AE-10

AE-10

Equipment for thermal neutron flux measurements in reactor R2

E. Johansson, T. Nilsson and S. Claeson

AKTIEBOLAGET ATOMENERGI

STOCKHOLM · SWEDEN · 1960

AE-10

Equipment for thermal neutron flux measurements in reactor R 2

E. Johansson, T. Nilsson and S. Claeson

Summary:

For most of the thermal neutron flux measurements in reactor R2 cobalt wires will be used. The loading and removal of these wires from the reactor core will be performed by means of a long aluminium tube and electromagnets. After irradiation the wires will be scanned in a semi-automatic device.

Printed April 1960

LIST OF CONTENTS

Equipment for Thermal Neutron Flux Measurements in Reactor R2

by

E. Johansson, T. Nilsson and S. Claeson.

Introduction.

The thermal neutron flux measurements which are part of the start program of R2 will mainly be performed by irradiation of cobalt wires. These wires (length 1 m, diameter 1 mm) will be irradiated between plates in the fuel elements and the activity distribution along the wires will then be measured in a semi-automatic apparatus.

Loading and Removal Equipment for the Wires.

As the core of the reactor is situated about 8 metres below the water level and the distance between the fuel plates is only 3 mm special loading and removal tools must be used for the wires (see fig. 1). The cobalt wire is lowered through a long aluminium tube by means of an electromagnet whose current is turned off when the wire is in position. The small aluminium disc (A) fastened to the wire by a screw of stainless steel prevents the wire from dropping through the fuel element and also gives a reference point on it. This disc must be removed before the activity measurement starts. The aluminium piece (B) acts to guide the wire along the centre line of the fuel element. After irradiation the wire is removed by a second electromagnet (see fig. 1). This magnet may for a few seconds be fed with a much larger current that it could stand continuously making the beginning of the removal more safe.

Both magnets hang by their feeding cables. Their weight is about one kilogram each and for corrosion reasons they are covered with araldite. The tube has a weight of 12 kilograms and will be pickled before use. The cobalt wires and the small aluminium discs will also be pickled. The lower ends of the cobalt wires will be rounded off in some way to prevent them from scratching the fuel plates.

The above equipment has been tested in combination with a model of a fuel element. The tests have been performed with the element in a water tank. None of the 140 loadings and 140 removals hitherto undertaken has failed and the wire has always landed near the centre line of the element. The equipment thus seems to work satisfactorily in its present condition.

Wire Scanning Device.

Fig. 2 shows a block diagram of the wire scanner. This consists of a scintillation detector, a cathode follower (type AE), a high voltage supply (type AE), a drive mechanism for wires (developed at AE), a pulse amplifier (type EKCO), a scaler (type AE) and a printing counter including a timer (type AMETRON). Two devices have been built.

The scintillation detector (see fig. 3) consists of a plastic scintillator (SINTILON) and a photomultiplier (EMI 6097 B). It is sensitive both to beta and gamma radiation but will in this special case mainly count gamma, because the beta radiation from Co^{60} is comparatively weak. The counter is surrounded by a lead shield about 2.5 cm thick. It is possible to change the counting efficiency by moving the counter axially. The scintillator used at present (jan. 1959) has a diameter and a length of 2.5 cm. The diameter is sufficiently small in view of desired resolution and measurements have further shown that the resolution will not deteriorate due to gamma leakage through the lead shield near the scintillator.

The drive mechanism for the wires is shown in fig. 3. Coil springs (not visible in the figure) make the weel B_1 (alt B_2) press the wire to the driving wheel A_1 (alt A_2) which is turned by a small syncronous motor M_1 (alt M_2). Because it is possible to shift from one driving system to the other in a short time the wire can be measured along its whole length in one step. The shifting is brought about by the bar S whose outer positions correspond to the two driving systems. When the bar is in an intermediate position none of the driving systems work. The speed of the wire can be changed by using other motors or driving wheels. A suitable speed should be 15 mm/min corresponding to a time of about one hour to measure a 1 metre long wire.

The procedure for a wire measurement will now be described. First the wire is moved from the right till the microswitch (uSw) gives contact. At this moment the green lamp G is turned out and the red lamp R is turned on. The bar is then moved from its intermediate position into position 1 which makes the wheel B_1 press the wire to the driving wheel A_1. The button T is then pressed down, whereby the motor M_1 and the printing counter start and the motor control lamp L_1 is turned on. After some time the bar can be moved into position 2 and the rest of the wire will then be driven past the counter by system 2. The control lamp L_2 corresponds to the motor M_2. When the back end of the wire leaves the switch the red lamp is turned out, the green one is turned on and an alarm signal indicates that the measurement is over.

The electric system of the drive mechanism is shown in figure 4.

The pulses from the scintillation detector are amplified and scaled down and then recorded in the printing counter. The counter prints the number of pulses from the scaler during successive (and equal) intervals of time. The length of the time intervals is determined by a timer and is in this case variable from 0 to 5 minutes. The maximum permissible counting rate is 500 pulses per minute.

The wire scanning devices have been tested very carefully - partly in connection with flux measurements in reactor R1 during the autumn of 1958. The drive mechanisms have proved to be very reliable while the printing counters have needed some small adjustments. At present (jan. 1959) also these parts work satisfactorily. The scintillation detectors with accessories have shown good stability, but reference measurements will yet be performed. This might be particularly important for series of measurements extended over a comparatively long period of time. Fig. 5 shows a photo of the wire scanner whose drive mechanism is shown separately on a photo in fig. 6.

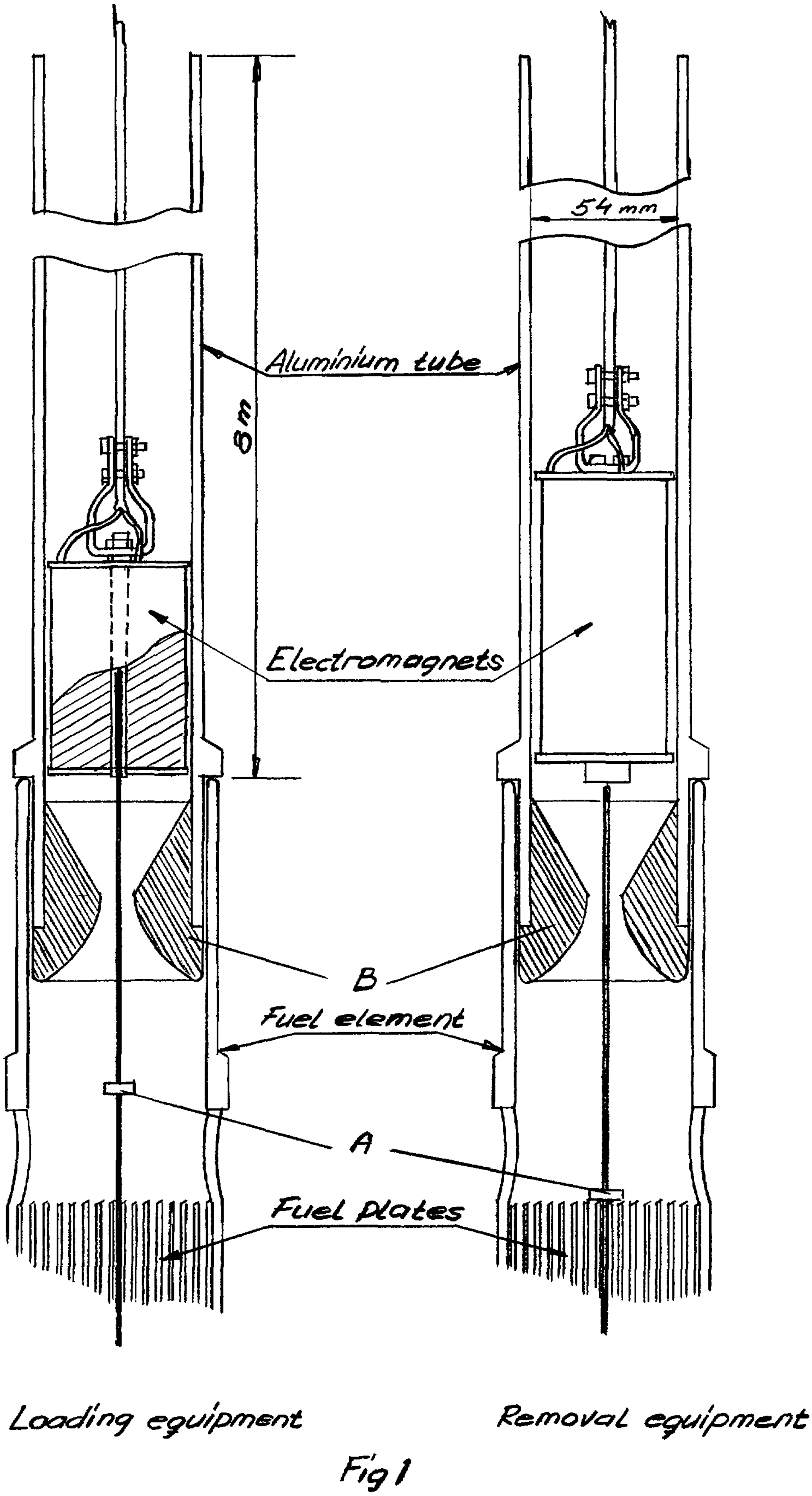
54 mm
8 m
Aluminium tube
Electromagnets
B
Fuel element
A
Fuel plates
Loading equipment
Removal equipment

Fig 1

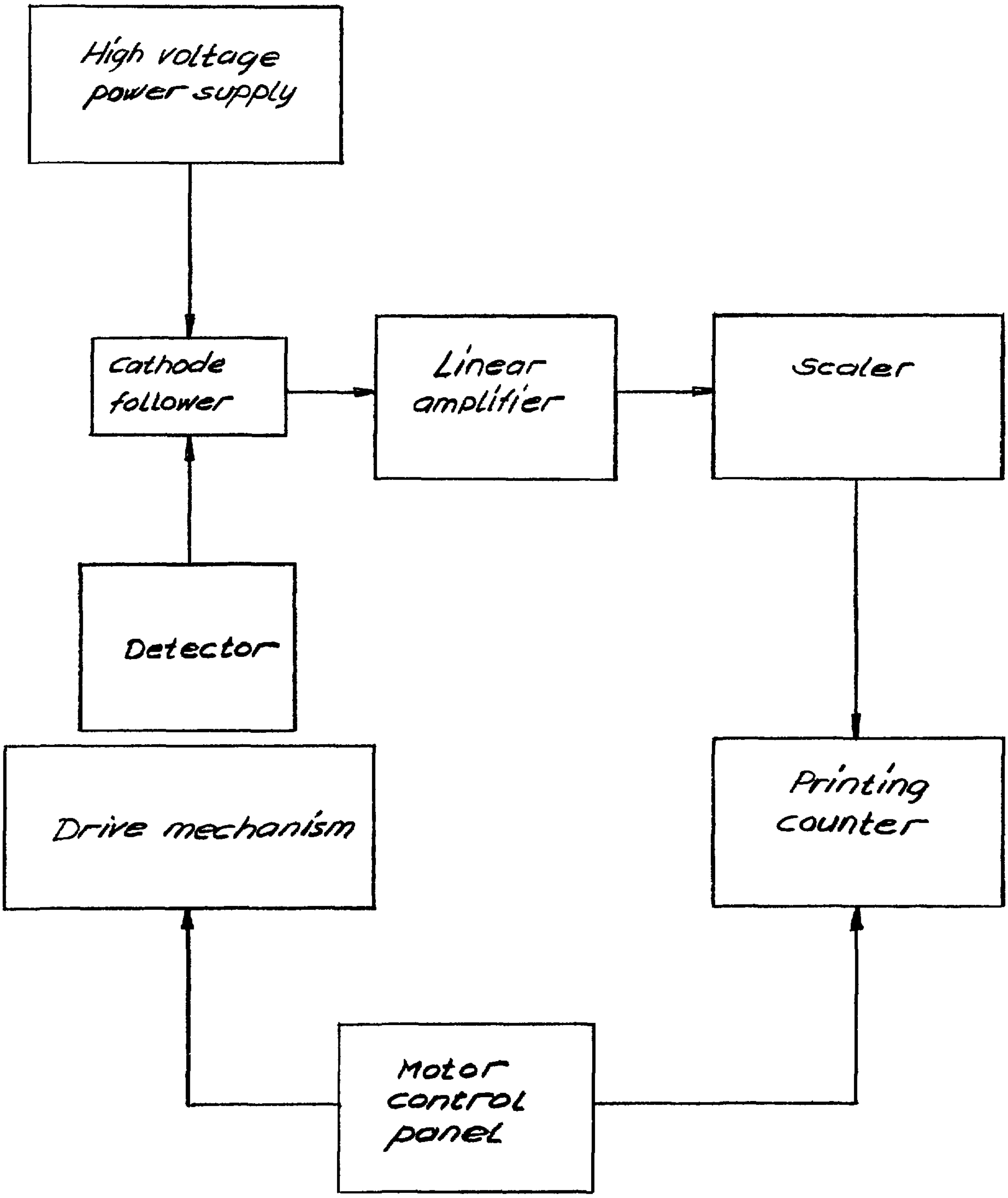

Fig 2

Block diagram of wire scanner

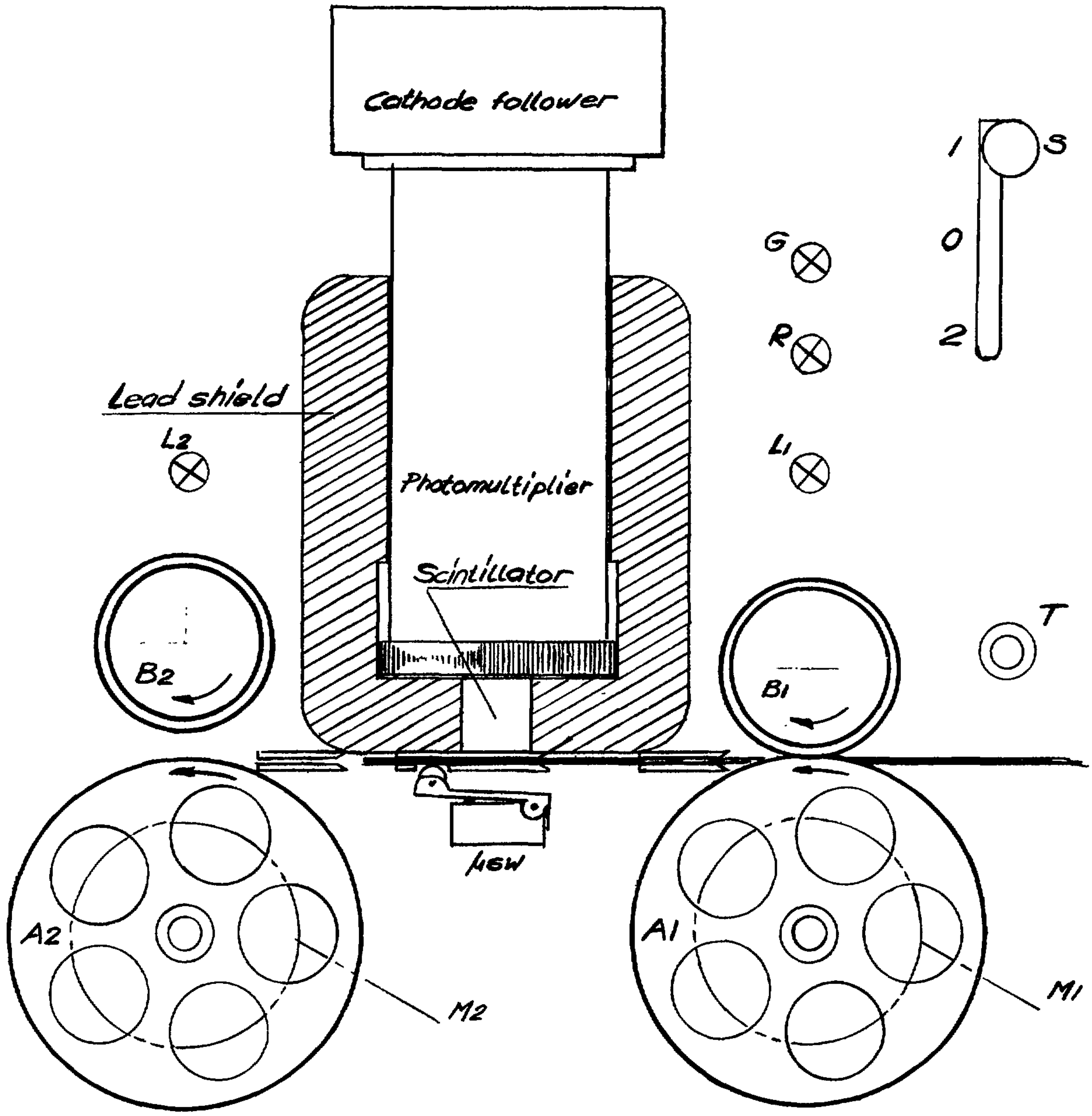

Fig 3
Detector and Drive mechanism

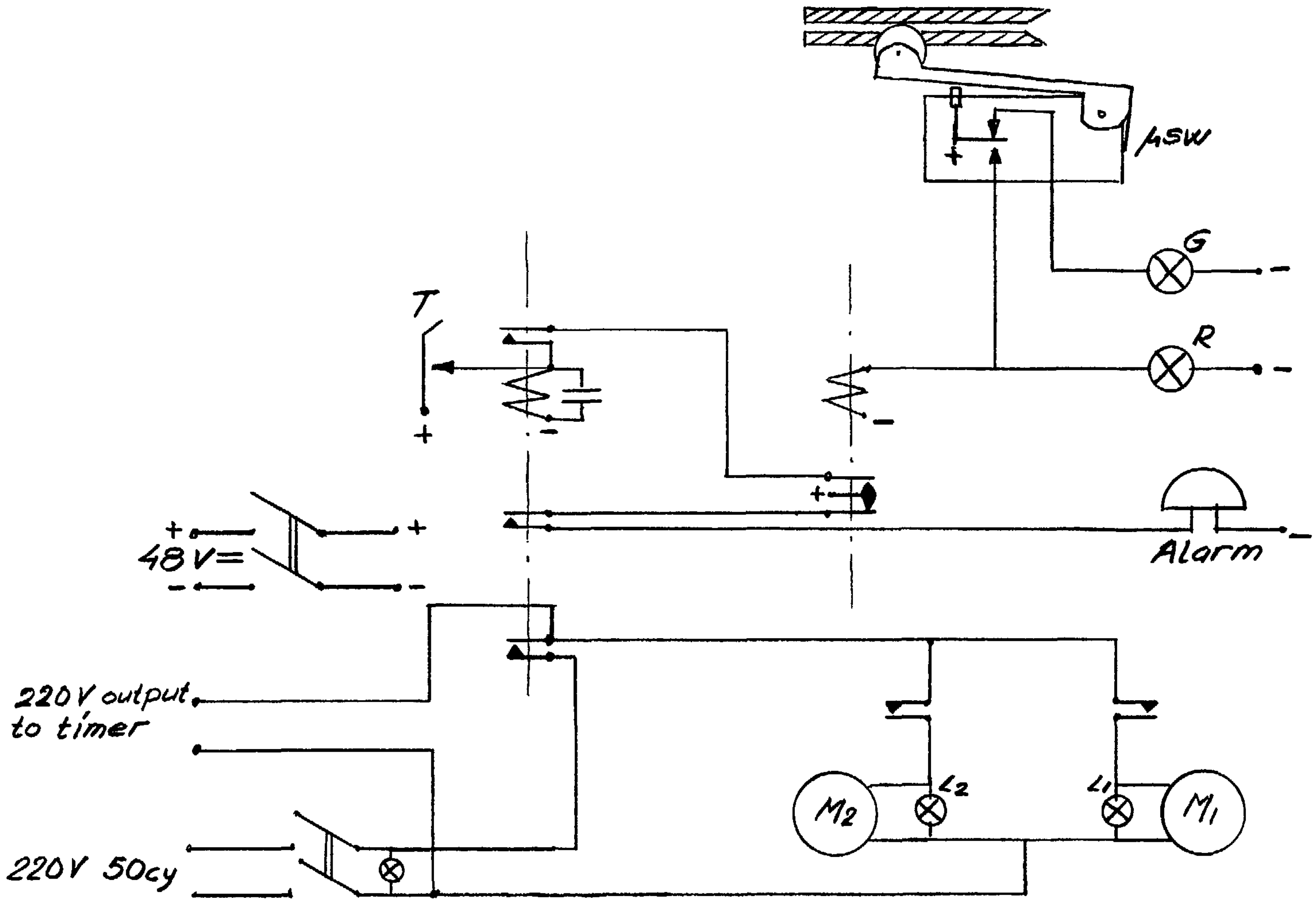

Fig 4

Diagram of motor control panel

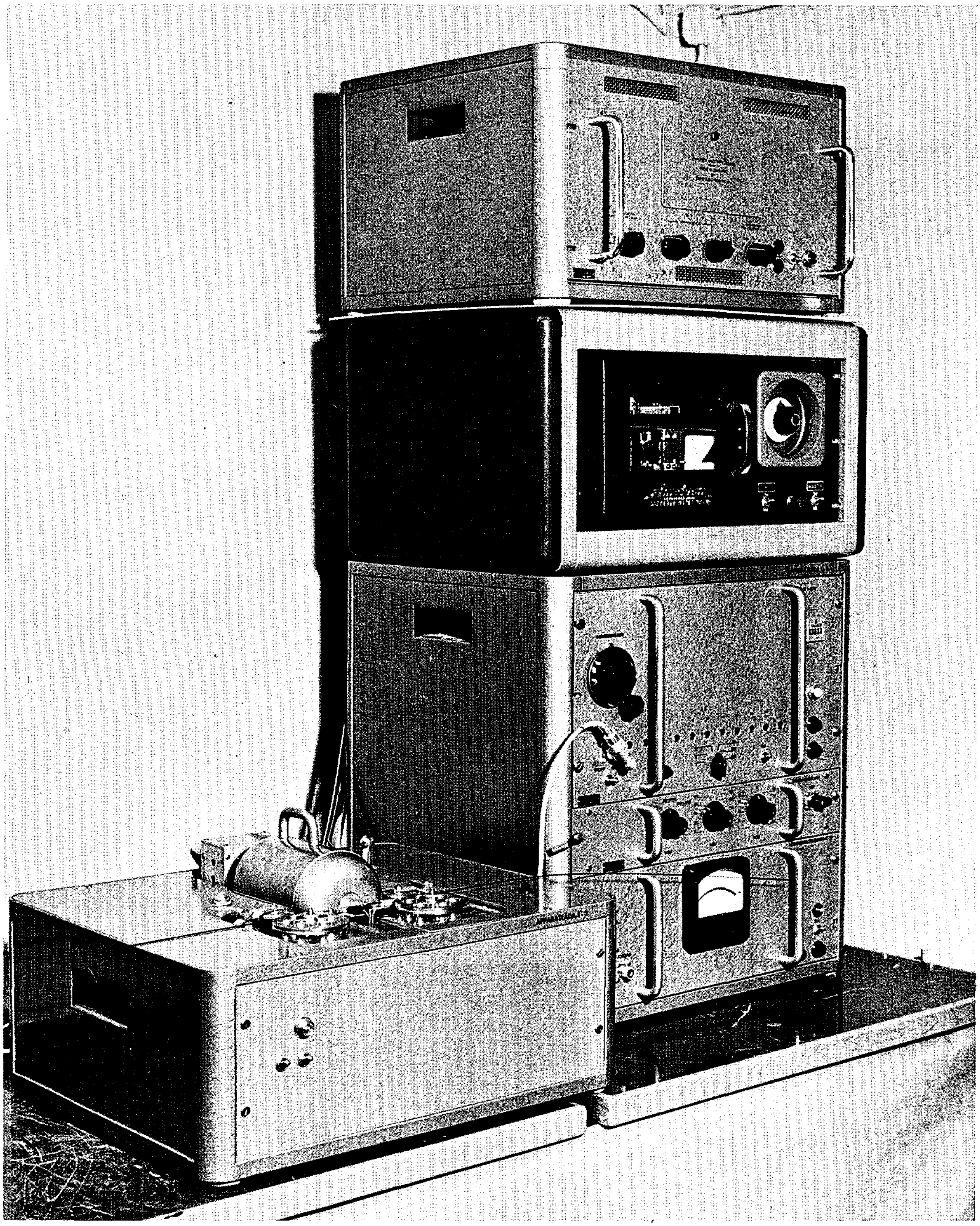

Fig 5
Wire scanner

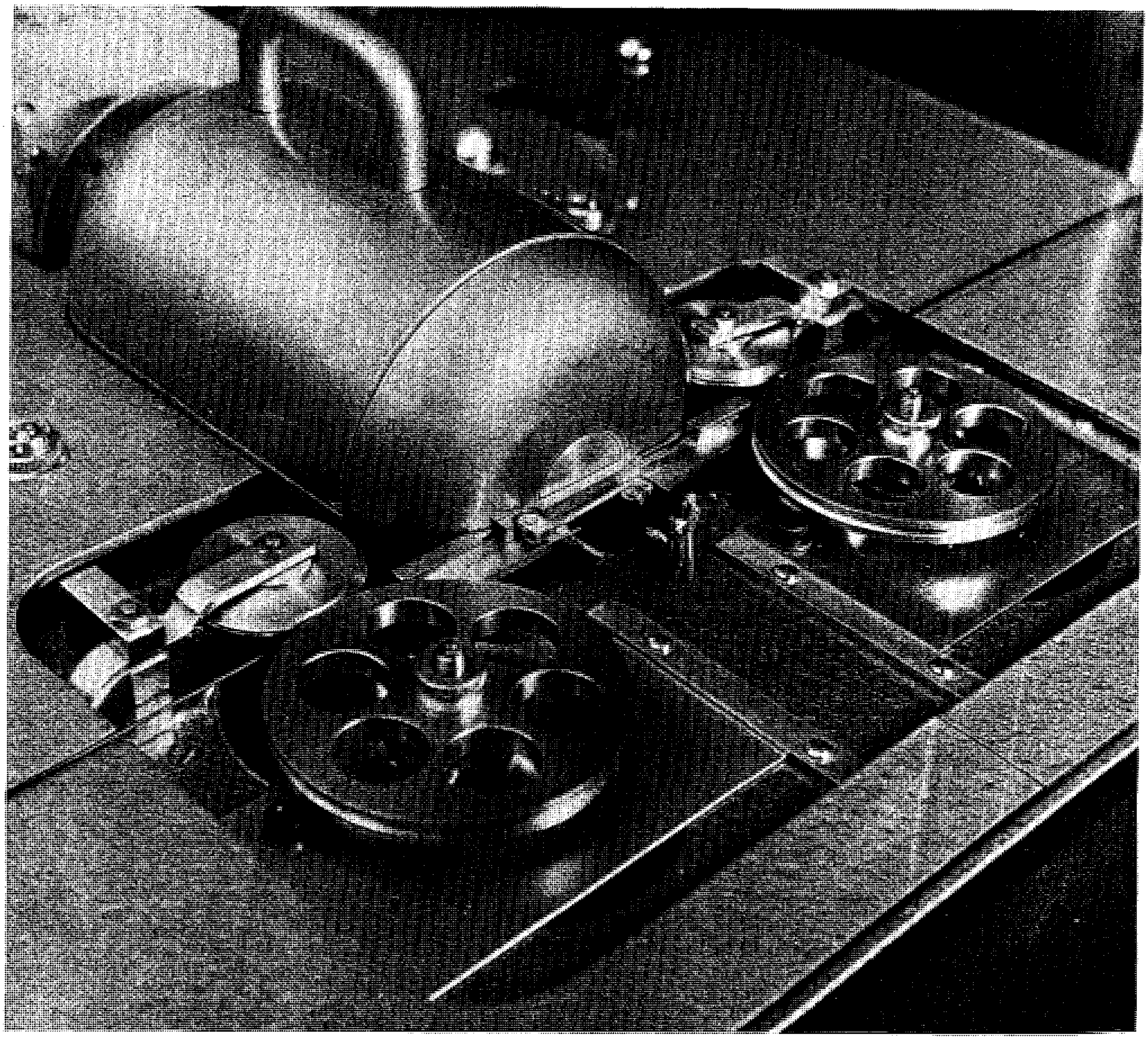

Fig 6
Drive mechanism

Additional copies available at the library of
AB ATOMENERGI
Stockholm - Sweden

Affärstryck, Stockholm 1960