R.F. Book

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RF #36

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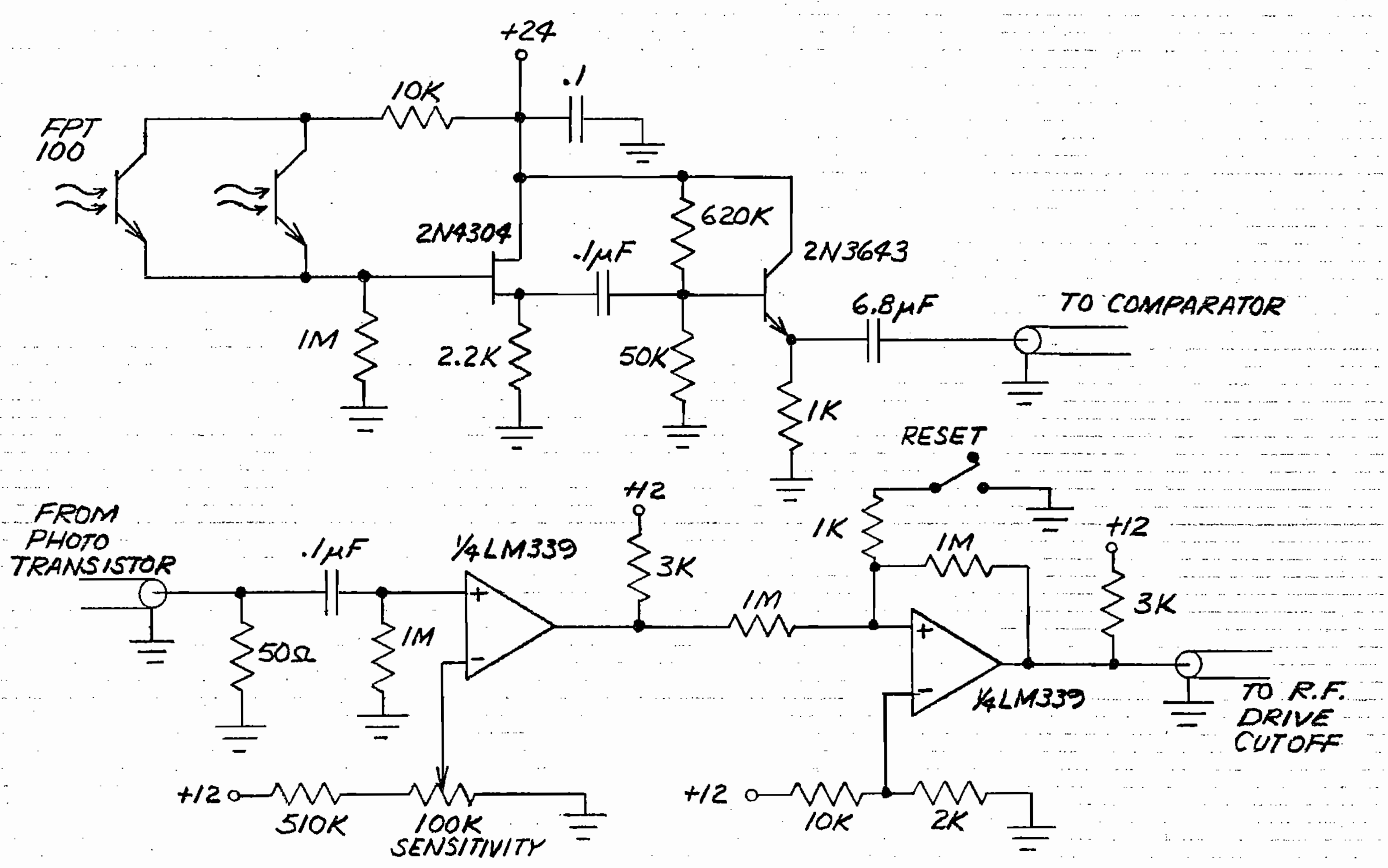
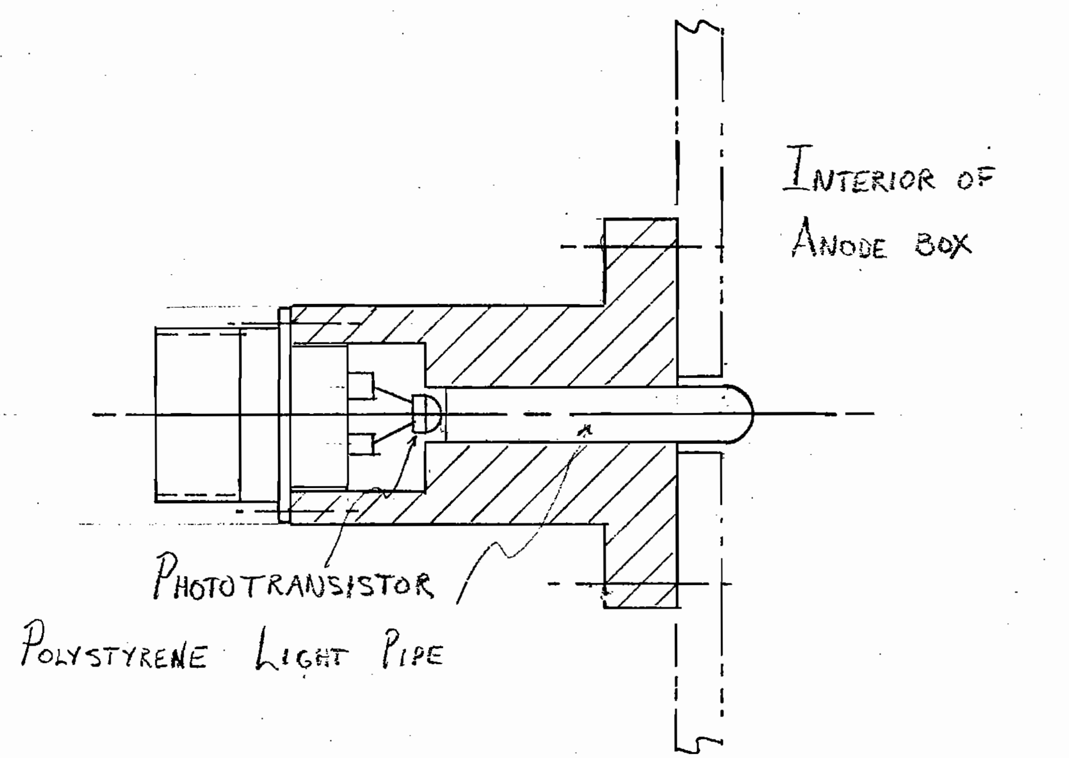
Spark detection circuit

There now exists a working circuit for detecting sparks in various places in the rf system. Although different locations require different light-gathering apparatus, the electronics is the same in all cases. The circuit, shown below is simply one or more phototransistors in parallel (for some situations require a number of phototransistors) with suitable buffers to drive a 50 r line. As light (presumably from a spark) is incident on the phototransistor, a pulse is transmitted to the control room where 2 comparators form a latch circuit that shuts off the rf drive until reset, either manually or automatically. The comparator can trigger with a pulse of only a few millivolts, but will typically be set to trigger for pulses of 1 V or more, depending on the required sensitivity and spurious noise in each case.



It is our intention to use this circuit to detect sparks in the transmitter driver and anode boxes, in the transmission lines, on the finger stock on the dee stem short, around the insulator and in the machine itself. Light gathering will be done with polystyrene light pipes enabling the photo transistors to be shielded from the ravages of unattenuated rf. I shan't discuss every one, but I do show a "typical" light collector below, one to be used on the transmitter box.



The light pipe, aobut 1/4" in diameter is mounted in an aluminum block with a 1/4" diameter hole in it. The tip of the pipe protrudes slightly into the interior of the transmitter, while the "posterior" end of the pipe is over 1 1/4 inches from the interior. The phototransistor, situated at the end of the rod is effectively shielded from rf, since the rf penetrating the hole in the aluminum is attenuated exponentially as a function of l/d, l being the depth of penetration into the hole and d the diameter of the hole. So the rf at the transistor should be down by at least a factor of 10^5 or so from that at the tip of light pipe. If this is not enough, we could also use a piece of brass screen to block the remaining rf.

Mixer Performance

Since the operation of the new rf system requires 3 signals 120° apart, with quadrature signals (i.e. 90° out of phase) for each, and an upper side band 2mHz above Fo with its quadrature signal, all over a wide frequency range, it had been long decided that we would build our own synthesizer. The fact that the frequency range of the synthesizer is from 9-65 mHz requires a low pass filtering of the mixer outputs that cuts off above the 80 mHz. Unfortunately, mixers non-linearity produces harmonics of as well as the fundamental frequency Fo. At frequencies below 30 mHz the 2nd and 3rd harmonics ($2F_o$ and $3F_o$) are not blocked by the low pass filter. Although the transmitter is not fazed in the least by these harmonics (being a tuned amplifier), they could possibly cause problems in our phase detection operation. Consequently we have investigated the amplitude of mixer output and relative harmonic content as a function of input amplitude. this was done for a commercially available mixer, the SRA I-H and our so called "home brew" mixers (i.e. homemade). The reaults are summerized in Tables 1 and 2, blank entries indicate relative harmonic content of <.5%. Optimum operating conditions have yet to be determined, being a compromise between output amplitude and spectral purity.

Table I

SRA I-H Mixer

LO Vrms at 70 mHz	RF Vrms at 60 mHz	F_o Vrms/50 r at 10 mHz	$2F_o$ % of F_o	$3F_o$ % of F_o	$5F_o$ % of F_o
.5	.5	.200	–	3.2	1.6
.75	.75	.355	.8	2.4	1.3
.75	.5	.282	.6	.8	1.0
1	1	.500	.9	2.8	1.4
1	.5	.282	.6	.5	.4
1.5	1	.563	.8	3.2	1.4
1.5	.5	.282	.6	.4	.4

Table 2

"Home brew" Mixer

V1 Vrms at 70 mHz	V2 Vrms at 60 mHz	F_o Vrms/50 r at 10 mHz	$2F_o$ % of F_o	$3F_o$ % of F_o	$5F_o$ % of F_o
.5	.5	.080	.7	2.8	2.5
1	1	.224	1.0	4.5	1.3
2	2	.400	1.3	7.1	2.0
2	1	.224	-	3.2	1.3
3	3	.500	1.1	7.1	1.8
3	2	.400	1.1	4.0	1.0
3	1	.224	-	1.6	2.0
4	4	.707	1.4	6.3	1.6
4	3	.563	1.1	5.6	1.1
5	5	.890	1.0	6.3	1.3
5	4	.800	1.0	5.0	1.1
5	3	.563	.8	4.0	1.0
5	2	.400	-	2.0	1.4