LEGIBILITY NOTICE

A major purpose of the Technical Information Center is to provide the broadest dissemination possible of information contained in DOE's Research and Development Reports to business, industry, the academic community, and federal, state and local governments.

Although a small portion of this report is not reproducible, it is being made available to expedite the availability of information on the research discussed herein.

ornl

OAK
RIDGE
NATIONAL
LABORATORY

UNION
CARBIDE

ORNL/TM-8212

ORNL/TM--8212

DE83 004689

Fission Chamber Assembly and Matching Preamplifier

J. T. DeLorenzo

OPERATED BY
UNION CARBIDE CORPORATION
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
NTIS price codes—Printed Copy: A03 Microfiche A01

ORNL/TM-8212
Dist. Category
UC-78

INSTRUMENTATION AND CONTROLS DIVISION

FISSION CHAMBER ASSEMBLY AND MATCHING PREAMPLIFIER

J. T. DeLorenzo

Date Published - December 1982

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
UNION CARBIDE CORPORATION
for the
U.S. DEPARTMENT OF ENERGY
Contract No. W-7405-eng-26

CONTENTS

1. DESCRIPTION

1.1 GENERAL

The fission chamber assembly provides a voltage pulse on the end of a twin-conductor cable as long as 230 ft which is an approximation of the chamber current pulse.

A preamplifier with a balanced input and low noise input stage terminates the cable from the fission chamber and provides a balanced output signal to drive a main amplifier.

1.2 CONSTRUCTION

The fission chamber assembly consists of a miniaturized fission chamber,[1] six feet of special fiber quartz glass coaxial cable, electrostatically shielded pulse transformer and decoupling network and thirty feet of double shielded twin-conductor transmission cable. The fission chamber, coaxial cable and transformer are enclosed by a flexible stainless steel jacket and electrically insulated from it. In the HFIR installation this outer jacket is continued over the twin-conductor cable in the form of the stainless steel rack which is part of the chamber positioning mechanism and tinned copper braid. (In other installations this enclosure for the twin-conductor portion of the assembly may take other forms.)

Connection of the fission chamber assembly to the long run of triple shielded twin-conductor cable leading to the preamplifier is made in a junction box of double walled construction.

The preamplifier is enclosed in a double walled box with the input cable connected to one end with a cable bushing and nuts. The outside shield of the triple shield configuration is connected to the bushing on the outer box. The three sections of the preamplifier (input gain stage, second gain stage and balanced cable driver output stage) are all separately shielded with power lines to each section decoupled with feed-through type high-frequency filters and electrolytic capacitors. The balanced output, preamplifier power and +300 V chamber supply are connected on the opposite end of the preamplifier with a quick-disconnect balanced output, preamplifier power and +300 V chamber supply are connected on the opposite end of the preamplifier with a quick-disconnect cable connector. The two output signal leads comprising the balanced output are brought out on two coaxial type contacts in this connector.

Details of all cable shielding and grounding for the fission chamber assembly, preamplifier and their associated junction box are shown in ORNL drawing Q2641A-1.

1.3 APPLICATION

This fission chamber assembly and preamplifier provides the input signal for the main amplifier in a wide-range count-rate channel[2] which is capable of monitoring neutron flux over a ten-decade span. It replaces an earlier design[1] which contained a vacuum tube preamplifier located six feet from the fission chamber.

The output signal is balanced and each side will terminate and drive 62 Ω against ground. The output pulse will be triangular in shape (50 ns rise-time, 150 ns decay) and, because of bandwidth considerations, required a change in the pulse transformer and the relocation of the differentiating network in the earlier design of the drawer for the wide-range count-rate channel.

1.4 SPECIFICATIONS

1.4.1 Fission Chamber Assembly (Test circuit Fig. 1)

1. Pulse response: (Each output, see Fig. 1A)

   Amplitude = $\frac{1}{40}$ × pulse generator output

   Risetime (10% to 90%) = 12 ns.

   Recovery time (time to 10% of peak) = 2.5 μs

   Undershoot = 30% of peak value.

   Polarity is dependent on the output terminal tested.

ORNL-DWG 16475

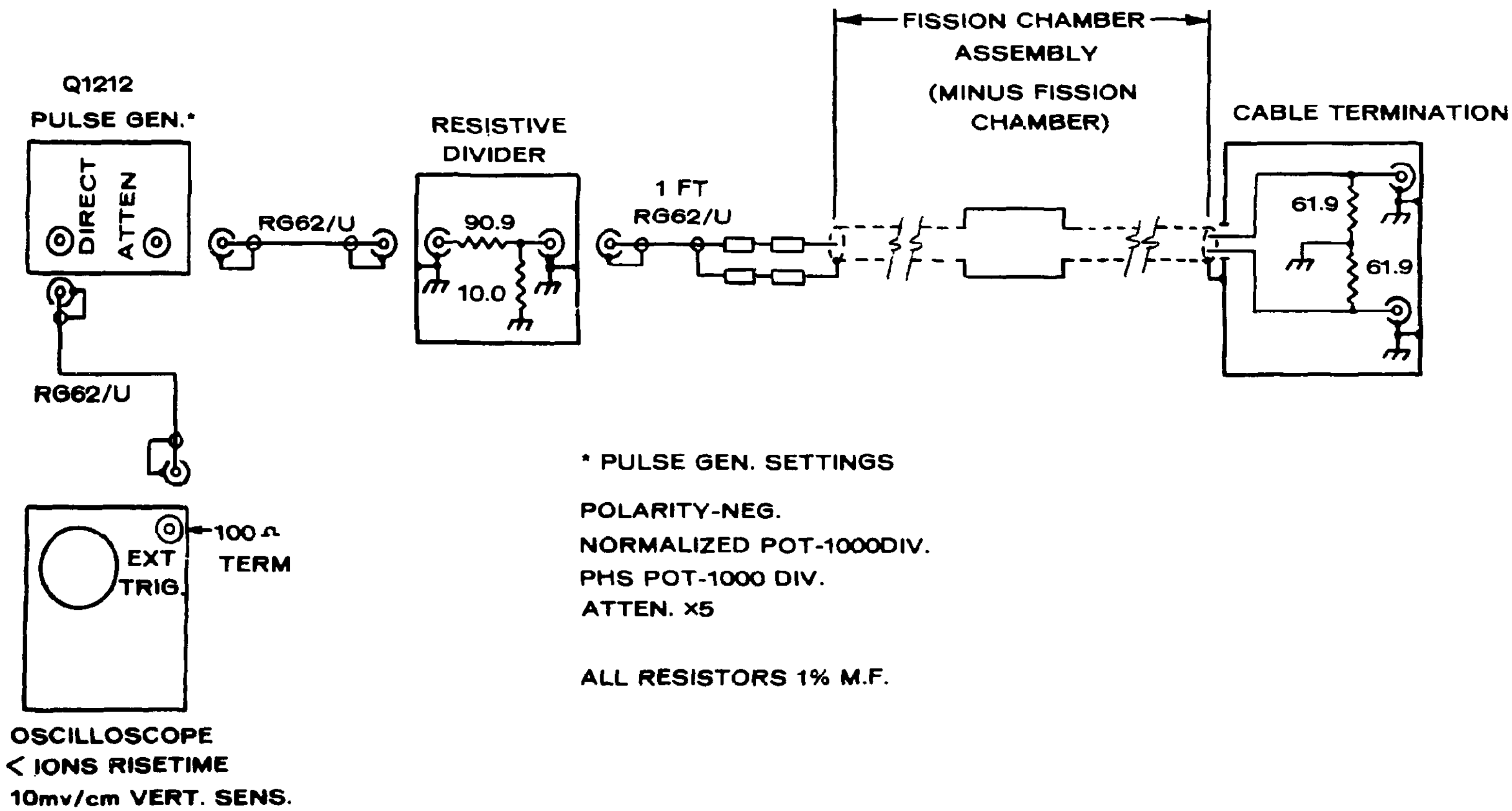


Figure 1. Test Circuit for Fission Chamber Assembly

ORNL-DWG 16474

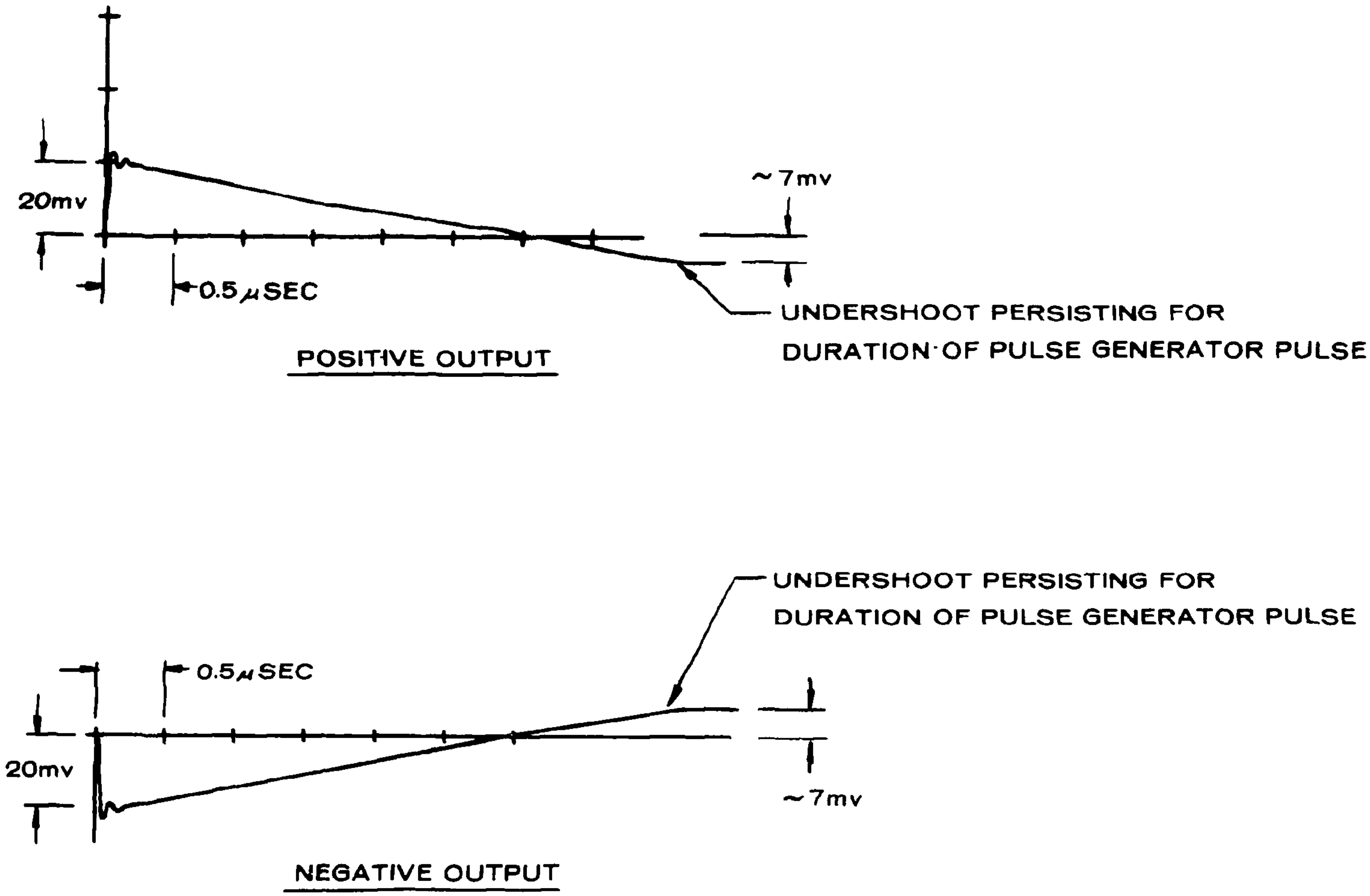


Figure 1A. Waveforms for Output of Fission Chamber Assembly

1.4.2 Preamplifier (single ended output, open circuit, test circuit Fig. 2)

1. Voltage gain:	1500.
2. Pulse shape:	Rise time (10% to 90%) = 18 ns. Recovery time (time to 10% of peak) = 5 μs Undershoot = 20% of peak. Polarity is dependent on the output terminal tested.
3. Linear output:	0 to 1.0 V.
4. Noise (10 Hz to 4 MHz bandwidth): with no input cable.	6.5 mV rms.

1.4.3 Power Requirements

1. Voltage (for (preamplifier):	+15 ±0.02 V; -15 ±0.02 V.
2. Current drain (for preamplifier):	50 mA from +15 V supply. 50 mA from -15 V supply.
3. Regulation (for (preamplifier):	±0.05% or better against ±10% line changes and with load changes from no load to full load.
4. Ripple (for preamplifier):	Peak to peak ripple less than 0.01 V.
5. Voltage (for fission chamber):	+300 ±15 V.
6. Current drain (for fission chamber):	Less than 0.1 mA.
7. Current limiting (for fission chamber):	3 mA max.
8. Regulation (for fission chamber):	Less than 10 V change from 0 to 0.1 mA load variation.
9. Ripple (for fission chamber):	Peak to peak ripple less than 100 mV.

ORNL-DWG 16473

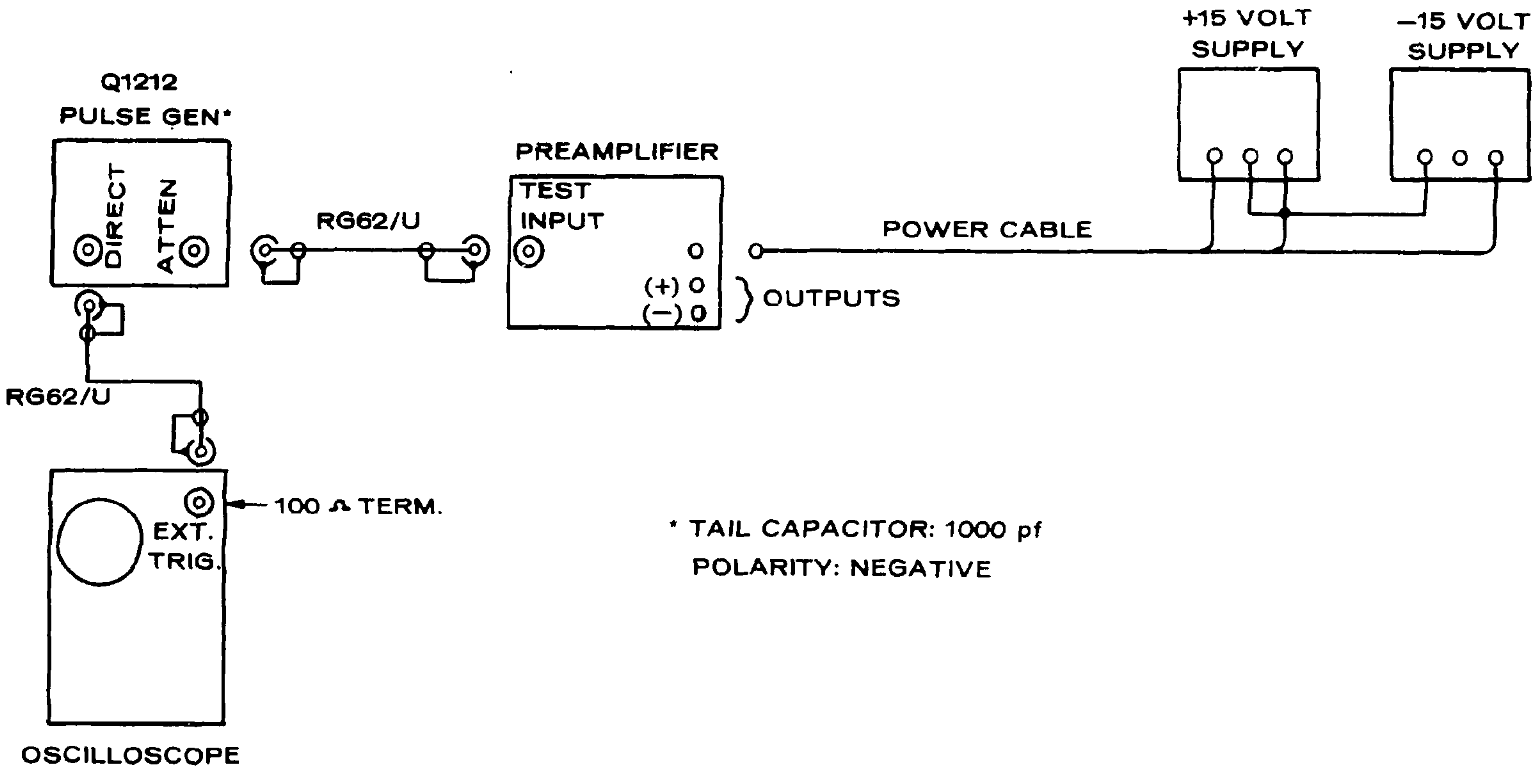


Figure 2. Test Circuit for Pre-amplifier Voltage Gain and Pulse Shape Measurements

1.4.4 Ambient Temperature Range

The ambient temperature range of all units is 0 to 55°C.

1.5 APPLICABLE DRAWINGS AND SPECIFICATIONS

The following list gives the drawing number (ORNL Instrumentation and Controls drawing number) and subtitles and fabrication specification number for the Fission Chamber Assembly and Matching Preamplifier.

Q-2641A-1	Circuit
Q-2641A-2	Fission Chamber Preamp and Pulse Transformer Network - Details Sheet 1
Q-2641A-3	As above - Details Sheet 2
Q-2641A-4	As above - Preamp Circuit Board Layout
Q-2641A-5	As above - Parts List
Q-2641-6	As above - Pulse transformer Housing and Details
Q-2641-7	As above - Chamber Housing and Details
Q-2641-8	As above - Chamber Cable Assembly and Details
Q-2641-9	As above - Transformer Potting Mold and Details
Procedure P-2641-1	Fission Chamber and Pulse Transformer Assembly and Test Procedure

2. THEORY OF OPERATION

2.1 GENERAL

The Fission Chamber Assembly and Matching Preamplifier was designed to give high noise rejection on the cable between the fission chamber and preamplifier.[3] The rejection capability is such that as much as 230 ft of cable can be tolerated between the two units. A triple shielded twin-conductor transmission cable with electrostatically shielded pulse transformers at both the fission chamber and preamplifier were required to achieve the necessary common mode rejection.

The supply voltage for the chamber was applied through a center tap at the preamplifier transformer and delivered to the chamber at a center tap on the chamber transformer. An R-C network is used to isolate the primary and secondary windings of the transformer at the chamber. Figure 3 shows a simplified schematic of the entire system and includes the pulse transformer and differentiating network in the wide-range count-rate channel drawer.

The current pulse from the fission chamber develops a voltage across the impedance existing across the terminals of the primary of transformer T1. This voltage is then transmitted to the preamplifier via a balanced and triple shielded cable. The turns ratio of the transformer is selected to give a primary time constant which is about one-half the electron collection time. This produces a pulse with a rise time nearly equal to the electron collection time, with the recovery time between three and four times the collection time. The preamplifier is designed to amplify this pulse with little distortion and apply it to a balanced line going to the main amplifier drawer. A balanced system is also used here to gain further noise rejection. The resistor R_o terminates the twin-conductor cable. The resistor, R_c, in series with the center tap terminates the balanced cable for common mode voltages (i.e., voltages that occur on both conductors with same polarity). The pulse shapes as they occur in various parts of the system are shown in Fig. 4.

ORNL-DWG 16472

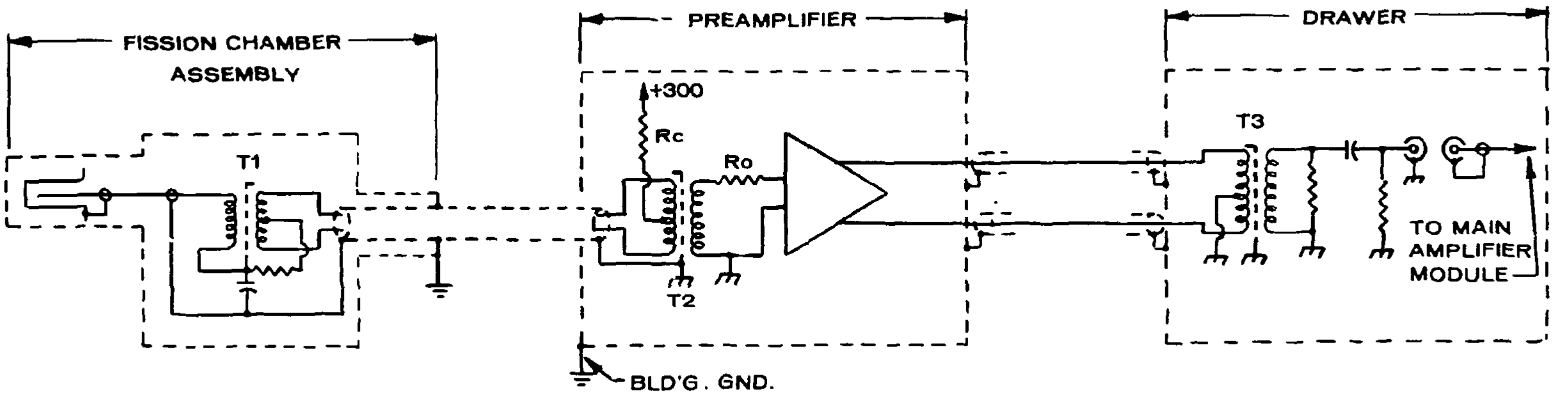


Figure 3. Simplified Schematic and Block Diagram of Fission Chamber Assembly with Pre-amplifier and Wide Range Counting Channel Drawer

ORNL-DWG 16471

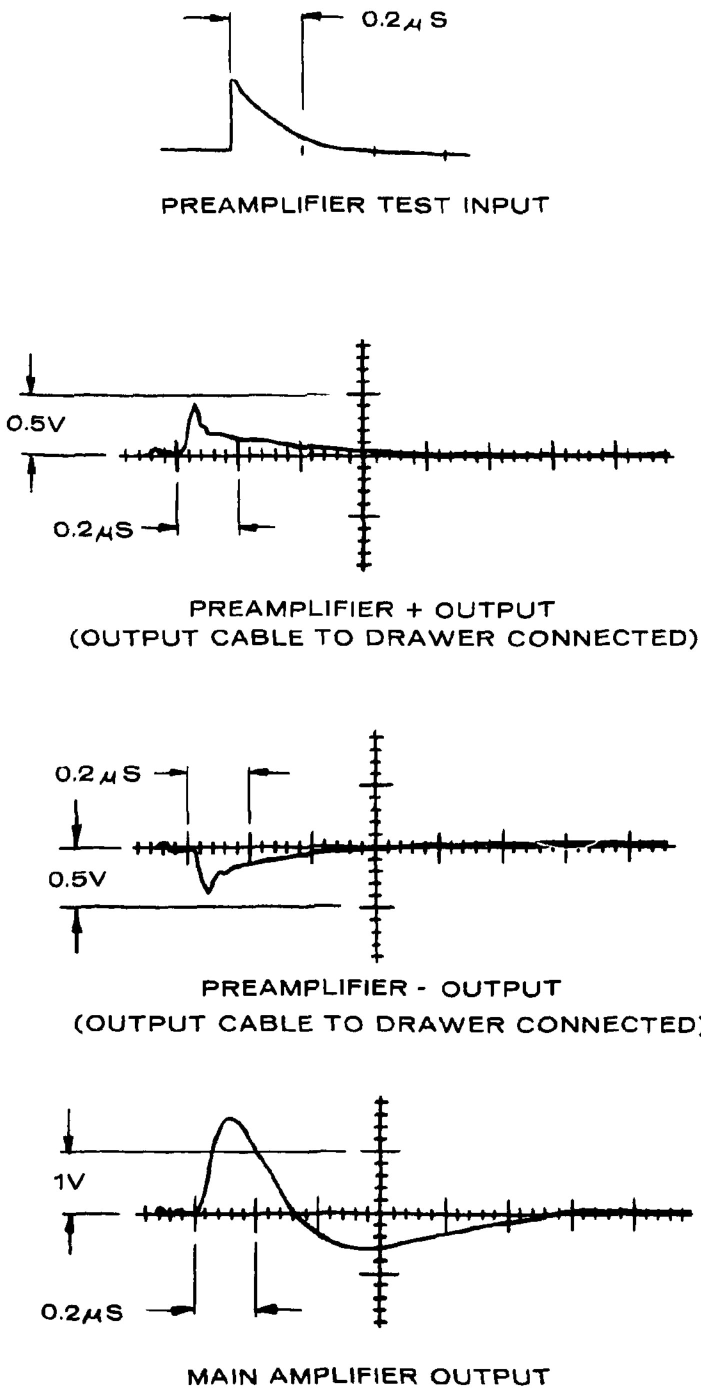


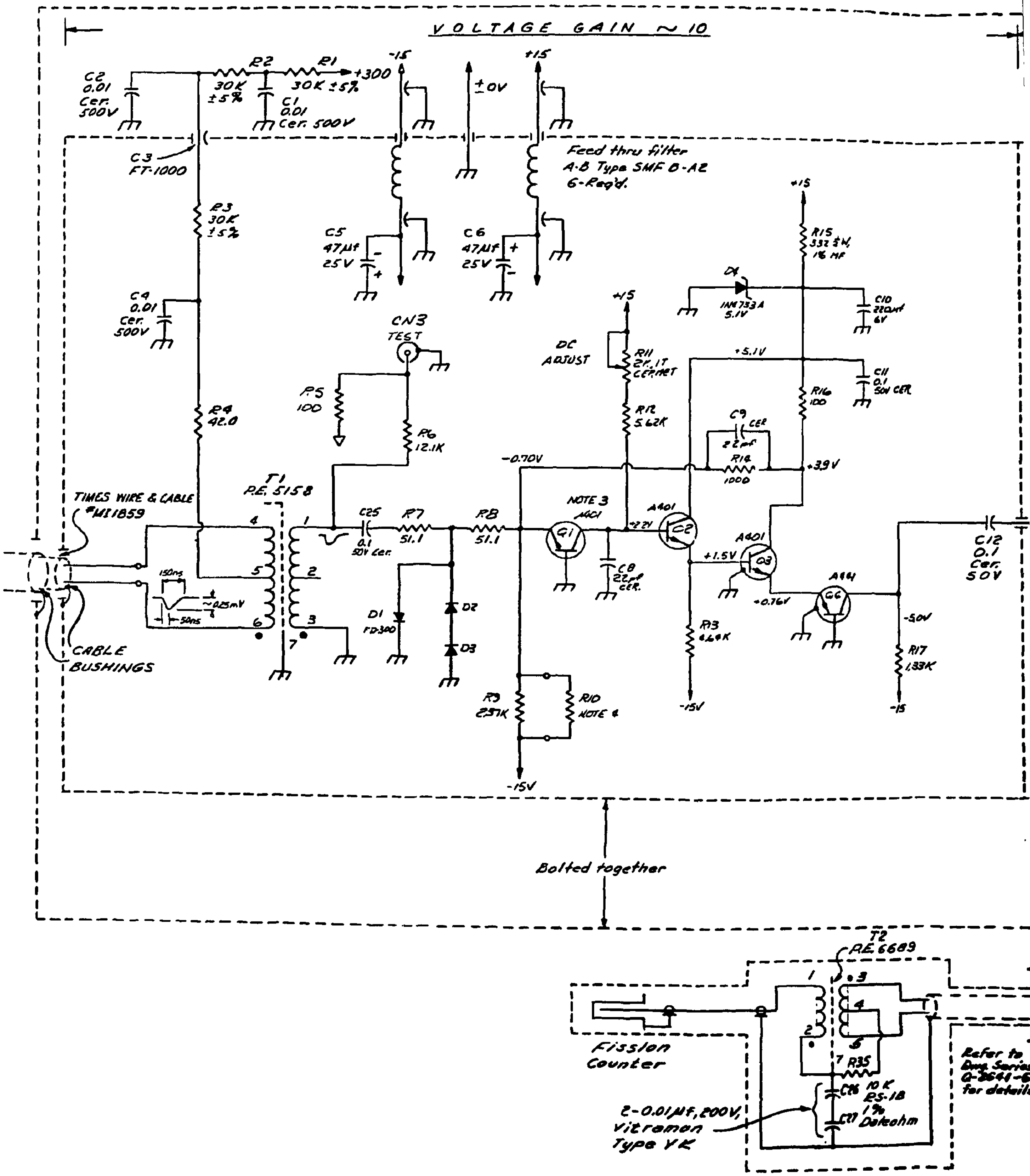
Figure 4. Output Waveforms of Pre-amplifier and Main Amplifier

The transformer (T2 of Fig. 3) at the input to the preamplifier has a 1:1 turns ratio and is connected to produce positive pulses. The complete preamplifier circuit is shown in Fig. 5. The low-noise input section has shunt feedback to obtain stabilized wideband amplification. Its input impedance is padded with R_o to create the proper termination for the input cable. It is non-inverting with a voltage gain of nearly 10, which is 3 db down at 50 MHz. The section consists of a common-base amplifier Q1 with feed-back to its emitter via R14. The ratio of the shunt feedback resistor R14 and R16 in the collector of Q3 determines the current gain of the stage. This ratio multiplied by the ratio of (R7 + R8) and R18 determines the voltage gain of the stage.

A second stage of amplification is obtained with a wide-band, differential integrated circuit amplifier either an MC1733C or NE592. This device has a differential input and a balanced output. Its overall single-ended gain is nearly 100 with a 3 db roll off at approximately 40 MHz.

The balanced cable driver section contains complementary amplifiers for the two outputs with transistors Q5 providing the negative output and Q6 the positive output. These amplifiers are common-emitter amplifiers with voltage gain determined by the ratio of R25 and R28 for one unit and R25 and R30 for the other. The input voltage to these driver amplifiers is the differential output of preceding differential integrated circuit amplifier. Output voltage pulses are obtained across the 51.1 Ω resistors in the collectors of Q5 and Q6 terminating the two co-axial cables which transmit the pulses to the main amplifier drawer.

Another transformer is required at the main amplifier drawer (as shown in Fig. 3) to apply the balanced signal to the unbalanced input of the main amplifier. The time constant involving the 100-Ω ladder attenuator of the main amplifier, the coupling capacitor, and the impedance "looking" back into the transformer secondary (including the shunting effect of R_s) was chosen as the differentiating time constant of the system. This time constant was selected experimentally to be 150 ns.


VOLTAGE GAIN ~ 10
C2 0.01 Cer. 500V
R2
R1
30K ±5%
30K ±5%
+300
C1 0.01 Cer. 500V
-15
±0V
+15
C3 FT-1000
Feed thru filter A-B Type SMF B-A2 6-Req'd.
R3 30K ±5%
C5 47μf 25V
C6 47μf 25V
+15
R15 332 ½W, 1% MF
D4 1N4733A 5.1V
C10 220μf 6V
C4 0.01 Cer. 500V
CN3 TEST
+15
DC ADJUST
R11 2K, 1T CERMET
+5.1V
C11 0.1 50V CER
R5 100
R4 42.0
R6 12.1K
R12 5.62K
R16 100
C9 CER 22pf
R14 1000
-0.70V
+3.9V
TIMES WIRE & CABLE #MI1859
T1 P.E. 5158
NOTE 3 A401
A401
A401
C25 0.1 50V Cer.
R7 51.1
R8 51.1
Q1
+2.2V
Q2
Q3
+1.5V
C12 0.1 Cer. 50V
C8 22pf CER.
150ns
~0.25mV
50ns
+0.76V
A414
Q6
D1 FD300
D2
D3
-5.0V
R13 4.64K
R17 1.33K
CABLE BUSHINGS
R9 237K
R10 NOTE 4
-15V
-15V
-15
-15V
Bolted together
T2 P.E. 6689
Fission Counter
R35
C26
C27
10K RS-1B 1% Dalcohm
2-0.01μf, 200V, Vitramon Type VK

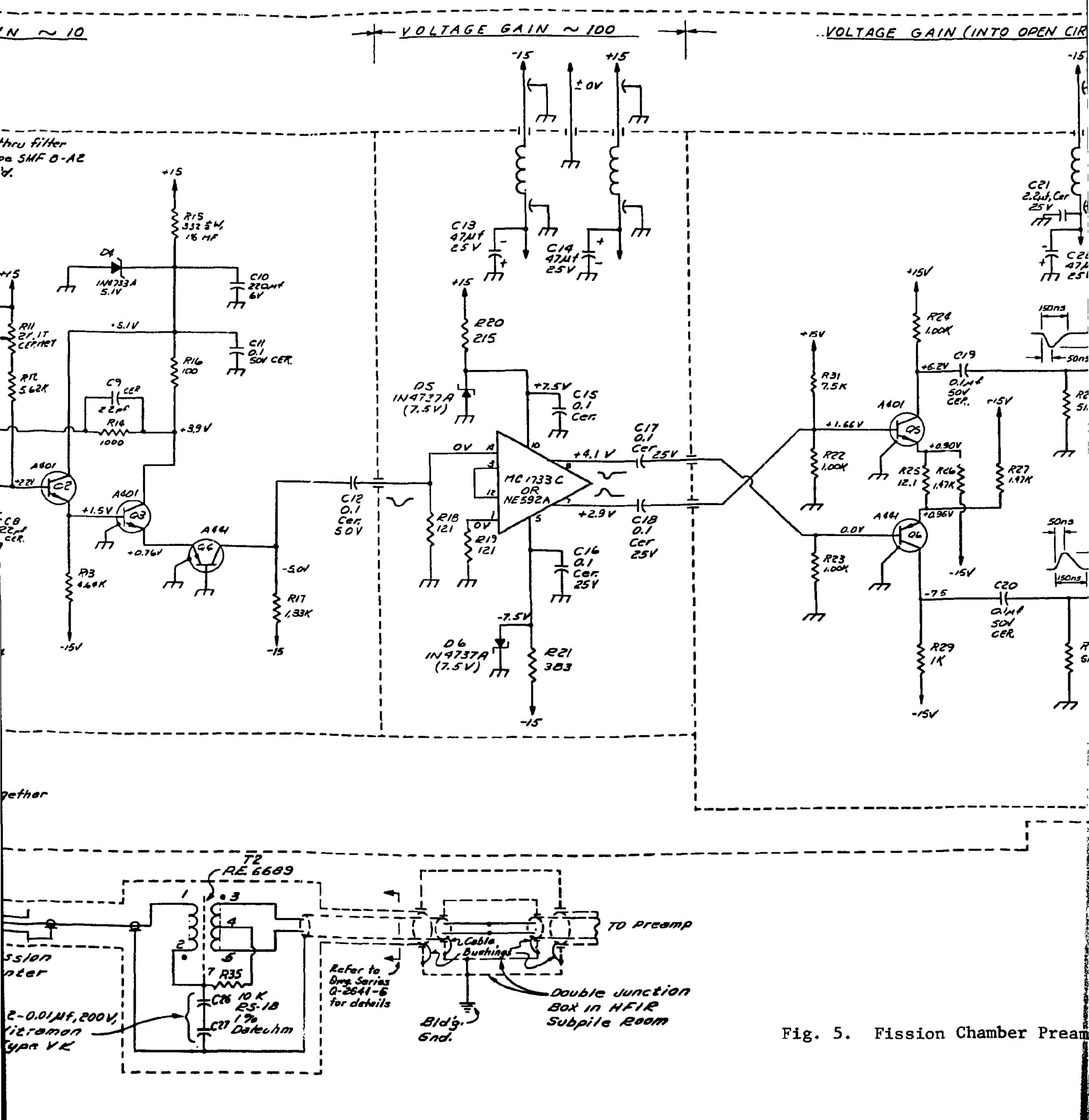
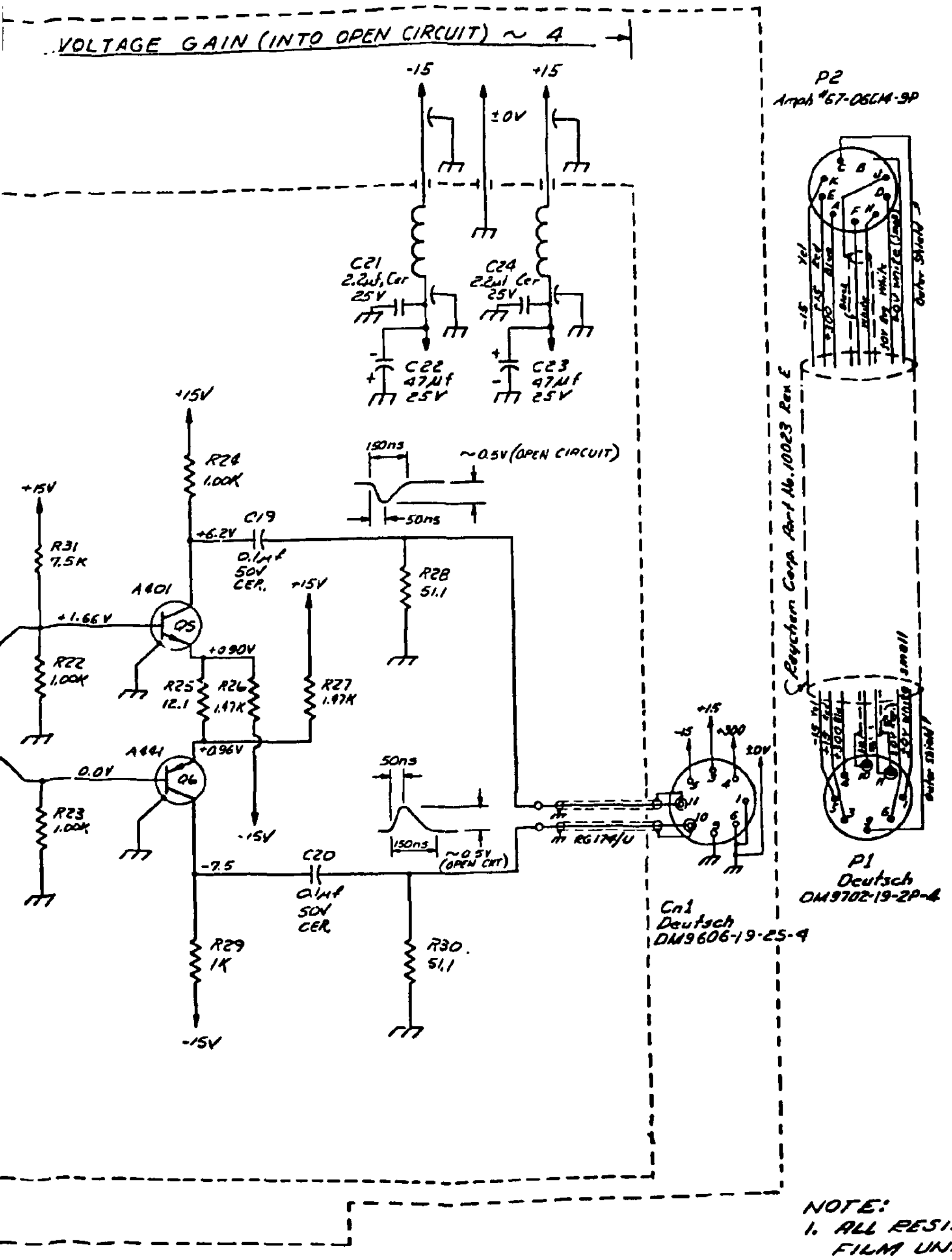


Fig. 5. Fission Chamber Pream



NOTE:
1. ALL RESISTORS ±1%, ¼W METAL FILM UNLESS DESIGNATED OTHERWISE.
2. ADJUST TO GIVE CORRECT D.C. OUTPUT VOLTAGE. NORMALLY 20 KOHMS AND HIGHER.
3. DO NOT ENGAGE CASE LEAD.
4. USE TO ADJUST DC OUTPUT LEVEL. IT SHALL NOT BE MADE LESS THAN 23.7K.

Fig. 5. Fission Chamber Preamp and Pulse Transformer Nework.

3. OPERATING INSTRUCTIONS

3.1 INSTALLATION

The preamplifier is mounted inside the cabinet containing the main amplifier drawer and should be securely tied to the building ground bus. The triple shielded input cable should be pulled through conduits free of an ac or noisy conductors. A connection should be made to the Fission Chamber Assembly cable in a double shielded junction box which also should be mounted to a reliable building ground. It is very possible to reverse the connections of the twin-conductor cable which will apply the wrong polarity pulse to the preamplifier. It may be necessary to observe the polarity of the pulse at the collectors of Q5 or Q6 to check this. (If the cabling from preamplifier to the main amplifier drawer is known to be correct, the output pulse from the main amplifier can also be used to determine this.)

The output cable connector should then be engaged and the preamplifier and fission chamber assembly is ready for operation.

4. MAINTENANCE INSTRUCTIONS

4.1 GENERAL

Any measurements within the preamplifier should be made with caution. The high gain and large bandwidth of the preamplifier makes it susceptible to oscillation and will give false readings. Voltage measurements should be made with a resistor in series with the hot probe lead. A value of 5000 to 10,000 Ω is adequate. This may be required even though the probe is already fitted with a resistor.

Oscilloscopes with at least an 80 MHz bandwidth should be used to check the preamplifier. High frequency oscillation may not be observed with oscilloscopes with lesser bandwidths. The ground clip on the oscilloscope probe should be made as short as possible when looking for waveforms within the preamplifier.

4.2 PERIODIC MAINTENANCE

No periodic maintenance is required.

4.3 CALIBRATION

No calibration procedure is required.

4.4 TROUBLE SHOOTING

Before any trouble shooting is to be attempted, it is imperative that the module (Q-2617) supplying chamber voltage be disengaged and the filter capacitors in the chamber supply current and the input cable be discharged with a 10 K resistor. It is important that this be done to avoid developing transients on the input which can destroy Q1 and possibly Q2. If the trouble shooting requires the chamber voltage to be present, care must be taken to avoid transients on the input.

If the preamplifier is suspected of a fault, a Q1212 pulse generator can be connected to the test input as shown in Fig. 3. The output signal can be observed at the input test point of the main amplifier conveniently. This signal will be attenuated to about 1/2 of its value at the output of the preamplifier (single-ended) not including the loss in the input attenuator. Present experience has shown that most preamplifier malfunctions have been caused by damage to transistors Q1 and Q2 which was produced by input transients.

4.5 Voltage Chart

Table 1 is the voltage chart for the transistors in the preamplifier. All voltages were taken with a battery operated voltmeter with input impedance in excess of 10 M-Ω. A 5600 Ω 1/2 W carbon resistor was connected externally to the VTVM probe tip. Supply voltages were +15 ±0.02 V and -15 ±0.02 V.

Table I

Transistor No.	Emitter (V)	Base (V)	Collector (V)
Q1, A401	-0.70	0.0	+2.2
Q2, A401	+1.5	+2.2	+5.1
Q3, A401	+0.76	+1.5	+3.9
Q4, A441	+0.76	0.0	+5.0
Q5, A401	+0.90	+1.66	+6.2
Q6, A441	+0.96	+0.0	-7.5
MC1733C	(1) 0.0, (8) +4.1	(5) -7.5, (10) +7.5	(7) +2.9, (14) 0.0,

REV. NO.	COMPON'T. or PIECE NO.	QUAN. REQ'D	STORES NO.	DESCRIPTION
				5. REPLACEABLE PARTS LIST
		1	Fabricate	Box, "A", per drawing Q-2641A-2 and ORNL Spec. Q-800-13.8.
		1	Fabricate	Cover, "A", per drawing Q-2641A-2 and ORNL Spec. Q-800-13.8.
		1	Fabricate	Plate, "A", per drawing Q-2641A-2 and ORNL Spec. Q-800-13.8.
		1	Fabricate	Box, "D", per drawing Q-2641A-2 and ORNL Spec. Q-800-13.8.
		1	Fabricate	Plate, "D", per drawing Q-2641A-2 and ORNL Spec. Q-800-13.8.
		1	Fabricate	Cover, "D" per drawing Q-820-50 and ORNL Spec. Q-800-13.8.
		2	Fabricate	Plate, cable bushing, per drawing Q-26441A-2 and ORNL Spec. Q-800-13.8.
		1	Fabricate	Plate, shield, per drawing Q-2641A-2 and ORNL Spec. Q-800-13.8.
		1	Fabricate	Shield, "D1", per drawing Q-2641A-3.
		1	Fabricate	Shield, "D2", per drawing Q-2641A-3.
		2	Fabricate	Shield, "D3", per drawing Q-2641A-3.
		1	Fabricate	Shield, "D4", per drawing Q-2641A-3.
		1	Fabricate	Shield, "D5", per drawing Q-2641A-3.
		1	Fabricate	Shield, "C", per drawing Q-2641A-3.
		1	Fabricate	Plate, preamp grounding, per drawing Q-2641A-3.
		1	Fabricate	Etched wiring board, per Q-2641A-4 and ORNL Spec. Q-800-13.13 and Q-800-13.14.
				NOTE: All of the following components and materials are ORNL supplied.
		1	06-776-1465 (modify)	Box, "C", complete with cover per drawing Q-820-14 and ORNL Spec. Q-800-13.8. To be modified by Seller per Q-2641A-2.
		1	06-776-1405 (modify)	Box, "B", complete with cover, per drawing Q-820-19 and ORNL Spec. Q-800-13.8. To be modified by Seller per Q-2641A-2.

OAK RIDGE NATIONAL LABORATORY OPERATED BY UNION CARBIDE CORPORATION INSTRUMENTATION AND CONTROLS DIVISION	PARTS LIST Sheet of / Drawing No.

REV. NO.	COMPON'T. or PIECE NO.	QUAN. REQ'D	STORES NO.	DESCRIPTION
				Q-2641A-5,
		1-1/4	06-880-3216 (modify)	Terminal Board, 5/16" W x 1/8" thick, epoxy fiber glass, per ORNL Dwg. Q-900-18, Det. 2. Seller to modify per ORNL Dwg. Q-2641A-3.
	T1	1		Transformer, pulse, electrostatically shielded, 1CT:1CT ratio, PRI. OCL 1/0 MH, 0.96 pf P/S stray cap., 2.5 μH leak. Ind. P/S, 0.650" L x 0.443" W x 0.400 H., 1.5" leads, Pulse Engineering, Inc. #5158.
		6	06-870-2000	Filter, feed-thru, complete with mounting nut and lockwasher, 12/32 mounting threads, A-B #SMFB-A2.
	C3	1	06-802-1040	Capacitor, fixed, ceramic, feed thru, 0.001 μF cap., 500 V DCW, 12-28 mounting threads, hook terminals 1-1/8" long, Centralab #FT-1000.
		7	02-059-5552	Nut, hex, SST, 18-8, 5/16" across flats, 5/64" thick (for use with above feed-throughs), H. M. Harper Co.
		6	06-984-3450	Socket, 4 contact, miniature, TO-18, transistor, teflon, 0.256" dia. by 0.195" high, gold plated beryllium contacts, Augat #8060-1G4R.
		1	06-984-4590	Socket, 14 contact, DIP, gloss filled nylon insulation, Augat No. 514-AG10D.
	C8,9	2	06-802-0235	Capacitor, 2.2 pf, ± 0.25 pF, 1000 V DCW, ceramic disc, NPO, Sprague No. CO30B10252R2C.
	C7	1	06-802-0084	Capacitor, 0.01 μF, ±20%, 50V DCW, ceramic, monolythic, Sprague 3CO23103X0500C5.
R1	C11,12 15,16 17,18 19,20 25	9	06-802-0087	Capacitor, 0.1 μF, ±20%, 50 V DCW, ceramic, monolythic, Sprague #3CZ5U104X0050C5.
	C21, 24	2	06-802-0091	Capacitor, 2.2 μF, ±20%, 25V DCW, ceramic, monolythic, Sprague #5CZ5U225X0050C5.
	C5,6 22,23	4	06-805-1550	Capacitor, 47 μF, ±10%, 6V DCW, polarized, electrolytic, solid tantalum, Kemet T330D476K025AS, Union Carbide.
	C10	1	06-805-1050	Capacitor, 220 μF, ±10%, 6V DCW, polarized, electrolytic, solid tantalum Kemet T330D227K006AS.
R1	C1,2 4	1	06-802-1430	Capacitor, 0.012 MF, 20%, 1KV, Semtech #2520E.

OAK RIDGE NATIONAL LABORATORY OPERATED BY UNION CARBIDE CORPORATION INSTRUMENTATION AND CONTROLS DIVISION	PARTS LIST Sheet of — Drawing No.

REV. NO.	COMPON'T. or PIECE NO.	QUAN. REQ'D	STORES NO.	DESCRIPTION
				Q-2641A-5
	R11	1	06-930-8051	Potentiometer, 2000 ohm, ±20%, 1/2 W, cermet element 1 turn, Beckman 61PNR2K.
				Resistor, precision, metal film, ±1%, 1/4 W, unless otherwise noted, per ORNL Spec SC-266, as follows:
	R25	1	06-932-7050	25 ohms.
	R4	1	06-932-7080	42.2 ohms.
	R18,19 28,30	4	06-932-7095	51.1 ohms.
	R7,8	2	06-932-7105	61.9 ohms.
	R5,16	2	06-932-7130	100 ohms.
	R20	1	06-932-7175	216 ohms.
	R15	1	06-932-0071	332 ohms, 1/2 W.
	R21	1	06-932-7210	383 ohms.
	R14,22 23,24 29	5	06-932-7265	1K ohm.
	R17	1	06-932-7280	1.33K ohms.
	R26,27	2	06-932-7285	1.47K ohms.
R1	R9	1	06-932-7310	2.37K ohms.
	R13	1	06-932-7345	4.64K ohms.
R1	R31	1	06-932-7370	7.5K ohms.
	R12	1	06-932-7365	5.62K ohms.
	R6	1	06-932-7395	12.1K ohms.
	R10	1		Trimmer for R9. Value to be determined in individual instruments on completion.
	R1,2, 3	3	06-936-6670	Resistor, 30K, ±5%, 1/4 W, carbon composition per ORNL Spec. SC-194, Allen-Bradley.
	D4	1	06-995-7287	Diode, zener, silicon, 1 W, 5.1V ±5%, Motorola #1N4733A.
	D5,6	2	06-995-7291	Diode, zener, silicon, 1 W, 7.5 V ±5%, Motorola #1N4737A.

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORPORATION
INSTRUMENTATION AND CONTROLS DIVISION

PARTS LIST

Sheet of

Drawing No.

REV. NO.	COMPON'T. or PIECE NO.	QUAN. REQ'D	STORES NO.	DESCRIPTION
				Q-2641A-5
	D1,2 3	3	06-995-7671	Diode, silicon, planar, high conductance, low low leakage, Fairchild #FD300.
	Q1,2 3,5	4	06-995-7562	Transistor, A401, NPN, Amperex Electronics.
	Q4,6	2	06-995-7563	Transistor, A441, PNP, Amperex Electronics.
	U1	1	Spec. order	Amplifier, differential, vidio, integrated circuit, Dip, Motorola MC 1733C.
	CN3	1	Spec. order	Receptacle, angle, .136 dia. flange mounting, teflon-14. insulation, BNC, Amphenol No. 5675 or Kings KC-71.
	C1	1		Connector, 9 female contacts plus 2 coax contacts, gold plated contacts, Deutsch #DM9616-19-2S.
		10	06-880-7053	Terminal, lug, split, brass, gold flash, per ORNL drawing Q-900-131, Detail 3, Amatom.
		4	06-880-7073	Terminal, lug, split, brass, gold flash, per ORNL drawing Q-900-131, Detail 2, Amatom #5643-B.
		2	06-880-7083	Terminal, lug, split, brass, gold flash, per ORNL drawing Q-900-131, Detail 1, Amatom #5643-D.
		1	06-878-1601	Bushing, cable, c/w nut, brass, cadmium plated, lacquer dipped, per ORNL Dwg. Q-900-32, Detail 6.
		1	06-878-1661	Bushing, cable, c/w nut, brass, cadmium plated, lacquer dipped, per ORNL Dwg. Q-900-32, Detail 9.
		1		Connector, 9 male contacts plus 2 coax contacts, gold plated contacts, Deutsch #DM9717-19-2P.
		2	06-886-4085	Insulator, standoff, teflon, press fit, brass, gold flash terminal, Sealectro #ST-250-SLIL.
		2	06-878-1561	Bushing, cable, c/w ut, brass, cadmium plated, lacquer dipped per ORNL Dwg. Q-900-32, Detail 4.
		2	06-878-1581	Bushing, cable, c/w nut, brass, cadmium plated, lacquer dipped, per ORNL dwg. Q-900-32, Detail 5.
		4	06-883-0113	Grommet, rubber, 1/16" groove width, 5/32" hold, 1/4" mounting hole, Minor #Z-2173 or equal.
		2	06-883-0173	Grommet, rubber, 1/16" groove width, 9/32" hold, 3/8" mounting hole, Minor #Z-1035-3 or equal.
		1	06-880-2930	Lug, solder, for #4 screw, 5/8" long, internal teeth, Shakeproof #2104-04-00.

OAK RIDGE NATIONAL LABORATORY OPERATED BY UNION CARBIDE CORPORATION INSTRUMENTATION AND CONTROLS DIVISION	PARTS LIST Sheet of / Drawing No.

REV. NO.	COMPON'T. or PIECE NO.	QUAN. REQ'D	STORES NO.	DESCRIPTION
				Q-2641-5
				Wire, hookup, #22 AWG, 7/30 stranded, teflon insulation, Type E, 600 V RMS, per ORNL Spec. SC-304.
		28"	06-993-3971	White
		8"	06-993-3957	Red/White stripe
		8"	06-993-3959	Red/Blue and White stripe
		8"	06-993-3987	Yellow/White stripes
		10"	06-993-0634	Cable, coax, polyethylene dielectric, black vinyl jacket tinned copper braid, Type RG-174/U, Times Wire co.
		2"	06-988-0832	Tubing, thermoplastic, shrinkable, irradiated, polyolefin, 0.125" I.D., Thermofit type SCL, Rayclad Tubes
		7"	06-988-0591	Tubing, teflon, extruded, clear color, 0.027" I.D., Penn. Flourocarbon Co.
		12	02-061-4305	Nut, hex, aluminum alloy, locking insert, 4-40 thread, Elastic Stop Nut Corp.
		6	02-072-0145	Screw, slotted, binding head, machine, 18-8 SST, 4-40 x 0.250" long.
		10	02-072-0147	Screw, slotted, binding head, machine, 18-8 SST, 4-40 x 0.375" long.
		16	02-072-0450	Screw, slotted, flat head, 100°, machine, 18-8 SST, 4-40 x 0.250" long.
		20		Rivnut, 0.370" long, countersunk, for 4-40 screw, #A-4-81, Goodrich Aviation. (Tool #C-6000-4-40 for rivnuts may be borrowed from ORNL).
		87	06-880-1442	Clip, anti-rattle, cadmium plated steel, #HS-99056-K-220, United Car Fasteners.
		2	02-076-7319	Washer, flat, 18-8 SS, 0.125" I.D. x 0.312" O.D. x 0.025" th.
		2	06-896-1585	Standoff, round, brass, cadmium plated, 0.025" L. x 4-40 thread x 0.187" dia., Amatom #8077-B0440.
				The above components shall be assembled, parts shall be mounted and wiring shall be routed in strict accordance with prototype of instrument (which shall serve as a wiring guide) supplied by the Company. Component lead lead dress and wiring methods shall conform to ORNL Spec. SS-160.

OAK RIDGE NATIONAL LABORATORY OPERATED BY UNION CARBIDE CORPORATION INSTRUMENTATION AND CONTROLS DIVISION	PARTS LIST Sheet of Drawing No.

REV. NO.	COMPON'T. or PIECE NO.	QUAN. REQ'D	STORES NO.	DESCRIPTION
				Q-2641-5
				Pulse Transformer Network
	T2	1		Transformer, pulse, electrostatically shielded, 2:1CT ratio, Pri, Ind. 400μH min, Leadk. Ind. 10 μH max, P/S cap - 5 pF max. Voltage rating 300 VDC between windings and core, Pulse Engineering, Inc. #6689.
	C26,27	2		Capacitor, 0.01 MFD, ±10%, 200 V DCW, ceramic type VR, Vitramon No. VK30BX103K.
	R35	1		Resistor, 10K ohms, ±1%, 1.1W, WW, Type RS-1B, Dale Electronics, Inc.

OAK RIDGE NATIONAL LABORATORY OPERATED BY UNION CARBIDE CORPORATION INSTRUMENTATION AND CONTROLS DIVISION	PARTS LIST	
	Sheet of	Drawing No.

6. ACCEPTANCE TEST PROCEDURES

6.1 TEST INSTRUMENTS AND COMPONENTS

The following test equipment is required:

1. A battery-operated (3 1/2 digits) voltmeter with a minimum of 10 M-Ω input impedance.
2. A pulse generator, mercury relay, ORNL model Q-1212C or Q-1212D.
3. An oscilloscope with a minimum of 100 MHz bandwidth.
4. A digital voltmeter, 4 1/2 digit.
5. Two power supplies, +15 V, −15 V, with less than 0.01 v peak to peak ripple.
6. Resistive networks for pulse generator and balanced cable terminations. See Fig. 1 for details.
7. A cable for power input to preamplifier.

6.2 PREAMPLIFIER PRELIMINARY TEST PROCEDURES

Connect the power supplies (if separate units are used) to the power mains so that they can be turned on with one power switch. Both supplies should be of similar construction such that the turn-on transients are the same. Adjust the supply voltages to within ±20 mv of the 15-V value. The 4 1/2 digit digital voltmeter should be used for this measurement.

Turn off the supply power and connect to the preamplifier. Turn the supplies on and permit at least a 15-min warm-up for the preamplifier, power supplies and all test instruments before making any measurements.

Make a voltage check of the preamplifier with the battery-operated 3 1/2 digit voltmeter (with 5600 Ω series resistor). It may be necessary to shunt R9 to obtain a -5.0V level at the collector of Q4. If a shunt resistor less than 23.7K-Ω is required, check the preamplifier for faults.

6.3 PREAMPLIFIER VOLTAGE GAIN

Connect the Q-1212 pulse generator to the input test connector as shown in Fig. 2. Disconnect the output cable from the positive output terminal of the preamplifier and monitor this point with a X10 scope probe. There should be no input cable connected to the preamplifier at this time. Adjust the pulse generator output until a 0.5 volt positive pulse is observed on the oscilloscope. A typical pulse generator signal under these conditions is approximately 150 mV. The signal across T1 is 0.01 × (pulse generator output) taking into account the attenuation produced by R6. This amounts to a voltage gain of approximately 1500 from the base of Q1 to the open circuit plus output terminal. A ±10% variation in this value is possible.

The same result will be obtained for the negative output of the preamplifier.

It should be recognized that this test does not completely include the input transformer, T1. An indirect test can be achieved by temporarily connecting a 121 Ω resistor across the two input terminals. If the transformer is operable, the voltage gain measurements above will be approximately halved.

6.4 PREAMPLIFIER PULSE SHAPE AND LINEARITY

The pulse shape and linearity test can be made with the setup as shown in Fig. 2. It is important that the ground clip on the scope probe (X10 in this case) should be kept as short as possible to give a true reproduction of the waveform.

For the pulse shape measurement, adjust the pulse generator until a 0.5 V output pulse is obtained. The results can deviate from those given in Sect. 1.4.2 by as much as ±20%. Repeat for both positive and negative outputs.

For the linearity measurement, adjust the pulse generator until a one volt output pulse is obtained. Use as much vertical deflection as possible on the oscilloscope. Reduce the pulse generator signal by a precise factor of two with either the X2 attenuator switch or the PHS control. The preamplifier output signal should be halved. This measurement is very approximate but will reveal any gross non-linearities. Repeat for both positive and negative outputs.

6.5 FISSION CHAMBER ASSEMBLY PULSE RESPONSE

The setup shown in Fig. 1 is used to measure the pulse response of the Fission Chamber Assembly. The resistive divider between the Q-1212 pulse generator and the assembly will properly terminate the pulse generator in 100 Ω and insure that a clean signal is applied to the assembly. It does, however, attenuate the generator pulse by a factor of ten. The resistive network at the output end of the assembly terminates the balanced cable. BNC connectors mounted on the enclosure for this network will provide convenient oscilloscope monitoring points. Because of the balanced nature of the signal, two outputs with reference to ground can be obtained and will be identical except for polarity.

With the pulse generator adjusted to give a one volt output pulse, the pulse viewed at the scope test points should have an amplitude of 0.25 V ±10% and a polarity depending on which of the two test points is being monitored. (The resistor attenuator at the input accounts for a factor of 1/10 and the 2 to 1 step-down transformer with center-tapped secondary accounts for another factor of 1/4.)

REFERENCES

1. D. P. Roux et al., *A Miniaturized Fission Chamber and Preamplifier Assembly (Q-2617) for High-Flux Reactors*, ORNL-3699, Oak Ridge National Laboratory, Oak Ridge, Tenn., October 1964.

2. R. E. Wintenberg and J. L. Anderson, *Trans. Am. Nucl. Soc.* 3(2), 454 (1960).

3. J. T. De Lorenzo, "A Neutron Counting System with a Fission Detector and a Flexible, Balanced Line," IEEE Trans. on *Nuclear Science*, NS-14,(1), February 1967, pp. 261-70.

ORNL/TM-8212
Dist. Category
UC-78

DISTRIBUTION

1. J. L. Anderson
2. D. S. Asquith
3. H. R. Brashear
4-5. J. M. Farmer
6. S. S. Hurt
7. R. V. McCord
8. L. C. Oakes
9. K. H. Poteet
10. J. A. Ray
11. J. N. Smith
12. H. E. Trammell
13. K. W. West
14. Central Research Library
15. Document Reference Section
16-17. Laboratory Records Department
18. Laboratory Records, ORNL RC
19. ORNL Patent Section

EXTERNAL DISTRIBUTION

20. Office of the Assistant Manager for Energy Research and Development, DOE/ORO, Oak Ridge, TN 37830
21. J. V. Leeds, Jr. (Chairman), Professional Engineer, 10807 Atwell, Houston, TX 77096
22. C. L. Hogan (Retired), Fairchild Camera & Instrument Corporation, 464 Ellis Street, Mountain View, CA 94040
23. C. A. McKay, Executive Vice President, Corporate Director of Technology, The Foxboro Co., 38 Neponset Ave., Foxboro, MA 30205
24. B. M. Oliver, Vice President, Research & Development, Hewlett-Packard Company, 1501 Page Mill Road, Palo Alto, CA 94304
25-192. Distribution as shown in TIC-4500 under UC-78

U.S. GOVERNMENT PRINTING OFFICE: 1982-646-056/240