Measurer of Meteorological Distance Visibility on the Horizontal Routes of the Ground Atmosphere

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Abstract*—Optical-electronic automatic measuring complex is described, intended for the operative measurement of atmosphere's transparency in the wavelengths region of 0.35-1.03μ and of the meteorological distance visibility in the different climatically conditions from 0.1 to 300km. The measurements of meteorological distance visibility on λ = 0.55μ are realized with sensitivity of the apparatus not worse 3.4·10-5km-1 /mv.*

Keywords—Optical-electronic system, meteorological distance visibility, atmosphere's infrared transparency.

I. INTRODUCTION

Meteorological distance visibility (Sm) is one of major optical-physics parameters of atmosphere, especially at flight and landing of aircrafts. In many airports by the most frequent weather phenomena, lowering distance of visibility, there are fog and snow-fall. At these weather terms insignificant absorption and insignificant changes of index of weakening of atmosphere are usually marked at the change of wave-length. To the weather phenomena that can substantially worsen visibility, a strong rain, smoke, sand and dust, belong. In optical-electronic instrument production the special place is borrowed the measuring complexes intended for researches of physical properties, in particular, of the ground and top layers of the atmosphere. And in this aspect a main role have the optical-physic measurements of radiation fields caused by molecular and aerosol dispersion. Such measuring systems play the rather important role not only in scientific researches of physical properties of atmosphere, but also in applied sense in the field of air navigation for an operative estimation of "Optical weather" of atmosphere. Described in the present paper Measurer of atmosphere's meteorological distance visibility (under the name of the Field Optical-Meteorological Post Automatic FOMPA) has an invaluable role at natural tests various thermovision apparatus, exact estimation of the transparency of atmosphere in infrared region of spectrum.

II. STRUCTURE AND PURPOSE OF THE EQUIPMENT

Measurer is intended for continuous measurement of meteorological distant visibility (Sm), or parameter of attenuation (α(λ)) of the atmosphere in the region of wave lengths from 0.35 to 1.1 μm and automatic processing of results atmosphere's spectral transparency in a range from 1 to 14μm. The working spectral diapason is allocated in the help 4 narrow-band interferential light filters in the wavelengths range from 0.35 to 1.1μm. The complex works at day and night, in various seasons of year, at any condition of "Optical weather" in clear atmosphere, in gauze, fogs, at a rain and snowfall. The complex FOMPA consists of two basic parts: measuring and recording (processing). Into a measuring part enters nephelometrical device in structure of two blocks: optical-mechanical and board of electronic management [1,2,3]. The optical circuit OMB is shown in fig. 1 OMB consists of four basic units: the gaffer, photometer, trap of light and control catering. The basic element MB is pulse xenon lamp ISS-100-5 of high intensity. The pulse of light radiation by duration 1- 1,5 μs is disseminated in atmosphere and is weakened basically under action of processes of aerosol and molecular dispersion. The part of absent-minded radiation in a direction 450 is accepted in photometer of the device, which target signal is direct - proportional to attenuation parameter of the atmosphere. Factor of proportionality between size of a signal and attenuation parameter as a constant A is determined with the help calibrating device under the known characteristics molecular dispersion of clean gases or dairy glass [4].

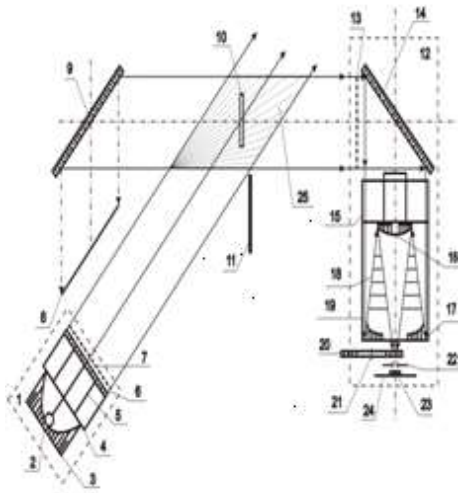

Figure 1. The optical circuit OMB of the Measurer atmosphere's meteorological distance visibility
1-Gaffer; 2-Lamp ISS-100-5; 3-Mirror parabolic; 4,15-Cellular blends; 5,11-Screens; 6,23- Protective glass; 7,13- Iris diaphragms; 8-Trap of light; 9-Mirror "Black"; 10-Control scattering; 12- Photometer; 14-Mirror flat; 16,17-Mirror objectives; 18-Blend round; 19-Blend cylindrical; 20-Light filter; 21-Axis rotation; 22-Diaphragm; 24-Plane PEM, 25-Worker volume of the device.

III. MEASUREMENT METHODS

Optical-electronic path of the device is formed of three channels; measuring, background and control. The measuring channel is formed by an optical method-by crossing a beam of light and field of sight of photometer. The background channel of system is formed of the measuring channel at absence of a light flow of radiation of a lamp within the limits of working volume of an atmosphere. The measurement background of the Sun and noise electrical signal on the background channel is spent in intervals between light flares with frequency equal frequency of radiation of a pulse lamp, the Control channel is formed by a mechanical way - by introduction in working volume of the device control scattering (see fig. 1). As against of the remote OMB block, which works directly in the atmosphere, BEM and recording part of a complex can be in a premise or in a body of auto laboratory and on distance operate by functioning of the equipment. At natural measurements in the atmosphere the account of the attenuation parameter of atmosphere $\alpha(ti)$ and meteorological range of visibility Sm(ti) at the any moment of time t i in absolute units is spent on the basis of measurements of signals measuring U1(ti), background U2(ti) and control channels U3(ti), according to relation:

$$\alpha(ti)=A\cdot(U3(0)/U3(ti))(U1(ti)-U2(ti)),$$
$$Sm(ti)=3{,}91/\alpha(ti)$$

on length of a wave λ=0,55μm. The final results of measurement $\alpha(0{,}55)$ and Sm also turn out in absolute units, [km- 1] and [km] accordingly, are deduced on light indication and registration.

IV. CONCLUSION

The developed complex provides definition of values of meteorological distance visibility in a range from 0.1 to 300 km on of direct measurements of a the basis parameter of the atmospheric attenuation. It is necessary to note that by essential advantage of the above described optical-electronic complex, developed by us, FOMPA in comparison with maintained now (especially on services of aircraft) similar devices [5] is the opportunity of maintenance of the periodic control of sensitivity of the equipment during operation and realization of all measurements on a background of a "black" mirror that provides high sensitivity of reception system.

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