

New Solutions in Development of Endoscopic Systems

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Abstract. The new solutions used at development and manufacturing of modern endoscopes are presented. The main purpose of endoscopes is to provide visualization of various closed internal chambers of tested objects. Previously developed endoscopic systems comprised two separate modules: endoscope itself and illumination one. The endoscope module consists of: casing with optical channel and control mechanism providing articulation of distal tip, part of illuminating bundle coming out of the casing and connected to illuminator and working part combining illuminating bundle and transmitting part of visualization channel. Regular illumination module is based on powerful halogen, xenon or other similar light sources and has built-in battery, charging unit and main adapter. In this case illuminating module has rather big size and weight and cooling system, heat protection of other elements and heat rejection system should be provided as well. Such a design creates certain inconveniences during operation.

Use of super bright LEDs made it possible to increase the illumination level of examined area by 40-60% as well as to place illuminating diode and power supply battery directly inside the endoscope casing.

Similar approach was used for TV-endoscopes, i.e. super bright LEDs were used as light sources. In this case the weigh and sizes of instrument as well as power consumption were reduces while performance features - enhanced.

Introduction

The main function of all types of endoscopic systems is to provide visualization of internal cavities of various examined items and objects in which lighting is absent. That is why the core part of any endoscope is its illumination module.

As a rule, the illuminating channel consists of light source (i.e. source and its power supply block) and fiber-optic bundle that guides the light beam to the examined area.

Traditionally the halogen and metal-halogen bulbs are use as light sources. When mentioned above bulbs are used it is required to provide system of light beam optical focusing at the input end surface of fiber-optic bundle as well as power supply and cooling modules. If the self-contained endoscope is designed for use on site where power supply is not available there is requirement to equip it with battery. All above determines overall dimensions of the developed equipment and illuminating module weight (especially in case of self-contained battery) and hence the necessity for endoscopic system to have two separate modules.

1. Design limitations in existing endoscopic systems

As it was mentioned above, most currently available systems onstist of two separate modules, i.e. visualization module and illuminating one. The visualization module or endoscope itself comprises housing with built in visualization optical channel, control mechanism for distal tip articulation and coming out of the housing part of bundle that is

connected to illuminator as well as operating part combining illuminating bundle and visualization channel.

The overview of standard endoscope is presented in Fig. 1. This is commercial endoscope fabricated by “Spectrum” company of ETG series with battery powered illuminating module BOA-20.



Fig. 1. Overview of flexible endoscope of ETG series with separate illuminating block with self-contained battery.

The weight of illuminating module with 20W power halogen bulb inside is 2.7kg and its dimensions are 160x180x90mm. Use of such systems is rather inconvenient.

2. New approaches to design of endoscopes

To eliminate disadvantages of described above kind it was proposed to use illuminators made of super bright LEDs with white glowing. In comparison with usually used bulbs the LEDs have increased light conversion and produced by them light beams are directional that provides working area illumination at level equal or exceeding the illumination level created by bulbs while power consumption is much less.

It was determined that LED of white glowing and 1W power provides illumination level 40-60% higher than 20W bulb used in illuminating module of endoscopes of ETG series.

LED dimensions (together with small radiator) make it possible to place it directly in the endoscope housing eliminating the necessity to have separate illuminating module.

From the other side the level of its power consumption makes it possible to use dry cell or battery of AA type which weight and dimensions considerably less than similar parameters of battery used for bulb powering. All these improve ergonomic and service performance of new instruments.

Also it is necessary to mention that LED uptime is dozens thousands of hours. It means that this parameter is better than similar one for bulbs by order.

3. Comparison of new endoscopes

Based on new approaches a number of portable self-contained monoblock fiber-optic endoscopes were developed and produced. This is ETA series in which the LED is mounted directly in the housing while supplying battery is installed in the “pistol” type handle. New design principles provided dramatic reduction of weigh and dimensions of the instrument with simultaneous increase of continuous operation time without battery replacement or charging as well as improved ergonomic parameters, see Fig. 2 & 3.

In the new series of endoscopes ETA achieved is triple reduction of weight (now it is 1kg) with double increase of continuous service time (2 hours) in comparison with similar parameters of ETG series endoscopes implementing bulbs.

Similar approach was used during development of semi-rigid endoscopes presented in Fig. 4. In those ones as illuminator used is LED with white glowing and power 1W and they have the same design of package as flexible endoscopes of ETA series.



Fig. 2. Set of flexible endoscope of ETA series with battery powered illuminating unit integrated into its housing

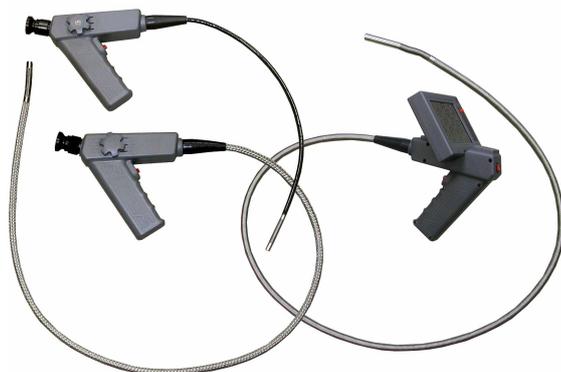


Fig. 3. Portable self-contained endoscopes of series ETA and ETV

The same technical solution was used during development of portable monoblock TV endoscopes of ETV series (Fig. 3) in which implemented is LED with power 3W. Made technical solution also helped to dramatically reduce weigh and dimensions of the system, reduce power consumption and improve performance characteristics in comparison with standard endoscopic systems.

The basic specification of fiber-optic endoscopes of ETA series and TV endoscopes of ETV series are presented in Table 1.

Table 1. Comparison table of technical parameters of various endoscopes

Parameter	ETA series	ETV series
Working part diameter	6-10mm	12mm
Length of working part	0.5 – 2m	2m
Distal tip articulation	$\pm 180^{\circ}$	$\pm 90^{\circ}$
FOV	60°	42°
Resolution	5 lines/deg	320x240 pixels
Power of illuminating source	1W	3W
Power supply	4xAA	12V DC
Power consumption	1.2W	10W
Weight	0.5 – 1 kg	1/2kg +2.7kg (BOS-20- illuminating module)

At the moment the development of portable monoblock TV endoscopes with diameter of working part 8mm and 6mm are coming to the final stage.



Fig. 4. Portable self-contained semi-rigid endoscopes of ETApzh series

Conclusions

Industry requires new systems with better technical parameters. The dimensions, weight of instruments and convenience of their use became more and more important. Development of instruments based on new design principles; implementing new components makes their practical use easier. New instruments will help to solve new class of tasks, to provide access to areas that, until recently, was not possible to examine or inspect due to absence of proper systems and instruments.