MPS/VA/Int 63-10

20th December 1963

TARGET INSIDE MAGNET GAP

(System 63)

A target, which is able to work inside a PS magnet has been constructed and three units of this type have been assembled. They have now been in operation for three months. Some details about this target mechanism, which may be of interest to users and for the operation are given in this report. Further details may be looked up in "Manuel pour la cible dans l'entrefer de l'aimant" which will be available in a few copies in some weeks' time.

Why are targets inside the PS-magnet of interest ?

A secondary beam, which is not disturbed by passing through the fringing field of the following PS-magnet, uses an iron pipe to shield the secondary beam as described by H. G. Hereward (1). Nevertheless the extraction angle of such a beam is in the order of about 6°, which also means a production angle of about 6° for a target in standard location. Besides the fact of arriving at lower production angles for negative particles by having a target inside the PS-magnet, the possibility of choosing different azimuthal target locations makes a given initial beam channel capable of conducting different particles at different momenta with an always good allround performance as described by E. Keil and B.W. Montague (2). The first beam of this kind, using for a single initial beam channel four targets inside the PS-magnet and one target (for positive particles) at standard location, has been described by E. Keil and W.W. Neale (3).

Where can these targets be used ?

To use these targets, the vacuum chamber inside the PS-magnet has to be modified (equipped with special flanges). This has been done in PS-magnet N°60, where there are four azimuthal places for the installation of these targets. A similar vacuum chamber is installed in PS-magnet N°100. There however, the joining tubes are of circular shape, which limits the maximum target length to 40mm and implies a slight modification of the internal chariot of the target unit.

PS/4167

What do these target units look like ?

Fig. 1 shows a complete target unit in front of a graph, which shows the magnet pole faces and the elliptical chamber in between. Further limitations in the vertical space for this target unit are given by the pole face windings and the coils of the main magnet (both are not shown in the drawing). Each unit of this kind can handle two target heads, which are visible in their down position in Fig. 1. There the connection tube to the vacuum chamber has an elliptical cross-section (42mm high ; 125mm width). The parts of this unit, which are hidden by the vacuum tube in Fig.1 are shown in Fig. 2 (vacuum cover retracted).

Why does it look so complicated ?

Each of the two target heads has besides the flipping mechanism two independent remote controls : one for radial position, the other to align the head with the internal beam . All this,together with security protections against operation faults, is housed within 130mm Ø on a length of 750mm, in order to keep the volume small, which has to be pumped down.

How does the radial remote control work ?

Fig. 3 shows the right hand end of the mechanism of Fig.2. Visible are the driving motor and two potentiometers for the radial displacement of one of the two internal cars. Two potentiometers have been chosen to measure the target radial position along the whole stroke of 180mm with an overall accuracy of better than 0.1mm. One potentiometer (black cylinder on the right hand side in Fig.3) measures the whole stroke with 10 turns, the other one (short black cylinder on the left hand side) produces a fine indication by making 60 turns along the whole stroke. Hence, the most inaccurate point is the 4^{o} gap of this second potentiometer, which corresponds to $(180/60) \times (4^{o}/360^{o}) = 0.03$mm. Besides this, the backlash of the reduction gear of less than 1^{o} (corresponding to 0.008mm) is small . Therefore all this gear has normal backlash and the only part, which had to be made without backlash, is the thread-shaft, which finally displaces the internal car. Displacement speed for this car is 1mm/sec only, to allow for positioning with 0.1mm accuracy.

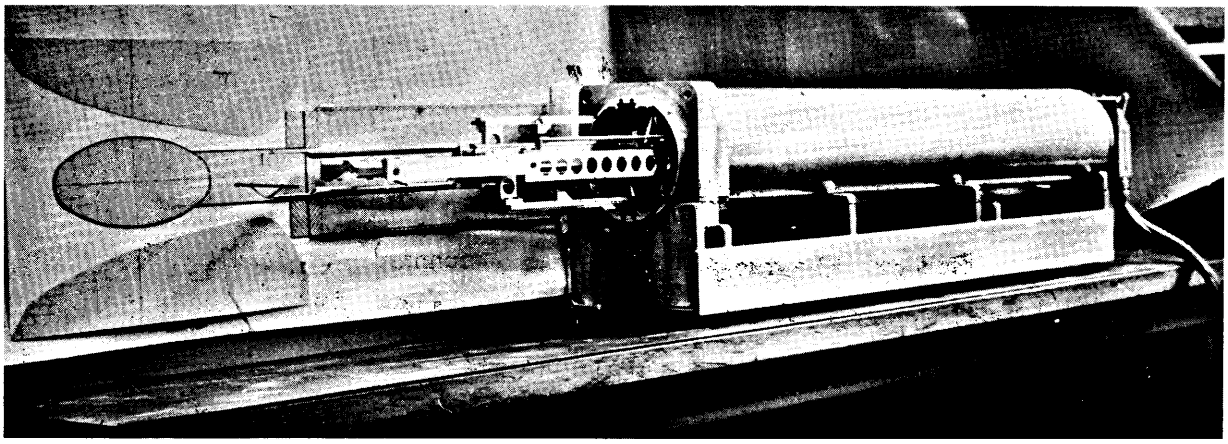

Fig. 1

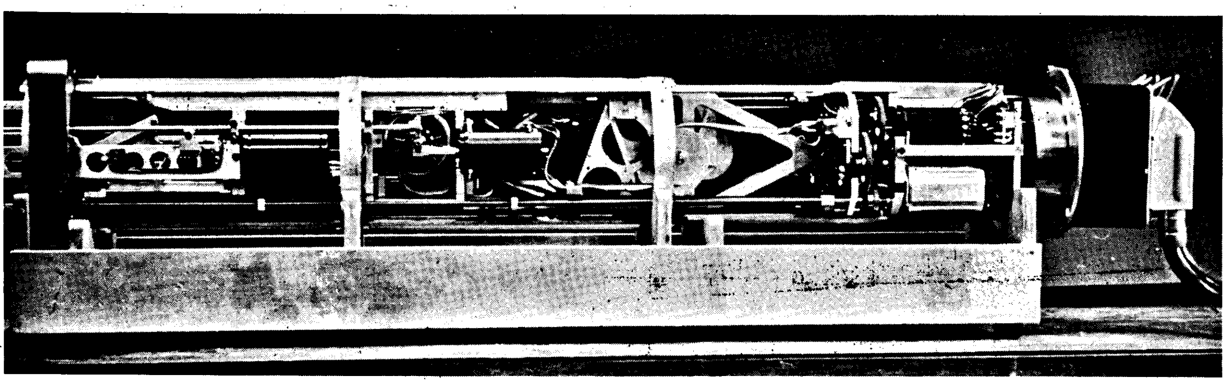

Fig. 2

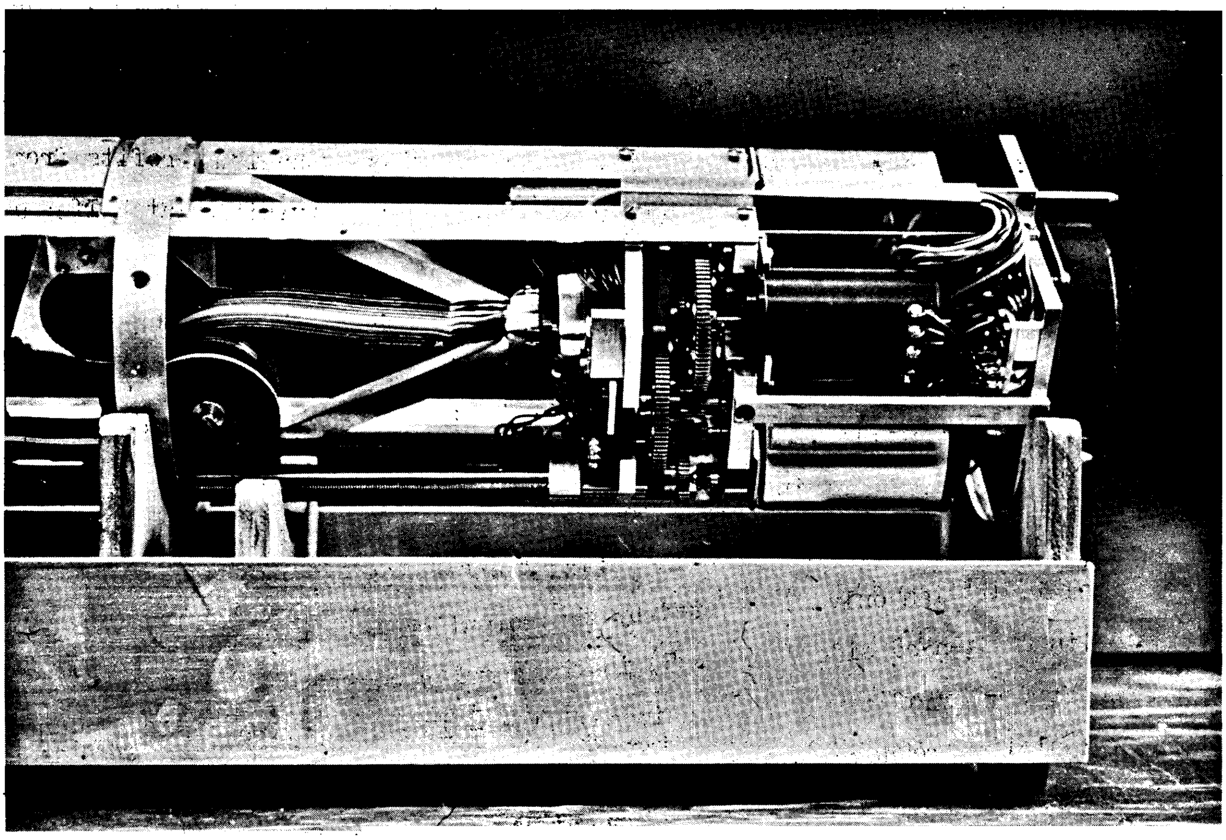

Fig. 3

What does the internal car look like ?

Each of the two internal cars is running with conical wheels on a top and a bottom V-rail and occupies half of the 116mm Ø inner circle, which is shown in Fig. 4. Here one of the internal cars (Fig.5) has been taken out. This can easily be done in order to use other internal cars for different target operation in the same radial drive unit. The car itself has a motor (black cylinder in the middle of Fig. 5) which flips the target. There is a second motor (white circle) and a potentiometer (black cylinder on the right-hand side), which allow aligning the target head with the internal beam, by turning the target around its horizontal support (tube ; see Fig. 1). Cables for supply and measuring arrive from the right-hand side via a drum (see fig. 3).

Why is the alignment remote-controled ?

Calculations have indicated that the efficiency of long point source targets of heavy material is influenced by the precision of the target alignment. For a target of 0.5mm height and 80mm length , alignment errors as small as 0.1mm drop the target effeciency by 10°/o already. It would be hard to align these targets as precisely inside the PS. Therefore a remote control has been incorporated, which can tilt the target ± 20 mrad (corresponding to ± 1.6mm on a length of 80mm) around an axe perpendicular to Fig. 4. The tilting mechanism profits from the play between small target car (four wheels) and rail (visible at half height in Fig. 5).

There is a long shaft, driven by the white round motor in Fig. 5, passing behind the black motor to the left-hand side of the photo, where it has an excentric bearing. The small target car has a slider along this shaft, and will be turned according to the position of the shaft. Since the system is only free of backlash (spring loaded) in the "target up" position, the target is aligned in this position only. Indicated by the potentiometer (hardly visible black cylinder on right-hand side of Fig. 5) is the angular position of the excentric shaft (± a quarter of a turn = ± maximum tilt = ± 15 as indication in MCR). Calculations for zero degree targets gave an increase of about 30°/o in efficiency along this range for perfect alignment. Measurements showed 20°/o only because the target itself cannot be made perfectly straight,

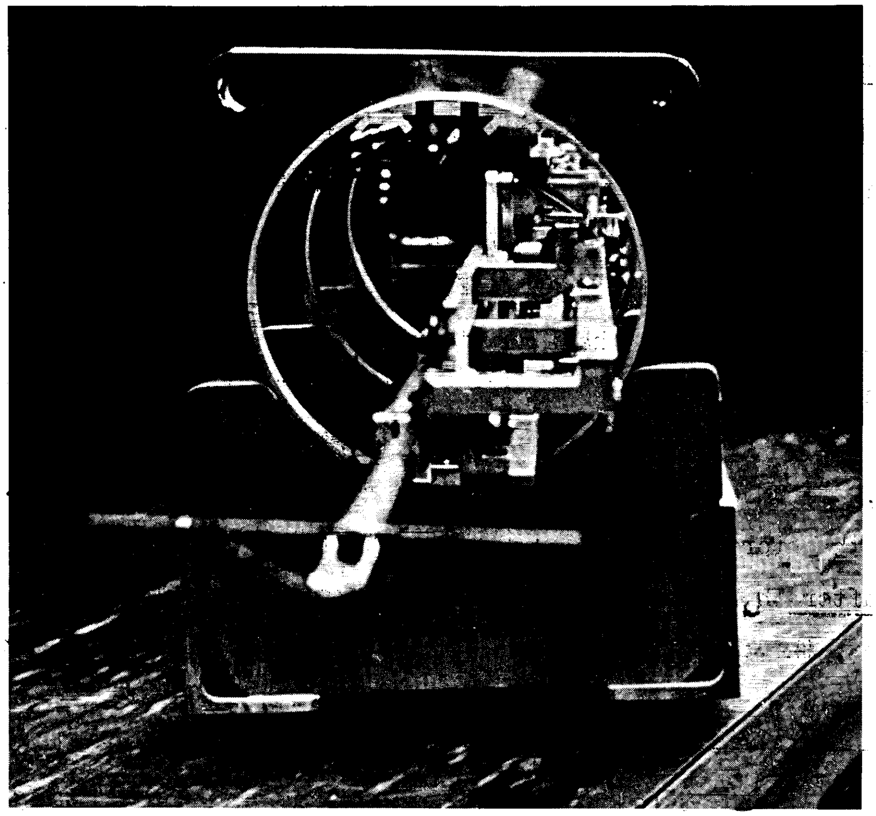

Fig. 4

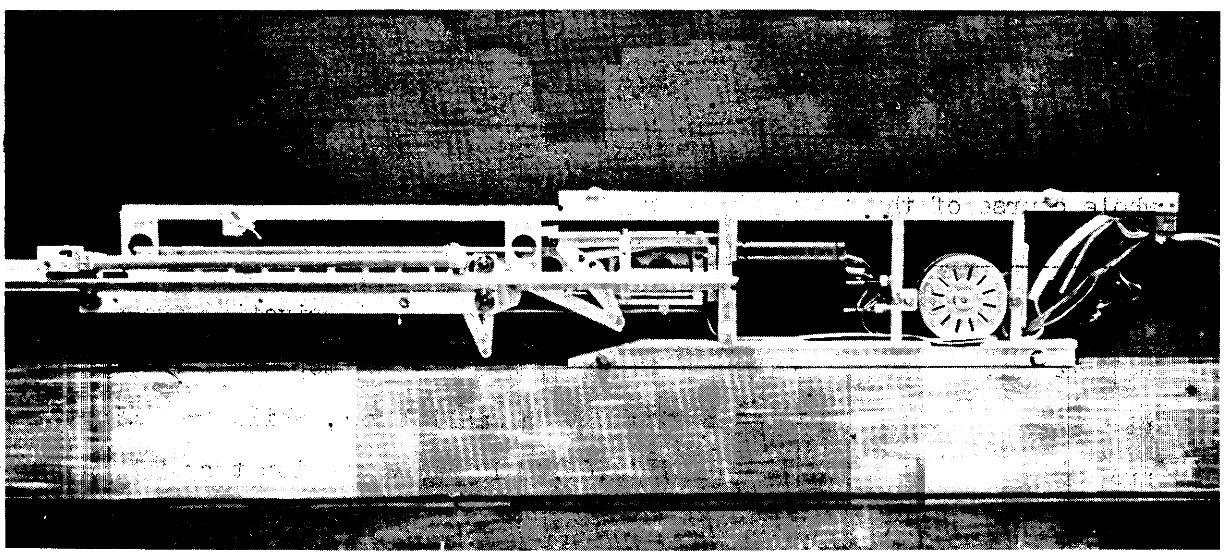

Fig. 5

How is the target actuated ?

The actuating motor does about 7 turns, to move the target into the "up" position and pulls it down again with 7 turns in opposite direction. A screw is turned, which is directly fixed to the motor shaft and displaces a nut about 20mm. Via two levers (appearing as V in Fig. 5) the small target car (rolling with four wheels along the rail in half hight) is displaced about 100mm. Fig. 6 shows the position of this car a few mm before being "up". The link between driving nut and the lever is flexible in length (spring loaded). So the driving nut can continue to move, after the small target car has reached its end position. This allows to consume the stored energy of the rotor and to close a microswitch for the target up signal after the end position has been reached. In addition to this horizontal displacement, the target head moves vertically at the end of the stroke.

Why does the target head move horizontally and vertically ?

To retract the target out of the normal chamber during injection, a horizontal displacement of about 100mm (radial position within $\pm$ 30mm) is necessary. An additional vertical motion is necessary, for having two target heads in one unit. It further allows using the targets as internal and external ones (target head passes in one case around the beam to the other side). It would be ideal to put the target in place first radially and then vertically. To do this with a single drive sufficiently fast, the finally chosen path of the target head approaches the "up" position at 45^{o}. Fig.7 shows the bottom target head a few mm before the "up" position, which is identical with the cross on the graph. Fig.8 shows the whole course of the target in operation.

How has this course been achieved ?

The tube, which is supporting the target, is pivoting around a horizontal axe of the small target car (axe of the left-hand top wheel in Fig.5). The right-hand end of this tube is lifted by a small lever, while the main lever approaches the horizontal position (Fig.6). This moves the top target head on the left-hand end of the tube down. End stop is made by the 45^{o} inclined screw in Fig. 6.

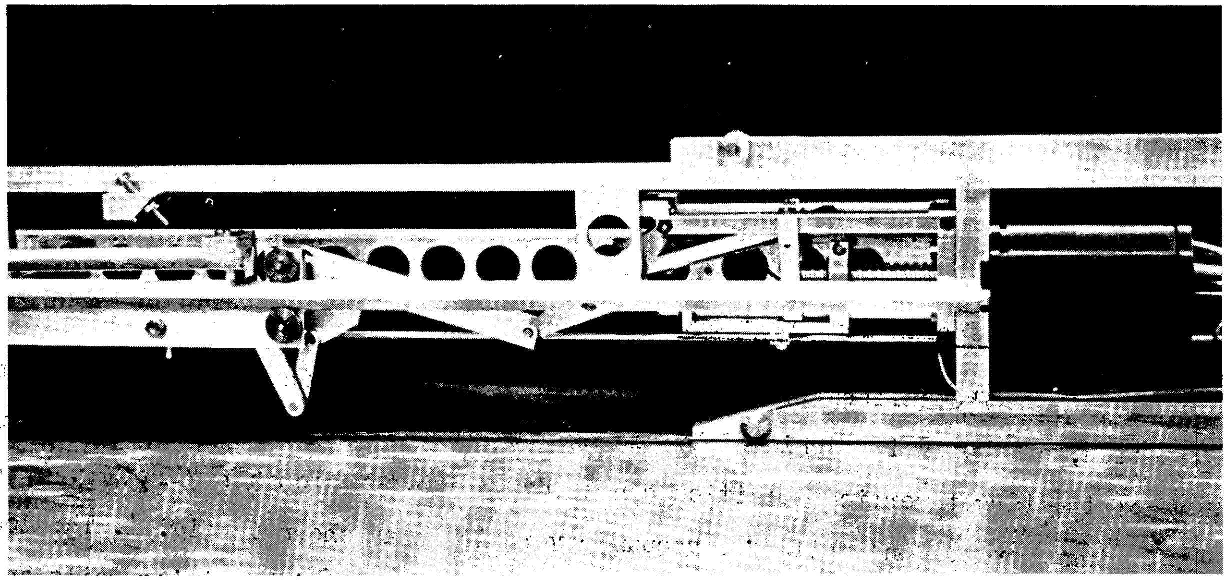

Fig. 6

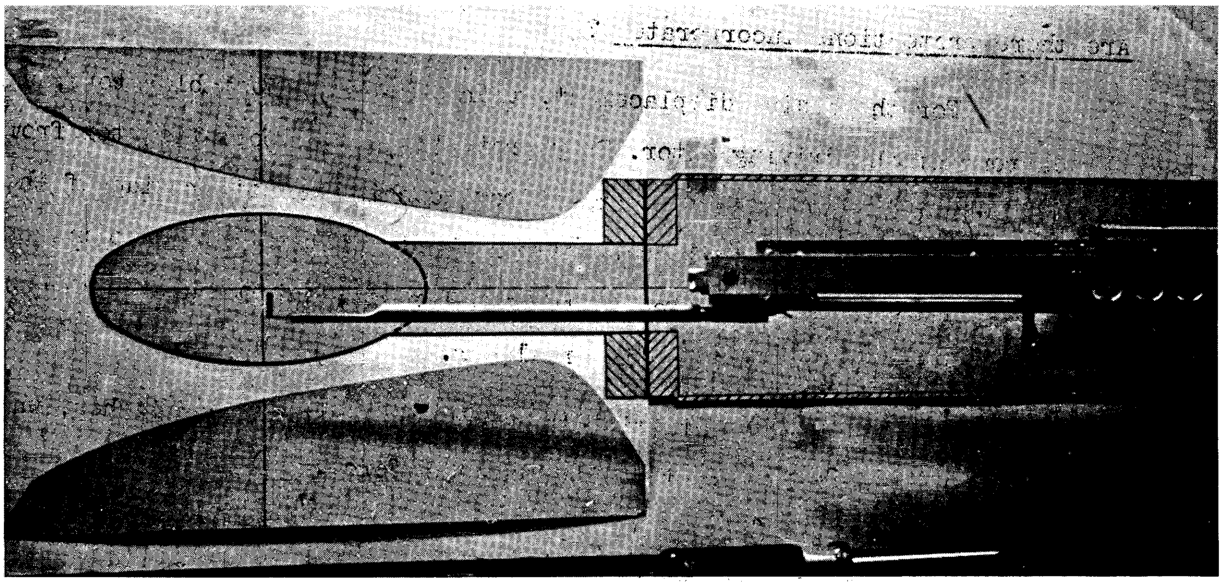

Fig. 7

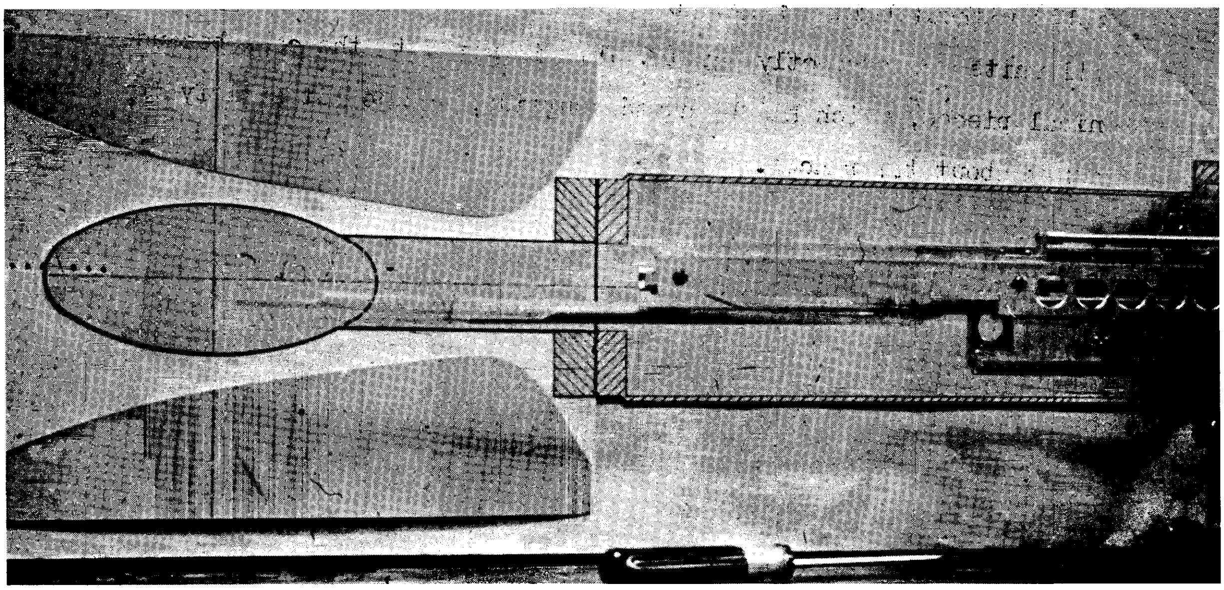

Fig. 8

What other facilities are there ?

The calibration of the potentiometers, which indicate the radial position, can be easily achieved by disengaging the gear chain (Fig.3). The adjustment of the target vertical position can be done with the stop screw in Fig. 6. Both things can be done while the vacuum cover is on as shown in fig. 1. The mounting of the whole unit into a PS magnet has been made easy with sliding rails and a rapid locking excenter.

Are there protections incorporated ?

For the radial displacement, there are two adjustable stops, which break the current of the driving motor. They protect the 10 turn potentiometer from being driven against its ends and the target from touching the other side of the chamber. There is further a mechanical stop between the two internal cars to prevent too large radial position difference of the two targets, which could do harm to a target head being touched by the other internal car.

For the target actuating there are two extra microswitches, which indicate when the target is actuated with too much force.

What are the unsolved problems ?

There should be a device to align target heads (fixed to the supporti tube) without being fixed to an actual unit. However this requires first, that all units are perfectly equal . This is not yet the case because of a few mechanical pieces, which had been made outside, and do not satisfy the narrow requirements about tolerances.

.../...

Who has done all this ?

Quite a number of people have joined their efforts in order to get the whole system into operation.

The basic idea of having a target in a magnet gap came from G.L. Munday. G. Brianti, H. G. Hereward and P.H. Standley helped with valuable advice.

The electronical equipment in the M.C.R. was made by J.J. Merminod with the help of J.P. Bovigny and Ch. Serre. M. Mary's group and K. Kohler also assisted, and Ch. Brooks initiated the measuring system.

H. Bobillier and J. Comte adjusted and mounted the units from the parts manufactured by the Central Workshop, some outside workshops and K. Kull from Atelier West.

The cabling system MCR - Ring was traced with the help of H. Körner, J. Thorlund and G. Becker. Some vacuum testing was done by H. Dent. W. Fritschi and W. Görlitz participated in the construction and drawing.

The project, the construction and first testing have been performed

by W. Richter and M. van Rooy

References :

(1) H.G. Hereward Small production angles using iron pipes, targets in magnets and Petrucci magnets ; Minutes of Sept. 1962 Meeting on future programme for CPS an AGS held at Brookhaven (J.W. Bittner ; Ed.) p. 24-28.

(2) E. Keil and B.W. Montague : Some secondary beams from internal targets in a PS Magnet unit - AR/Int. Psep/62-2.

(3) E. Keil and W.W. Neale : A High momentum separated particle beam for use with the 1.50 metre British national hydrogen bubble chamber at CERN.

(4) L'appareillage de commande des cibles internes type 1963 (à paraître).

(5) Manuel pour la cible dans l'entrefer de l'aimant (à paraître).

Distribution:

Scientific and technical Staff of MPS
Scientific Staff of Experimental Teams working on the PS

PS/4167