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WORK DONE ON AA KICKERS AND SHUTTERS DURING THE JANUARY/FEBRUARY 1982 SHUTDOWN

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1. KICKERS

At the beginning of the shutdown all the ring terminator resistors for the injection kickers in sections K3 and K4 and ejection kicker in section K22 were measured with the Dana Bridge. Before the bake out of the first half ring the LEMO pots on K3, K4 tanks were removed and the compensation capacitors mounted inside these pots were also measured. Three of the capacitors were found to be leaking insulation oil and were replaced. The results of both resistor and capacitor measurements are shown below in Table 1.

TABLE 1.

Module	Resistor No.	Value	Capacitor Value (Original)	Capacitor Value) (Now)	Comments
INJ. 1	K03/1	15.0867 Ω	1040 pf	1040 pf	
2	K03/2	15.0567	1050	1050	
3	K03/3	15.0607	1050	1050	
4	K03/4	15.0292	730	730	
5	K03/5	15.1232	725	1000	Leaky Cap. changed
6	K04/1	15.2840	720	720	
7	K04/2	15.2720	720	700	Leaky Cap. changed
8	K04/3	15.2602	720	720	
9	K04/4	15.1747	720	1000	Leaky Cap. changed
10	K04/5	15.1549	1050	1050	
SPARE (K3)	K03/6	15.0697			
SPARE (K4)	K04/6	15.1628			
EJ-KICK-22	EJ 22	15.3724			
EJ-22 SPARE	EJ 22 SPARE	15.1198			

All resistors measured at 18°C.

Capacitors on pots 5 and 9 have been replaced with 1000 pf capacitors since there were not enough 680 pf (nominal value) capacitors available.

All drift stabilisers have been re-tested and calibrated using the special purpose test equipment. The centre-zero meter on these chassis has now been calibrated to read directly the drift in nano-seconds (± 100 ns). Subsequent tests have shown that they are now working much better than before. Three tested and calibrated spare units have been placed in the kicker cabin in the AA machine.

All injection modules were tested and set-up whilst pulsing into the ring terminator resistors. The rise/fall time of each module was measured and together with other operating data assembled in Table 2.

During these tests it was found that module 3 dump switch had a very poor rise time. The reservoir voltage tap settings and adjust potentiometer were both fully at the end of range. Since the module performance specification could not be met the tube was changed for a new one from stock. The change in performance between old and new dump switch tubes, both working at 70 kV is shown below.

Test voltage = 70 kV. Total filament hours = 5647 for old DS tube

Old DS tube	New DS tube
Serial No. 4129	Serial No. 4454
V_{RES} = 6.85 V	V_{RES} = 5.65 V
t_r = 53 nS	t_r = 38 nS

With the new dump switch installed, module 3 was gradually pulsed up to a maximum of 80 kV. It was left to pulse at this level for 3 hours and subsequently re-synchronised with the other injection kicker modules. The delay unit which is installed in the ring equipment for setting the injection pulse width has been adjusted together with the modules so that a pulse width range of 422 to 800 nS is obtainable in the magnets. The injection system pulse width has been set to 725 nS and displayed with the kicker control programme.

From Table 2 the results show that at least 4 other tubes are being operated near the end of the reservoir voltage range. These tubes are relatively new, only having 4000 hrs. filament time. If the rise times of these become comparable to the one which was changed, the following alternatives should be considered to enable maximum tube lifetime to be obtained.

a) Continue to work with the tube, providing the jitter is acceptable. A slow fall time dump switch will not drastically affect the injection sum pulse performance.

b) Install different reservoir transformers, for the dump switches in question, as is done in the FAK, to enable high reservoir voltages and faster rise times to be obtained.

c) To interchange tubes in a module between main switch and dump switch. The main switch does not need a fast rise and one could also accept tubes with some jitter in this position.

The ejection kicker was also tested and adjusted during the shutdown. The present main switch (Serial No. 3481) and double cathode dump switch (Serial No. 3980) have accumulated 3957 filament hours with a further 136 hrs. on standby. The total number of shots to date made with this generator is 2.35×10^5. The ejection magnet movement system has been checked on manual and computer control. The traversing speed in both directions is still 10 mm/sec.

1.1 Oil

The pressure gauge on the oil system main reservoir tank has been changed, the old one had a defective indicating needle. The new gauge has a wider range 0 - 50 Kg/cm^2 and the normal pressure reading observed is 6.5 Kg/cm^2. Oil leaks on both main and reserve reservoirs have been repaired. These were occuring at the sight-glasses on the tank walls. The bottom sight-glass on the main reservoir has been removed and its fixing holes sealed.

1.2 Gas

The SF_6 gas distribution system has been repaired where leaks were found and modified to isolate the leaks where they still exist. Gas leaks in the manifold to the tank pots has been considerably reduced. Two new valves have been installed to isolate leaks in the Lemo feed-through pots K3, K4, K22 and the ejection kicker Faraday cage and all the PFN's. The present gas leak is about 100 grams per day and seems to be limited to the K3 pot manifold system. At start-up the SF_6 gas bottle full of gas weighed 101,5 Kg and will be empty when this weight has dropped to approximately 63 Kg. To avoid the K3 tank modules tripping due to a loss of gas pressure, the bottle has been left open to the K3, K4, K22 installations via one of the new valves.

1.3 Analogue monitoring

The 12 servo tacho signals have been connected from the servo monitoring matrix in the ring to the SOS crate in the equipment building next to the ACR. The remaining kicker signals will be connected to the SOS via buffer amplifiers in the ACR, and the total tested during the first week of March from the MCR.

TABLE 2.

Parameter	MOD 1	MOD 2	MOD 3	MOD 4	MOD 5	MOD 6	MOD 7	MOD 8	MOD 9	MOD 10
MS tube S. No.	3809	3830	3708	3728	3422	3522	3498	3727	3387	3150
DS tube S. No.	4094	4087	4454	4138	3608	3596	3617	3569	4360	4026
Total Fil. hours	5525	5618	5647	5648	4807	5620	4717	5582	3399	5675
Standby Fil. No.	140	139	140	138	136	139	144	142	146	165
MS V_{RES}	5.96	6.12	5.85	5.80	5.46	5.95	5.75	5.93	5.95	5.70
DS V_{RES}	5.87	6.78	5.65	6.78	6.80	5.83	6.80	6.35	5.87	6.40
MS Jitter (nS)	2	5	9	2	2	5	9	2	3	2
DS Jitter (nS)	4	5	2	2	2	2	3	2	2	2
Rise time (nS)	43	39	42	43	42	43	39	45	44	43
Fall time (nS)	36	39	38	39	40	33	37	36	39	38
Total pulses x 10^6	1.89	1.88	1.88	1.81	1.84	1.87	1.87	1.75	1.82	1.87

2. SHUTTERS

At the beginning of the shutdown the pre-cooling tank KPM 4 was replaced. The present tank is now equipped with the new flex pivots and large UHV parts for quick disconnect in case repair is needed.

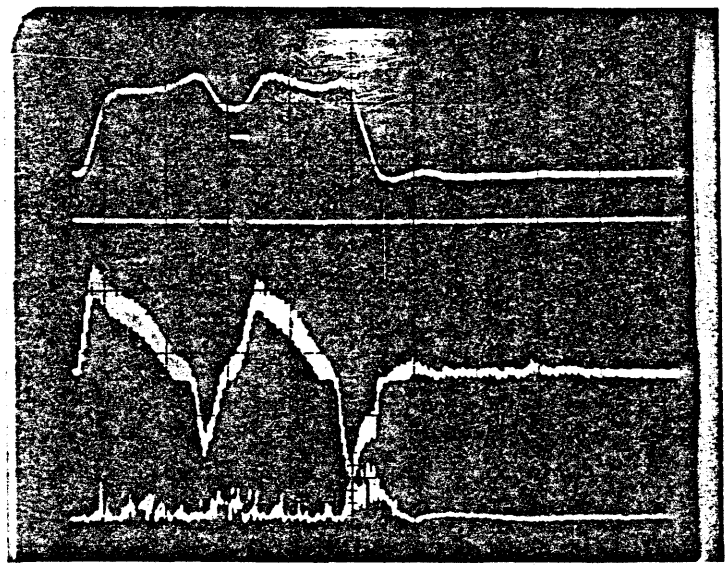
For this installation the following ISOFLUX servo motors were used: Type 445.2.12.

- Upstream motor Serial No. I 003198
- Downstream motor Serial No. I 003430.

During the testing of this tank the downstream encoder became faulty and had to be replaced. The new encoder has the Serial No. 25906.

The 360^{o} drive function is installed now for both the injection and pre-cooling shutters. This function is the normal operating function from now on, although a quick return to the old regime can be made by changing the timing values via specialist access in the timing programs. The asynchronous 'open' and 'close' commands remain exactly as before. For the user from the ACR touch panel there is a new program which enables all shutters to be opened or closed together or all shutters to be commanded to run under function control.

To gain access to the individual shutter systems there are two other buttons, which when pressed call in the old control programs. It is now not possible when running in the 'normal' 360° function mode to vary the time during which the shutters are open. This has been programmed into the function and is approximately 110 ms for a crank angle of ± 43° about BDC. To help identify when the shutters are open, a pulse is generated from the logical AND of the open pick-ups on each shutter piston. This pulse, about 40 msecs. wide goes high when all shutters are open (at 180°) and goes low again as the first shutter moves away from the 180° position. This means that ± 50 msecs. either side of the middle of this pulse the shutters are in the open condition. There are separate 'OPEN' indicator pulses for both injection and pre-cooling shutters available in the ACR. Photo No. 1 shows the open indicator pulse of the pre-cooling shutter system together with the operating waveforms of shutter 16.1.1.



Motor speed

'OPEN' indicator pulse

Motor current

Accelerometer signal

Photo No. 1

To enable this new function to be installed, modifications had to be made to the function generators and to the distribution of timing cables which control them and the servos. The new connections are shown in the timing block diagram of Fig. 1. The major change in this scheme is that the 'clear' pulse for each servo system is now generated by the function generator at a fixed

time after the function has ended rather than use the computer generated clear pulse. This avoids the problem of having to protect the servos against a badly timed clear pulse, which in itself could cause damage to the pivots. The absolute position indicator unit has been re-calibrated with the potentiometer attached to each motor shaft. The indicating scale has been marked, with the 'open' and 'close' positions clearly shown, including the $\pm 43^{o}$ band at the open position. All servo's have been adjusted using the new functions and photo's of each can be found in the shutter log book in the ACR. The total function time from CLOSE to OPEN and back to CLOSE is now adjusted to be approximately 550 mS for both systems.

Distribution:

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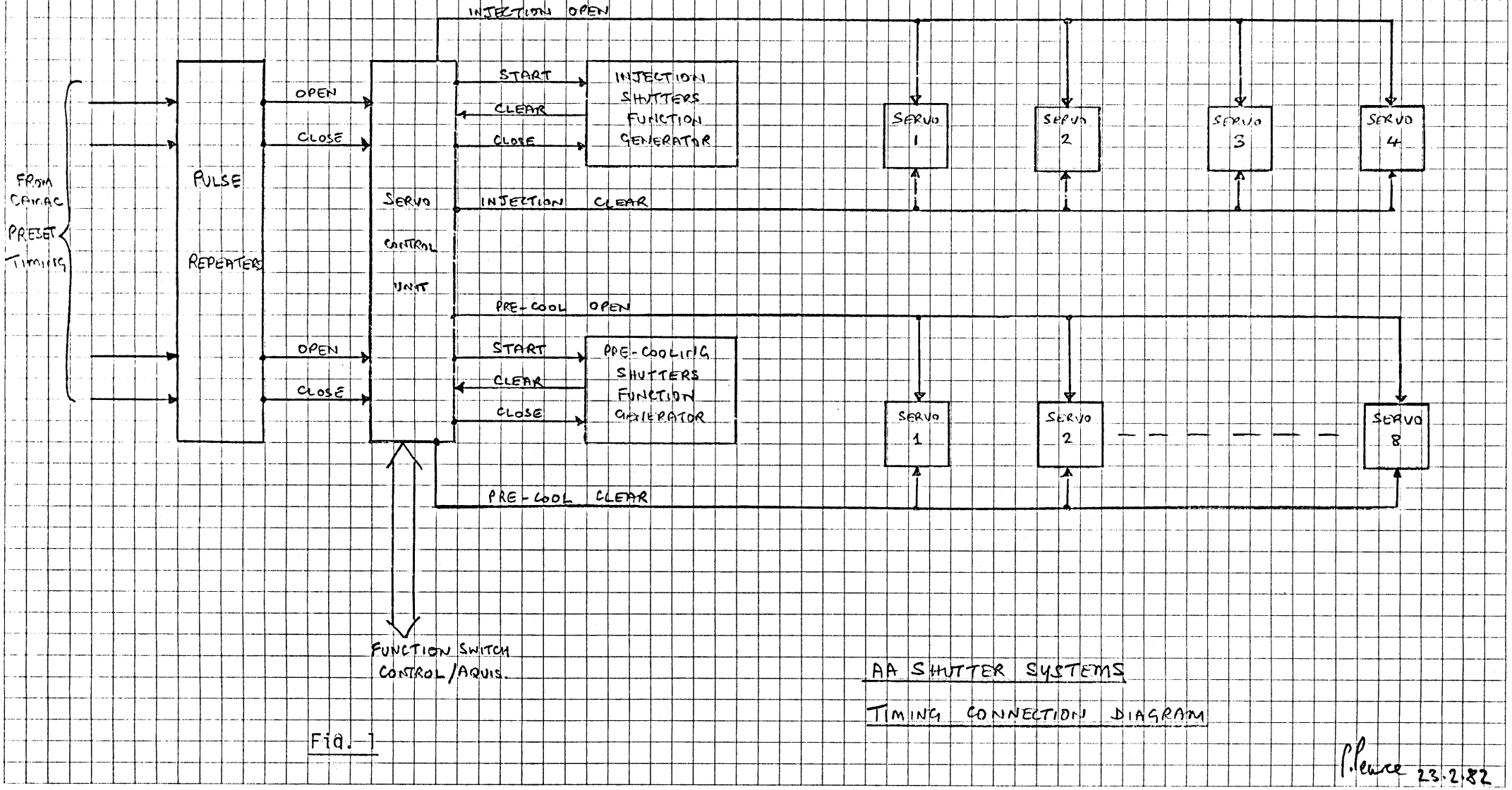

AA SHUTTER SYSTEMS

TIMING CONNECTION DIAGRAM

Fig. 1

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