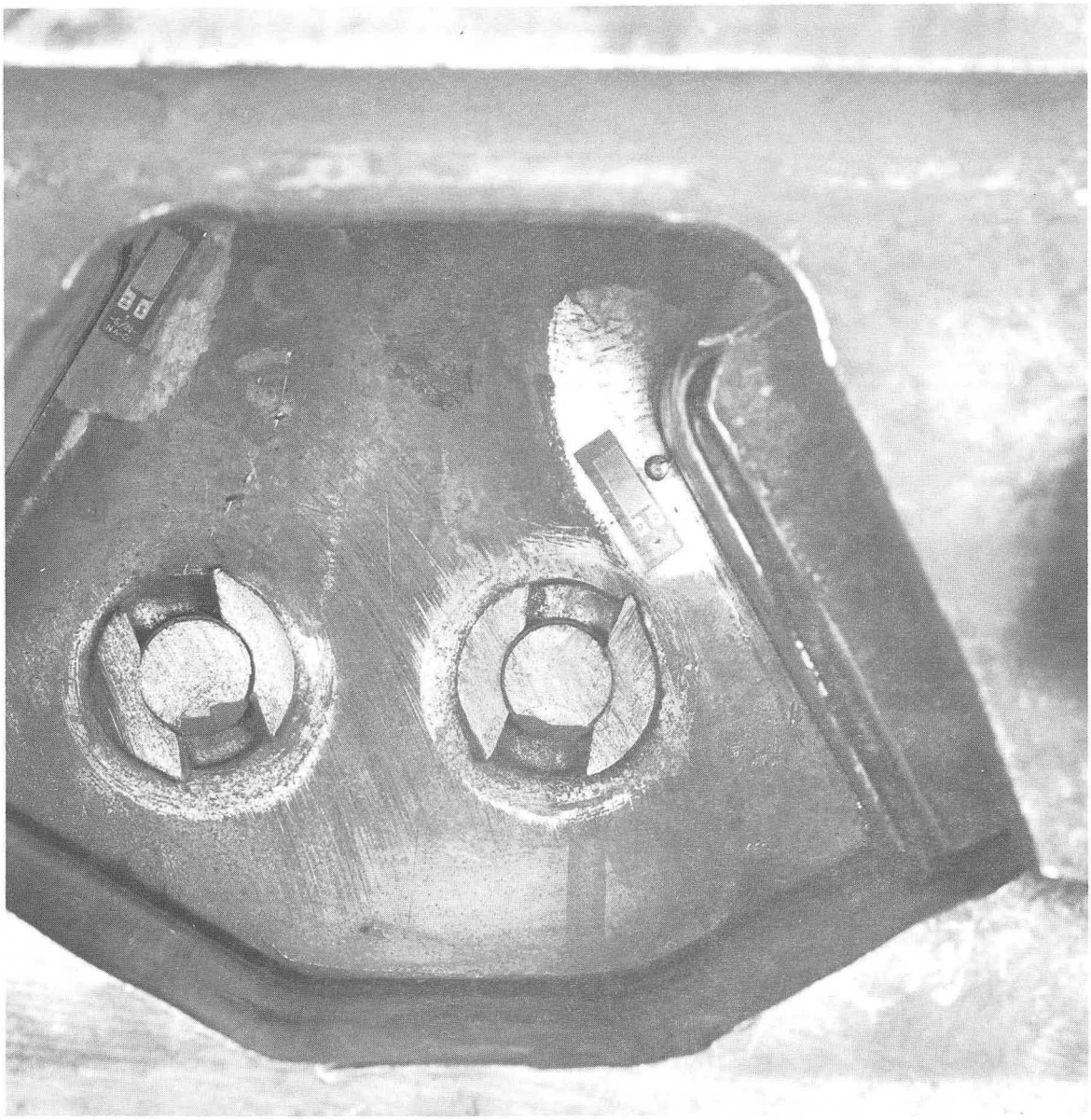
B. Generator Pole Stresses

The analysis of stress in the generator pole has shown that cyclic variation in centrifugal forces during Bevatron flat-top pulsing may lead to fatigue damage and ultimate pole failure as previously experienced. The speed range change during Bevatron operation has been limited to 100 rpm to reduce the possibility of this damage. However, with the detection of the lamination cracks it is apparent that further reduction may be necessary.



XBB 682-561-A

Fig. 2. Bevatron generator field poles, showing location of fatigue life gage.



CBB 682-559

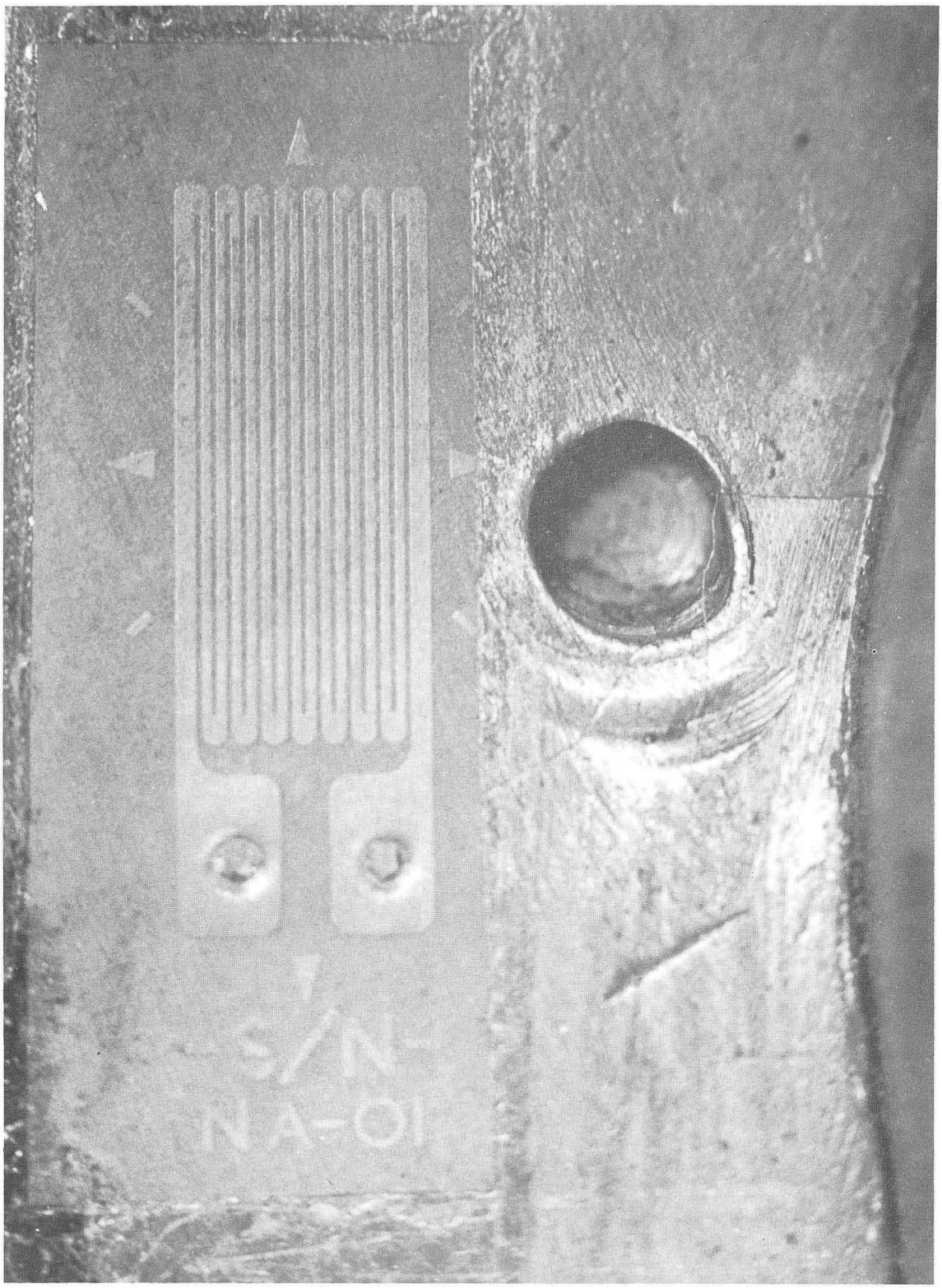
Fig. 3. Fatigue life gages installed on the field pole laminations.

The fatigue life gage has shown that it can serve a dual purpose. It can integrate and has memory of cyclic stress, and can also serve as a crack detector. It is this second mode that is now of special interest at the Bevatron.

The Mechanical and Electrical Engineering Groups have tests in progress directed to reducing stress in the dovetail. The results of these tests will be reviewed in subsequent quarterly reports.

C. Magnet Pulsing Record

The magnet pulsing record is shown in Table II.



XBB 683-979

Fig. 4. A small crack and stopper hole in the pole lamination.

Table II. Bevatron motor generator set monthly fault report.

1967	4 to 6 pulses/min								7 to 8.7 pulses/min								9.3 to 17 pulses/min								Total				
	1.5 to 6.9 kA				7.0 to 9 kA				1.5 to 6.9 kA				7.0 to 9 kA				1.5 to 6.9 kA				7.0 to 9 kA								
	Pulses	Faults 14	Faults 26	P/F	Pulses	Faults 14	Faults 26	P/F	Pulses	Faults 14	Faults 26	P/F	Pulses	Faults 14	Faults 26	P/F	Pulses	Faults 14	Faults 26	P/F	Pulses	Faults 14	Faults 26	P/F	Total	Arc backs 14	Arc through 26	P/F	Ignitrons replaced
Jan.																													No pulsing; pole replacement
Feb.																													
Mar.																													
April																													
May	1,202	0	7	171																					1,202	0	7	172	Overspd test
June	1,660	0	0	∞					130,221	1	10	11,838	48,831	3	5	6,104	117,334	1	2	39,111	9,662	1	1	4,831	307,708	6	18	12,821	
July													11,281	0	0	∞	92,033	3	8	836	243,712	5	17	11,079	347,026	8	25	10,515	
Aug.													3,942	0	0	∞	141,360	3	17	7,068	245,219	4	12	15,300	390,521	7	29	10,847	
Sept.									7,182	1	0	7,182	15,998	1	0	15,998	15,008	8	6	11,940	77,123	6	2	9,641	267,551	16	8	11,147	9/24 to 10/9
Oct.	1,200	0	0	∞	80	0	0	∞	10,535	0	0	∞	49,625	13	14	1,837	211,983	12	20	6,624	17,400	6	16	790	290,823	31	50	3,590	Pigtail shutdown 3 A-4
Nov.	1,594	0	0	∞					1,537	0	0	∞					360,917	31	20	7,076					364,048	31	20	7,138	
Dec.																	297,131	16	7	12,918	7,543	0	1	7,543	304,674	16	8	12,694	

Table II

STAFF

E. J. Lofgren	Bevatron Group
W. A. Wenzel	Alternate Group Leader
Walter D. Hartsough	In charge of Bevatron Operations
Kenneth C. Crebbin Fred H. G. Lothrop Wendell Olson	Operation supervisors
William Everette	Radiation control
Duward S. Cagle Frank W. Correll Robert G. Gisser William H. Kendall	Operating crew supervisors
G. Stanley Boyle Robert W. Brokloff Ashton H. Brown Gary M. Byer Donald N. Cowles James R. Guggemos Charles H. Hitchen Robert M. Miller Joseph F. Smith Harvey K. Syversrud Marsh M. Tekawa John E. Tommaney Stanley T. Watts	Bevatron operators
Robert W. Allison, Jr. Yves M. Baconnier Warren W. Chupp Kenneth C. Crebbin Tom Elioff Robert Force Fred H. G. Lothrop Donald Milberger Robert Richter Glenn White William A. Wenzel Emery Zajec	Development and support
Edward Hartwig Robert Force	In charge of Electrical Engineering Group
Marion Jones	In charge of Electrical Coordination Group
Kenow Lou Cedric Larson	In charge of Mechanical Engineering Group
Harold Vogel	In charge of Motor Generator Group

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.