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POLYCANAL

A multi-channel pulse transmission system

1. Introduction

In big accelerators great distances have to be overcome to link different places with each other and specially with the control center. This suggests investigating multi-channel transmission systems which above certain distances become economical and moreover save considerable space in cable trenches. For a more detailed study as to the advantages of such systems see [1]

POLYCANAL is such a system. It is designed for the transmission of timing pulses which have the same quality (rise time, attenuation) at the receiving end as though they had been sent over individual cables. Moreover the transmitted signals conserve the reproducibility of 10^{-4} with respect to the CPS cycle, as one single pulse train (called M or B) serves for both : time reference for the synchrotron and clock pulse train for the multi-channel transmission.

2. Principle

For the control of the CPS, clock pulse trains (called M and B) are distributed throughout the machine area. They allow very high precision timing of any function in connection with the CPS. The individual pulses of the B-train are related to the magnet field with a reproducibility of $\pm 10^{-4}$, the pulses of the M-train determine the magnet cycle within $\pm 10^{-4}$ The time resolution of these pulse trains is chosen in such a way that most applications are covered without interpolation.

It looks advantageous to use these pulse trains as well as clock pulse trains for a multi-channel transmission (fig. 1a). Part of the time interval between any two consecutive pulses of the clock pulse train is available for the division into a number of transmission channels (τ_{max} in fig. 1b) Each channel number (1 ... n) corresponds to a characteristic time delay $\tau_1 \dots \tau_n \leq \tau_{max}$

Fig. 2 shows the block diagram of a POLYCANAL transmission with n channels. At the input the pulses to be transmitted (M_a, M_b,.....) pass through the characteristic channel-delays D_1....... D_n (τ_1 .... τ_n) and enter the same cable. At the receiving end the gates G_1 ... G_n are opened with corresponding delays D'_1..... D'_n (τ'_1 .... τ'_n) by the clock pulses. The gate-on-time τ_g essentially determines the channel width τ_c (fig. 1c). The transmission cable can be used only in one direction. But it is possible to connect transmitters at any place (fig. 3). Between different feeding points there should be a diode to assure the transmission in the right direction. The cable end is terminated. In a test set-up the cable lengths were ℓ_1 = 2 km and ℓ_2 = 3 km. Only one cable has to be installed for either direction, as the clock pulse train (M and B) is in any case distributed everywhere.

3. Cost and economy

Using printed circuit cards the same card can either be used for the transmitter or for the receiver.

Depending on the number of channels used in the same place one has the choice between a plug-in system with plug-in units, 3 units high and 1 unit wide, or an arrangement where the cards are directly plugged into a crate. The prices are :

Plug-in :	transmitter	sFr	170.-
	receiver	sFr	200.-
	1 channel	sFr	370.-
Crate :	transmitter	sFr	140.-
	receiver	sFr	170.-
	1 channel	sFr	310.-

Fig. 4 shows the comparison between 100 channels (+ 1 cable) and 100 single cables, the critical length being about 200 m .

4. Circuit design

a) The transmitter

The transmitter consists of a standard one-shot (fig. 5), which is already in use for delay units[2]. The potentiometer (multiplier 1 to 10) is replaced by a selected resistor of about 1,15 kohms. This resistance value gives the best temperature stability[3]. For a temperature variation of 30°C (20°C to 50°C) the absolute error (in time) is less than ± 2‰ . The various time delays τ_x (x= 1...n) are achieved by different condensers. The minimum possible spacing between two channels is 8 µs, up to about $\tau_x \approx 600$ µs, and 14 µs up to about $\tau_x \approx 1{,}3$ ms.

The output pulse of the one-shot is amplified by a blocking-oscillator [4].

b) The receiver

The receiver consists of the standard one-shot, a gate and a blocking-oscillator.

The time constant of its one-shot is :

$$\tau_x' \approx \tau_x - \tfrac{1}{2}\,\tau_c$$

where τ_c is the channel width (fig. 1c).

What has been said above on the temperature stability of the transmitter, also holds good for the receiver.

The gate (fig. 6) is a one-shot with two planar transistors 2N 1613 and a planar diode FD 100. When the one-shot is triggered, it opens the diode FD 100 for a time τ_g (fig. 1c).

For the time being τ_g is adjusted to 6 µs up to about $\tau_x \leq 600$ µs. For $\tau_x > 600$ µs, $\tau_g \approx 12$ µs, due to the absolute error caused by temperature variation.

The maximum for τ_x is given by the dynamic error (duty-cycle of one-shot)[3].

In the POLYCANAL system the number of channels in 1,3 ms is thus about 125 channels for M-pulses (300 cps) or about 55 channels in 0,5 ms for B-pulses (1,2 kcps).

The input impedance of the receiver is in the order of 18 kohms.

After passing through the gate, the transmitted pulse is amplified by a blocking oscillator.

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Distribution : (open)

MPS Scientific and Technical Staff

RF Group

REFERENCES

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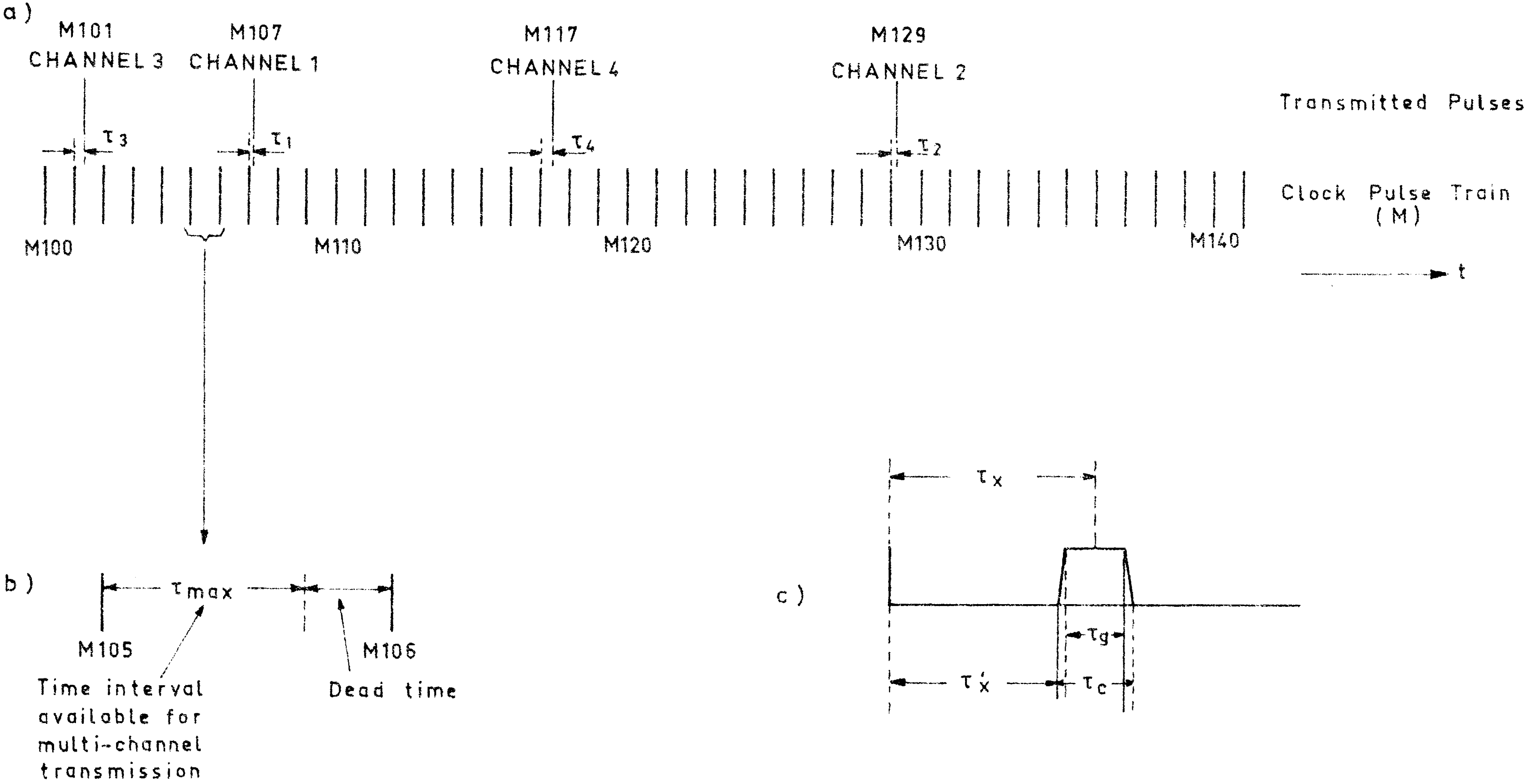
2. O. Barbalat : Delay Unit. MPS 2113 and Delay Unit MPS 2444, March 1963 .

3. H. Pflumm : Development of a Delay Unit for Timing Pulses, MPS/Int. RF 61-3, 6 February, 1961 .

4. K. Unser : Transistorized blocking oscillator, (Private communication)



τ_x (x = 1...n) = Transmitter time delays
τ_x' = Receiver time delays
τ_c = Channel width
τ_g = Gate-on-time

Fig. 1

POLYCANAL SYSTEM DEFINITIONS.

A.G.

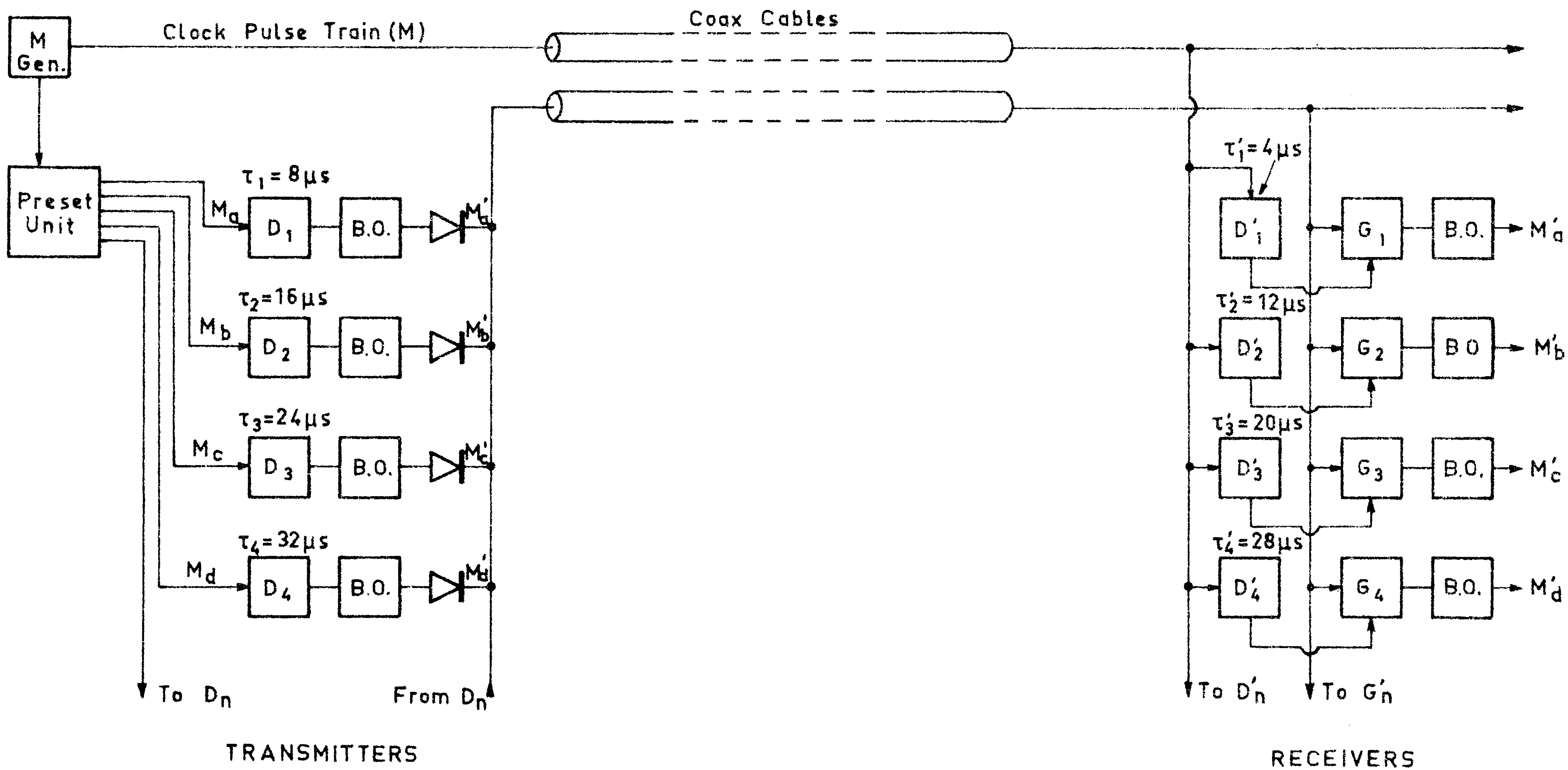


Fig. 2

POLYCANAL SYSTEM

BLOCK DIAGRAM.

A.G.

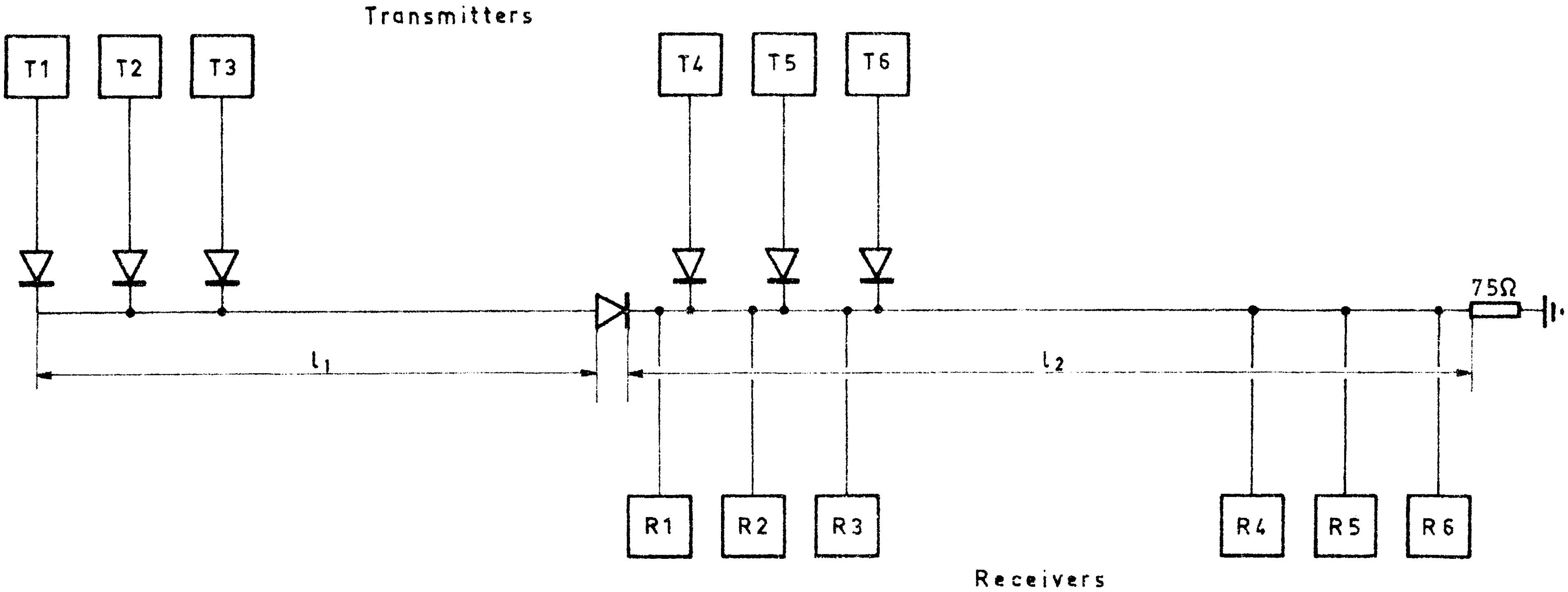


Fig. 3

POLYCANAL SYSTEM
BLOCK DIAGRAM.

A.G.

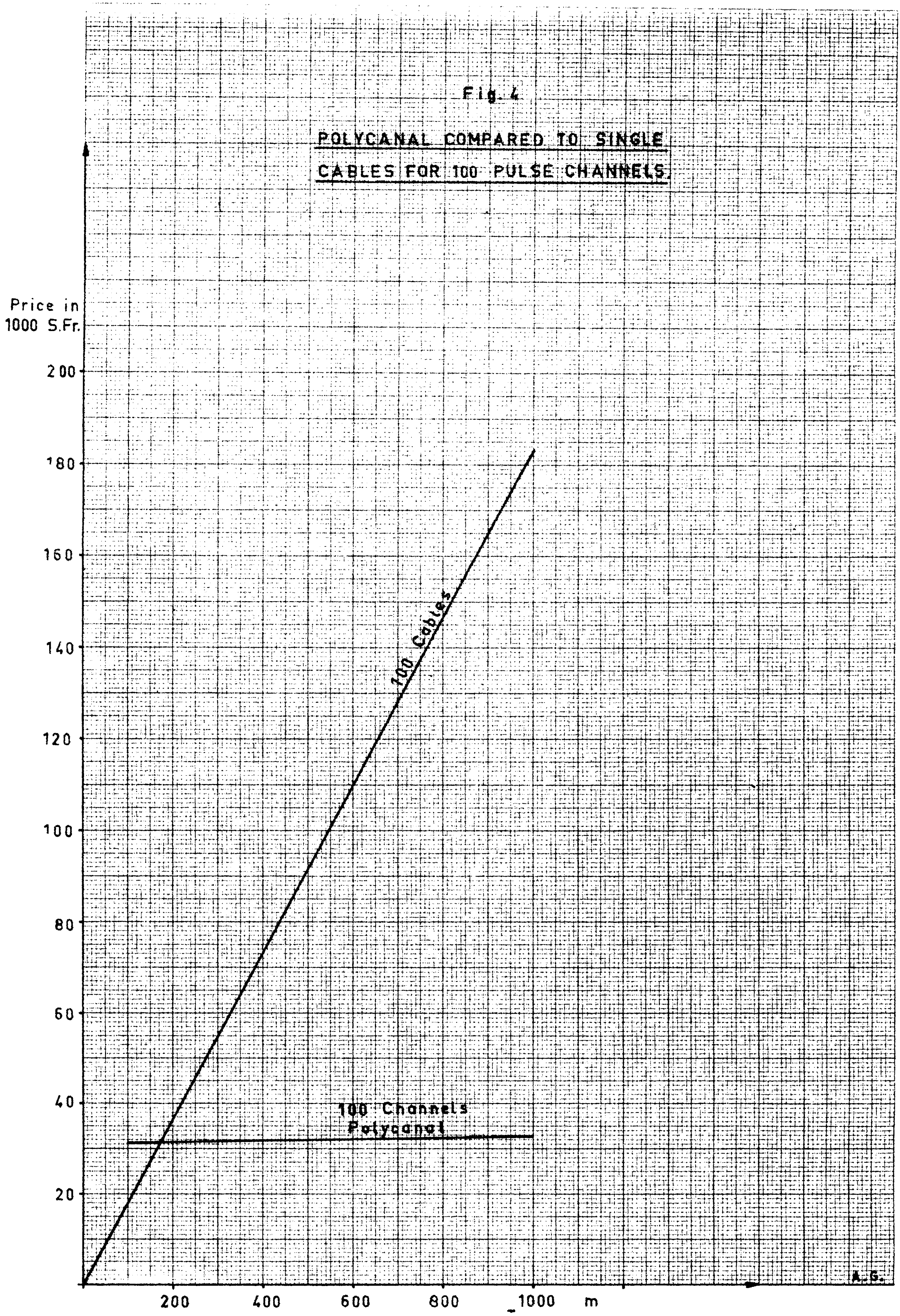


Fig. 4
POLYCANAL COMPARED TO SINGLE
CABLES FOR 100 PULSE CHANNELS
Price in
1000 S.Fr.
200
180
160
140
120
100
80
60
40
20
100 Cables
100 Channels
Polycanal
200
400
600
800
1000
m
A.G.

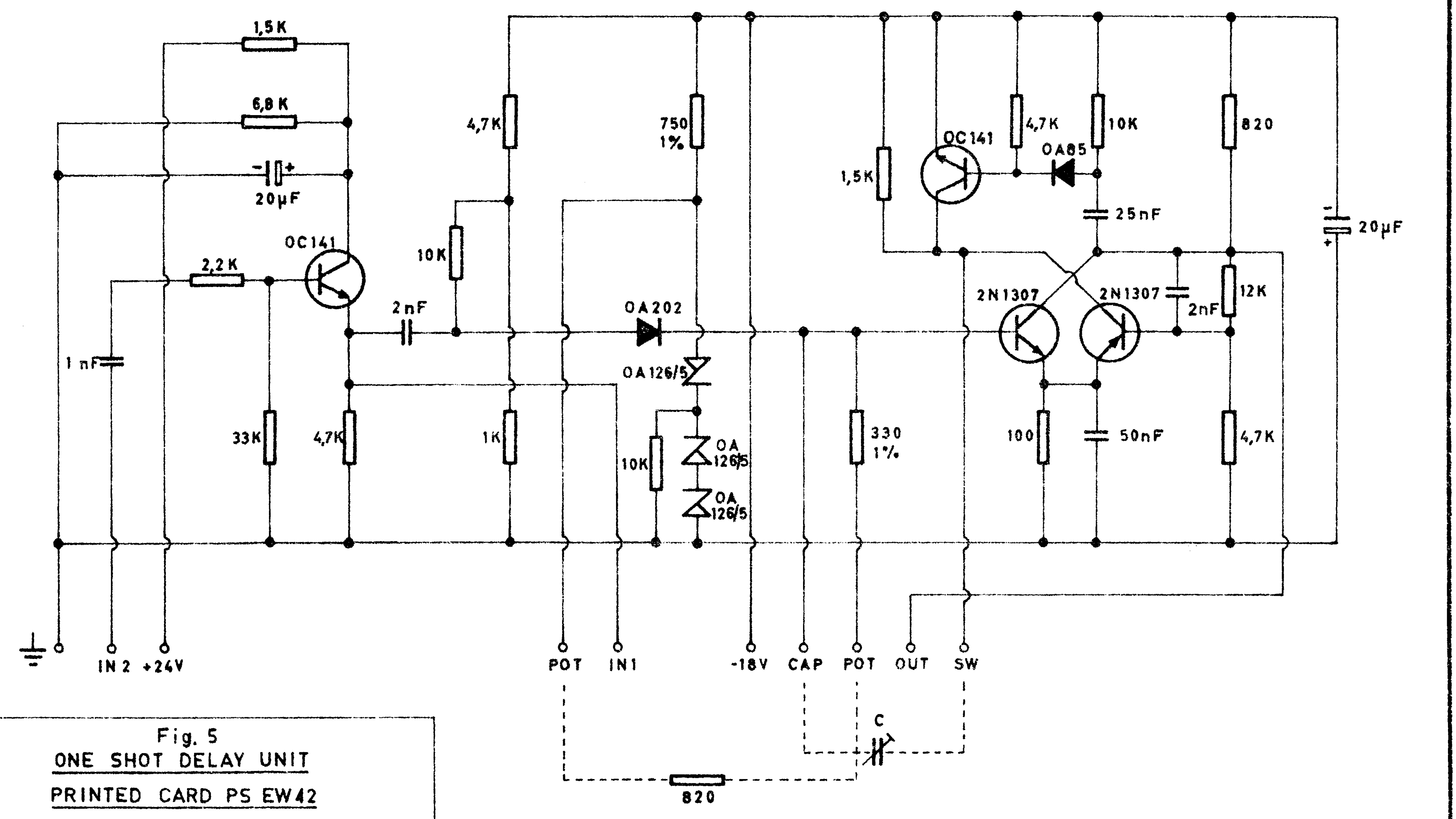


Fig. 5

ONE SHOT DELAY UNIT

PRINTED CARD PS EW42

CERN MPS 2028.

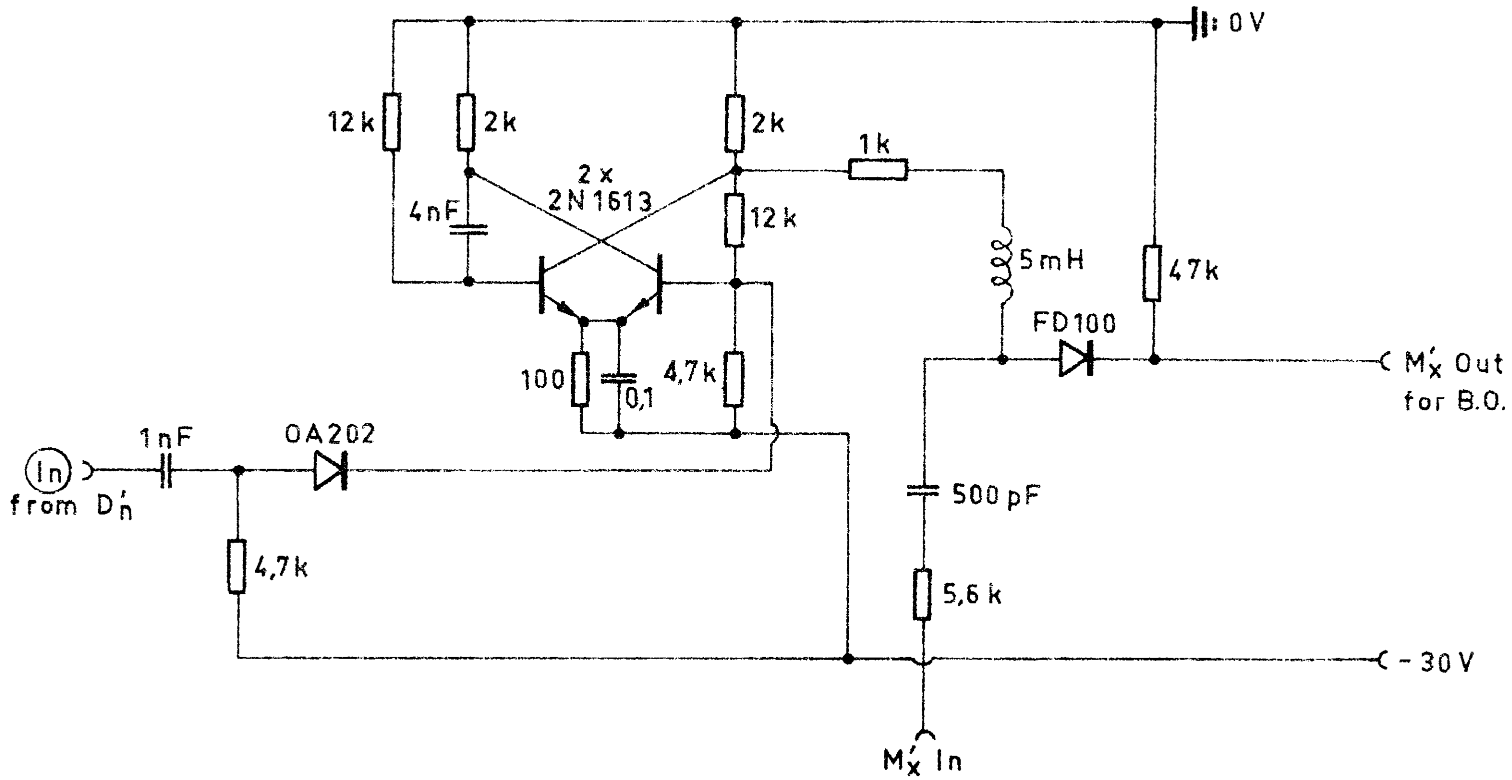


Fig. 6

POLYCANAL SYSTEM
GATE OF RECEIVER.

A.G.