COPPER-VAPOR-LASER-BASED MEDICAL FACILITY FOR USE IN DERMATOLOGY

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We describe here a medical facility based on copper-vapor laser and intended for use in dermatology. The mean power of the Cu*-vapor laser emission at the output end of a transportation optical waveguide is about* 5 W. *The facility described provides for isolation of either yellow* (578.2 nm) *or green* (510.6) *emission as well as smooth regulation of the output power. The exposure time available for irradiation may be varied from* 1 *to* 9999 *seconds.*

Some dermatological and cosmetological diseases have not only medical aspects, but very often create a social and psychological discomfort for such patients. The variety of such diseases is wide enough, so the number of people who suffer from them is large. Suffice it to say that about 3% of population have such abnormalities as capillary dysplasia (wine spots), about 30% suffer from varicose veins, and many more people have various pigment abnormalities.

The treatment and curing of the capillary dysplasia and some other vascular diseases of skin make a big problem in cosmetology and plastic. No absolutely effective methods have been developed so far for treatment of that sort of pathology. At the same time, the methods of criotherapy, for instance, are low efficient and often produce certain negative cosmetological effects.[1]

In recent years many researchers, primarily outside Russia, have reported on a good cosmetological effect that can be achieved in curing some skin damages of the vascular diseases' origin using the copper-vapor laser (CVL) radiation. Much promising results have been obtained with both yellow and green emissions of CVLs. The irradiation with light in this portion of spectrum produces a scleroterapeutic effect on vasculature without serious damages of the surrounding tissues. This treatment restores the natural skin color while producing no cicatrization, that gives a good cosmetological effect.[2] Below we give the list of dermatological diseases and wavelengths of light most efficient in their treatment with the CVL radiation. Thus the capillary hemangioma, facial telangiectasia, spider, senile hemangioma, telangiectasia can effectively be treated with the radiation at 578.2 nm wavelength (yellow line), while the benign pigment abnormalities with the radiation of green line at 510.6 nm wavelength. At the same time the sum radiation at 510.6 and 578.2 nm wavelengths is efficient for treatment of such abnormalities as carate, fatty adenoma, trichoepithelioma, and other benign tumors and nodes.

Taking all the above said into account we have developed a medical facility, for curing vascular affections of skin, that is based on a copper-vapor laser. This facility may be produced on a serial scale. The view of this installation is shown in the figure. This medical facility is being produced in two versions. Both versions involve a copper-vapor laser. The difference between the versions is that one of them is equipped with an additional electronic channel that provides for regulation of the output power.

A more detailed description of the principle of operation of a copper-vapor laser with the regulation of output power may be found in Ref. 3. The active element of the laser is a gas discharge tube UL–102 “KvantB that is manufactured at the Scientific Production Association “IstokB, Fryazino. The laser delivers 6 to 7 W of total mean power at two, green and yellow, lines. The pulse repetition frequency may be varied from 7 to 16 kHz. In the version without power regulation we use a TGI1–1000/25 thyratron as a commutator, while in the version with the power regulation thyratrons TGI3–500/16 and TGI1–270/12 are used for this purpose. The pulse repetition frequency is being set in this laser with a built in generator whose end cascade, that triggers the thyratrons, is based on KP810A field transistors. The discharge circuitry of the laser power supply provides for direct discharge of a capacitative storage through a thyratron. The energy storage capacitor of the power supply is charged from a high-voltage rectifier using a diode- based resonance circuit. The hardware of the facility comprises two blocks. The first one contains a rectifier and power control circuits. In the second block we assemble the resonator with the active element, modulator and the circuits that provide for the storage capacitor charging. To ensure higher stability of the laser operation we use a step regulator of the voltage applied to the hydrogen generator and heater of thyratrons. The regulator keeps this voltage stable within 3% limits at the variation of voltage in the power line about 10%. To make the control of laser operation simpler we use a two-stage high-voltage rectifier.

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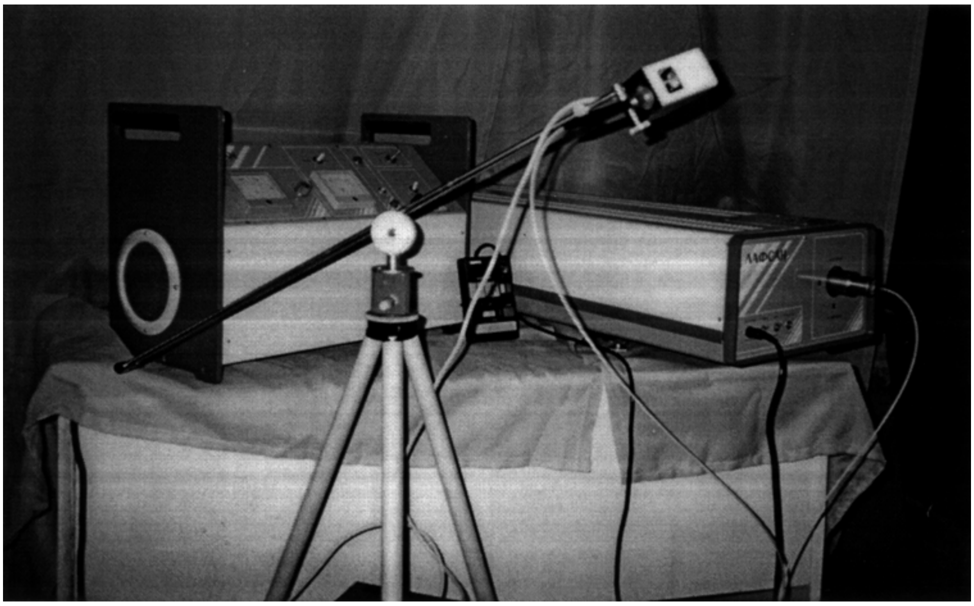

Foto of the medical facility for dermatology.

In five minutes after switching on the laser, needed to warm up the thyratrons, the first stage of the rectifier is being switched on that provides 50% of the working voltage and laser is operated at the repetition rate sufficient for consuming 50 to 70% of maximum power from the power supply to maintain the laser self-heating. Then, in 15 minutes, the second stage of the rectifier is on and the laser is operated at the pulse repetition frequency providing optimal regime of the laser operation in the self-heating mode. Such a sequence of putting the laser into the working state enabled us to built in into its electric circuits a programmable timer that automates the control of this process.

At the output end of the laser resonator there are placed an electromagnetic shutter of the laser beam controlled by the timer, a spectral beam divider, and a waveguide unit. The shutter is made in the form of a screen that is being driven with an electromagnet. It enables the exposure time to be regulated, using the timer, from 0 to 9999 seconds with a one-second step. After the shutter the laser beam enters the spectral dividing block where it is possible to isolate either green or yellow line as well as to transmit the beam without separation of the lines. Before the beam reaches the waveguide block it passes through the beam attenuator that makes it possible to smoothly vary the emission power from 0 to its maximum value. In the block of an optical waveguide the beam is focused onto the end of a quartz monofiber.

The power and repetition frequency control block of the laser provides no only for a possibility to regulate the output parameters of the emission but also to form a train of emission pulses that may be useful when varying the mode of skin abnormality treatment.

The power consumption of the facility from a 220 V and 50 Hz line does not exceed 2.2 kW. The thermal regime of the laser operation is maintained with forced-air cooling. Full time during which the laser reaches it working state is 55 minutes. The weight of the facility is below 80 kg.

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