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E. PÁSZTOR
L. KIRÁLYHIDI
P. RIEDL

ION-IMPLANTER FOR BUBBLE MEMORIES

Hungarian Academy of Sciences

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E. Pásztor, L. Királyhidi, P. Riedl

Central Research Institute for Physics
H-1525 Budapest 114, P.O.B. 49, Hungary

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ABSTRACT

An ion-implanter using 120 keV, 100-200 μA Ne ion beam has been constructed and built for eliminating of "hard" bubbles in magnetic bubble memory materials. The machine is a combined version of two accelerators built earlier: the accelerator column being taken from a neutron generator; the sweeping system and the target chamber originating from a heavy-ion implanter.

АННОТАЦИЯ

Для целей подавления жестких доменов в пленках магнитных гранат для ЗУ на ЦМД было построено оборудование для ионной имплантации, работающее при максимальной энергии ионов 120 кэВ и ионном токе Ne 100-200 μA. Оборудование создано комбинацией двух ранее разработанных устройств: система ионного источника с камерой ускорения взята от нейтронного генератора, а система сканирования вместе с камерой мишени - от имплантера тяжелых ионов. Такое решение обеспечивает, с одной стороны, надежную, многократно испытанную конструкцию, с другой стороны, экономичное производство устройства.

KIVONAT

120 keV maximális ion energiával és 100-200 μA Ne ion árammal működő implantert épitettünk a mágnes buborékmemória anyagok "kemény" buborékainak kiküszöbölésére. A berendezés két korábban létrehozott gyorsitó kombinációjából jött létre: az ionforrás-gyorsitó oszlop együttes egy neutrongenerátorból, a sepertető rendszer-targetkamra egység pedig egy nehéz-ion implanterból származik. A kombinált megoldás egyrészt sokszorosan kipróbált konstrukciót, másfelől gazdaságos gyártást biztositott.

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1. ON THE PROJECT

One of the special problems we are faced with in our research on bubble memory materials is the presence of so called "hard" bubbles. These "hard" bubbles have a higher coercive force than the other domains and this is why they are able to distort the information that should be stored in the memory. If we form an amorphous layer just on the surface of the magnetic film by bombarding the surface with energetic ions the hard bubbles can be eliminated.

After a number of tests carried out on a heavy-ion implanter [1] we arrived at the following specification:

- maximum energy of ions	120 keV
- type of ions	single charged Ne
- intensity of ion beam	100-200 μA max. 1-2 μA/sq. cm
- number of wafers to be implanted in one bench	25
- target chamber should be on earth potencial	
- homogeneity of the implant	98-99%
- diameter of wafers	from fragments to 3"

The experiments demonstrated the very important fact that there is no need to form an isotopically pure ion beam. In other words this means that there is no need to apply mass separation before or after the acceleration. Because of this, it is possible to make use of a very simple construction which - regarding its main components - was checked earlier.

More than 15 years ago a neutron generator was constructed and built in our institute for activation analysis [2] [3]. Subsequently a series of neutron generators type NA-2 /and the combined electronic system/ was produced and sold to factories and institutes all over the world. The experience gained in using the NA-2 neutron generator has been very satisfying regarding its performance and reliability. Similar results were obtained in connection with our heavy-ion implanter [1]. It was accordingly thought that it might be profitable to combine the two machines: the ion source and the accelerating column being taken from the neutron generator, the sweeping system and the target chamber originating from the heavy-ion implanter.

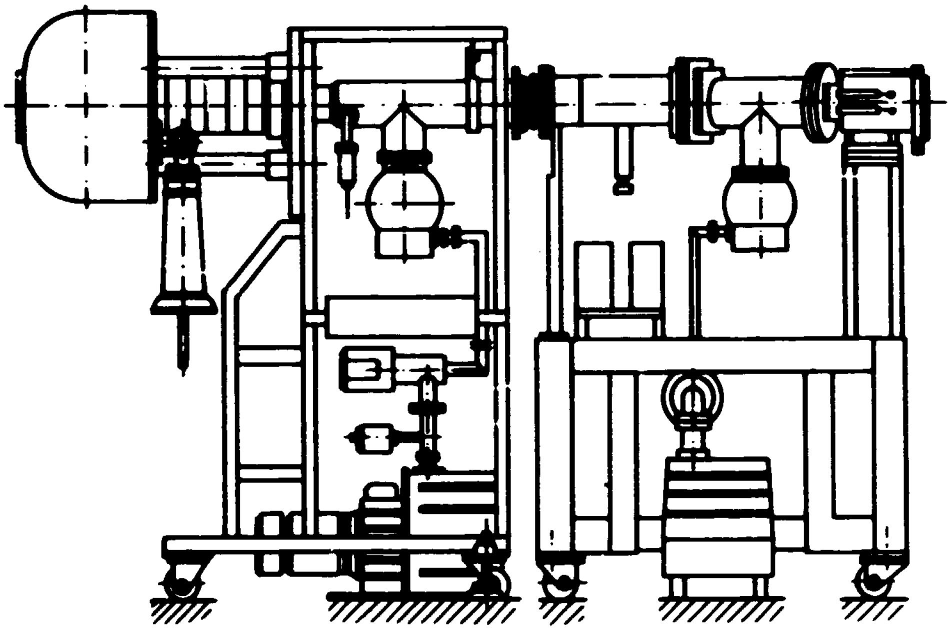

Fig. 1.

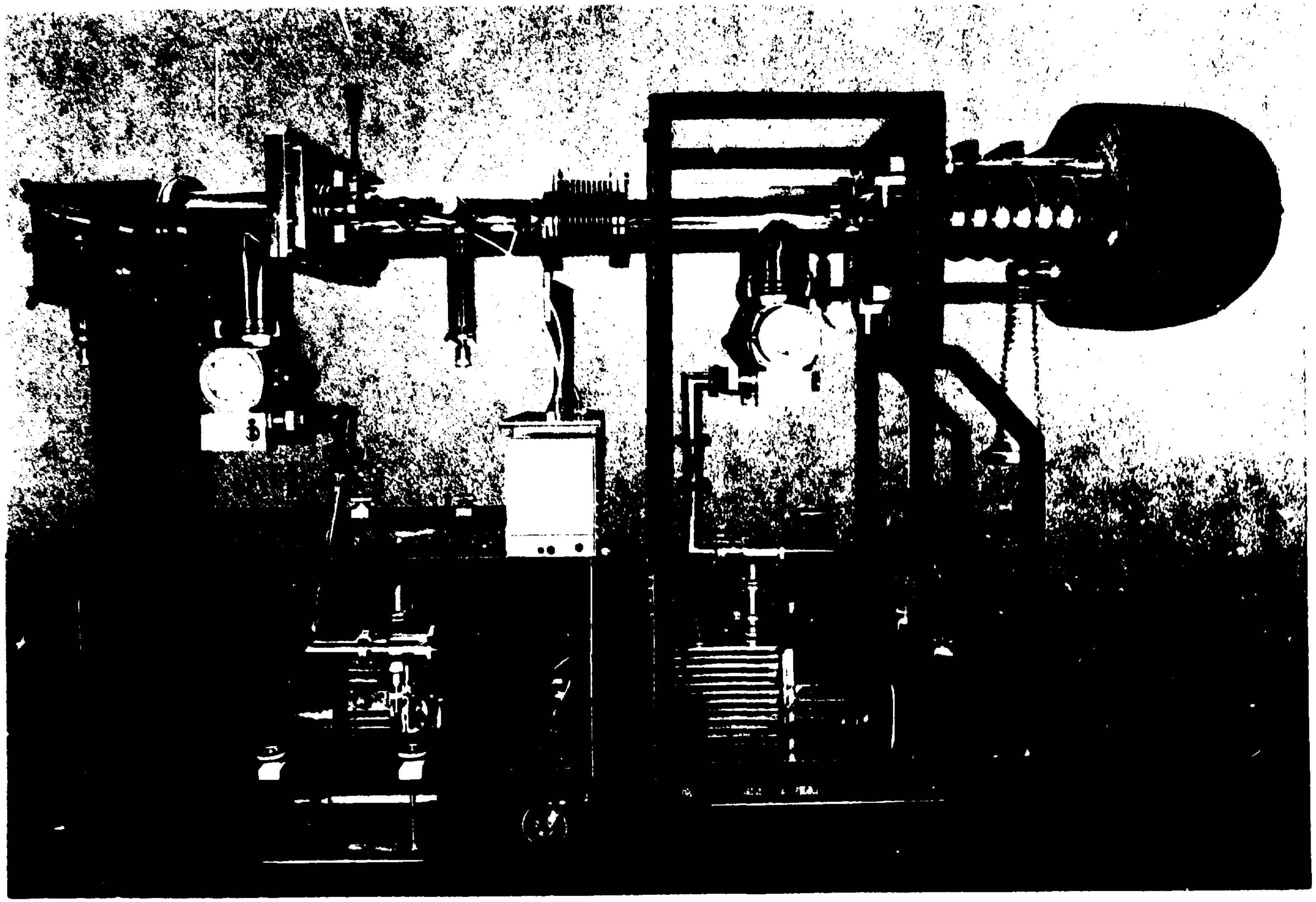

Fig. 2a.

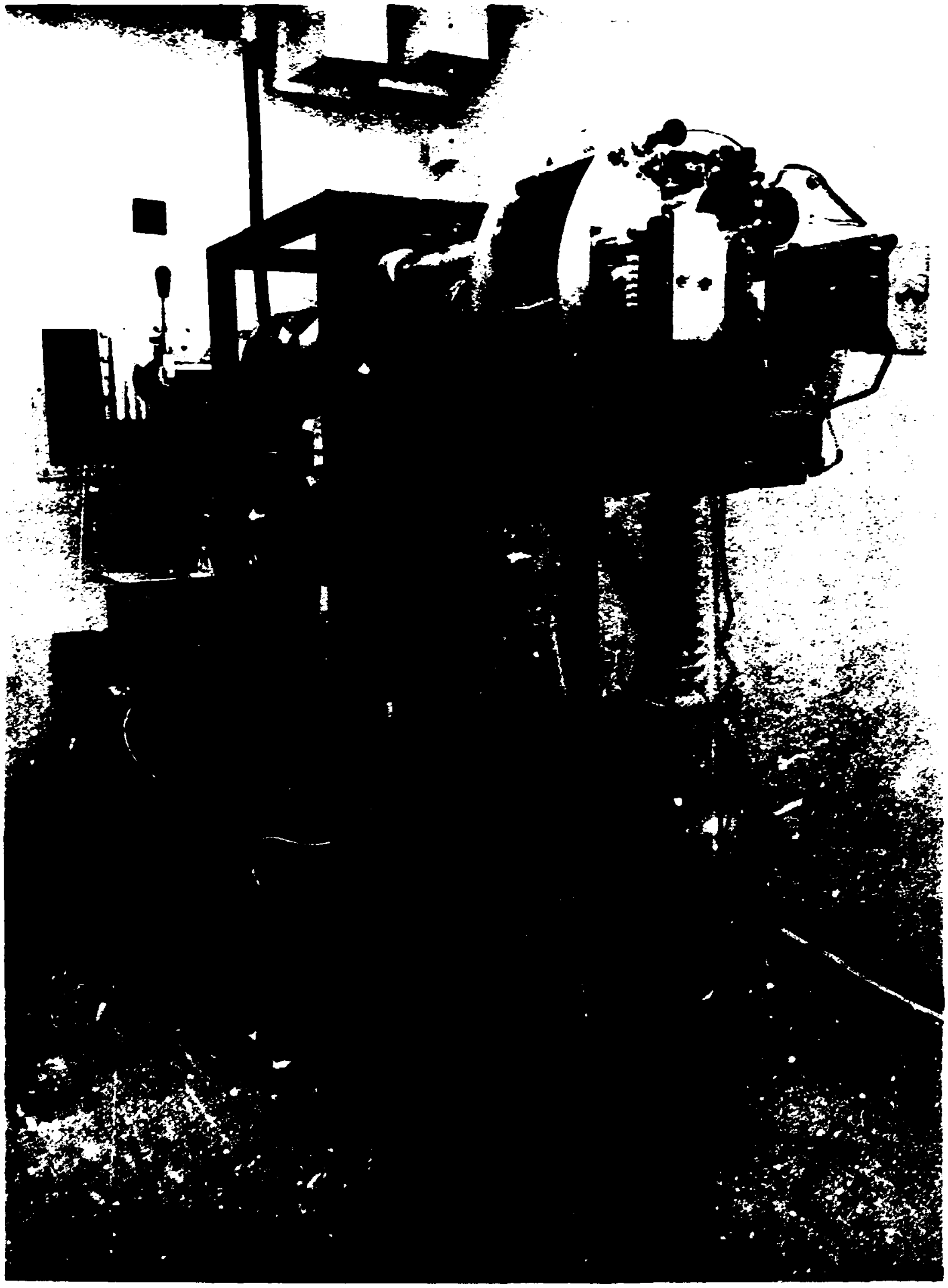

Fig. 2b.

The idea explained above is reflected in the mechanical construction of the machine. One part contains the ion source - accelerating tube assembly, the other one holds the beam line - target chamber unit. Each has its own vacuum system and the two parts are connected by a stainless-steel bellows. /See Figs. 1 and 2a, 2b/.

2. THE ION SOURCE AND ITS CONNECTED UNITS. ACCELERATING TUBE

A radiofrequency type ion source is used to produce Ne ions. The source and its extration system have a very simple construction but excellent ion optical features. The most important compnent of the extraction system is a small cylinder made of quartz. /See Fig. 3/. Under the influence of the extraction voltage the ions generally move out of the discharge towards the extraction canal and the quartz cylinder. A part of the ions impinge on the quartz cylinder and they remain there generating an electrical field which deflects the ions coming later and focuses them into the extraction hole. The height and diameter of the quartz cylinder are determined in such a way that the cross-over of the beam is located at the smallest diameter of the canal. The smallest diameter being 0.5 mm only enables a very economic gas consumption: a few normal ccm/hour [5].

The prefocusing lens - containing four electrodes and forming a periodic field - fits the emittance of the source to the accelerating tube. This tube has seven sections; its insulators are made of glass; the electrodes of stainless steel. The glass insulating rings are cemented together by PVA /polyvinylacetate/ [4]. /See Fig. 3/. The accelerating voltage is fed to the electrodes through a resistor chain. Each unit of the chain is 100 megohm and protected against dust and humidity by epoxy resin. Inside, the electrodes are formed like tea cups and shield the tube wall. There are no primary or secondary particles that could bombard the insulators. The diameter of the tube aperture is 81 mm, for about 60-61 mm of that diameter the field is virtually homogeneous /98-99%/. /The maximum diameter of the beam in the accelerating tube is 30-32 mm/.

The smallest diameter of the beam is at the sweeping unit. Thereafter the beam expands and on the wafer it reaches 13-15 mm using the maximum current.

To drive the ion source a 40 MHz/150W oscillator is applied. The coupling to the source is inductive. The oscillator with its two ceramic /planar triode/ lamps is built into a compact unit and placed just in the vicinity of the source. /See Fig. 4/. The power supplies of the extracting and prefocusing voltages are on the first "floor" of the high voltage terminal. On the "ground floor" of the terminal /also holding the corona shield/ the controlling variacs and the needle-valve for the gas are located.

The accelerating voltage is provided by a separated high voltage source. This source is of simple construction: it is a one-way rectifier using selenium rectifiers. The high voltage is connected to the high voltage terminal

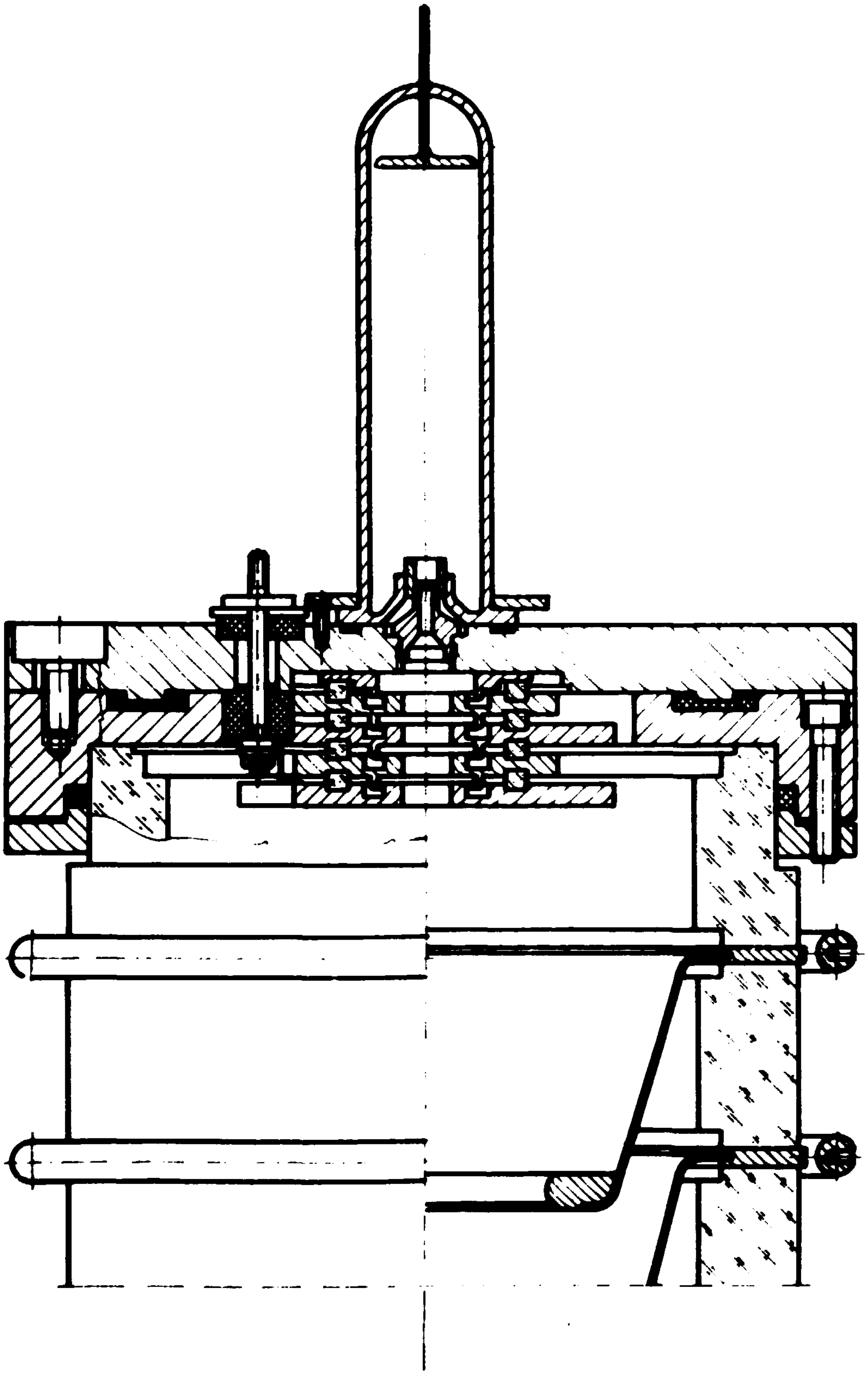

Fig. 3.

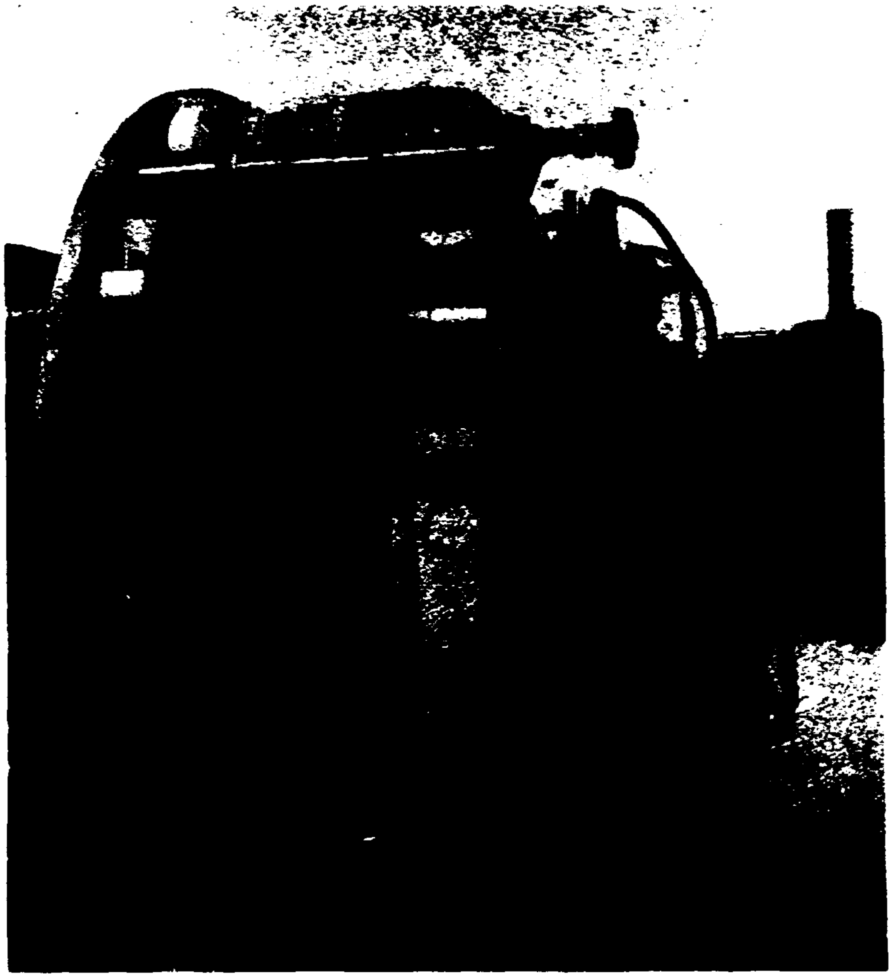

Fig. 4.

through a cable like that generally used in X-ray machines. The 220V network voltage needed for the ion source is supplied by a 120 kV isolated 220/220V transformer also taking place in the high voltage source box. This voltage is connected to the power supplies in the terminal through the cable cores originally used to heat the X-ray tube.

3. BEAM LINE, VACUUM SYSTEM, SWEEPING, TARGET CHAMBER

From the exit of the accelerating tube to the target chamber the beam is conducted along a tube-assembly /see Figs. 1 and 2/ which also serves as the vacuum system of the machine. The vacuum system contains two turbomolecular pumps - each having a pumping speed of 510 l/sec - and their backing pumps /each with a pumping speed of 26 m^3/hour/. The switching on of the turbopumps is locked: switching on actually takes place when the forevacuum pumps are already running and the valves between the turbo and rough pumps are open. The total pumping speed of the turbopumps of more than 1000 l/sec enables us to maintain a vacuum better than $2,7 \times 10^{-4}$ Pa in the target chamber during implantation. The vacuum system can be separated by a gate valve into two independent parts. When the gate valve is closed the target chamber can be vented and the wafers changed. The pumping-down time of the chamber is identical with the running-in time of the turbopump and is about 6 min.

The vacuum system is generally vented by liquid nitrogen. In an emergency or if there is a shortage of liquid nitrogen, containing a special type of zeolith two mechanical fittings are used for venting.

The sweeping system has two pairs of plates: one pair for the x-and one pair for the y-direction. The x pair has an additional 7° bending against the neutralized particles in order to provide uniform homogeneity on the wafer. The uniformity of the implant using these pairs of plates was investigated earlier [1]. The actual electronics /see Fig. 5/ is based on the earlier results. The linearity of sweeping voltages is better than 1%, the homogeneity in an area 100x100 mm^2 is about 98-99%.

The target chamber has a relatively small volume /10-12 l/ and works like a slide projector. If there is any disturbance during the implantation the wafer can be callad back after stopping the beam. In such cases the scaler stores the dose implanted untill stopping occurs. On starting again the scaler continues counting. /See Fig. 6/.

For checking the beam intensity and the homogeneity there are five measuring electrodes: one in each corner of the area to be implanted and a fifth in its centre. The electrodes are connected to two meters. One of them is fixed to one corner-electrode the other can be switched to the other electrodes. When all the measured currents are equal in all electrodes then the homogeneity is correct and the implant may start. Equality of the implant can be checked during the whole time of implantation because the electrodes do not disturb the beam. To enable correct measuring of the positively charged

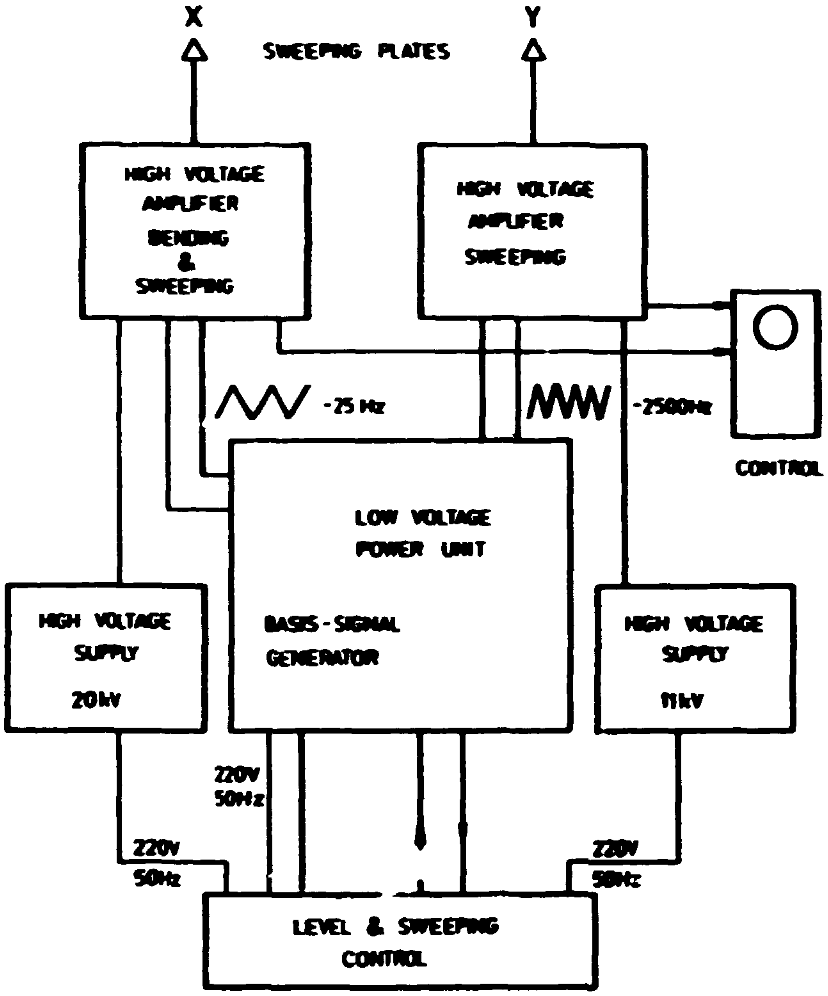
X
SWEEPING PLATES
Y
HIGH VOLTAGE AMPLIFIER BENDING & SWEEPING
HIGH VOLTAGE AMPLIFIER SWEEPING
~25 Hz
~2500Hz
CONTROL
LOW VOLTAGE POWER UNIT
BASIS-SIGNAL GENERATOR
HIGH VOLTAGE SUPPLY 20kV
HIGH VOLTAGE SUPPLY 11kV
220V 50Hz
220V 50Hz
220V 50Hz
LEVEL & SWEEPING CONTROL

Fig. 5.

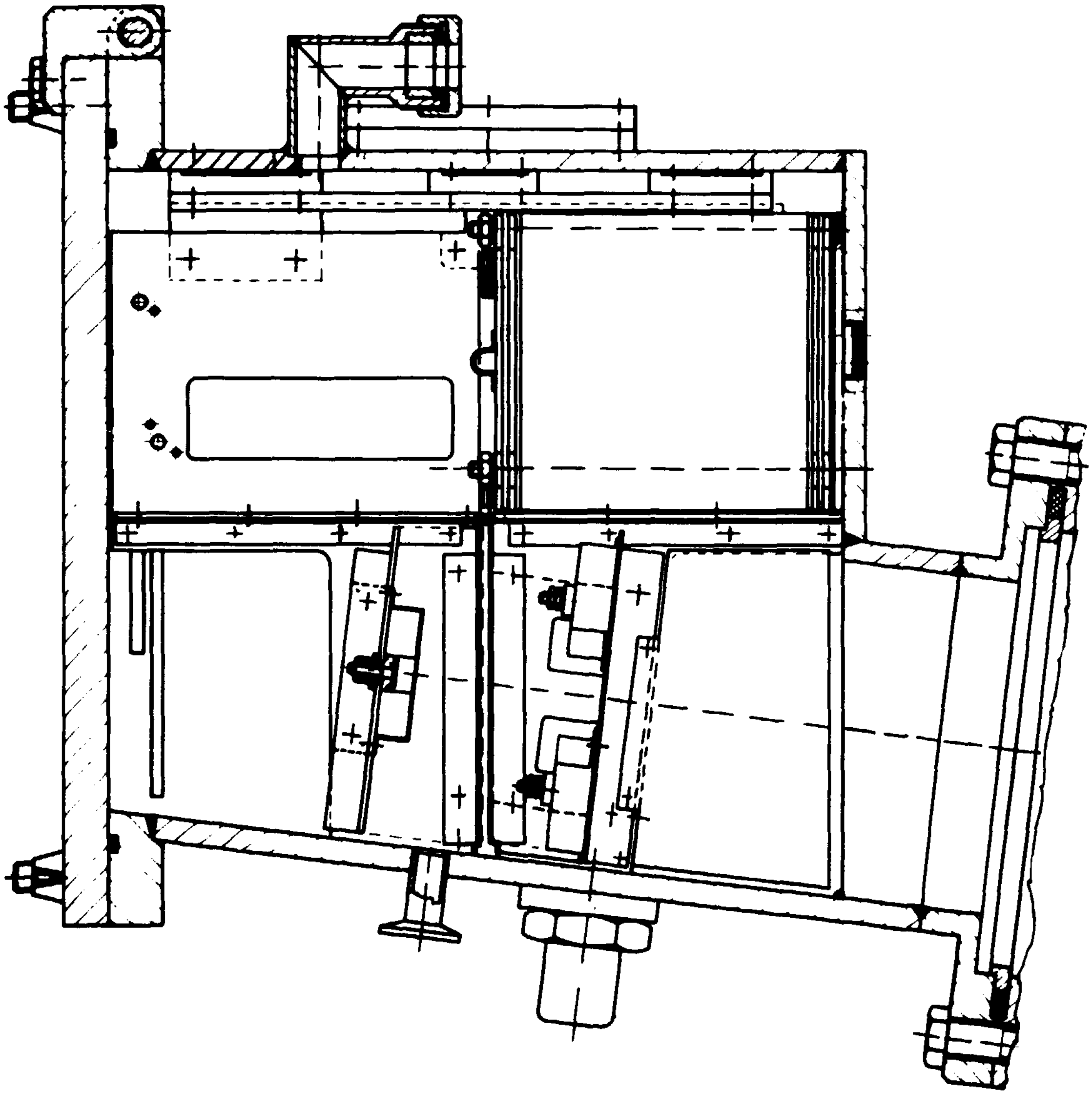

Fig. 6.

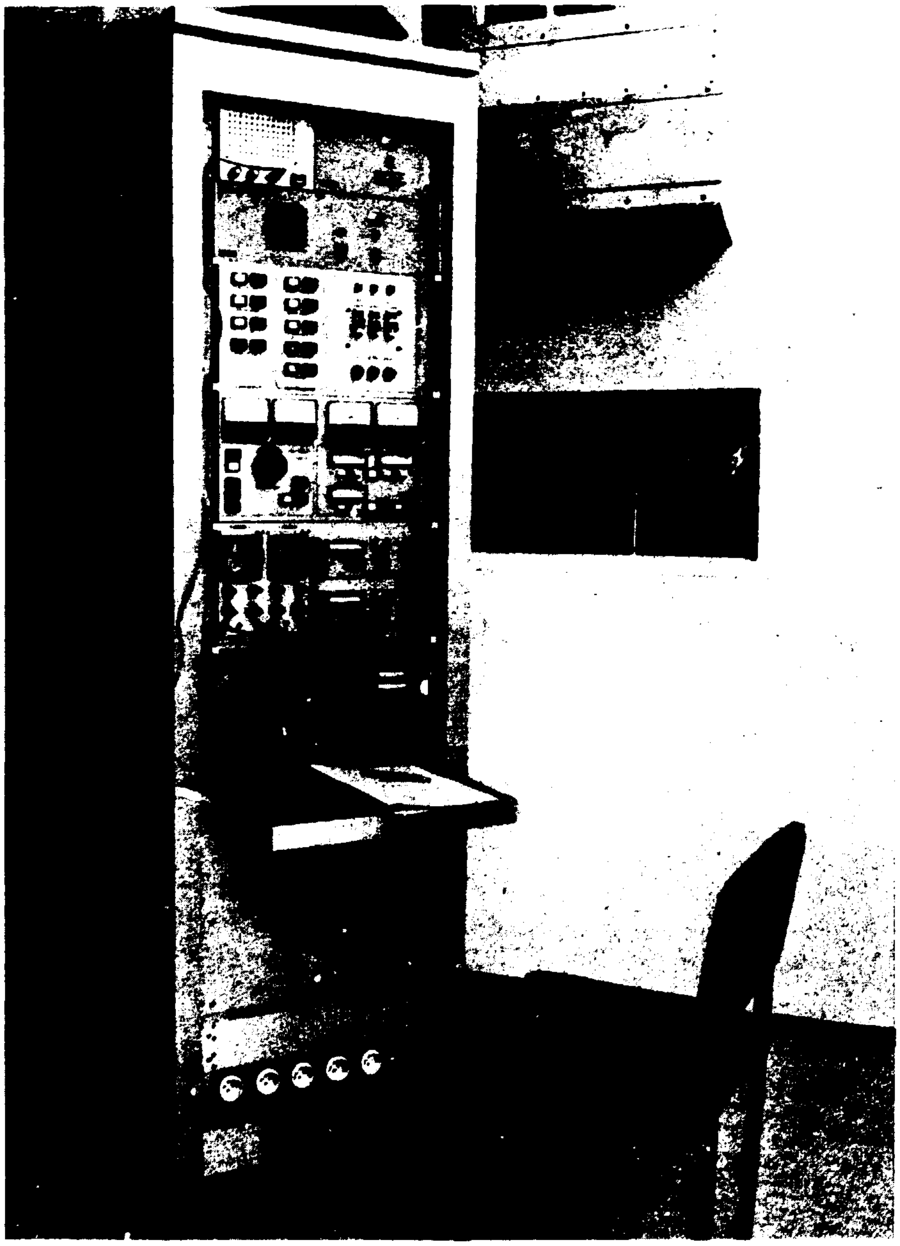

Fig. 7.

particles the electrodes are surrounded by a relatively strong /cca 1000 Gauss/ magnetic field generated by permanent magnets which are well protected against ion bombardment.

4. CONTROL SYSTEM, PROGRAMING

All the electronic units belonging to the machine - except those in the high voltage terminal and the power amplifiers of the sweeping- are located in a 19" rack. /See Fig. 7/.

At the top one can see the turbopump driving unit and the amplifier for communication between areas of the control desk as well as of the machine.

The next level contains the switching panel for the vacuum system. As mentioned earlier the turbopumps are locked, first the rough pumps thereafter the connecting valves should start.

One level of the rack is used for the ion source and acceleration control. The accelerating voltage can be switched on only in the zero position of the control variac. The ion source parameters are controlled by small DC motors mounted on the base plate of the accelerator column. /See Fig. 2a/. The motors drive plastic shafts which are in the holes of the plastic insulator rods holding the high voltage terminal /Fig. 2a/. The actual position of the variacs located in the high voltage terminal and driven by the shafts is signalized on the control desk by the current of the potentiometers also driven by the DC motors.

Two oscilloscopes show the current distributio of the beam in the x-and y-directions in the vicinity of the wafer. These pictures are very useful for monitoring the shape and position of the beam.

In the lower part of the rack the DC units of the sweeping are located.

The most important unit has been applied for the sweep and dose control. Both the preselected dose and the number of wafers can be preset. The sweeping voltages in the x-and y-directions can be steered independently. The shape /so the linearity/ of the sawtooth waves can also be seen on the scopes switching over them to those voltages.

After presetting the dose and the number of wafers to be implanted as well as having controlled the desired ion current intensity, one needs only to press the start button for the whole implantation process to run automatically. After implanting the last wafer the electronics switches off the beam.

ACKNOWLEDGE

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REFERENCES

[1] E. Pásztor KFKI Report N^o 76-63 /1976/

[2] E. Pásztor Instr. Techn, Exper. N^o 4 /1965/
E. Klopfer /in Russian/

[3] E. Pásztor Isotopenpraxis Vol. 3. N^o 7. /1967/

[4] E. Pásztor et al. KFKI Report N^o 71-47 /1971/

[5] Erõ J. Magyar Fizikai Folyóirat 3. 529. 1955

Kiadja a Központi Fizikai Kutató Intézet
Felelős kiadó: Krén Emil
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Nyelvi lektor: Harvey Shenker
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