CONSTRUCTIONAL DESIGN OF THE NINE CHANNEL LYOT FILTER

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ABSTRACT

Nine channel Lyot filter (9-channel filter), as the key part of the Solar Multichannel Telescope (SMCT), is being finally adjusted in Huairou Solar Station of Beijing Observatory.

This filter was designed for observing the local region of the sun on nine different wavelengths in real-time. The filter, which comsists of about 1,500 pcs. of optical elements and weighs near 300kg, is the biggest and most complicated one in the world.

This paper describes the mechanical and electronic design of the 9-channel filter.

INTRODUCTION

The optical design of 9-channel filter was made by Ai Guoxiang and Hu Yuefeng of Beijing Observatory in 1986. In consideration of very long optical path, this filter has to be divided into two parts: The first (head) and second (body) part placed in convergent and colliamating beam respectively.

We made the mechanical and electronical design for the 9-channel filter with the following special features:

1. There are numerous optical elements to be used, so the filter is extraditional big and heavy, the oil-sealing and thermostatic control are rather difficult.

2. There are 52 pcs. of rotatable achromatic 1/2 waveplates used for tuning the passbands. It needs rather complicated driving mechanism and computer control.

3. Both 1st and 2nd parts of the filter should be remounted easily on their correct positions with accurate repeatability.

1. MECHANICS

Fig.1 shows the arrangement of the 9-channel filter inside the steel case of 60cm Gregorian tube of SMCT.

In the front of the filter head there is a small part composed of an infra-blocking filter, a 5-waveplates wheel driven by a step-motor and an achromatic KD*P cell, which is oil-sealed for high transmission and protection of the water-dissoluble KD*P material.

Nearly all optical elements of the head and body parts of the filter are enclosed in corresponding cuboidal oil-sealing chamber sorounded by four heating plates for thermostatic control. Outside the heating plates, step-motor boxes are placed for rotating the 1/2 waveplate through oil-sealing shaft and a slit wheel inside the box for giving a zero-point signal, which is given by a photoelectric sensor. In the body of the filter, 43 sets of step-motor boxes are surounded by another four heating plates, which take the role of primary thermostat.

There are five collimators in the front of the body part of the filter, just behind which there are nine interference filetrs for isolating the working wavelengths.

The working temperature (42°C) of the body part is monitored by a L-shape mercury-in-glass thermometer read by a small telescope in the end of 60cm tube.

By use of positioning wedge and backing support, the filter head and body can be remounted on their correct position respectively. The backing support also prevents the very heavy body part to strike on the followed optical elements (Fig.2).

2. THERMOSTATIC CONTROL

The thermostatic electronics are composed of: Heating coil and temperature measuring bridge around the heating plates; Control circuits and power supply in a separate controller.

The temperature is measured by a DC Wheastone Bridge, of which two fixed arms are made of G $-M_n$ wire with very small temperature coefficient, other two are of copper wire. Temperatue relays contacted with a heating plate are used for overheating warning and restricting the temperature to be less than 45°C. A 10-ring potentiometer on the filter cover is used for tuning temperature.

The control circuits in the controller case were designed for: Temperature autobalancing, quickly heating, overheating warning and protecting etc.

During one year trial operation, the temperature stability is about 0.01°C in the days not very cold.

3. COMPUTER CONTROL SYSTEM

A computer system (Fig.1) was developed for controlling eighty step-motors used for four tunable Lyot filters of SMCT.

The host computer is equipped with a programmable parallel data card (8255), of which the ports A, B, C are used for data, adress and communication respectively. For controlling the waveplates, we use 80 sets of slave computer subsystems, each one consists of a MCS-48 monolith computer and a step-motor driving unit (Fig.3).

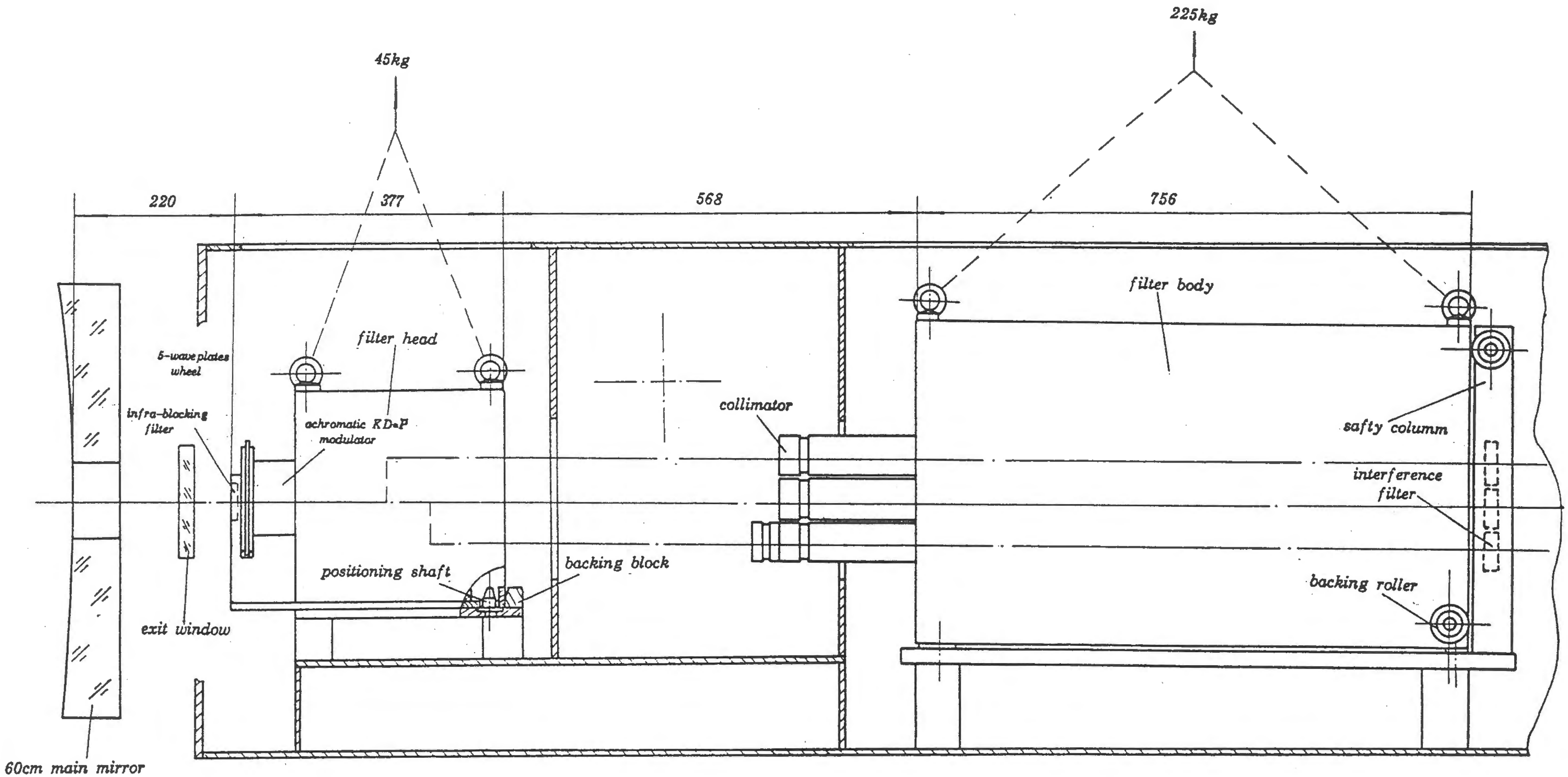

Fig.1. Arrangement of the nine-channel Lyot filter in 60cm Gregorian tube

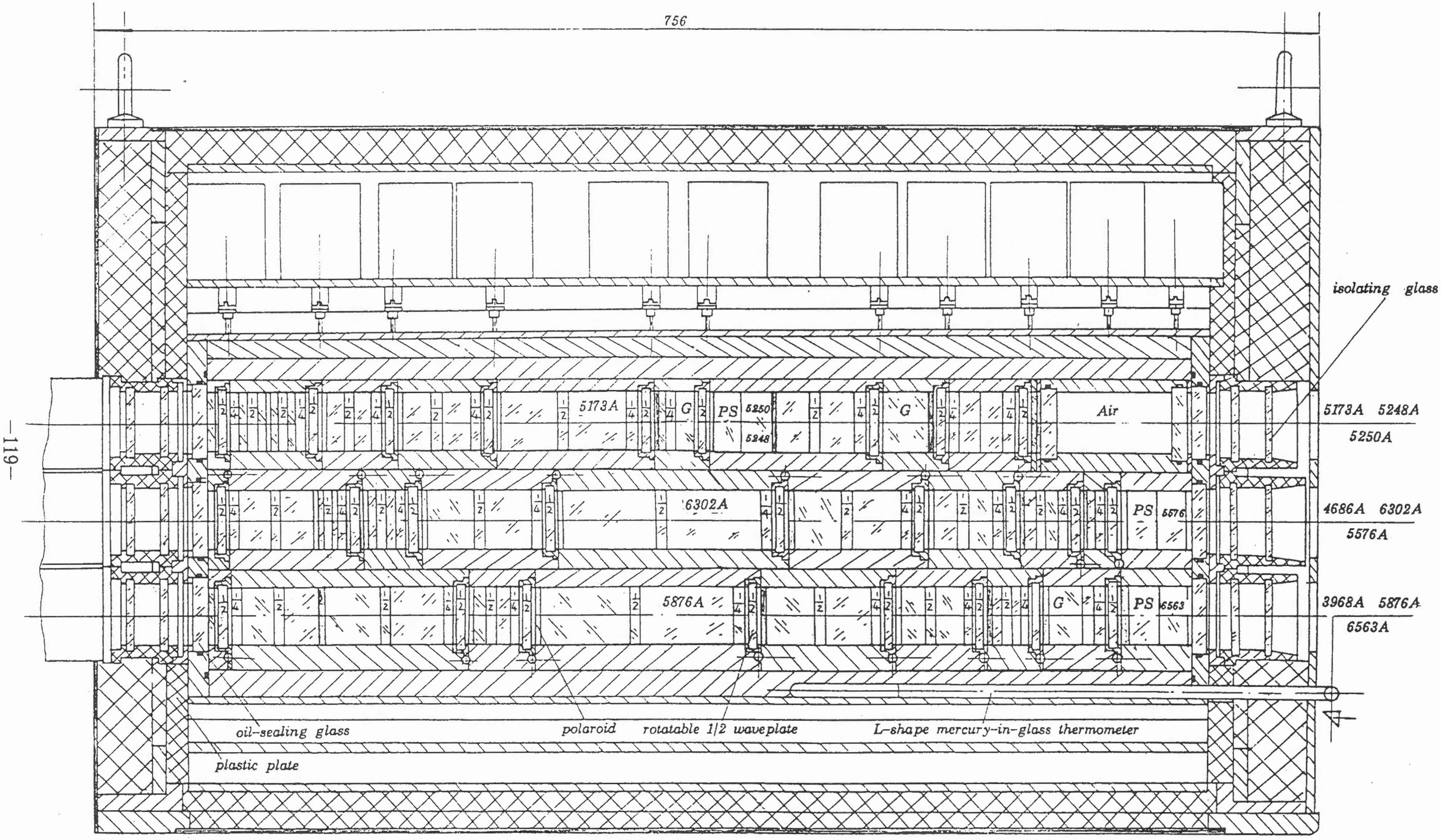

Fig.2. Vertical section of the filter body

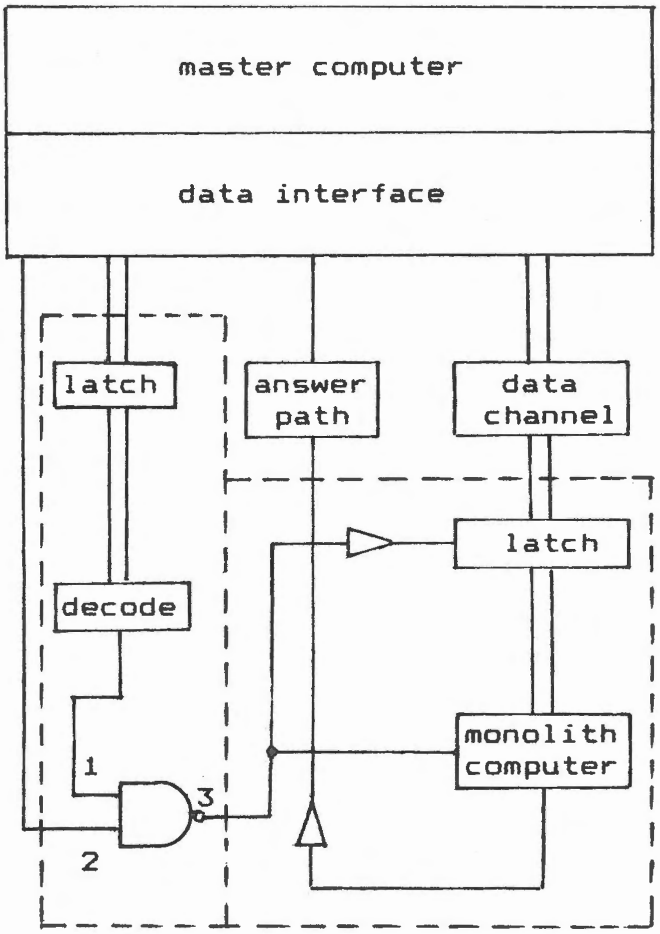

Fig.3. Block diagram of control system

Between the host and slave computers there is a set of interface circuit which consists of photoelectrical coupling isolation, channel number display, data path and detector network of the answering path. The data path so-called eighty-divider is composed of two-stage driving circuit. Answering path called eighty-way convertor concentrates the answering signals of eighty slave computers into a logical gate, then transmit them into the port C of the parallel data card, which informs the host computer to carry out a new operation.

The decoding network is used mainly to decode the preselective adress, which is sent by the host computer through the B port of 8255 card and selecting the corresponding slave computer. The special feature is that the decoding is done after latching, so the data are stable and reliable.

The host computer is a real-time control and command device to make parallel control for the rotating waveplates. It can not only select any one of eighty slave computers, but also send the data and commands to the selected slave computer to control the rotating waveplate (rotating direction, angular position and returning to zero-point). Another function of the host computer is to set up a big data library according to the needs of the users.

The first function of the slave computer is to communicate with the host computer and receive its commands. The second is to judge and decide the content of the commands which control the operation mode of the waveplates. The third is to run corresponding programs as step-motion, returning to zero-point etc.

Practically, the monolith slave computer is a driving system of the stepmotor (Fig.4). The zero-point of the 1/2 waveplate is decided by corresponding monolith slave computer and processed by software. An infra-photoelectric sensor with Schmidt circuit is used as a detective element with an accuracy of 0.01mm or 2 arc minutes, which is enough for tuning the passband.

The control programs of the host computer are divided into two parts: one is the observing program provided by astronomers. Another is the driving program for transmitting the commands and data from host to slave computer. The driving program is given with menu mode to be adopted by the observer. Besides, another checking program is provided for maintaining the control system.

The programs are written by assembly language. The developement of the monolith computer is done by use of a SICE emulator. Provided the microcomputer is jointed with a RS-232 standard interface, the emulator can share the resources of hadware and software, and perform the development for each monolith computer.

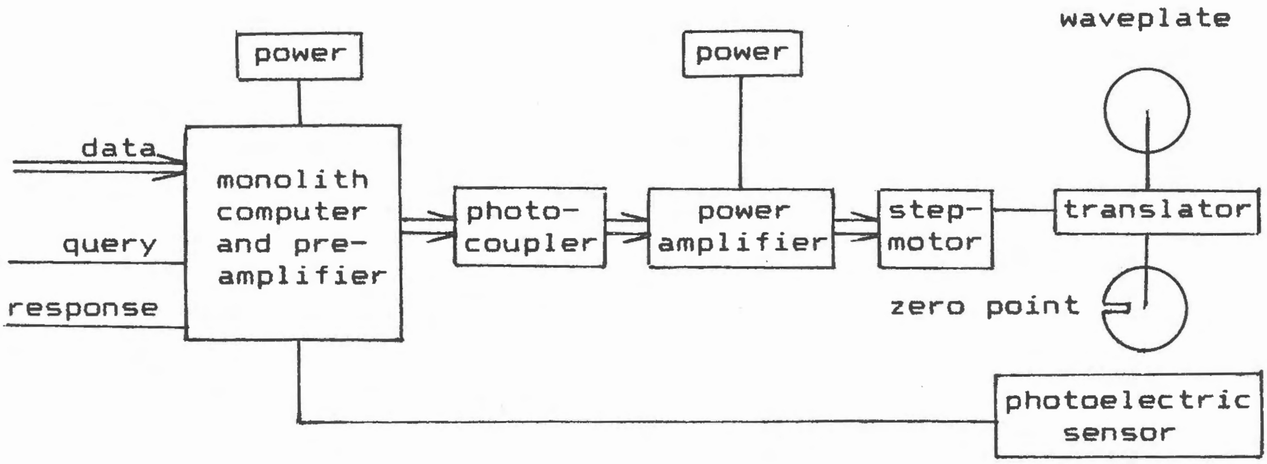

Fig.4. Block diagram of slave computer

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