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SATELLITE SPECTROPHOTOMETER FOR RESEARCH OF THE TOTAL OZONE CONTENT

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Abstract: *The measurement of the atmospheric ozone and its influence upon the climate and life on Earth is undoubtedly one of the most current issues of the present time.*

The paper presents the functional scheme of a satellite optoelectronic spectrophotometer for measuring the total content of the atmospheric ozone and other gas components of the atmosphere, which has increased precision, smaller weight and energy consumption, increased space and time resolution, quickness of reaction and increased volume of useful information.

The object of the paper is the design of an appliance which ensures research of the ozone content in the atmosphere from the board of a satellite.

Key words:

The research of the gas content of the Earth atmosphere by means of different methods has been performed during the last few decades. The interest in this problem has greatly increased because of the following facts:

- The anthropogenic influence on the gases and aerosols in the atmosphere has significantly increased;
- The different physical mechanisms which influence the change in the gas and aerosol content of the atmosphere and thus having an impact over the different characteristics of the environment and more specifically over the weather and climate on Earth, are becoming clearer.

In earlier times, special attention was paid to the concentration growth of carbon oxide, but now the contemporary trends show that the increase of other small gas content such as O_3, CH_4, CO, N_2O, freons, etc. may in the near future induce a considerable total influence on the Earth climate, rather than the concentration growth of carbon oxide.

The most dramatic example for regional change of the gas content of the atmosphere is the Antarctic ozone hole – a phenomenon which has been widely discussed and researched by specialists from different countries and which is connected with direct or indirect influence of the anthropogenic factors. According to

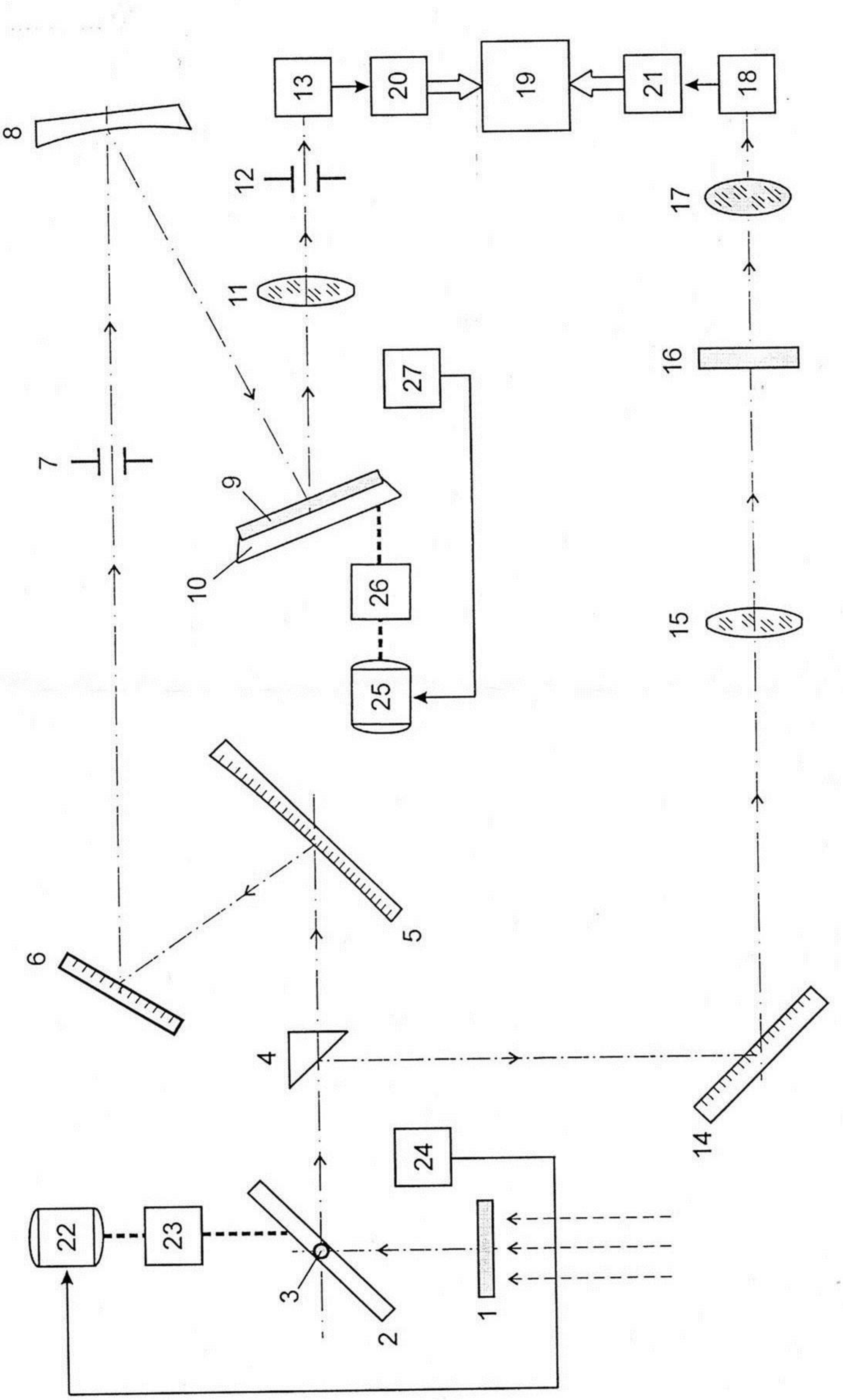

Fig. 1. Optoelectronic spectrophotometer for research of the total content of the atmospheric ozone and other gases in the atmosphere

predictions, during the next 10 to 50 years, the ice around the Pole will melt during the summer season.

The change of the gas content and the possible consequences from these changes stimulate the creating and functioning of different observation systems for control of the gas content of the Earth atmosphere.

The problem is solved by inventing an optoelectronic spectrophotometer for research of the total content of the atmospheric ozone which has spectral, electronic and photometric channel which has greater precision, lighter weight and energy consumption, greater space and time resolution, quick response, better reliability and increased volume of the useful information.

An example is shown on Fig. 1, which is a block scheme of optoelectronic spectrophotometer for research of the total content of the atmospheric ozone and other small gases in the atmosphere.

According to Fig. 1, the opto-electronic spectrophotometer for research of small gas content in the atmosphere consists of light-protective blend 1 which is situated in front of a plane scanning mirror 2 with mounted etalon source 3 in it, which serve the photometric and spectrometric channel and they are inlet scanning system, controlled by step electro-engine 22, which by means of gear 23 is mechanically connected with scanning mirror 2 and electronically connected with photoelectric transformer angle-code 24 for feedback.

A concave mirror 5 is mounted in front of the plane mirror 2 on the same optical axis and a reflective prism 4 is fixed between them and it guides part of the optical system towards the spectrometric tract and another part of it towards the photometric tract of the spectrophotometer. The concave mirror 5 from the spectrometric tract is optically connected with plane mirror 6 which goes through inlet hole 7 and by means of concave mirror 8 – with diffraction grating 9, which is mounted on a flexible carrier 10 and from it through camera lens 11 and outlet hole 12 with sensor 13.
Reflective prism 4 is optically connected with the photometric tract and through plane mirror 14, objective 15, interference filter 16 and optical lens 17 with sensor 18. The sensors 13 and 18 correspondingly from the spectrometric and photometric tract are connected with microprocessor system 19 through analog-digital transformers respectively 20 and 21.

The step electro engine 25 is connected mechanically by means of a mechanical block 26 with the carrier 10 of the diffraction grating 9 and the photoelectrical transformer angle-code 27 is electrically connected with the electro engine 25.

HOW THE SPECTROPHOTO-METER WORKS

The plane scanning mirror 2, which is moved by the step electric engine 22 and the gear 23 perform scanning at angle $\beta=\pm45°$ which is regulated by the reverse connection, done by the photoelectric transformer angle-code 24. The optical signal, reflected by the concave mirror 5 and the plane mirror 6 through entrance whole 7, goes to the concave mirror 8 and from there parallel beams go to diffraction grating 9 which is mounted on the carrier 10. The monochromatic signal from the diffraction grating 9 goes through camera objective 11 and exit whole 12 and reaches sensor 13. The electrical signal from the sensor exit 13 is transformed into digital type in the analogue-digital transformer 20 and is sent into 8-order binary code for transformation in the microprocessor 19. The gradual scanning of diffraction grating 9 which is mounted on the mobile carrier 10 is done by a mechanical block 26 which is coupled with the step electrical engine 25 and the reverse connection for the position of the diffraction grating 9 is done by the photoelectrical transformer angle-code 27.

Part of the optical system from the reflecting prism 5 goes to the photometric channel and is reflected by the plane 14 and from the objective 14 goes to the interference filter 16. From there, the monochromatic optical signal through lens 17 is focused on the sensor 18. The electrical signal which is obtained in the sensor, is passed towards analogue-digital transformer and it goes to a microprocessor system 19 in the form of 8-order binary code.

The inside calibration of the spectrophotometric and photometric channel is performed at closed light-protecting blend 2

Fig. 2. satellite optoelectronic spectrophotometer for research of the total content of the atmospheric ozone

and thus the signal of the etalon calibrating source 3 is registered as minimal border sensitivity of the device. The external calibration of the spectrophotometer is performed by rotation of the entrance scanning system at 180° from the basic position (0°), i.e. in the direction of the sun discus. The functional scheme allows the researched spectral range to be scanned continually or discretely without changing the starting regime of the diffraction grating 9 and by selective permission for transmittance of electrical system as a function of its momentary angle position which is read by the photoelectric transformer angle-code 27.

The measuring process and the registration are completely automated. Fig. 2 presents the spectrophotometer for research of the total content of the atmospheric ozone.

CONCLUSION

A satellite optoelectronic spectrophotometer for research of the total content of the atmospheric ozone and other gases in the atmosphere has been developed. It has greater precision, smaller weight and energy use and also increased space and time resolution, quick response, better reliability and larger volume of useful information. It is copy righted by a Patent BG 657007B1 by the Patent Authority of Republic of Bulgaria.

REFERENCES:

1. Velchev N. Fizicheska optoelektronika. Universitetsko izdatelstvo “Paisii hilendarski”, Plovdiv, 2008, 141 p.
2. Getzov P. Sputnikovi sistemi za ekologichen monitoring. Sb. Nauchni trudove “Nauchno-tehnologichen transfer”, IKI-BAN, Shumen, 2000, p. 5-9
3. Zhekov ZH. Optichni metodi I sredstva za otkrivane na otdalecheni obekti ot borda na kosmicheski letatelni aparati. Universitetsko izdatelstvo “Episkop K. Preslavski”, Shumen, 2006, 308 p.
4. Mardirossian G. Aerokosmicheski metodi v ekologiata I izuchavane na okolnata sreda. Acad. Izdatelstvo “Prof. Marin Drinov”, Sofia, 2003, 208 p.
5. Patent BG 657007B1 issued 26.08.2009 Satellite optoelectronic spectrophotometer for research of the total content of the atmospheric ozone and other gases in the atmosphere. Zhekov Zh., MArdirossian G., Getzov P., Stoyanov S., Hristov I. Patent Authority of Republic of Bulgaria