MPS/Int./VA 61-5
8.3.1961.

A SIX-HEAD TARGET

The idea of a multiple head target came out of some discussions on the methods of solving the target problems arising from the proposed measurement of the life-time of the neutral π^0 (Ref. : Internal Report SC 60-7, by G. von Dardel). It soon became obvious that if a mechanism capable of changing target heads from one machine pulse to the next could be developed, this would greatly enlarge the PS facilities. Associated with such a mechanism should be an automatic changing system which can be preprogrammed.

A prototype six-head target and its associated drive unit has been completed and has undergone a short test in the machine. A brief description follows which explains the main features of the mechanical and electrical system, also included are some operational details and provisional results.

Some possible uses of the six-head target are :

1) Comparing target head materials;
2) Comparing target head shapes;
3) Having available spare fragile target heads;
4) Satisfying the target changes required during one run of the machine.

MECHANICAL PART (Fig. 1)

As known from the normal flip target, the heads are mounted on a main supporting rod and actuated by a small magnet. The band linking the magnet and target axis in the normal target has been replaced by a small tube (not shown in Fig. 1). The axis on which the normal target is mounted has a crank which can actuate each of the six heads. This was made in order to change the heads and at the same time diminish the bouncing in the "up" position. In this position the crank pin remains in the slot of the head support

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and therefore no teflon buffer is needed to determine the "up" position. Towards the end of the up movement the crank drive already produces a de-acceleration.

For the change of targets, all six heads are assembled on a short tube with an internal thread. The position of this tube is changed by turning the internal screw and so any head can be moved into the position where it can be actuated by the crank. This arrangement maintains the same geometrical position of the wanted target with respect to the beam. To produce the appropriate movement of the drive screw, the motor for target change (on the left in Fig. 1) turns via two spur gears and a maltese cross. Each position of the maltese cross corresponds to a special target head being in the right position. The reduction in the spur gears between the maltese cross and "shaft for target change" has been chosen at an appropriate value.

Using this kind of drive there is no need to stop the motor very precisely and a potentiometer (target head indicator) which is turning on the same shaft as the maltese cross can indicate which target head is working.

Not shown in Fig. 1 are the contacts which are connected to the target device and are used to interlock the operation of the magnet and the motor. They are assembled in such a way that the magnet cannot be actuated while the motor is turning or the motor operated while the magnet is energized. A third contact disconnects the motor when the appropriate position has been reached. Two further contacts indicate the up and down positions of the target.

ELECTRICAL SYSTEM (Fig. 2)

The electrical system of the six-head target can be split into three separate units : a) target drive, b) head selection, c) programmer.

a) Target drive. The target drive is similar to that of a normal flip target. The main differences being that the trigger for the

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target is first delayed and this delay has six individual controls allowing different times for each head. By this means compensation for the velocities of the targets can be made so making it possible for all targets to arrive in the "up" position at the same time in the machine cycle. The value of the current pulse has also six individual controls (target acc.) thus allowing very heavy targets and very light foils to be mounted at the same time.

b) Head selection. As mentioned early in the report it is not necessary to stop the motor very precisely and therefore a simple ON-OFF Servo has been used for the motor control. This Servo consists of two potentiometers and a voltage comparator (See Fig. 2). The desired position is chosen by selecting a position on the fixed potentiometer and then to make a comparison with that of the voltage from the target head indicator which is mounted on the target. The resultant output from the voltage comparator drives the motor in such a way as to reduce the comparator output to zero.

c) Programmer. It can be seen from Fig. 2 that the various functions such as delay, acceleration and head selection are brought into action by the relays 1 - 6, each relay being associated with a particular target head. It is the function of the programme unit to operate these relays at the appropriate time in the machine cycle and change to the next desired target after a given number of operations. The programme unit has two functions, the first being the sequence in which the targets will operate and the second is the number of operations performed by a given head before the system changes to the next selected head.

The sequence of operations is controlled by a stepping switch and a sequence selector. The stepping switch produces a closing contact (Sw 1 - Sw 6) which is advanced always in sequence by an input pulse (advance one step). This closing contact feeds 24 V to the sequence switch which in turn operates one of the six relays. The operation of this relay connects the appropriate circuits and also the coincidence circuit to the machine pulse counter. The counter operates each machine cycle and after

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a preset number of operations (number of operations Fig. 3) an output from the coincidence circuit resets the counter to zero and at the same time produces an "advance one step" pulse for the stepping switch.

All changes in the automatic system start after X_2 and are finished in less than 1,5 sec. (worst case of changing from head 1 ⟶ 6 in one cycle).

OPERATION (Fig. 3)

Before starting to operate the six-head target it is wise to make the following adjustments ;

1. All target acceleration at minimum, i.e. max. resistance.
2. Press count stop.
3. Press magnet stop.
4. Reset stepping switch.

For manual operation press count stop and stepping switch to reset. Under these conditions all targets in turn should be operated continually by selecting it on the first position of the target sequence switch (extreme left). After the duration of the current pulse has been fixed (current pulse) to correspond to a particular flat-top operation, the target flip can start (close magnet stop). Now it is possible to increase acceleration to suit the target heads. The individual delays are adjusted with the aid of the target "IN-OUT" signal.

Set "No. of operations" at 1 on each switch and remove count stop and place stepping switch in position "RUN". This produces a change each cycle and if the automatic changing is working, it will be indicated by the appropriate windows lighting up.

Finally the number of operations on each head can be set (See example Fig. 3).

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NOTES ON TARGET HEADS.

There are certain limitations which must be placed upon the size and shape of target heads mounted on this unit. The maximum thickness of a target is 3 mm. if all six heads are required; by sacrificing the number of heads available it is possible to mount thicker targets. The shape of the target should be such as not to exceed the area enclosed by the foil target shown in Fig. 1. When using this target for comparison it should be programmed in such a way as to reduce the number of changes required to a minimum, as this prolongs the life of the unit (reduces the wear).

N.B. All targets have the same azimuthal position (i.e. for example Straight Section 1 310 mm. down stream from magnet reference point R. 100).

PRELIMINARY TARGET STUDIES.

During the first trial of the six-head target, six different vertical line source targets have been compared.

Target specifications :

1) Stainless steel wire 0,1 mm ∅ supported with frame
2) " " " 0,4 mm ∅ supported with frame
3) " " " 0,4 mm ∅
4) " " " 1,6 mm ∅
5) Aluminium rod of 1 mm ∅ and 20 μ wall (both increasing in thickness
6) " " of 1 mm ∅ and 50 μ wall (towards support.

These targets have been used at a 50 msec flat-top operation. The burst shapes of the heads 3 to 6 are shown in Fig. 4. Conditions for spiralling beam and gain of counter are the same. In Fig. 5 the wires of 0,4 mm ∅ with and without frame are compared.

The difference in the two counter signals of Fig. 5 is due to vibrations of the wire. They are very small with the wire supported by the

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frame (the magnet ripple is predominant there). The wire without supporting frame however is vibrating with big amplitudes at a rather high frequency. Now the thickness of the wire seems to be big enough to blow up the beam sufficiently at the first traversal, so that the counter signal is showing a roughly exponential decay without any magnet ripple. With the 1,6 mm ∅ self-supported wire (Fig. 4) the amplitudes of the vibrating wire are much less important. The thickness of this wire is sufficient to kill big part of the beam at its first traversal. Therefore these vibrations can be seen in the counter burst.

The special targets No. 5 and 6 (Fig. 4) have been made to get a burst shape rather like a square. The idea is to increase the target mass seen from the beam at a rate corresponding to the blow-up of the beam by scattering. The difficulty is to get beam position and target thickness increased to the corresponding level, because there is no means of vertical beam steering at the moment and the exact determination of the beam position is rather cumbersome. In this case here, the beam has hit the target straight away too far at the bottom.

We wish to acknowledge the work of K. Kull for the mechanical construction and that of J.P. Bovigny for the construction of the electronic drive unit.

Ch. BROOKS

W. RICHTER.

Distribution : (open)

All E.i.C.
All M.C.R. Operators
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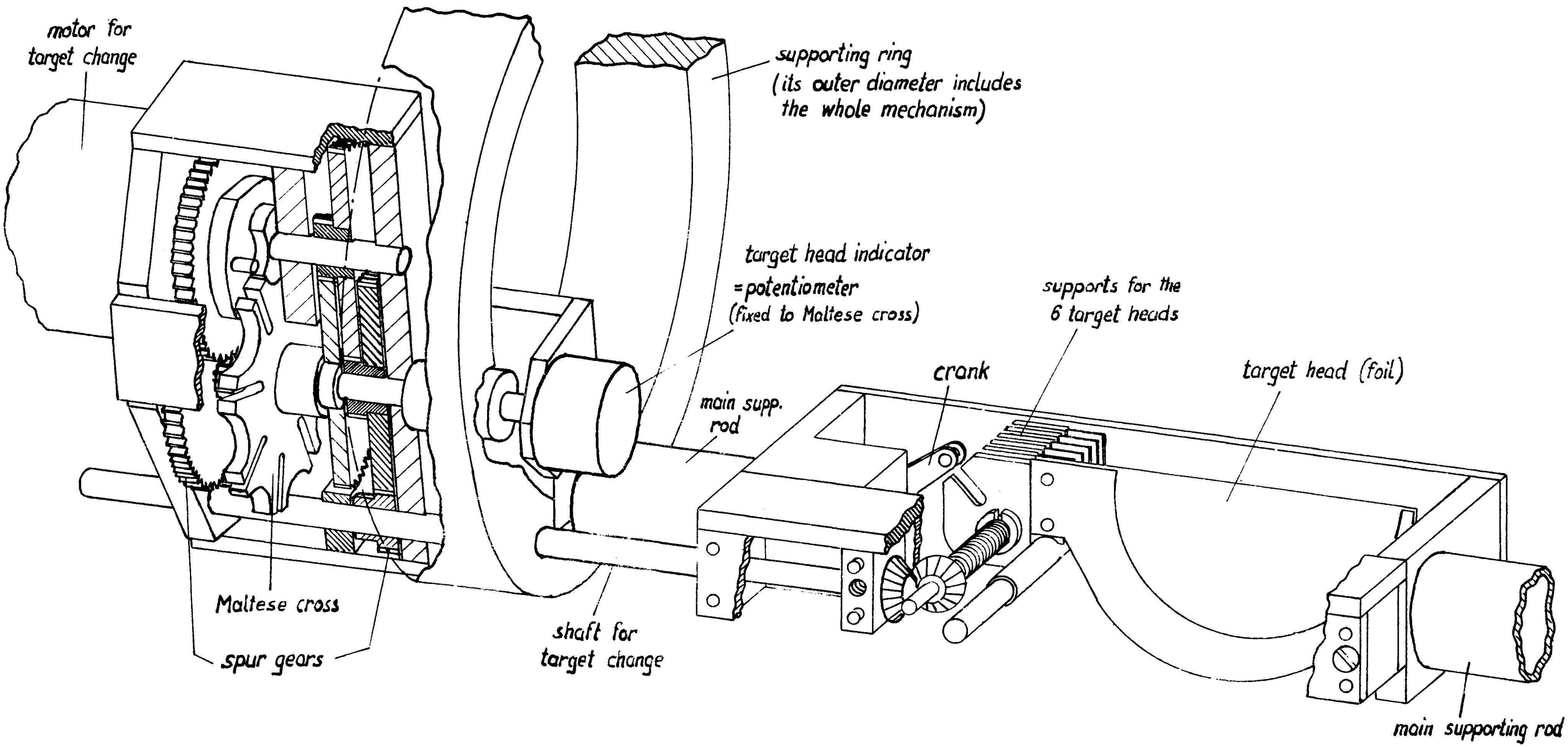

Fig 1: Mechanism of six-head-target, scale 1:1

The magnet, which is pulling the target by turning the crank, is not shown. All electrical connections and contacts (security devices) are ignored.

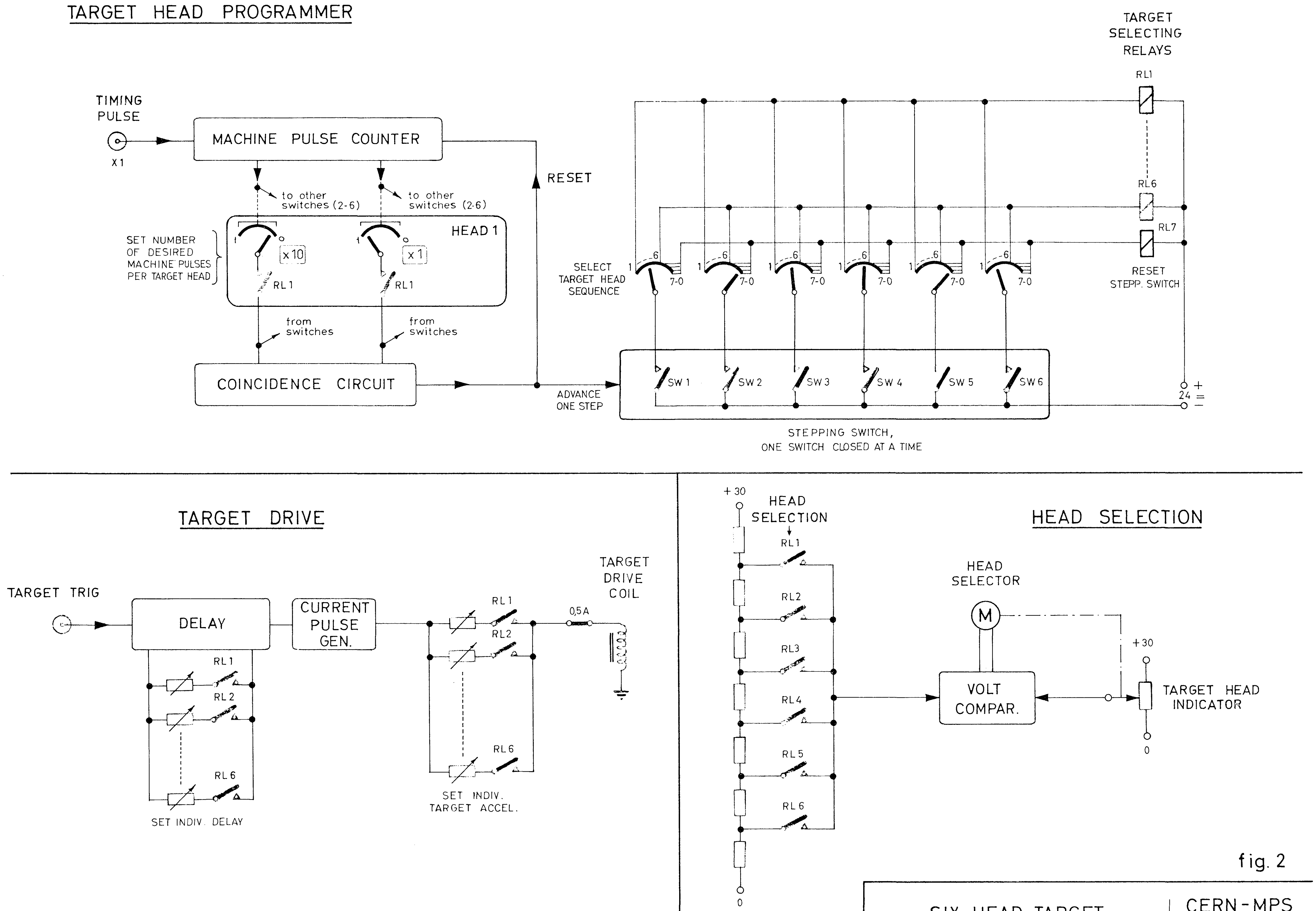

fig. 2

SIX HEAD TARGET DRIVE UNIT

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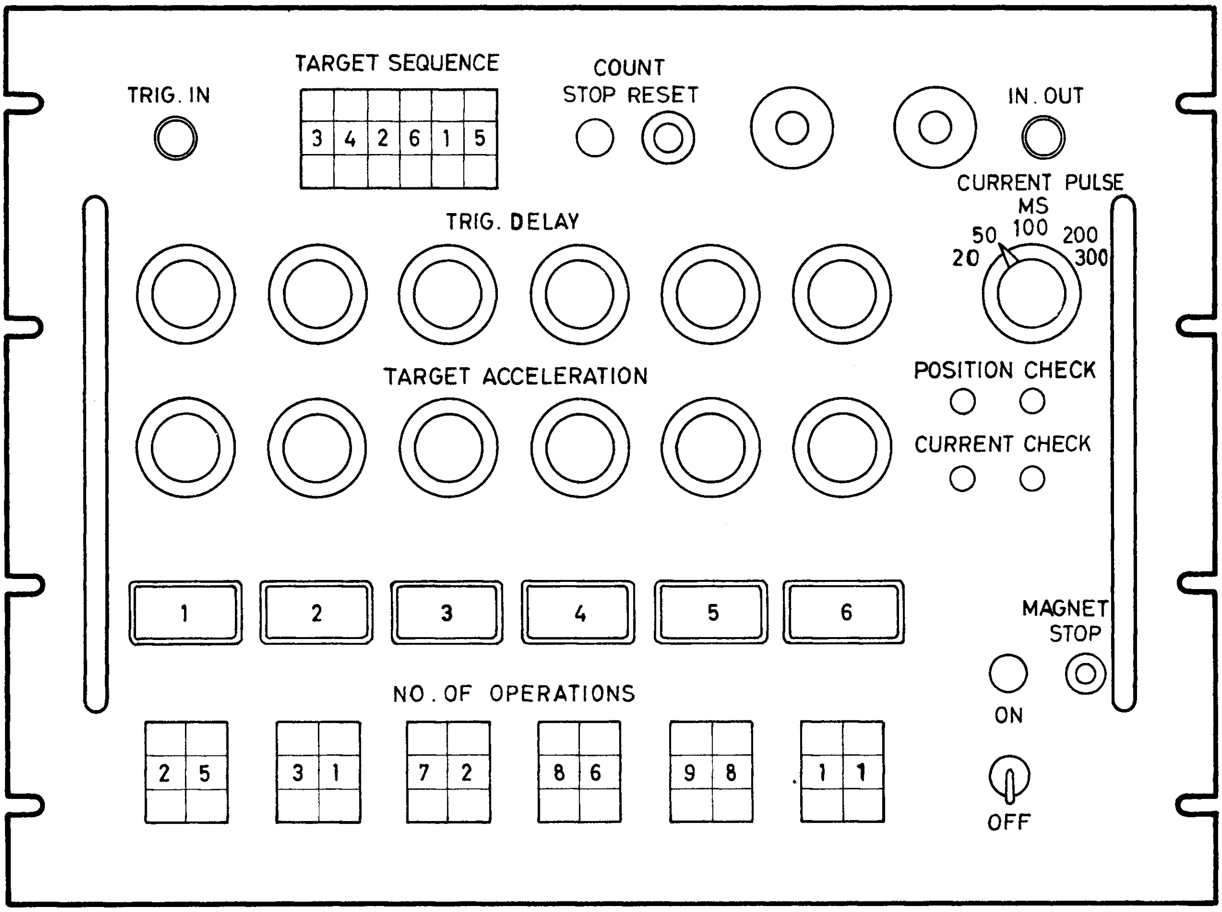

EXAMPLE :

TARGET SEQUENCE	Nº OF OPERATIONS
3	72
4	86
2	31
6	11
1	25
5	98

fig. 3

SIX HEAD TARGET
DRIVE UNIT

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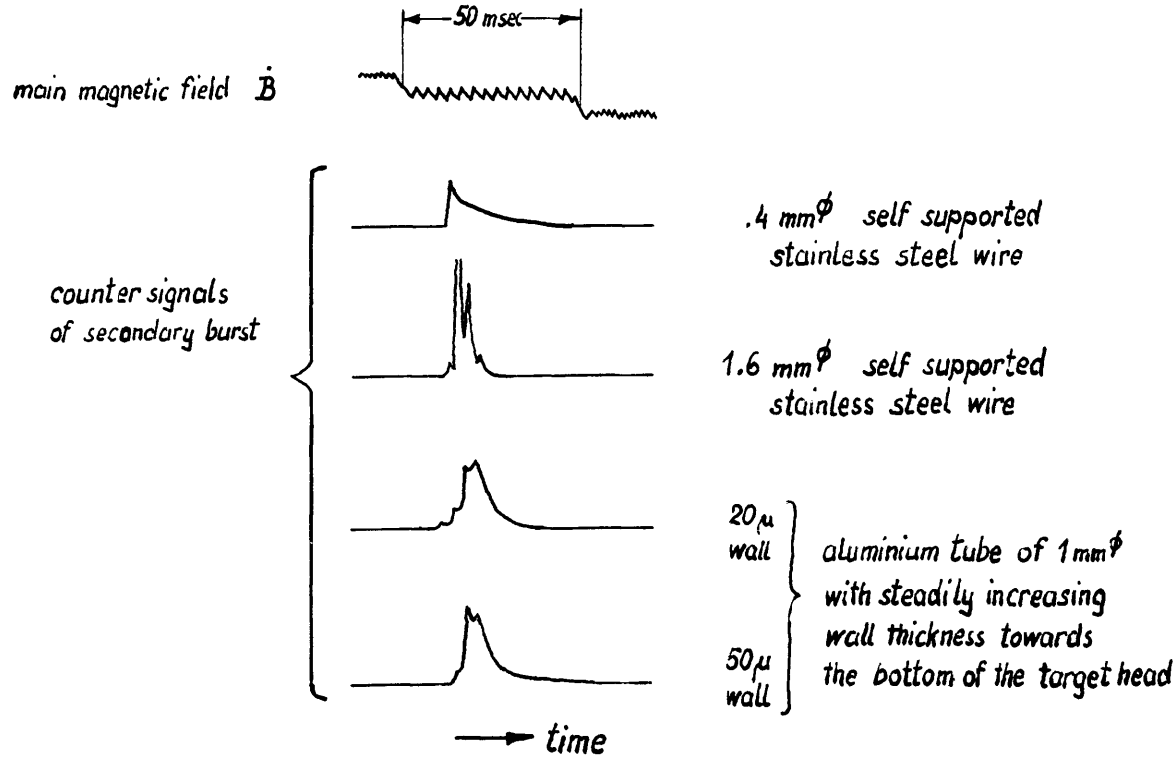

Fig. 4 Burst shapes of different wire targets under same conditions; fall of magnetic field during flat top 100 Gauss; energie 24 GeV

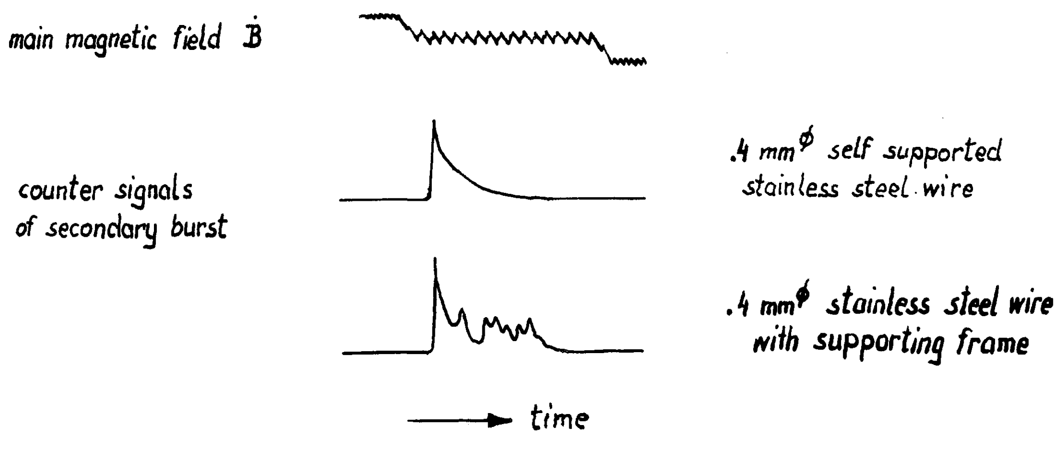

Fig. 5 Burst shapes of .4 mm$^\phi$ wire as line source; second trace: without, third trace: with frame; at 24 GeV; fall of magnetic field during flat top (50 msec) 150 Gauss