

MECHANICAL DESIGN OF THE NEW SCREEN MONITOR

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Abstract

The PF 2.5-GeV linac is now being upgraded for the KEKB project. A new screen monitor has been developed in order to reinforce the beam monitoring system. The screen monitor comprises a vacuum chamber, an actuator and a screen. The spatial sizes of all the mechanical components were diminished in order to increase the available space of the new beam line. Particularly, the compactness of the actuator made it possible to shorten the driving time of the screen (~0.2 sec) to the center of the beam line. This report describes the mechanical design of the new screen monitor in detail.

1. Introduction

High-current electron beams (6×10^{10} e/bunch) are required to produce a sufficient number of positrons for the KEKB project[1], [2]. The screen monitor is important in order to easily handle the beam orbit and to measure the transverse spatial size of such beams. About one hundred new screen monitors in total (about eleven monitors/sector on the average) will be installed in the new beam line. New mechanical design of the screen monitor could diminish its spatial size, particularly those of the vacuum chamber and the actuator, and could reduce the price of the monitor. The compactness of the actuator makes it possible to shorten the driving time and to make the speed of the actuator fast. The price of the monitor is about 2/3 compared with that of the old design due to a simplification of the manufacturing process.

2. Chamber Design

The new screen chamber was designed so as to increase the available space (see fig.1). The chamber is made of stainless steel (SUS 304). The length between the flange ends was reduced to be 85 mm from 160 mm (old design). The vacuum pipe is 45 mm in diameter and 1.5 mm thick. This vacuum pipe can be directly joined with a vacuum pipe of a current monitor by welding. Both ends of the pipe can be connected with a quick-release flange (manufacturer's standard KF flange) which couples by a clamp chain coupling with a metal gasket. This flange makes it possible to easily mount the screen monitor on the new beam line. A small viewport (ICF70) is coupled to the bottom port of the chamber. Fluorescent light emitted from the screen through the viewport is guided down to a support table of the linac by optical mirrors, and is received by a TV camera. The actuator is divided from the screen (in vacuum) in the chamber by a small bellows.

3. Actuator Design

The screen actuator comprises a central shaft (SUS304), a cylinder (JDA16×5[3]) driven by compressed air and a micro-solenoid valve (030-4E1[3]). A compact commercially available cylinder and valve were selected so as to be directly mounted on the chamber. The main specifications of the cylinder

are shown in Table 1. A double acting-type cylinder, which has a size of 16 (bore) mm × 5 (stroke) mm, is used so as to be able to push down and pull up the central shaft which is connected to the cylinder through a small universal joint. A compressed-air system (~5kgf/cm²) of the linac can operate the cylinder, whose operating speed is adjustable by speed controllers. The cylinder actuates the central shaft which drives the screen. The central shaft is connected to an edge of the screen holder joined with a link (MoS₂-coated aluminum) through a coupling pin (SUS304) fixed inside the chamber; it pushes the edge down and tilts the screen at 45° to the beam line. A small bush (phosphor bronze) mounted on the chamber makes it possible smooth and straight driving of the central shaft. The shaft stroke (3mm) is limited by two stopper screws which accurately set the screen center position to the beam line center.

Table 1 Cylinder specifications

Operation	Double acting type
Bore size (mm)	16
Stroke (mm)	5
Operating pressure range (kgf/cm ²)	2.0~7.1
Operating speed range (mm/s)	30~500

A micro-solenoid valve using the shading method[3] is used to control the cylinder driven by compressed air. The shading method stabilizes the valve drive. A 200V (AC) power supply controls the "OPEN/CLOSE" of the valve (the load current is ~15mA). The main specifications of the valve are given in Table 2.

Table 2 Micro-solenoid valve specifications

Operating method	Shading method
Pressure range (kgf/cm ²)	1.5~7
Voltage range (ACV)	180~250
Value of current (mA r.m.s)	18 (Inrush)
	12 (Holding)
Insulation resistance (MΩ)	>100

The driving position of the screen is monitored by a non-contact micro sensor switch (solid state type) mounted just on the outside of the cylinder. The sensor switch[3] acts by a small magnet attached to a piston inside the cylinder. The sensor signal (DC 24V level) is sent to the linac control system, which monitors the position status of all the screen monitors. The main specifications of the sensor switch are given in Table 3.

Table 3 Sensor switch specifications

Applicable stroke (mm)	3~5
Load voltage (VDC)	10~28
Load current (mA)	5~50
Insulation resistance (MΩ)	>100

A commercially available screen material (AF995R[4]), which is made of 99.5% Al_2O_3 and 0.5% CrO_3 , is used to obtain a sufficient amount of fluorescent light. The screen size (the size $25 \times 33 \times 1^t$ mm³) was reduced in comparison with that (the size $50 \times 50 \times 1^t$ mm³) of the old design because of the compactness of the chamber. This size is large enough to measure the transverse spatial size of a positron beam (16 mm in maximum diameter).

4. Local Controller

A local controller will be newly installed. This controller was mainly designed in an upgrade of the preinjector of the linac in 1992. A block diagram of the electric circuit is shown in fig.2. The main power source (1φ 3W, 200V(AC)) is supplied to the controller from the linac power supply system. The power line, which is controlled using of two electric relays (R-1, R-2) through control signals of the linac control system, is supplied to the valve. The first relay (R-1) controls

the "OPEN/CLOSE" status of the valve. The second (R-2) is used as an auxiliary or for a special screen monitor (two-step type). Manual control switches are also available for local tests. A 24V(AC) power line, which is supplied to a TV camera, is generated by using a transformer. A 100V(AC) power source is used for auxiliary power. The 24V(DC) power which is supplied to illumination lights (LAMP) for the screen is also generated by using the same transformer and a diode bridge. The position status signals of the cylinder from the sensor switch is sent to the linac control system through this controller.

5. Conclusions

A compact screen monitor has been developed and will be installed in the new beam line. The monitor length is about half compared with the old type. The compact screen actuator makes it possible to shorten the driving time (~0.2sec) to the center of the beam line. The driving time was reduced to be about 1/3~1/2 in comparison with that of the old type. A quick-release flange was used for easy installation into the new beam line.

References

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- [2] S. Kurokawa et al., "Accelerator Design of the KEK B-Factory", B-Factory Accelerator Task Force, KEK Report 90-24, 1991.
- [3] KOGANEI Corp., Iidabashi Matsumoto Bldg., 1-21 Agebacho, Shinjyuku, Tokyo.
- [4] DEMARQUEST, Z.I. n° 1, 27025 EVREUX Cedex, FRANCE.

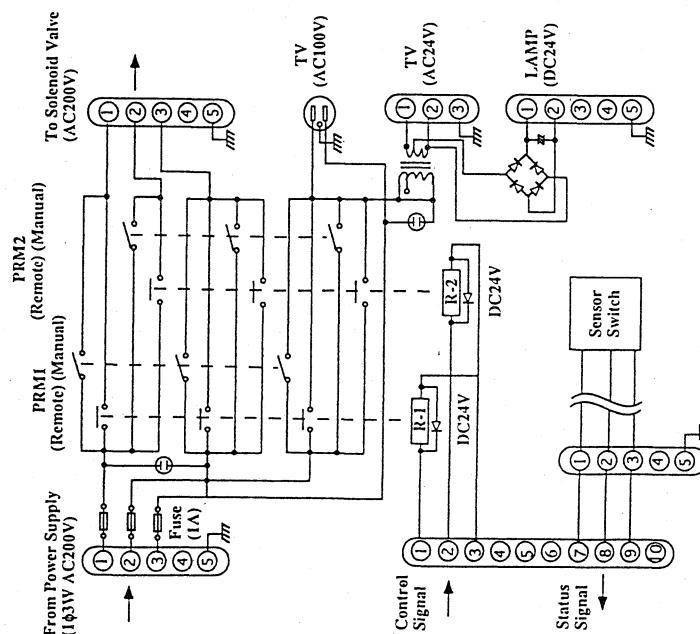


Fig.2. Electric circuit of the local controller.

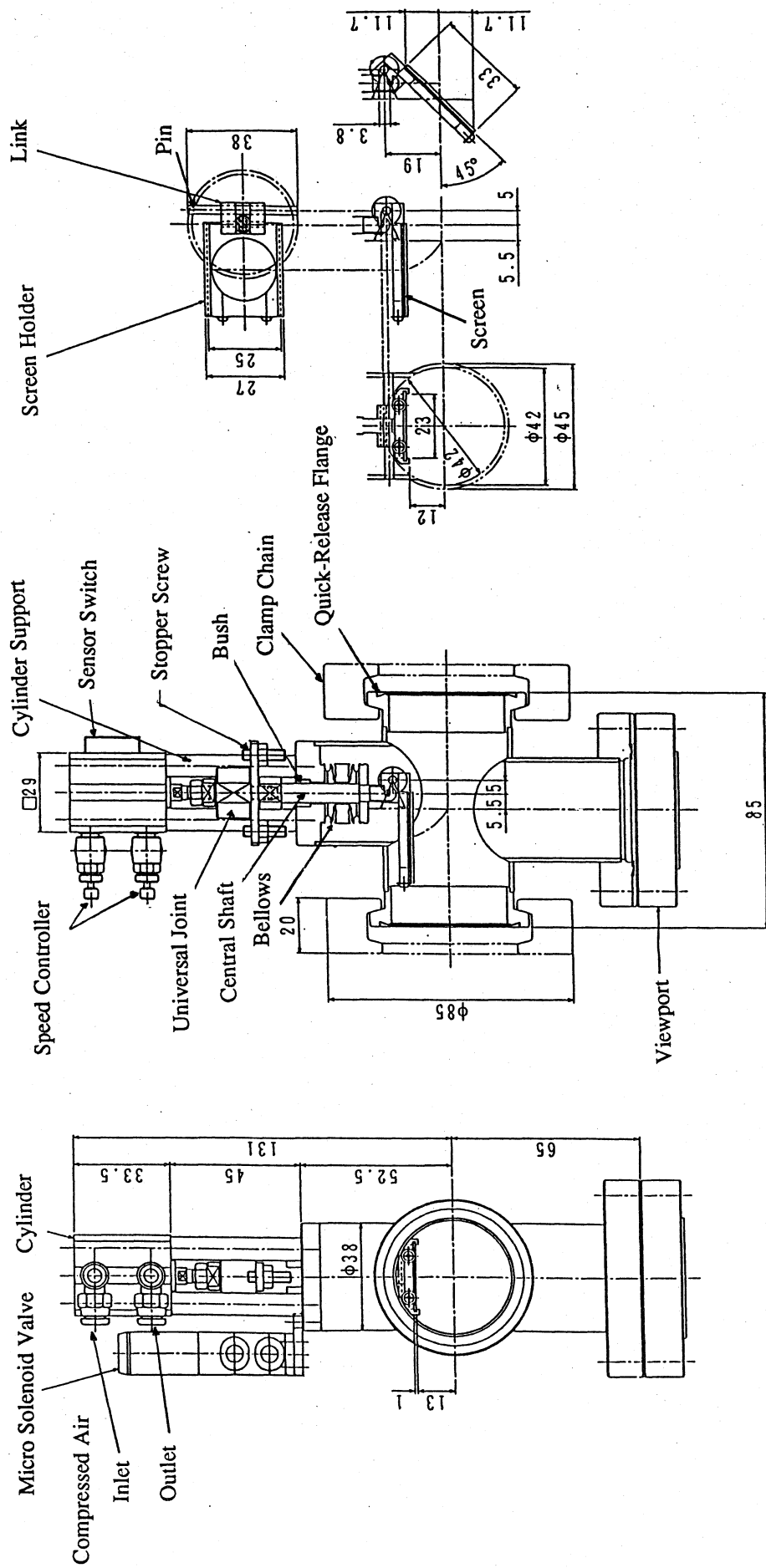


Fig.1. Mechanical design of the new screen monitor.