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A MAGNETOSTRICTIVE DELAY LINE*)

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ABSTRACT

Although developed for use in a wire spark chamber readout system, this sonic delay line can also be used for general purposes. The delay is fixed by the sonic transducer, and can be as long as ~ 600 μsec. Double input and gating facilities are included.

*) CERN type N9010

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1. MAIN CHARACTERISTICS

a) Delay: fixed in each line, is given in μsec by $t = 1.89 \times \ell$ where ℓ is the length of the sonic transducer (Fe-Co wire) in cm. The maximum delay that has been tested is 600 μsec. Small adjustment of the delay (±2 μsec) around the preset value is possible.

b) Two-pulse resolution: 800 nsec for delays up to 600 μsec (corresponding to ~ 1.2 MHz maximum p.r.f.).

c) Input and output inpedance: 50 Ω (LEMO 50 Ω connectors).

d) Input and output pulses: +2 V, 400 nsec rectangular pulses with $t_r \sim 20$ nsec.

e) Jitter: less than 10 nsec.

f) Temperature shift: about 3×10^{-4} (percentage variation of the delay per one degree centigrade change in the temperature of the sonic transducer).

g) Double independent input: with gate facility (gating level: +2 V).

h) Power supply: +24 (10 mA) and +3 (20 mA) per each double element.

Two independent delay lines are mounted in a standard NIM module. Protection against moderate external magnetic fields is ensured.

2. SONIC TRANSDUCER

The delaying element is a hard Fe-Co wire (Vacoflux) 0.2 mm in diameter. A sonic pulse is generated in this wire by a pulsed coil, because of the magnetostrictive effect; inverse magnetostriction (Villari effect) produces in the receiving coil the delayed output. The velocity of sound in the wire we used is about 5.29 cm/μsec at 20° C; because of dispersion and absorption of the sonic pulses, the limiting length of the transducer is about 3 m, corresponding to a maximum delay of ~ 600 μsec.

The magnetostrictive wire is inserted in a teflon tube, 1 mm outer diameter, and spiralized around a cylindrical support; the whole mechanical part, including coils, damping pads, and polarizing magnets, is contained in an iron box 7 cm diameter (Fig. 1). The metal shielding protects the transducer from external magnetic fields.

The coils are 0.8 mm long, with 120 turns of 0.03 enamelled copper wire; the central hole of the coil, in which the MS wire is threaded, does not exceed 0.3 mm in diameter.

Reflections on the two open sides of the transducer are reduced by means of suitable neoprene damping pads.

3. PULSER AND AMPLIFIER CIRCUIT

Two independent inputs are provided (Fig. 2) by means of double OR diode network; the input must be a positive 2 V 400 nsec long square pulse. The μL gate which follows is always open, and can be closed by a +2 V pedestal at the GATE input. Rise-time of the gate is typically ~ 20 nsec.

The power switch then applies a current pulse of about 1 A peak value to the transmitting coil; the sonic pulse is generated in the Fe-Co wire by magnetostrictive action.

At the receiving end, an MS pulse of ~ 20 mV is picked up by the coil, amplified by two CE stages with high input impedance (to match the output impedance of the receiving coil), and shaped by a simple saturated switch. Power output is obtained by means of an additional emitter follower.

Small adjustments of the gain, in order to compensate for differences in the mechanical transducers, can be made by suitable variation of the emitter resistors in the two first transistors.

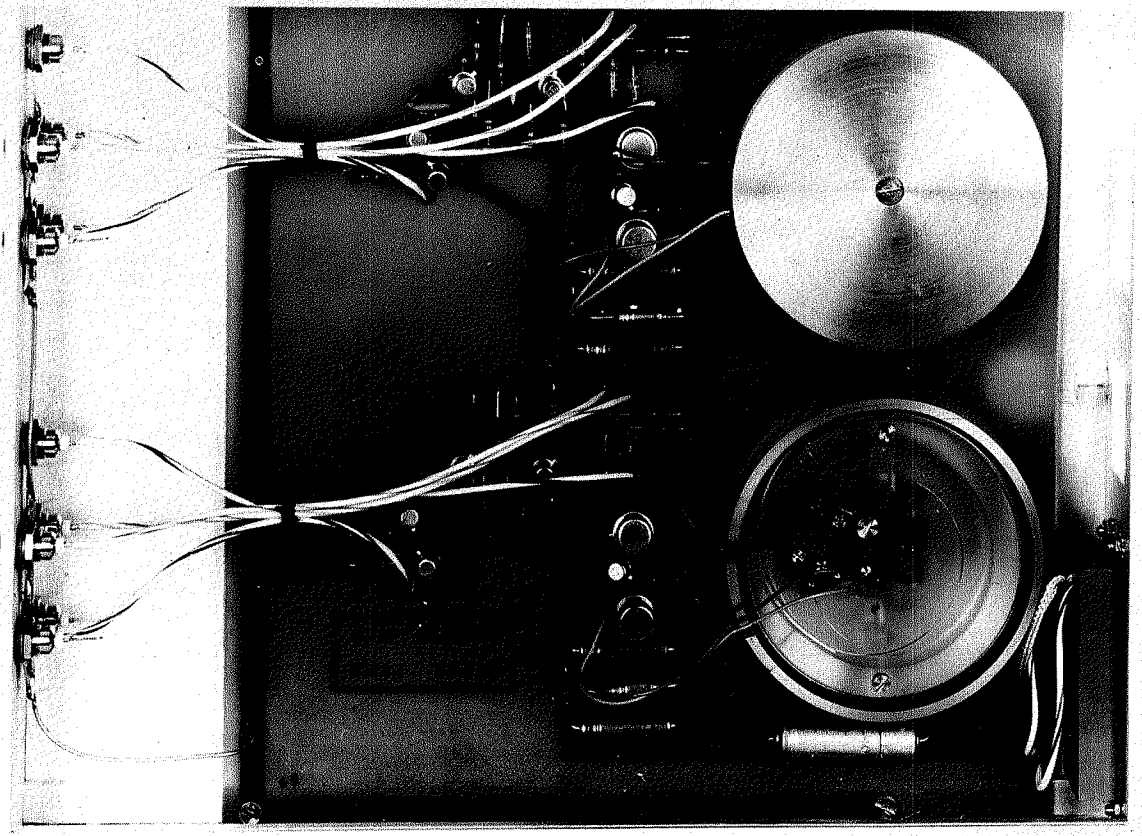

FIG. 1

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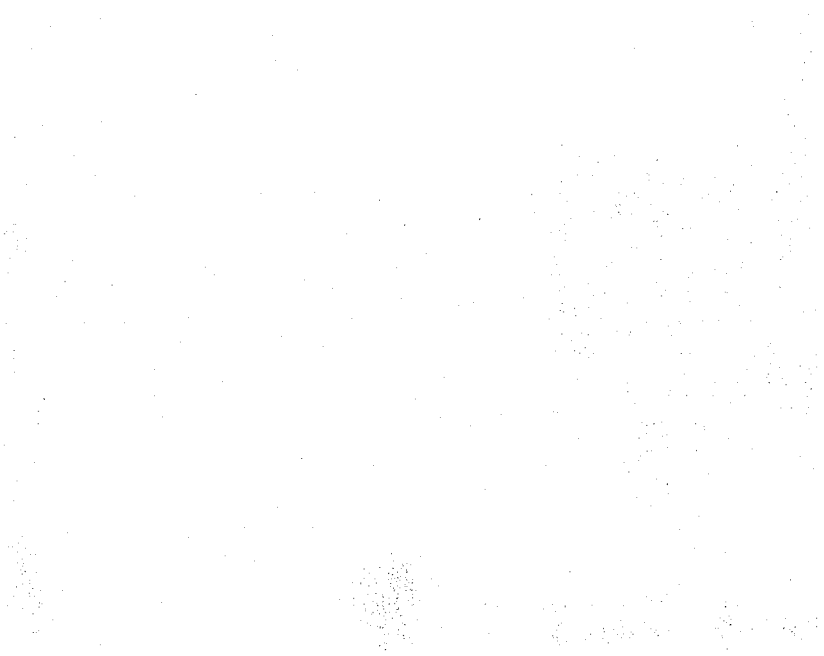
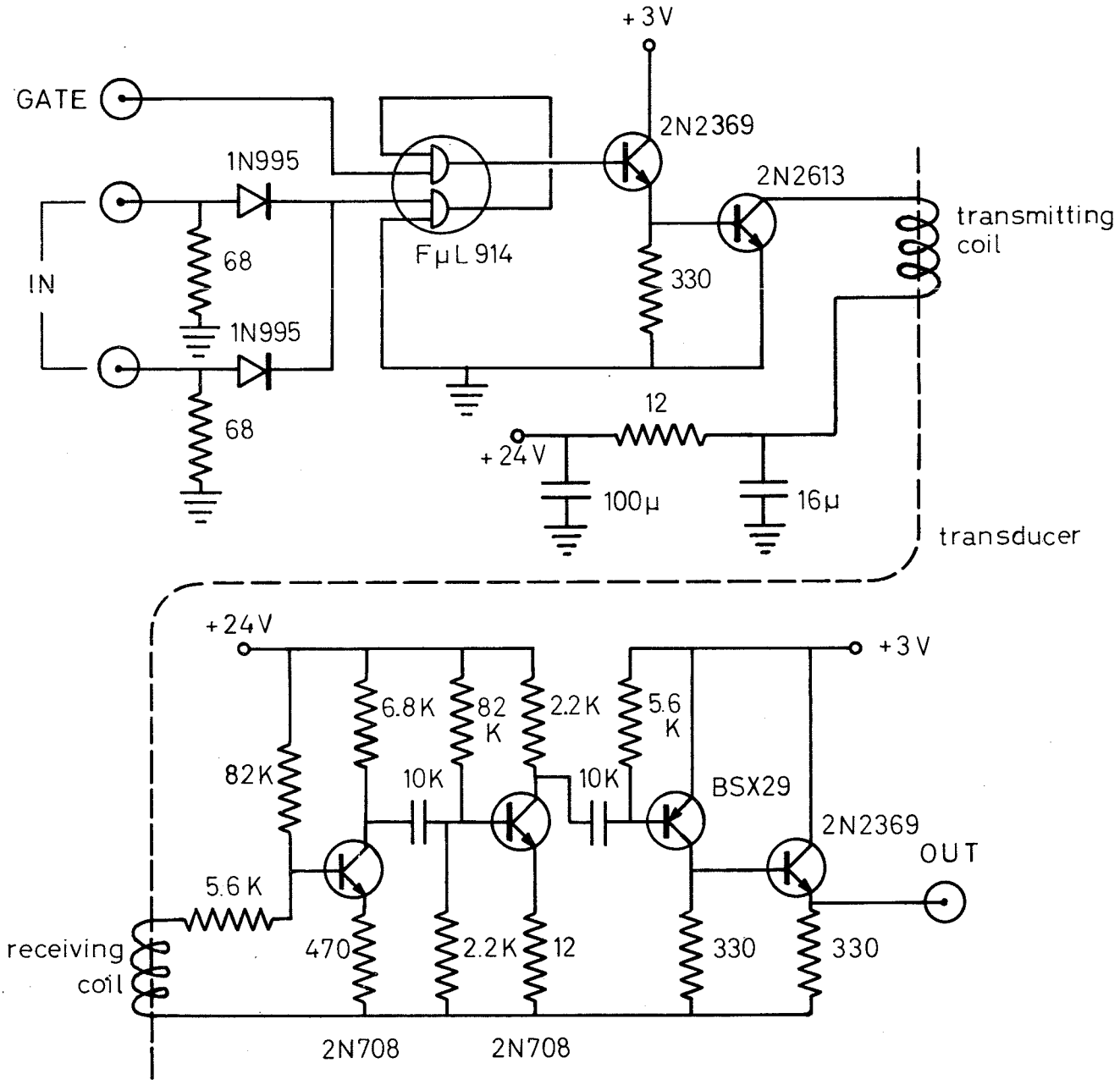
VIEW OF THE UNIT DOUBLE M.S. DELAY LINE	CERN - NP N 9010 1/6/1967





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CIRCUIT DIAGRAM DOUBLE M.S. DELAY LINE	CERN - NP N 9010 1/6/1967

FIG. 2