A uniform & unified system for ophthalmic microsurgery [1]

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As pioneered by Harms, Ophathalmology has benefited extensively from microsurgery [1]. Barraquer was the first to organize the technical apparatus of ophthalmic operating rooms by grouping the microscope and other microsurgical instrumentation into a system [2]. In 1968, Sautter and Draeger reported a new microsurgery unit with all main controls leading to and from the ceiling, thereby allowing floor space to be free of multiple supports, cables, hoses, and wires. Each single foot switch activated in the pedal was installed in the base of the chair, and each controlled its own corresponding element. The pedal always remained constant in relation to the operator's chair regardless of its position [3]. This system, however, still restricted total freedom of movement.

Due to lack of uniformity and unification of available instrumentation, the actual practice of ophthalmic microsurgery in the anterior and posterior segments has been performed with an enormous variety machines, each having at least one foot-switch and a manually operated control panel. The advent of pars plana vitreous surgery has exemplified this situation [4]. The positioning of both staff and equipment, including devices for the administration of anesthesia, often requires several undesirable floor-mounted stands.

"Le SYSTEM"

In this research project, our purpose is to unify and optimize in a single system (Fig. 1) all commonly used instruments for both anterior and posterior segment microsurgery, with control through a central multipurpose foot-switch connected to a selector (Fig. 2). The selector allows simultaneous activation of any two chosen modalities within the system, which includes the following instruments: an automated irrigation/aspiration device, phacoemulsificator, vitreous cutter, membrane peeler cutter, diathermy, cryotherapy instrumentation and a light source all arranged in a modular configuration over a portable stand and which accommodates a change or addition of units as is necessary. This uniform and unitized microsurgical apparatus was named "Le System" and built in 1981 by the staff of the BPEI Ophthalmic Biophysics Laboratories [5].

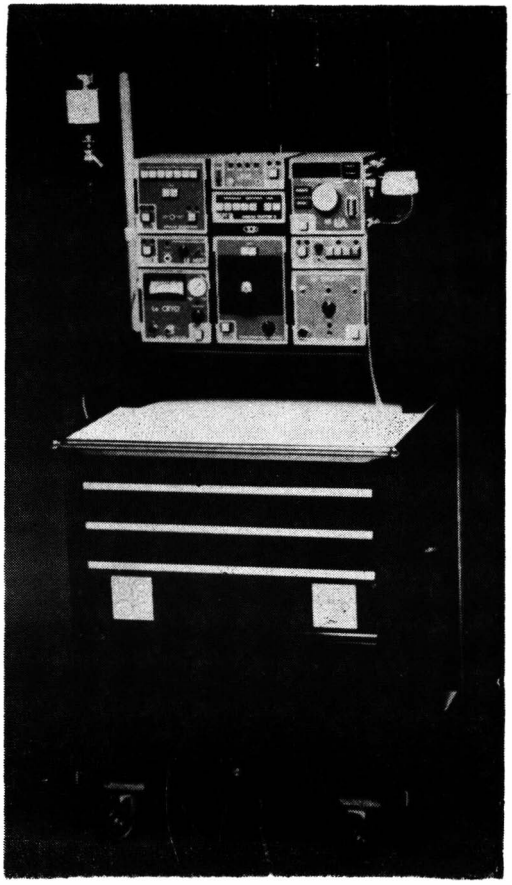

Fig. 1 — General view of the System

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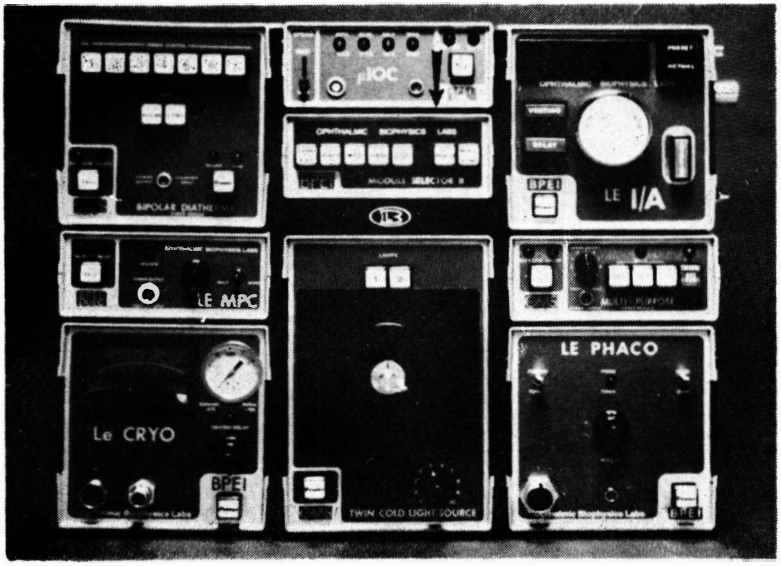

Fig. 2 — Picture showing all units arranged in modular configuration around the central selector (arrow). Each of these units can be utilized independently of the System.

THE MULTI-PURPOSE FOOT-SWITCH

The foot-switch (Fig. 3) is connected directly to the central mode selector, which has a front panel with seven push buttons indicating the specific units in the system. Power to these units is turned off and on by a switch located on the upper part of the foot-pedal's body. Also located on the upper part of the pedal are two additional switches to control the infusion pressure and flow. These switches allow the surgeon to regulate the patient's IOP during surgery. Located on the lower part of the pedal are two dual mode switches, parallel to one another. The right pedal controls aspiration, the phacoemulsificator and the vitreous cutter modules. The left pedal controls the membrane peeler cutter, diathermy or cryo modules. The multi-purpose foot-switch can be controlled with one foot, leaving the other foot free to control surgical suite lighting, as well as the position, focus, and magnification of the surgical microscope [6]. An excellent management of these pedals and switches is achieved by wearing no shoes during the surgical procedure, thereby allowing a precise, tactile sensation.

THE IRRIGATION/ASPIRATION UNIT

This unit includes an intraocular pressure monitor in the body of the automated irrigation-aspiration power module. The front has an indicator which gives a digital readout of the negative pressure of the aspiration system or, by pushing another button, a readout of the intraocular pressure. The automated aspiration system is connected to a vaccum pump which allows a negative pressure to a minimum of at least -600 mm Hg. If available, an external vacuum source can be utilized as well. The suction is controlled by use of the right pedal on the foot-switch: the stronger the pressure on the pedal, the stronger the aspiration. Thus the aspiration forces are controlled by the surgeon in a quasi-linear manner [7]. The maximum level of aspiration can be preset by using the dial located on the front panel. When the pedal is totally depressed, this preset level is reached within two seconds. When the pedal is released, the aspiration is turned off within miliseconds.

Infusion is controlled in two different ways: there is a switch to instantly open or close the line, and a motorized, dual speed pole to raise or lower the infusion bottle [8]. The surgeon thusly maintains independent control of the infusion bottle height and of the infusion flow at all times, hence as a presise control of his patient's IOP.

The automated irrigation-aspiration unit can be connected to any surgical device while the intraocular pressure is being monitored.

THE PHACOEMULSIFIER

The phacoemulsifier is a new ultrasonic piezoelectric power unit. It will energize a variety of commonly used probes such as the Girard, the Shock or the Cavitron 9000 as well

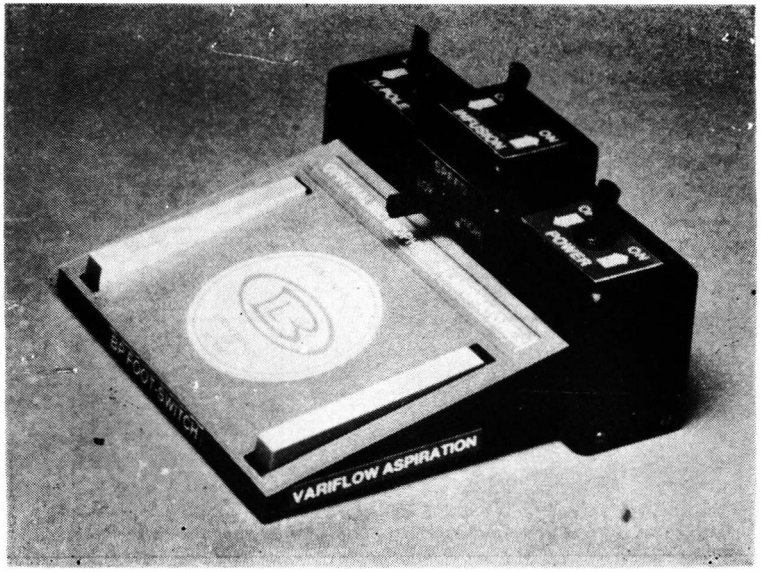

Fig. 3 — Picture of the multi-purpose foot-switch showing the parallel right and left two-step pedals and the central switch, which not only changes the speed of the vitreous cutter but also regulates the ultrasonic vibrations of the phacoemusificator. The upper part of the foot-switch contains three additional switches: 1) The connection to the power for either the vitrectomy or phacoemulsifier instruments, 2) Power connection to the infusion line, and 3) Height control for the motorized infusion pole.

as two new ultrasonic micro handpieces designed by one uf us (JMP) [9]. It works at frequencies of between 20 to 90 kHz, is automatically tuned and can be set in two different modes as indicated on the front panel: continuous or pulsatil. The continuous mode is the normal manner of operation and is activated until the foot-switch is released. The pulsatil mode is a new way of fragmenting lens material. While the operator presses the pedal, the instrument emits very high pressure ultrasound waves for a short period of time then stops. The principle is analogous to that of a jack-hammer. Aspiration continues to occur during this brief off-time interval. The number of frequency pulse/seconds goes from 1 pps to 10 pps and may be changed at the rear of the power supply or in the multi-purpose foot switch. This unit is controlled through use of the two-step right pedal. When using the first step, the phacoemulsificator is turned on. When the second step is activated, linear automatic aspiration is achieved as well.

THE VITREOUS CUTTER UNIT

The vitreous cutter is a multi-purpose power supply which provides rotary forward and reverse, as well as oscillatory movement for a four-sided cutting tip, at a frequency of up to 3 Hz (720 cuts/minute) [10]. The cutter's power supply consists of a rechargeable nickel cadmium battery pack that accepts any one of several types of probes: the VISC, STAT, TAC, EMPAC, SITE, BOSTON-GRIESHABER and the new VITAC IV. The control panel contains a dial to present the lowest of two speeds. Either maximum or minimum speeds can be selected by the surgeon at the foot-switch. This unit is controlled through the two-step right pedal. The vitreous cutter utilizes no aspiration during the first step. However, during the second step, linear aspiration is activated.

THE DIATHERMY

This unit is a 1.25 Mhz medium frequency bipolar generator which is utilized in continuous or pulsatil modes [11]. It is controlled by the two-step left pedal. The first step activates the diathermy probe for a preset time of 250 msec, while the second step switches the system to the continuous mode. A selector presets the intensity from 0.125 to 8 joules or 0.5 to 32 W according to pulsatil or continuous mode. This module will power all kinds of bipolar diathermy probes, including those specifically designed for transvitreal applications [12].

THE LIGHT SOURCE

The light source consists of a fiber optic

illumination system with two high intensity halogen bulbs. The front panel is provided with a switch to turn the instrument off and on, and a dial to control light intensity. As many as six colored filters are selectable: for fluoroscopy, HpD detection, blue light hazard, photography, and other special applications. In addition, the light source was designed to accommodate up to five different fiber optic connectors to fit any of the commonly available light probes.

This unit can be used independently for all types of microsurgical procedures as well as to power other instruments such as indirect ophthalmoscopes and microscopes, etc. The light source is not controlled by the central selector of the multi-purpose foot-switch as are other units in the system.

THE MEMBRANE PEELER CUTTER (MPC)

Designed by Machemer et al in 1976, the membrane peeler cutter is a solenoid-activated, guillotine microscissors that can be used as a hooked needle, as well as provide its own source of fluid saline [13]. As with other units in this system, the MPC's control is battery powered and can be set in two different modes through a switch on the front panel. In step mode, a single cut follows each depression of the foot-switch. In multi mode, repetitive cuts are initiated at preselected rates of one to six cuts per second. The instrument is controlled by the left two-step pedal, with the first step acivating the scissors while the second step keeps the blades in a closed position for ease of entry into or exit from the eye. The MPC module will accommodate other solenoid activated microsurgical instruments such as the Kloti vitreous cutter [14], the Stampelli Optikon vitrectomy handpiece [15] and the Sutherland Automated Scissors (SAS).

CRYOTHERAPY UNIT

The cryogenic principle utilized in this apparatus is based upon the well known invention of Sir Percy Amoils and was popularized by the Keeler brothers in the middle 1960 [16]. "Le System" cryogenic module is powered by compressed N_2O gas. Its panel contains an indicator showing the temperature of the probe's tip which can be made to reach a low of -88°C simply by adjusting the gas pressure, and a dial to preset the time of application, if desired, from 1.0 to 10.0 seconds [17].

This instrument is also activated by the two-step pedal on the left, with the first step used for preset times and the second step automatically switching the system to continuous mode. Both modes are immediately deactivated by releasing the pedal.

The tip of the cryogenic probe freezes in 0.5 seconds. An automatic defrost is activated upon release of the foot-switch. Total defrost is obtained in 2.0-4.0 seconds.

Probes employed in several ophthalmic procedures can be attached to this unit, including those used in cataract extraction, retinopexy, cyclocryotherapy, and transvitreal coagulation.

RESUMO

Apresentamos um novo sistema unificado e aperfeiçoado para microcirurgia ocular, o qual pode utilizar todos os tipos de instrumentos disponíveis atualmente para a cirurgia tanto do segmento anterior quanto do posterior. Os aparelhos dispostos de uma forma modular e compacta são controlados por apenas um pedal com múltiplas funções o qual é ligado a um seletor que permite o uso de dois aparelhos simultaneamente. As características básicas e vantagens práticas tanto do sistema como dos aparelhos modificados são descritas.

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