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TECHNOLOGY UTILIZATION

BIOMEDICINE

A COMPILATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Foreword

The National Aeronautics and Space Administration and the Atomic Energy Commission have established a Technology Utilization Program for the dissemination of information on technological developments which have potential utility outside the aerospace and nuclear communities By encouraging multiple application of the results of their research and development, NASA and AEC earn for the public an increased return on the investment in aerospace and nuclear research and development programs

This Compilation is one of a series of documents intended to present such information, and is divided into two sections Section one describes a number of instruments that have proven useful in monitoring and treating patients Section two presents several diagnostic, prosthetic, and therapeutic devices

Additional technical information on individual devices and techniques can be requested by circling the appropriate number on the Reader Service Card included in this Compilation.

Patent Statements reflect the latest information available at the final preparation of this Compilation. For those innovations on which NASA and AEC have decided not to apply for a patent, a Patent Statement is not included Potential users of items described herein should consult the cognizant organization for updated patent information at that time.

Patent information is included with several articles. For the reader's convenience, this information is repeated, along with more recently received information on other items, on the page following the last article in the text

We appreciate comment by readers and welcome hearing about the relevance and utility of the information in this Compilation

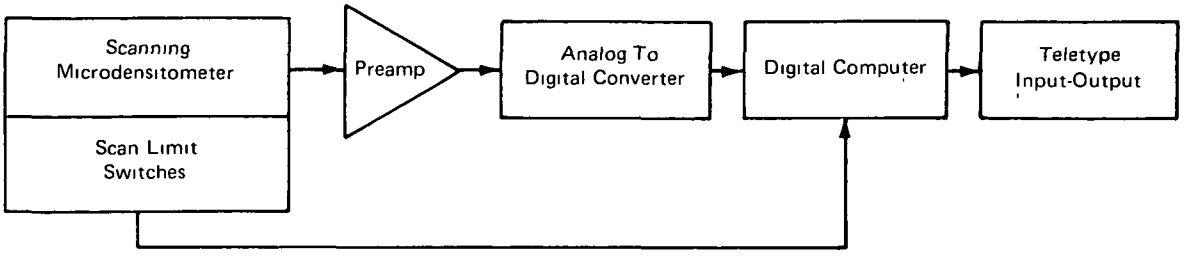
Jeffrey T. Hamilton, *Director*
Technology Utilization Office
National Aeronautics and Space Administration

For sale by the National Technical Information Service, Springfield, Virginia 22151

Contents

Section 1. Instrumentation

INSTRUMENTATION FOR BONE DENSITY MEASUREMENT



Bone density measurement systems with quite acceptable accuracy have been in use for some time However, as increased interest in this area demands more and more data, the analog instrumentation used for data reduction lacks sufficient speed

The basic measurement system evaluates the integrated bone density over a specific cross section of bone. A roentgenogram of a standard aluminum calibration wedge and the bone specimen is obtained in a single exposure Optical transmittance of the developed film is then measured by means of a scanning microdensitometer The image of the wedge is first scanned to determine optical transmittance versus wedge thickness as recorded on the film Graphical representation of the optical scanner output for a scan of the wedge image is in the form of an output voltage curve The bone image is scanned next along the desired cross section, resulting in a second output voltage curve These curves are the basic inputs for measurement of bone density

The computation system must now convert the voltage output for the bone scan to a curve of equivalent density (in terms of wedge thickness) and integrate the area under the resulting curve Conversion between output for the bone scan and equivalent wedge thickness is made using the wedge scan curve The curve is entered at the value of optical scanner output and wedge thickness is read on the abscissa This equivalent wedge thickness is used in the subsequent integration of the density

In one analog system, in use for many years, conversion between optical scanner output during bone scan and equivalent wedge thickness is made by using a nonlinear resistance slidewire output from a chart recorder Integration is accomplished with an electromechanical integrator

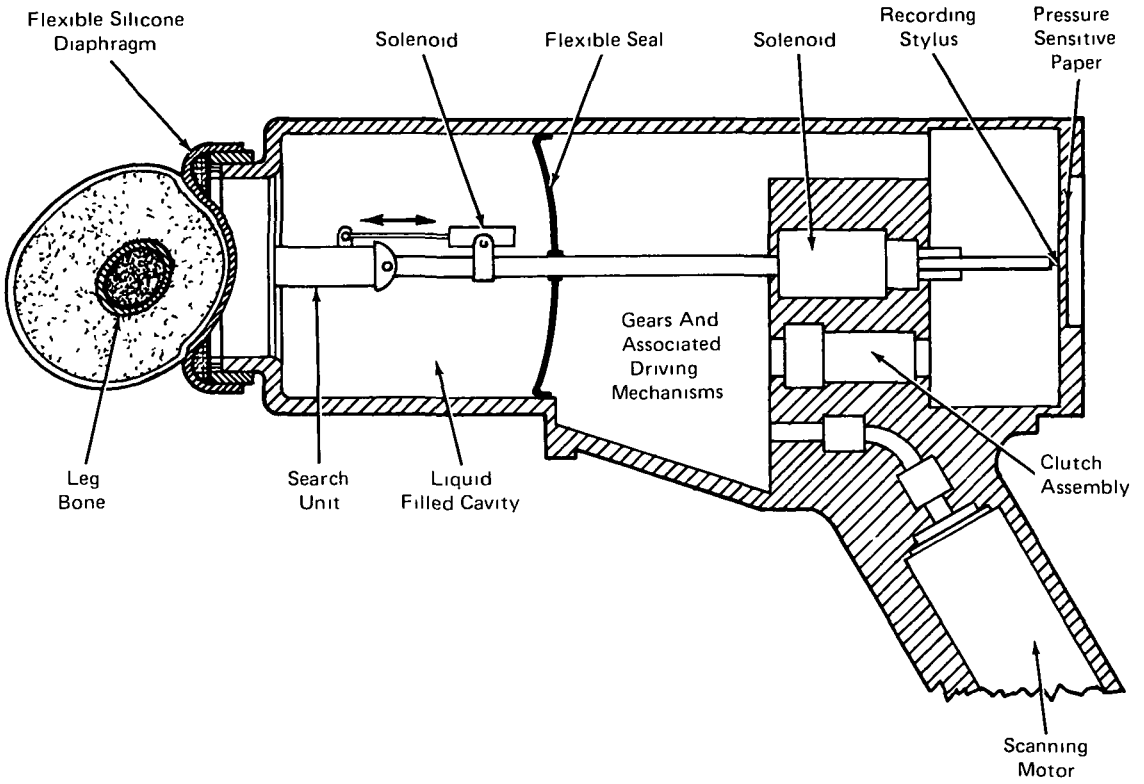
A system using a digital computer has been implemented to perform the computation functions similar to those performed by the analog system Optical scanner output voltage is converted to a digital format for storage and subsequent processing by a digital computer After both wedge and bone scans have been completed, the computer converts stored bone scan data to equivalent wedge thickness by using the stored wedge scan data Bone density is then integrated along the scan by using the trapezoidal approximation integration formula A block diagram of the digital instrumentation is shown in the figure

In operation, data collection by the computer is controlled by the limit switches of the densitometer, which mark the beginning and end of the scans Sampling times are controlled by a clock in the computer The teletype unit is used to control the computer by directing it to prepare for a wedge or bone scan, specifying bone scan speed used, and specifying printout options desired. It is also used to type identifying information on the printout.

Source Louis S Meharg of
Kaman Instruments
under contract to
Johnson Space Center
(MSC-11388)

Circle 1 on Reader Service Card.

ULTRASONIC, HAND-HELD, DIAGNOSTIC SCANNER FOR BONE INTEGRITY



This hand tool permits the rapid and mechanical scanning of bone integrity and determination of density without the need for surgery or X-rays Current ultrasonic techniques do not allow convenient scanning of areas that are not readily accessible to bulky equipment

A small, portable, electrically powered ultrasonic hand tool, coupled with auxiliary ultrasonic equipment, can be used for scanning small areas and fracture sites conveniently It should be noted that due to the pulse echo ultrasonic technique used (reflection from the bone surface), the use of this equipment is limited generally to bone surfaces not hidden behind other bones, e g , arm, leg, skull

The hand-held tool consists of an ultrasonic search unit that carries a housing assembly accommodating a solenoid The solenoid plunger is fitted with an extension and a recording stylus which records upon pressure sensitive paper located in the cavity at the rear of the unit In operation, the front end of the scanner is fitted with the proper bodyfitting silicone rubber diaphragm, a couplant of water or grease is applied, and the scanner is placed on the area to be examined The spiral scanning motion of the ultrasonic search unit is recorded as a spiral pattern on the pressure sensitive paper Discontinuities appear as breaks in the spiral pattern

The scanning motor causes the mechanism to rotate about the centerline of the main cylindrical body While rotating, the clutch assembly causes an outward translation in a radial direction, thus producing a spiral motion The search unit is rotated a short distance back and forth by a solenoid as shown This produces a curvilinear motion of the ultrasonic search unit, which enables the beam to hit the bone perpendicular to the bone surface, and thus reflect the maximum area of the curved bone surface This type of search unit motion is called "compound motion"

The best interrogation frequency for inspection of bone integrity is between 500 kHz and 500 MHz To determine bone density, lower frequencies may be required

A variety of flexible silicone diaphragms will be required to form fit the hand tool to various portions of the body It may prove more practical and time saving to have the equipment on a multiposition adjustable stand during the scanning operation with the patient's body member strapped rigidly in place

Source J. B Beal
Marshall Space Flight Center
(MFS-14102)

Circle 2 on Reader Service Card

SENSING AND DISPLAY IMPROVE BRAIN WAVE MONITORING: A CONCEPT

This concept for increasing the effectiveness of biomedical sensing and display promises greater monitoring capability while lessening skill requirements in operating personnel Present techniques, based on commercially available instrumentation, monitor passive brain waves from a number of discrete probe contacts (usually 10 for each hemisphere of the brain) applied externally with a conductive attachment paste The waves, after amplification, are printed out in strip chart form, requiring interpretation by skilled medical personnel Because of the limited number of probes, the fact that only passive signals are recorded, and the method of data presentation, only massive tumors or lesions, extensive in masking effects and affecting large areas of the cortex, are detectable

The new concept overcomes these deficiencies by employing the following techniques (1) The number of probe points is increased from 10 to 25 or 50 per hemisphere in order to locate lesions or tumors more precisely The preamplifier gain attainable with usable signal-to-noise ratios determines the optimum number of probe points (2) Microelectronic preamplifers are used so that each stage permanently mounts adjacent to its probe contact point Power supply voltages can be maintained at relatively low levels with low current drain A successful design could operate at levels of 10 to 20 volts with total power dissipation of 3 to 5 milliwatts per preamplifier Thus, the ability to attain required signal-to-noise ratios is appreciably enhanced

A major feature in this concept is the deployment of an increased number of probe locations in a fixed array within a semiflexible plastic housing for each hemisphere The housing incorporates a shielding ground plane (Faraday shield) to prevent radio frequency interference This permits greater gain factors in the individual amplifiers, improving sensitivity and signal-to-noise margins

The display system organization samples each channel input from the monitoring array at a rate at least twice as great as that of the frequency-time wave forms under consideration, in accordance with the Nyquist sampling theorem However, since detailed comparison of waveform characteristics is a necessity, the sampling rate per channel may be greater than the characteristic waveform frequency-time relationship by a factor of ten or more

The information sampled on a per-channel basis is converted into binary digit form and stored in a computer memory bank

At some later time, after the introduction of a perturbing input, such as one used to produce "evoked" potentials, the sampling and storage operations are repeated The computer system operates to compare the original signal with the new one, while signals are still in binary form Differences are displayed on a cathode ray tube (CRT), together with the signal waveforms themselves Alternatively, the differences may be augmented by the use of "Z" modulation on the face of the CRT

Source R L Trent
Electronics Research Center
(ERC-10233)

Circle 3 on Reader Service Card.

BIOMEDICAL RECORDING SYSTEM

A new Biomedical Recording System which collects medical data directly from the patients, incorporates a means for permanently recording and displaying the following parameters electrocardiograph (ECG) and electroencephalograph (EEG), heart rate, respiration rate and approximate depth by impedance pneumography (ZPG), auscultatory blood pressure, leg circumference changes, body temperature, and time (IRIG-B code) Because the system is designed for easy operation, the operators need not be technically skilled, and the system is electrically grounded to avoid endangering the patient

The recording and readout units, designed for compatability, are packed in three carrying cases resembling personal luggage The time required for setting up and checking the instruments is less than 30 min Data are recorded on magnetic tape for machine analysis

Readily available components are incorporated into the system wherever possible Specific system units are as follows the three carrying cases for signal conditioning and data monitoring equipment, plus accessories, complete case-interconnecting harnesses, special-subject harnesses and four normal-subject harnesses, two blood-pressure cuffs with microphones, one audio microphone-speaker set, with cable, sufficient recording supplies for more than 12 hr operation, and several plug-in modules for the signal-conditioner case

The plug-in modules include one signal conditioner each for the ZPG, blood pressure, and cardiotachometer, one vector (VCG) resistor network, two signal conditioners each for the leg circumference, EEG, and body temperature, and three blank plug-in units

A magnetic-tape recorder-reproducer can record or reproduce at least seven data channels continuously and can handle 1 hr of vocal annotation without changing tape Magnetic tape is the primary recording medium, but a graphic recorder can be used simultaneously to record four channels of data with two mark channels

An IRIG-B time-code generator and display unit provides a time code for both recording systems, as well as a digital display of hours, minutes, and seconds An output from the generator initiates the cuff-inflation system

Specific parameters for the tape-recorder channels are determined by the location of the signal conditioners in the signal-conditioner case The output from any signal conditioner can be connected to the signal input circuits of any graphic-recorder channel Taped data can be reproduced on the graphic recorder in the field without adjusting the amplifier gain in either the tape-recorder-reproducer or the graphic-recorder-drive amplifier

The following documentation may be obtained from
National Technical Information Service
Springfield, Virginia 22151
Single document price $6.00
(or microfiche $0 95)

Reference
NASA-CR-101978 (N70-10044), Biomedical Recording System

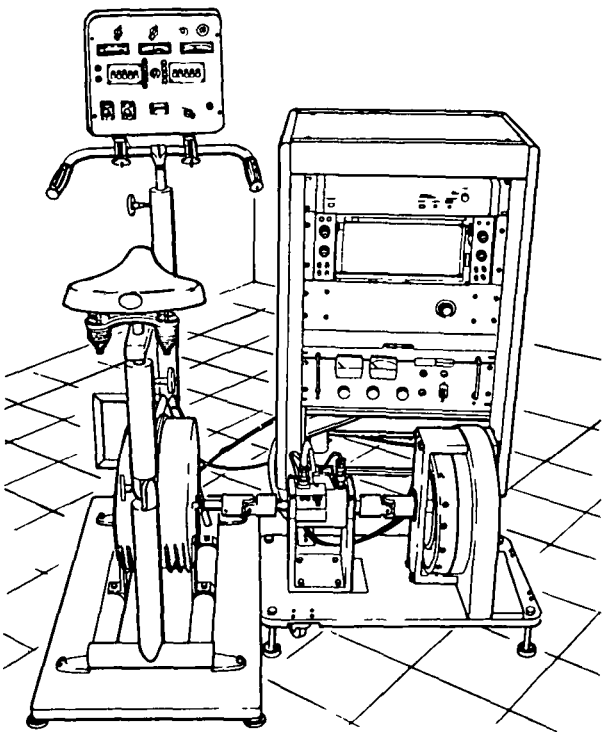
Source H A Vick of
Northrop Corp
under contract to
Johnson Space Center
(MSC-13653)

MULTIMODE ERGOMETER SYSTEM

A manually operable, multimode ergometer system avoids ergometer design and calibration problems, such as inaccurate measurements, large weight, size, and input power requirements, poor heat dissipation, high flammability, and inaccurate calibration

The system consists of (1) a lightweight, accurately controlled, multimode ergometer with low power requirements, low heat output, and minimal flammability, (2) a restraint system for securing the test subject while tests are performed under zero-G conditions or while the ergometer is not in the horizontal position, and (3) a calibration system with which the ergometer can be calibrated to within ±3 0 watts over a range of 25 to 30 watts

The multimode ergometer includes a self-powered load module, a support frame, an electronics module,



a control panel, a programmer, and an operator-support device for hand-mode operation

The load module consists of a lightweight metal housing containing a gear and pulley system, a dc torque motor (operated in the generator mode), a flywheel, a load cell, a speed pickup, and heat-producing electronic components A polyimide spur gear is meshed with a steel gear to reduce noise, weight, and flammability A flywheel, bearing-mounted on the drive shaft, is gear-belt driven to produce a calculated inertia of approximately 2 16 kg-m^2 (1 48 slug-ft^2) The dc motor, in the generator mode, is a 14 9 joule (11 ft-lb) motor capable of an output of 350 watts This output is used in conjunction with a force sensor to produce the system load

The frame is of simple welded tube construction with adjustable, stowable handlebars and seat The pedal configuration may either be stowed or used in the hand or foot mode of operation

Control and display components are conveniently located for operator viewing and adjusting A programmer provides for work load control in five protocol steps in which the heart rate per step can be selected over the range of 100 to 200 beats per minute, in increments of 10 beats per minute, and the time can be selected from 1 to 10 minutes, in increments of 1 minute A switch provides for selecting either the ECG vest or the ear heart rate detection sensors. Provisions are made for automatic shutdown of the load at heartbeat rates of 160, 170, or 180 beats per minute Program reset may be accomplished at any time, if desired, and work rate may be programmed by heart rate, or selected manually through the range of 25 to 300 watts

Visual display of actual heart rate, pedal speed, actual work rate, and total work rate is provided.

The necessary electronics for programmer control and display are in solid-state modules for easy repair and light weight

The restraint system consists of a form-fitting body belt with padded suspenders for comfort and as protection for ECG electrodes and conductors It secures the operator firmly yet comfortably on the ergometer seat, without restricting body movement or blood circulation. It is easily donned and adjusted, essentially by one-hand operation

A horizontal strap between the ends of the body belt temporarily secures the operator to the ergometer seat at zero-G conditions while the remaining equipment is secured and adjusted The fastening devices secure easily, provide positive attachment to prevent failure under imposed working loads, and detach quickly for safety purposes

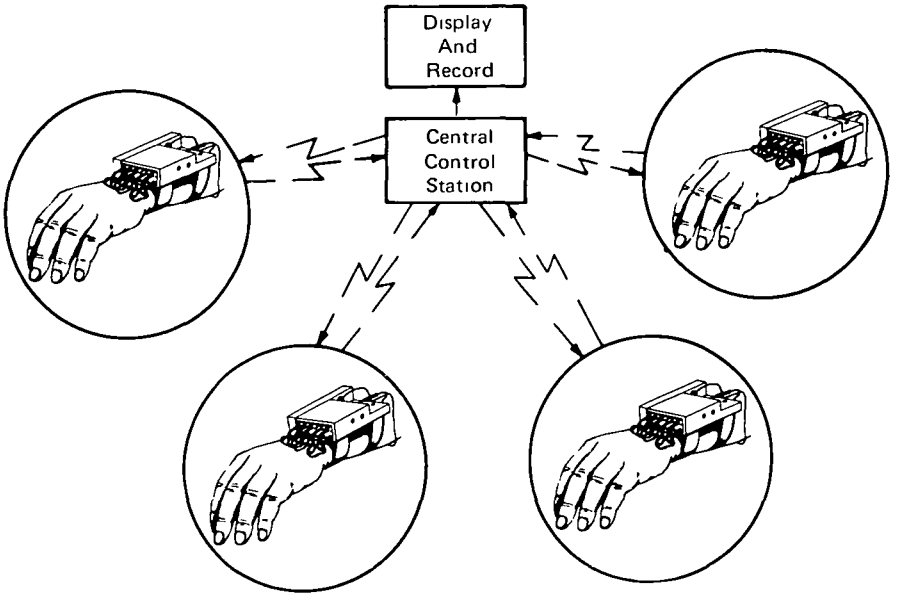
The calibration system consists primarily of a 95 2 joule (70 ft-lb) torque motor and supporting frame, a power supply, a 110 joule (83 ft-lb) torque sensor, a power computer, a multirange recorder, and a power controller

A speed control feedback system with an input for the ergometer maintains the calibrator motor at the desired speed over the operational torque range Signals from the speed pickup and a slip-ring strain gage system in the torque sensor are fed to the power computer, where they are displayed as rpm and torque respectively. In addition, they are multiplied and displayed as watts and horsepower

Source R L Gause, R. A Spier, and B. G. Bynum
Marshall Space Flight Center
(MFS-21044, 21045, 21046)

Circle 4 on Reader Service Card

AUTOMATED SYSTEM MONITORS PATIENTS



This radio-linked patient monitoring system is capable of collecting several channels of physiological data from as many as 64 hospital patients and transmitting the data to a central control station The information is transmitted in digital form for direct processing by a computer

The system consists of a central control station and battery-operated patient units comprising small strap-on electronics packages designed to ensure minimum encumbrance and discomfort to the patients, who may be either ambulatory or bedridden A complete patient unit, including battery, weighs less than one pound Conventional biomedical sensors are associated with each patient unit Typically, sensors include 4 electrocardiogram electrodes, 2 thermistors for temperature measurement, and a strain gage consisting of a mercury-filled silicone rubber tube which is slipped over a big toe or a thumb to monitor blood pressure pulsations

The central control station and patient units share a single broadcast frequency pair A patient unit is not active until it is interrogated by the control station and signaled to transmit its data for central display and recording During normal "all patients" operation, each of the patient units in the system is interrogated in turn for two seconds by a coded message from the central control station In this period, the patient unit addressed transmits its data to the central station for display and/or recording In the "single patient" mode of operation, any patient can be continuously monitored by setting a selector switch in the central station to the desired patient number

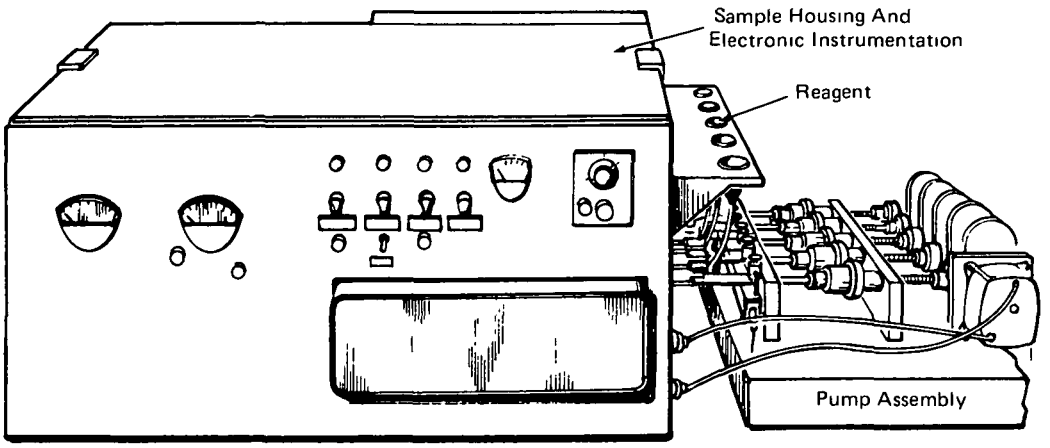
The feasibility of this system has been demonstrated in tests involving two patient units at distances of more than 125 feet from the central station With further development, a system is envisioned which would enable several central stations to monitor the physiological condition of a large number of patients for routine detection and treatment of disease Particularly advantageous application of this system would be in intensive care wards

With appropriate selection of transducers and signal conditioning circuitry, the system could be used to monitor a wide variety of industrial processes

Source R E Bedard, W S Dawson, and R L Buxton of
The Boeing Company
under contract to
Marshall Space Flight Center
(MFS-14552)

Circle 5 on Reader Service Card.

AUTOMATIC BIO-SAMPLE BACTERIA DETECTION SYSTEM



An automatic electromechanical device greatly reduces the time required for bio-sample analysis in the detection of bacteria Bio-samples, such as urine specimens, can be analyzed in 15 minutes, and the instrument processes a sample a minute Since urinary tract infections are indications of kidney or bladder disease or diabetes, and since the occurrence of such infections in the United States is second only to that of respiratory ailments, examination of urine for bacteria is an important and frequently conducted procedure in the clinical laboratory

Present techniques to find bacteria in urine involve incubating the specimen with nutrients on an agar surface for one or two days, and counting the visible number of bacterial colonies This number provides an index of the number of viable cells capable of dividing However, considerable time is required to complete the analysis, and the process can only be performed in the laboratory by skilled microbiology technicians

With the device just developed, the time and skill required for such analyses are minimized, and although the unit has only been built in prototype, it is conceivable that it could be made portable for nonlaboratory use

Basic research behind the system design concerned means of detecting microbiological life on other planets, using two chemicals – luciferase and luciferin – found in the common firefly These chemicals produce a bioluminescent reaction when in contact with adenosine triphosphate (ATP), which is found in all living organisms. In urine samples, the concentration of bacterial ATP is directly proportional to the number of bacteria present in the sample

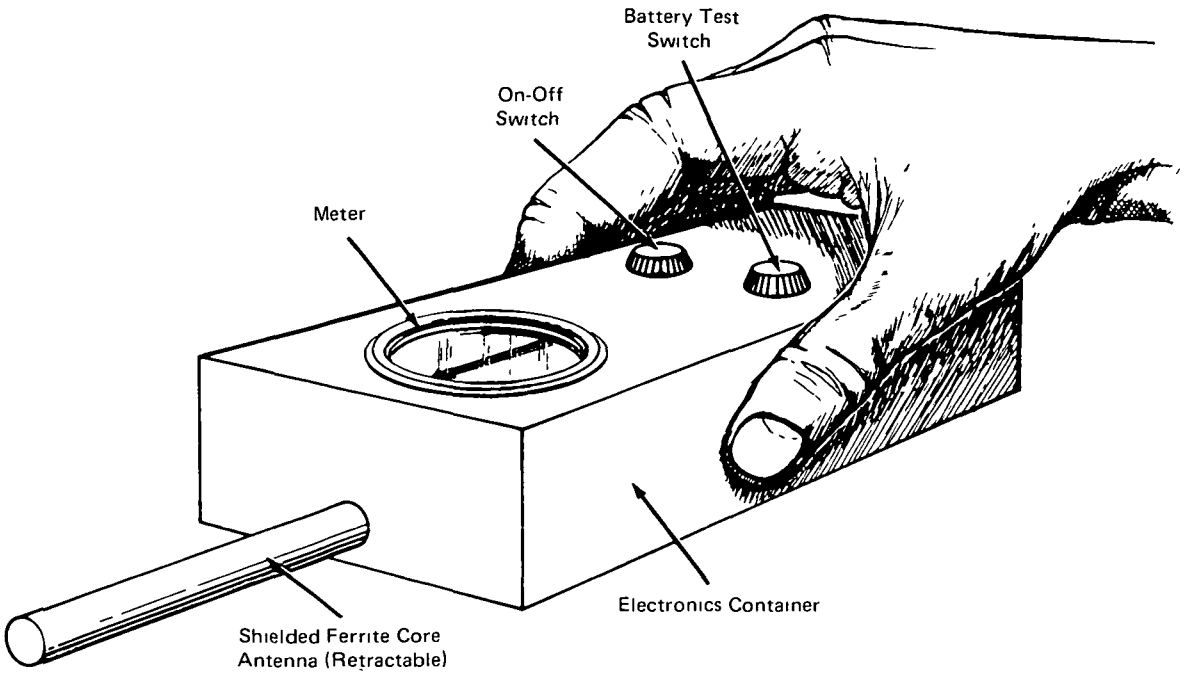
In operation, the vials containing the urine samples are placed in openings in the periphery of the revolving table inside the light-tight housing As the table turns, a series of spouts located at specific points around the table sequentially dispense chemical reagents into the vials to remove ATP from nonbacterial sources and release bacterial ATP The amount of reagent dispensed by each spout is controlled by a pump system located outside the housing At the final test point, a photomultiplier tube senses the light from the bioluminescent reaction in the urine when the luciferase-luciferin mixture is added The output signal from this photomultiplier is directly proportional to the bacterial ATP concentration, which in turn is proportional to the number of bacteria present in the sample. When the reaction measurement is completed, the vials are ejected from the table

The instrument has potential application to other physiological fluids, such as blood or spinal fluid, in tests where bacterial count is of immediate importance It can also be used to detect and count bacteria in any fluid source, including water supplies, containing living organisms

Source G. L. Picciolo, B N Kelbaugh,
E. W Chappelle, and M Colburn
Goddard Space Flight Center
(GSC-11169)

Circle 6 on Reader Service Card.

DETECTOR FOR METAL FRAGMENTS IN THE HUMAN BODY



A small, portable electronic device (see figure), based on the design of an eddy current gage used for measuring the thickness of foam insulation on a metal surface, has been proposed as a rapid and safe means for detecting and locating nonferrous as well as ferrous metal fragments (or larger objects) accidentally introduced into the human body Present X-ray methods are relatively cumbersome and slow, and present a radiation hazard In addition, the X-ray equipment is generally at an appreciable distance from the accident site It is believed that the proposed device would be of emergency value to doctors in war zones and at accident sites, and to surgeons in hospital operating rooms.

The circuit is an early model of the eddy current gage developed for measuring the thickness of foam insulation A specially designed oscillator circuit is supplied regulated power from a battery. To minimize the generation of eddy currents in the human body itself, the oscillation frequency is maintained at 20 to 40 kHz. When the ferrite core antenna with inductance windings is passed over an area containing imbedded metal, the induced eddy currents in the metal are reflected as an abrupt frequency shift in the circuit. An indication of this change appears on the meter connected between the emitter-follower and power supply. Laboratory tests have shown that a search of an area from two or more angles will accurately locate the position of a metal fragment imbedded in the area This device would be capable of detecting a 22-caliber bullet at distances up to 1 ft. within a 1.27 cm (0 5-in.) diameter circle The electronic circuitry and retractable antenna could be packaged into a container having a volume of approximately 984 cm^3 (60 cu in) and weighing approximately 0 907 kg (2 lb)

Source R. L Brown and R W Neuschaefer
Marshall Space Flight Center
(MFS-14797)

Circle 7 on Reader Service Card

DIRECT READING OF PULSE AND RESPIRATION RATES

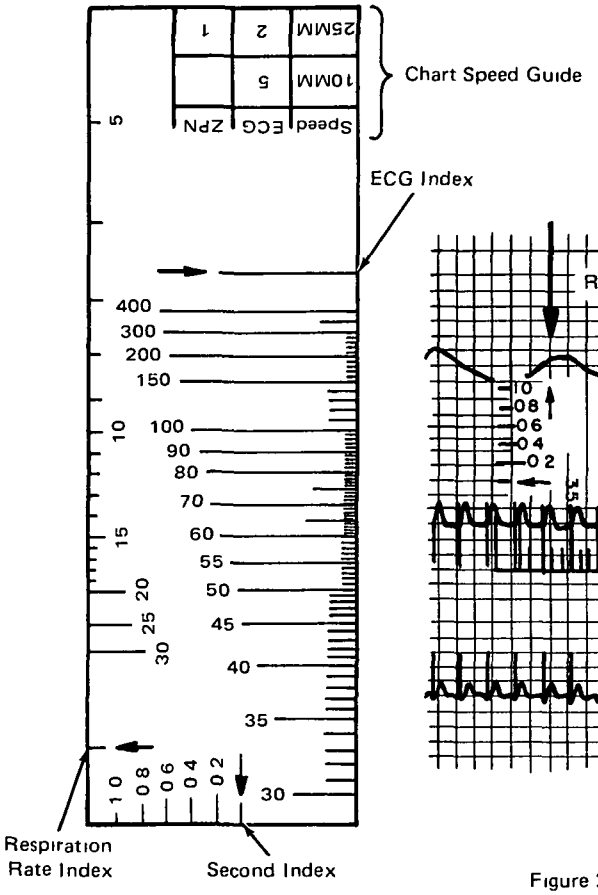


Figure 1 Scaled Card

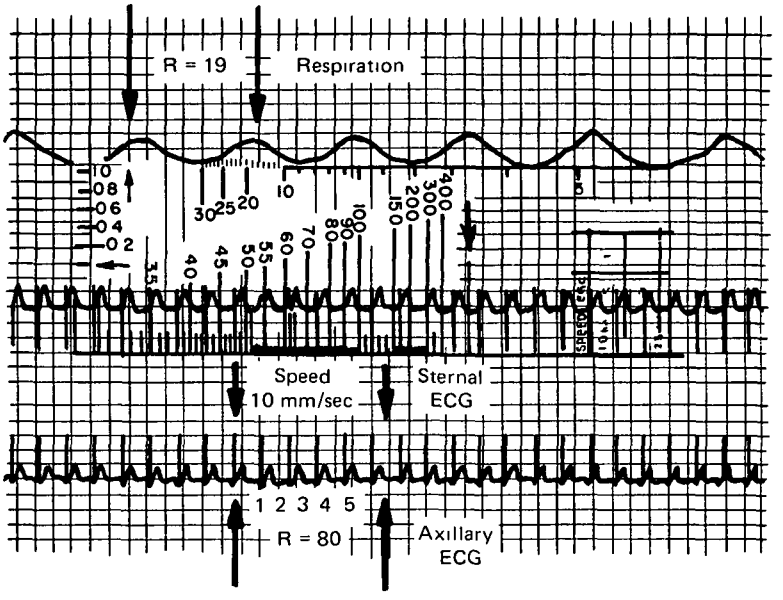


Figure 2 Card used to read respiration rate of 19 cycles/min

This technique enables quick and direct reading of pulse and respiration rates Formerly, the quick method of reading recorder traces of electrocardiograms and respiration rates consisted of analysis of a 10-second period and multiplication by six for a count That procedure could result in errors

In this method, the appropriate index of a calibrated card of transparent plastic, about 6 inches long (Figure 1), is aligned with a repetitive point on the electrocardiogram or respiration complex For recorder speeds of 10 and 25 mm/sec the number of complexes are counted as indicated on the card, and the heart or respiration rate is read directly from the appropriate scale (Figure 2) For other recorder speeds, the number of complexes to be counted is determined by simple numerical conversion (speed 5 mm/sec = 10 ECG, 2 ZPN) The readings yielded are accurate as well as immediate, they save much time in data analysis

Also incorporated on the card is a second indicator for aiding measurement of time intervals on the electrocardiogram complex at 25 mm/sec Doctors, hospitals, and health authorities may be interested

Source J P Wise
Kennedy Space Center
(KSC-10233)

No further documentation is available

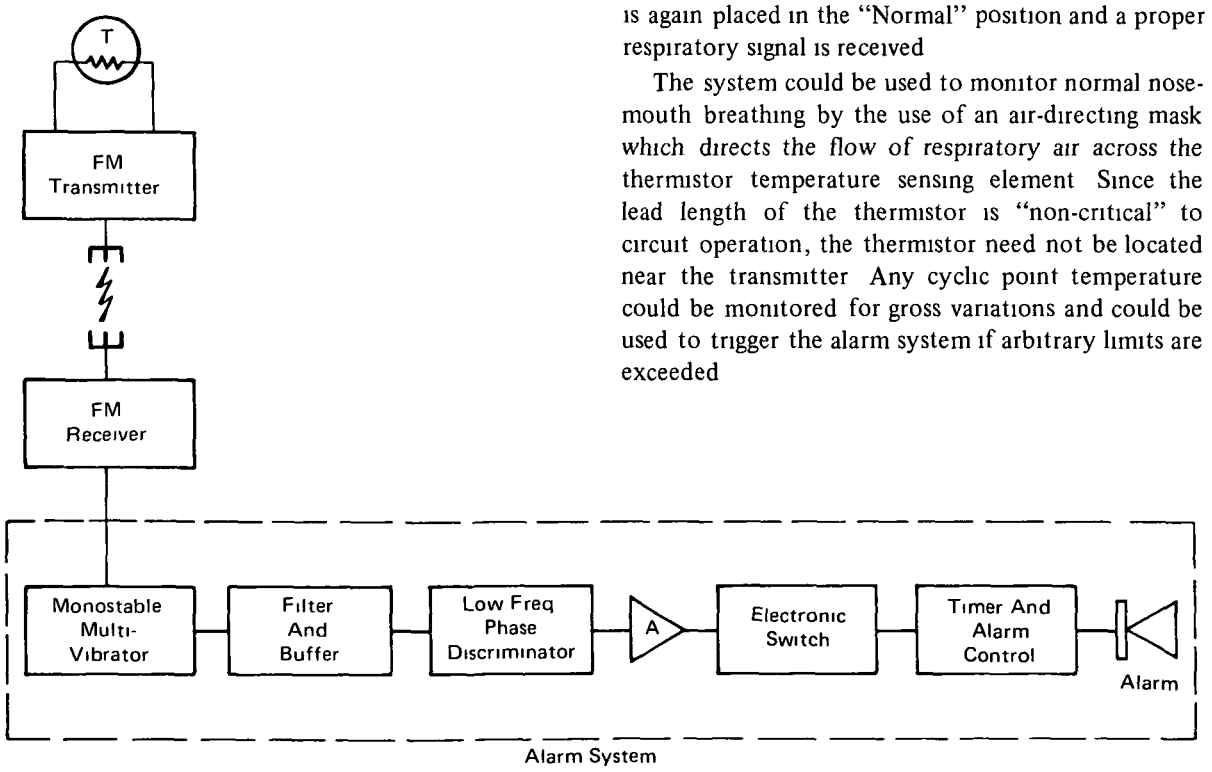
PATIENT RESPIRATION REMOTELY MONITORED BY RF SIGNALS

Tracheostomy tubes are surgically implanted in the wind pipes of patients to relieve breathing difficulties In the past, this required continual attendance by a nurse to detect tube clogging and the onset of suffocation This is extremely expensive and very demanding since a lack of oxygen for a 2 to 4 minute period can result in death or brain damage

This monitoring system immediately recognizes respiration failure or decline, and actuates an audible and/or visual alarm The system incorporates a miniature radio transmitter, so that the patient is unencumbered by wires, yet can be monitored from a remote location such as a nurse's station or a room other than the patient's room at home

The temperature sensor/FM transmitter is attached directly to the tracheostomy tube, thereby allowing the inspired and expired air to flow directly over a thermistor temperature sensor This sensor responds to differences in the temperature of the airflow through changes in its resistance The FM transmitter has a nominal subcarrier pulse frequency which increases as the thermistor resistance decreases with increasing temperature An FM receiver is used to receive the respiration signal The pulsed receiver output is used to trigger the alarm system The first stage in the alarm system is a monostable multivibrator which provides amplitude discrimination against changes in the level of the receiver output signal This output is filtered, buffered by an emitter-follower, and coupled to a low frequency phase discriminator which serves as a frequency-to-voltage converter The voltage changes caused by respiration are amplified with an adjustable gain of approximately 2 to 23 and are used to actuate an electronic switch which provides a reset pulse for each respiratory cycle considered to be of sufficient length (as determined by the setting of the amplifier gain control) The reset pulse is used to discharge a capacitor that serves as the timing element of the alarm control If the capacitor does not receive a reset pulse for a preselected time (arbitrarily chosen to be 10 seconds), the alarm control actuates an audible and/or visual alarm A "Reset-Normal" switch is provided that turns off the alarm when placed in the "Reset" position and allows 1½ minutes to clear any obstruction in the tracheostomy tube At the end of this time interval, the alarm will sound again and will continue to operate until the "Reset-Normal" switch is again placed in the "Normal" position and a proper respiratory signal is received

The system could be used to monitor normal nose-mouth breathing by the use of an air-directing mask which directs the flow of respiratory air across the thermistor temperature sensing element Since the lead length of the thermistor is "non-critical" to circuit operation, the thermistor need not be located near the transmitter Any cyclic point temperature could be monitored for gross variations and could be used to trigger the alarm system if arbitrary limits are exceeded



A prototype system has been assembled largely from components developed for space research purposes. First trials using this equipment to monitor the respiration of human patients have been conducted at Children's Hospital Medical Center, Oakland, California after initial experiments on a young dog The patients, all children, had had tracheostomy tubes implanted and ranged in age from 6 weeks to 4 years These trials, conducted under continuous monitoring by a doctor or a nurse, are continuing with excellent results An indication of the sensitivity of the apparatus is provided by the fact that it was successfully used to monitor the respiration of a six week old child that was housed in an isolette where the temperature is maintained at 80°F (29°C).

Source J M Pope and J Dimeff
Ames Research Center
(ARC-10174)

Circle 8 on Reader Service Card.

ELECTRONIC SLEEP ANALYZER

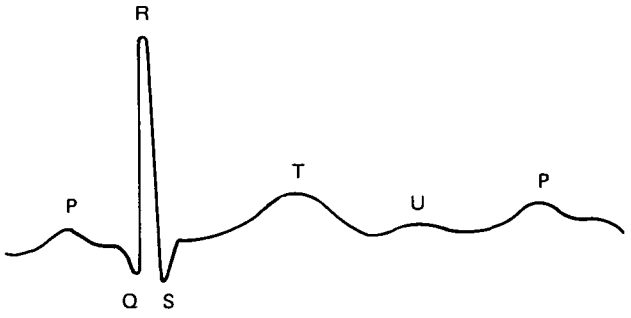
An electronic analyzer instrument has been designed and constructed in prototype form to automatically monitor the stages of sleep of a human subject The analyzer provides a series of discrete voltage steps with each step corresponding to a clinical assessment of level of consciousness awake, drowsy, light sleep, deep sleep, and abnormally deep sleep (e.g , coma). The sleep level is also indicated by the illumination of one of six panel lamps The instrument is based on the operation of an EEG (electroencephalogram), as the latter is generally recognized to be the most dependable indicator of the occurrence of sleep and of the various stages of sleep The new instrument has been designed for possible use in manned spaceflight monitoring and would therefore have to be independent of human experts for proper interpretation of the data over extended time periods In addition, for such use, it must operate over a limited telemetry bandwidth to allow continuous transmission of conventional EEG activity This analyzer differs from previous sleep analyzers in that it includes all of the following features (1) packageable in small size (for use on a spacecraft), (2) requires very little telemetry bandwidth or time, (3) designed specifically for the determination of state of sleep, (4) operational in real time, (5) requires only one channel of EEG activity (central to occipital), and (6) not excessively biased by occasional electrode or movement artifacts

The instrument uses selected aspects of the total available EEG signal to continuously assess the subject's state of consciousness or sleep, this assessment is expressed as a dc output voltage proportional to sleep stage It considers approximately 15 sec of EEG before making a decision concerning the level of sleep, and therefore the output changes very slowly Thus, the desired information can be telemetered using as few as 3 samples per minute (each sample could be a 3-bit number proportional to the output voltage of the analyzer) This method is comparable to that of human interpretation, in which a block of EEG signals several seconds in duration is ordinarily considered as a whole, rather than in a wave-by-wave analysis

Source J D Frost, Jr of
Baylor University College of Medicine and
The Methodist Hospital
Houston, Texas
under grant from
Johnson Space Center
(MSC-13282)

Circle 9 on Reader Service Card

CARDIAC R-WAVE DETECTOR



ECG Input Waveform

This device is designed to obtain a reliable signal from a natural heart's systolic contraction in order to coordinate the action of a heart-assist device with the action of a failing natural heart The cardiac R-wave detector processes the natural heart's electrocardiac signal in a sequence of operations which essentially eliminates all components from the input signal except the R-wave

At the beginning of the heart's pumping cycle, the isometric contraction of the ventricular muscle mass generates a pronounced electrical signal known as the QRS wave complex of the electrocardiogram (ECG) The R-wave portion of the QRS complex can be detected and used as the reference signal for a heart-assist pump cycle The cardiac R-wave detector obtains an input signal from surface electrodes attached to the patient's right arm and left leg and produces an electrical output pulse used to actuate a heart-assist device It does not require the use of blood pressure or pump pressure waves

The cardiac R-wave detector processes the input signal in a sequence of operations which detects the R-wave in the presence of high electrical interference All false signals except those generated by vigorous motion or extreme muscle tensions are rejected In succession, the detector's electronic circuit rejects signals that occur equally from the two surface electrodes attached to the patient's body, attenuates low- and high-frequency components, rejects low-amplitude signals, rejects short-duration signals, and rejects signals during the pumping time of the heart-assist pump

Advantages of this detector, compared to conventional detectors, appear to include, better discrimination between the R- and T-waves, generally better noise filtering characteristics, and flexibility in the polarity of the trigger pulse

The following documentation may be obtained from
National Technical Information Service
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0 95)

Reference
NASA TM-X-1489 (N68-13999) Cardiac R-Wave Detector

Source V D Gebben
Lewis Research Center
(LEW-10394)

SYSTEM MONITORS POST-OPERATIVE CRANIAL PRESSURE

A system has been devised for post-operative monitoring of fluidic pressures within the cranial cavity at or near the site of neurosurgery Provision is made for both meter-indication and short-term chart recording of such pressures High and low limits can be preset, utilizing electroptical limit-detection devices, adjustable in accordance with the physicians' requirements, if these limits are exceeded, subsidiary alerting signals may be activated

During initial recovery periods following extensive neurosurgery, the body's normal recovery pattern results in increased cranial fluidic pressures at the site of the trauma One of the major problems encountered in monitoring the patient's condition is the similarity of response of immediately available indicators, such as physical responses and body temperatures, and their trends due to increased cranial pressures, the formation of hematoma, and/

or infection The actions required by the physician to enhance recovery differ widely, depending upon the causative factors involved

This monitoring system utilizes a miniaturized pressure-sensing transducer, combined with suitably stable amplification means, a meter provided with a scale calibrated in terms of pressures in an appropriate range of millimeters of water, and a miniaturized chart recorder covering a similar range of pressures The transducer can be sterilized in accordance with normal operating room chemical procedures

This system could also be used in those cases involving reduction of aneurisms associated with major branches of either carotid artery within the cranium It is common practice, following such an operation, to temporarily clamp off the associated carotid artery to promote healing and reduce blood pressures at the site of the operation Arterial blood flow to that hemisphere of the brain is maintained through the "circle of Willis", using the unclamped carotid artery as the prime source of blood supply A commonly encountered problem is the sympathetic reduction of blood flow through this carotid artery which could result in dangerously low levels of blood flow to the brain On the other hand, excessive blood pressures at the site of the operation frequently necessitate further operative procedures

For this application, the pressure transducer could be sutured in the carotid artery, between the site of the operation and the arterial clamp, and the monitoring pressure scale of the instrument changed to an appropriately lower range A range shifting switch, modifying the forward-current transfer ratio of the amplification means, is provided for this purpose The low-pressure limiting feature would be employed to provide an alerting indication and to automatically open up the arterial clamp The high pressure limiting feature would be used to provide an alerting indication only Since it is possible for a decrease in cranial blood pressure to lag blood flow loss to the brain by a period of time measurable in minutes, and since considerable variation among patients exists in what might be considered normal, it may be desirable to use an additional monitoring transducer to reduce this time lag The additional transducer could take the following forms (1) a means of monitoring actual blood flow through the unclamped carotid artery, the transducer output reflecting volume flow, (2) a means of monitoring the blood pulse amplitude of the unclamped carotid artery, or (3) an EEG probe whose output provides an indication of brain activity in the region of the electrode contacting area If the peak EEG amplitude decreases by some appreciable proportion (10-20%), this information would serve as an energizing input

If any of the additional transducer outputs noted above were made available, a suitable logic-combining OR function could be introduced at the input of the system to energize the low-limit feature

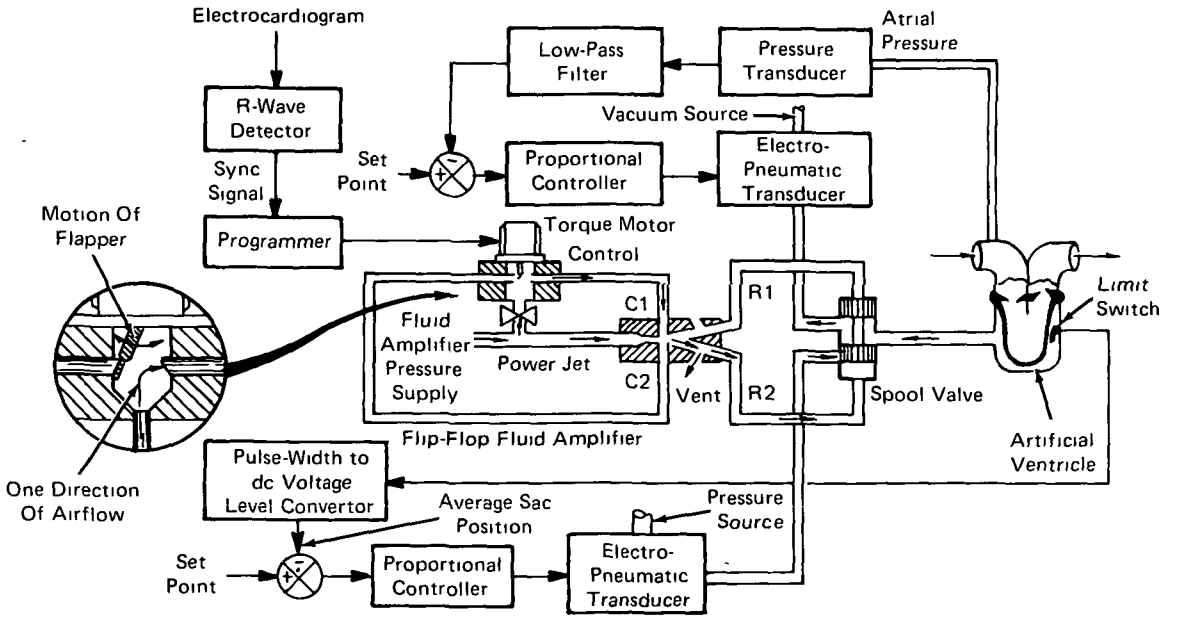
A modified carotid arterial clamp has been designed which provides failsafe operation in the event of power failures The clamp retains the pressure "reset" feature, and incorporates a quick-release solenoid normally held "ON" to apply pressure to the artery If the power fails, or the low-level indication point is exceeded, the solenoid releases the clamp without applying any torquing force An auxiliary battery provides an audible alarm in the event of local or general power failures

For patient convenience, all hard-wired interconnections between patient and monitoring equipment could be replaced by existing telemetry equipment and systems

Source R L Trent and L E Long
Electronics Research Center
and C A Fager, Jr of
Lahey Clinic
under contract to
Electronics Research Center
(ERC-10336)

Circle 10 on Reader Service Card.

CONTROL SYSTEM FOR AN ARTIFICIAL HEART



This system was designed to drive a pneumatic, sac-type, heart-assistance blood pump with a controlled pulsatile pressure that makes the pump's rate of flow sensitive to venous (atrial) pressure. The stroke is centered about a set operating point and the pump is synchronized with the natural heart

A combination of relatively inexpensive industrial pneumatic components produces a control system for a heart-assistance pump having the greatest degree of simplicity consistent with the required degree of sophistication in control

An R-wave detector (see figure) senses the occurrence of the R-wave of an electrocardiogram and triggers a programmer The programmer generates a pulse, adjustable in duration, with its leading edge adjustably delayed after the occurrence of the R-wave. The programmer drives a small torque motor that alternately caps the control ports of a fluid-amplifier The output of the amplifier causes a spool valve to shuttle and alternately supply gas pressure and vacuum to the blood pump to initiate the artificial heart's systolic and diastolic strokes

The pump is controlled by manipulation of the levels of gas pressure and vacuum supplied to the spool valve over a period of several heartbeats, manipulation is by means of standard industrial process-controllers coupled to industrial electropneumatic transducers. Venous pressure is fed back to the vacuum-controller, thereby controlling the volume to which the sac fills The output of a limit switch indicates distension of the sac The signal from the limit switch is fed back to the pressure-controller to increase the volume of the ejection stroke until the sac barely reaches full distension at the end of filling

All components but the R-wave detector and the programmer are standard industrial units, thus, the system combines simplicity with versatility and reliability Venous-pressure (atrial) and sac-position feedbacks provide the necessary sensitivity of the blood's rate of flow to venous pressure without ventricle overtravel Thus the blood's average rate of flow can be changed to accommodate change in physiological demand and to ensure a balance of blood volumes in pulmonary and systemic circulations

By substitution of a free-running oscillator for the R-wave detector and addition of a second output-pressure channel, the system can be used to control a total-heart-replacement pump The oscillator provides a variable pulse rate, and the two output-pressure channels provide pulsatile driving pressure for the left and right heart-replacement pumps

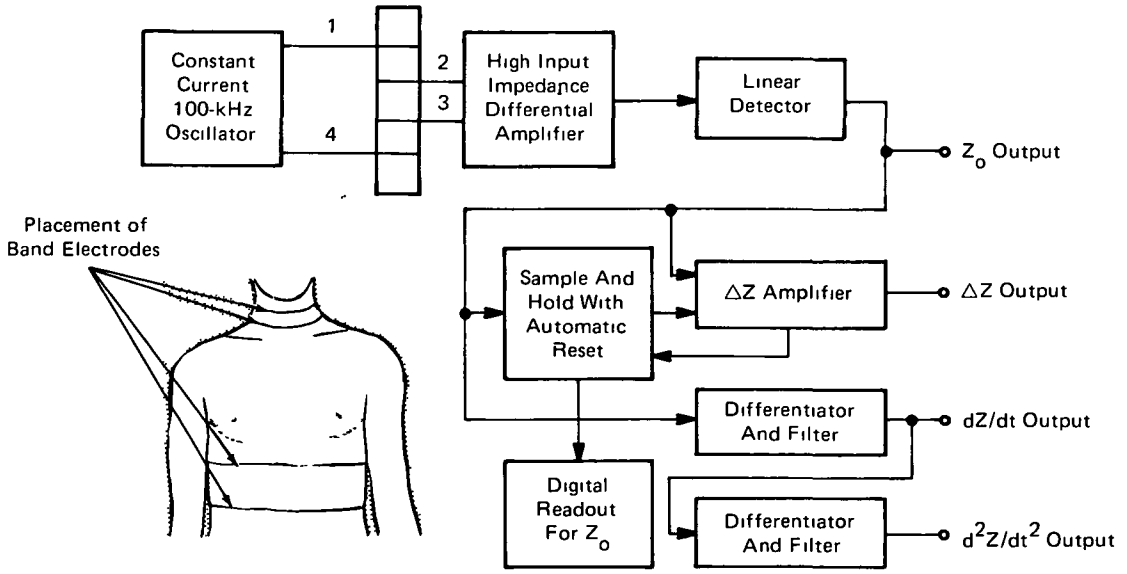
The following documentation may be obtained from
National Technical Information Service
Springfield, Virginia 22151
Single document price $6 00
(or microfiche $0.95)

Reference

NASA-TMX-1953 (N70-17953), Design and Performance of a Heart Assist or Artificial Heart Control System Using Industrial Pneumatic Components

Source J. A Webb, Jr , and V D Gebben
Lewis Research Center
(LEW-11057)

NEW ELECTRICAL IMPEDANCE PLETHYSMOGRAPH MONITORS CARDIAC OUTPUT



A four-electrode impedance plethysmograph has been developed to satisfy a need in medical clinics and research laboratories for a simple, bloodless method of measuring ventricular stroke volume or cardiac output of humans In using the instrument, two band electrodes are placed around the subject's neck, a third band is placed around the thorax at the level of the xiphisternal joint, and a fourth band around the lower abdomen The electrodes at the upper neck and the abdomen are excited by a 100 kHz sinusoidal current and the resultant voltage (impedance) changes occurring with the cardiac cycle are monitored from the other two electrodes Stroke volume is calculated from the first time derivative (dZ/dt) of the impedance change data, using a formula relating impedance change to volume change in a conducting medium The new instrument is automatic, operates with only one recording channel, and minimizes patient discomfort

As shown in the block diagram, current from the 100-kHz oscillator is fed to the thorax (bands 1 and 4) by means of coaxial cables These have electrically driven shields to reduce the effective cable capacity and thereby maintain high output impedance at the electrodes. The voltage from the thorax (bands 2, 3) is recorded by a differential amplifier having coaxial leads The use of this amplifier allows a ground to be placed anywhere on the body The differential input

impedance of the amplifier measured at the cable ends using 100-kHz current is 10^5 ohms. Positive feedback is used on the input to reduce the effects of cable capacity. The common mode rejection is 50 dB at 100-kHz The output of the differential amplifier is fed to a linear detector, whose output in turn is fed to a stable sample and hold circuit and to the ΔZ (impedance change) amplifier This amplifier also receives an input from the sample and hold circuit and subtracts the two inputs to give the ΔZ output.

The sample portion of the sample and hold circuit can be operated either manually by a switch or automatically The automatic operation is achieved by sensing the output of the ΔZ amplifier and then sampling when the output exceeds an adjustable preset limit. This allows the system to record the small Z changes due to the cardiac signal, but if respiration, movement, or other artifact causes a larger change in Z, the system will automatically rebalance in approximately 40 milliseconds The output of the detector is also fed to two analog differentiators to give the first and second time derivatives (dZ/dt and d^2Z/dt^2 respectively). The null balance circuit connected to the sample and hold output nulls an accurate dc voltage against the output of the sample and hold circuit to accurately measure the value of the mean impedance Z_0

Significant features of this impedance plethysmograph are as follows

1 High output impedance (10^5 ohms) at the electrodes for the current source
2 High input impedance (10^5 ohms) at the electrodes for the voltage pickup system
3. Use of a floating electrode system not requiring grounding
4 One percent absolute accuracy and linearity
5 Fully automatic operation with a balancing time of 40 milliseconds
6 Manual balancing that requires only the movement of one switch
7. A low-noise first derivative output (80 mV peak to peak)
8. Power required, 25 watts at 110 Vac (50-400 Hz), weight, 16 lbs , volume less than 1 cubic ft

Source W G Kubicek, R P Patterson, and D A Witsoe of the University of Minnesota under contract to Johnson Space Center (MSC-11447)

Circle 11 on Reader Service Card.

RF TELEPHONE LINKS SPEED EMERGENCY DIAGNOSES

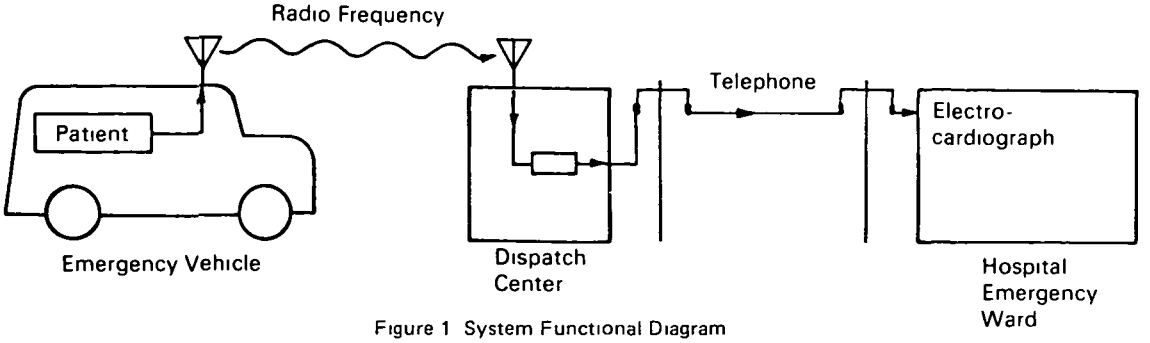


Figure 1 System Functional Diagram

In the handling of injured or stricken human subjects at a distance from hospital emergency facilities, diagnosis has in the past been delayed by that time increment involved in transporting the subjects to the hospital To eliminate the major portion of this delay, a system has been devised whereby the cardiovascular function of the subject may be monitored at the hospital facility by means of an rf/telephone-transmitted electrocardiograph of the subject from the ambulance immediately

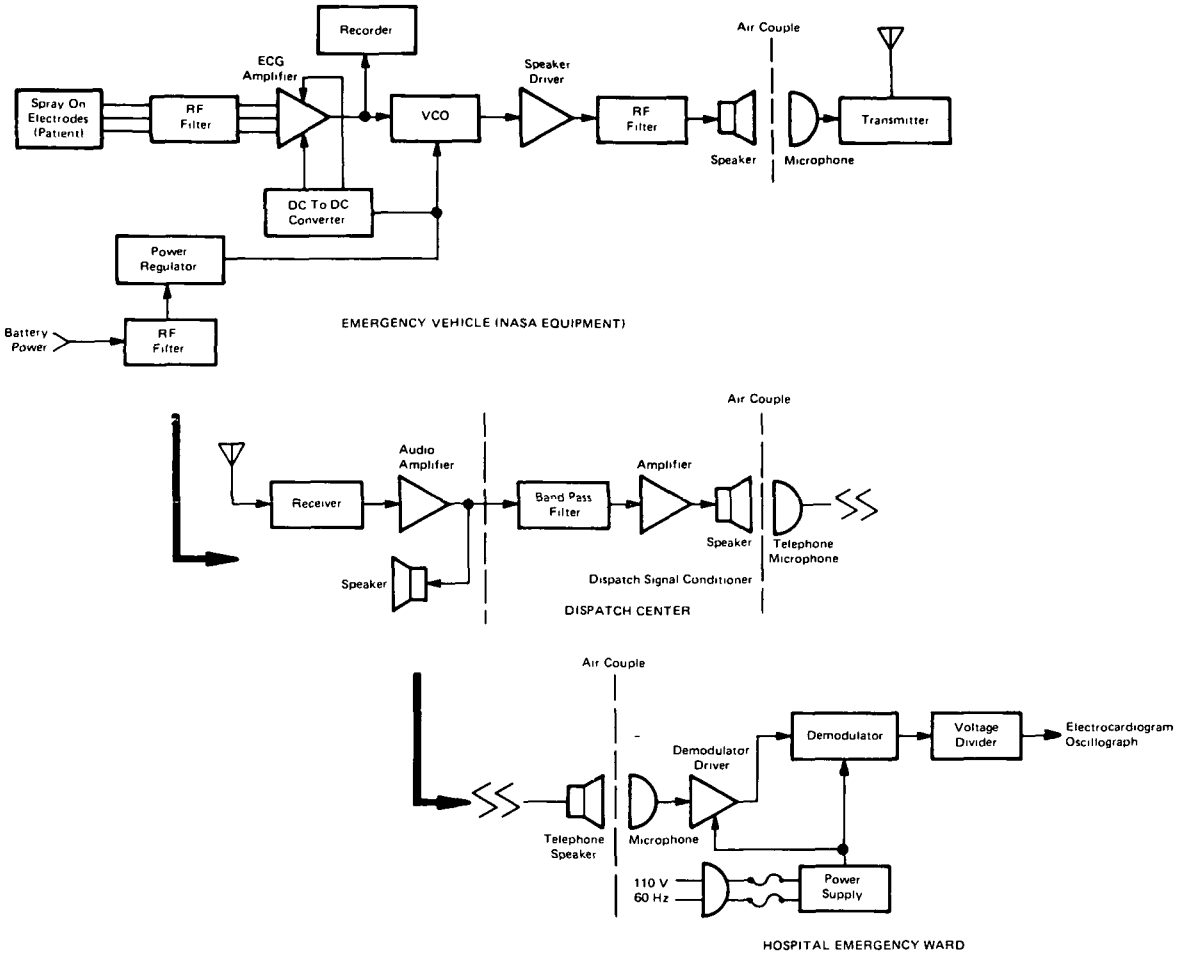


Figure 2 System Detail Diagram

following arrival at the emergency scene Figure 1 shows the system in functional block diagram and Figure 2 shows it in detail

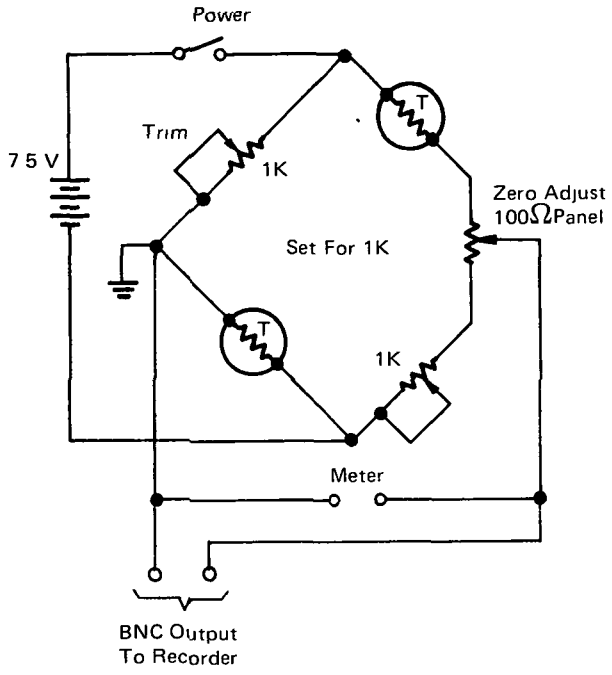
The system permits the use of voice (standard) rf transmitting and receiving components between the ambulance and a centralized dispatch station (to afford optimum use of hospital selection by location) and commercial voice telephone connection to the selected hospital emergency room Success with this idea has been accomplished by a combination of simple amplification and basic filtering techniques in the emergency vehicle electronics and the use of relatively anechoic devices for speaker-to-microphone arrangement at the three operational locations, emergency vehicle, dispatch center, and hospital emergency ward.

This system is presently being used successfully in several communities around the country

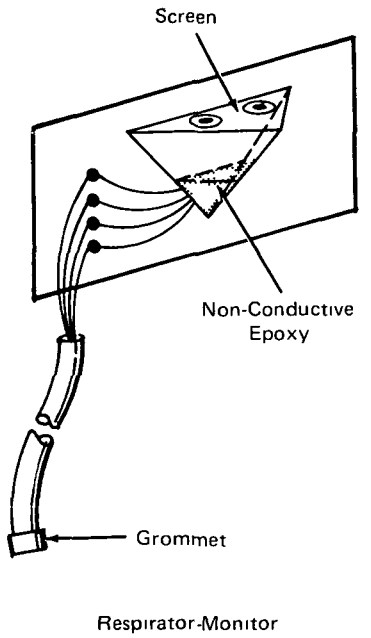
Source C E Lewis, Jr , L. R Carpenter, and R T McDonald
Flight Research Center
(FRC-10031)

No further documentation is available

NOSEPIECE RESPIRATION MONITOR



Dual Thermistor Bridge



Respirator-Monitor

This device monitors the rate and amplitude of a patient's or research subject's respiration and utilizes fast response readout devices in conjunction with a sensor that neither encumbers nor causes discomfort

The nosepiece respirator-monitor is small, easy to wear, inexpensive, and produces signals usable by most conventional high-impedance, rapid-response, medical signal conditioners

This monitor uses inexpensive components and measures respiration in a manner that produces a large signal with minimum delay The system incorporates the fast response of a heated thermistor to ambient temperature changes The thermistor is heated to an impedance of approximately 1000 ohms, from which state it is cooled by patient breath inspiration and warmed by patient breath expiration. The sensor rests beneath the patient's nostrils The lead wires travel above the patient's ears and form a grommet-contained harness about his head. High amplitude response and zero baseline of the system are due to the dual thermistor bridge arrangement shown in the illustration, the bridge yields approximately 11 mV/°C (5.5 mV/°C per thermistor) The nulled output may be fed to any high impedance dc amplifier, signal conditioner, oscilloscope, or recording device

Source L E Long, N E Rice,
and A L Lavery
Electronics Research Center
(ERC-10136)

Circle 12 on Reader Service Card

Section 2.
Diagnostic, Prosthetic, and Therapeutic Implements

ELECTRODE PASTES FOR QUICK APPLICATION AND REMOVAL

An evaluation of electrode pastes for use with electrocardiographs (ECG) and electroencephalographs (EEG) was made by a group of researchers This research represented a further effort to obtain highly conductive, drift-free, noninterfering pastes for medical applications

In the preliminary phase of this study, approximately 300 candidate materials were screened including (a) natural and synthetic rubber compounds, (b) synthetic rubber, (c) various natural and synthetic rubbers and resins mixed with silver metal powder, (d) silicone resins, (e) conductive gels, and (f) a variety of adhesives Natural and synthetic rubber compounds were found to be impractical because they could not readily be made conductive and at the same time retain permanent tack Metal powders such as silver could not be added to rubber compositions without encapsulating the metal Although salt solution could be added to water emulsions of homopolymers such as polyvinyl acetate, they were observed to leave a brittle nontacky film upon drying In these investigations such fluoroelastomers as Veton were rendered extremely tacky, but they could not be made conductive without the addition of certain organic conductors still in the developmental stage Silicones as well as the fluorinated elastomers were found to be extremely hydrophobic and would not readily adhere to the skin

Research for a quick don-doff electrode also included studying the behavior of electrolytes in synthetic resins as well as adhesives derived from natural products Electrodes based upon polyvinyl acetate, polyvinyl methyl ether, aqueous dispersion of polyisobutylene (butyl rubber), copolymers of vinyl acetate and ethyl hexyl acrylate, sodium alginate, vinyl plastisols, sodium polyacrylate, pectin gels, comonomers of acrylates and styrene, gelatin, celluloses, starch phosphates, polyvinyl alcohol, acrylics, and many combinations thereof, have been evaluated The following are among those determined as the most promising (1) starch phosphate, a vinyl ether polyelectrolyte and a finely divided silica filler, (2) a specific resin, sorbitol, and a siliceous filler, (3) selected glycols, and (4) sodium caseinate solution The compositions that incorporated certain fillers were found to give the proper thixotropy to the adhesive compositions, but they were observed to dry more readily when exposed to the atmosphere The evaluation of compositions based upon specific resins investigated disclosed that they gave good body to the gel structure, particularly the pectin gels, the aggressive tack and stringy character of the resins were significantly reduced In this study, sorbitol was used as a humectant and selected glycols were used to plasticize the adhesive formulas The lithium ion was used in all materials as the supporting electrolyte in order to make the composition conductive

The results of screening a large number of formulations having the desired don-doff properties for an electrode paste led to the conclusion that a water soluble or water-dispersible base would be the most favorable A number of the most promising formulations were prepared and evaluated to provide a base for ultimate refinements and further study Two of these formulations that were determined to provide such a base were (1) a series of poly (methyl vinyl ether/maleic anhydride) interpolymers in low to high molecular weights and (2) starch gels of the "gum drop" variety

Source B Mosier of
Institute for Research, Inc
under contract to
Johnson Space Center
(MSC-13249)

Circle 13 on Reader Service Card.

CARBON OFFERS POSSIBLE ADVANTAGES AS IMPLANT MATERIAL IN HUMAN BODY

Evidence from several sources indicates that a number of high-purity, high-strength carbon or graphite composites which have been developed for aerospace applications are chemically, biologically, and physically compatible with the fluids and tissues in the human body In addition to their high strength and long-term biocompatibility, these materials can be readily fabricated into complex configurations and are amenable to several of the commonly used sterilization techniques Because of these characteristics, the aerospace carbonaceous materials are proposed as surgical implants to correct various pathological conditions in the body resulting from disease or injury

An example of the possible medical use of the carbonaceous materials would be as *cosmetic and protective bone replacements* in the skull, face, and hands In present practice, stainless steel (or other metal) replacements are prepared as inlays and secured to the adjacent bone by pins or screws However, stainless steel has been found to degrade substantially with time from chemical and galvanic corrosion. This results in reduced strength of the replacement and probable toxic reaction of the host tissues to the corrosion products The carbonaceous materials could be advantageously substituted directly for metals in this application Other suggested uses of the carbonaceous materials in the body are outlined below

Implantable Splints Such splints are generally beams or elongated plates attached directly to the damaged bone by pins or screws They extend sufficiently beyond the damaged area to carry the full loading from the undamaged area on one side of the fracture to the undamaged area on the other side This arrangement permits the damaged area to repair itself without being displaced or disturbed by body activity While it is desirable to leave the splints in permanently, degradation of the metals presently used is often found to make their eventual removal mandatory In some cases, it has been found necessary to remove them even before healing is completed, either because of the toxicity of the corrosion products or the decline of structural integrity in the splint. Substitution of carbonaceous materials for metals promises to alleviate these problems

Myoelectric Probes These devices are implanted in the desired muscle tissue to pick up (or introduce) the small electrical signal (picowatts to nanowatts) by which the nervous system instructs the muscle to perform In medical research they are used to study the phenomena of motor control and reactions to various stimuli. In rehabilitation, attempts are being made to utilize the naturally occurring myoelectric signals to control externally powered prosthetic devices The apparent galvanic inertness of the carbons indicates that they should be very desirable materials for this application when implanted to provide a percutaneous electrical conductor. Flexibility of the carbon filaments or small-diameter rods would permit normal motion of the body member without disturbing the implant

Epithelial Bone Extensions The orthopedic concept involved is based on the premise that bone can be induced to grow to an inorganic member designed to pick up mechanical loads external to the body and transfer them directly into the skeletal structure. Materials that have been investigated to date are corrosion-resistant metals and high-strength ceramics Success has been very limited because of corrosion problems and rejection of these materials by the body tissues. The carbon materials show promising potential for this application.

Circulatory Bypass Implants In hemodialysis and other treatments of the bloodstream, it is desirable to implant a bypass connection permanently into an artery and the corresponding vein so that the blood may be circulated through auxiliary equipment outside the body and returned to the normal bloodstream after treatment. Materials presently used for this purpose are stainless steels and various polymers The steels lack long-term biocompatibility, and the polymers are not sufficiently durable, so that the implants must be replaced more frequently than is desirable The improved biocompatibility expected from the substitution of the carbon materials, coupled with their high physical strength, indicates their attractiveness for this application

Implantable Prosthetics The preferred materials presently used for anatomical joint replacement (e g , for hip joints) are type 316 stainless steel, certain titanium alloys, and in some cases, ultrahard materials, such as stellite Degradation of these materials is principally attributable to low-rate galvanic action with the body fluids, which results in surface, intergranular, or massive corrosion and con-

sequent loss of structural integrity of the metals In some cases, the corrosion products are also toxic to the host organism. In almost all cases, mobility of the joint decreases because of substantially increased friction The structural properties of certain aerospace carbons closely approximate those of type 316 stainless steel, and in addition, these carbons provide self-lubrication on bearing surfaces These carbons therefore appear to offer excellent potential as replacements for anatomical joints

Replacement Heart Valves One of the most widely used replacement heart valves is the Starr-Edwards design, a simple ball-in-cage check valve Some recent reported failures of this valve are apparently due to deterioration of the ball by a very slow chemical reaction with the bloodstream Vitreous carbon spheres can be produced in a variety of sizes to very precise dimensions and with polished surfaces. By making them hollow, their normal specific gravity can be matched to the bloodstream to provide neutral buoyancy, thus reducing inertial effects. This material is heat-sterilizable and is apparently unaffected by the conditions encountered in the body

Source J Benson of
Rockwell International Corp
under contract to
Marshall Space Flight Center
(MFS-18204 through 18210)

Circle 14 on Reader Service Card

ADENOSINE TRIPHOSPHATE USED TO MEASURE URINARY TRACT INFECTION

A rapid, routine procedure detects and counts the bacteria present in urine samples. The bacterial level indicates the extent of urinary tract infection The procedure depends on the presence and measurement of adenosine triphosphate (ATP), a nucleotide present in all known living matter. A quantitative determination is made by measuring the light emitted in the bioluminescent reaction of ATP with the enzyme luciferase

To use the ATP assay for the detection of bacteria in urine, non-bacterial ATP must first be removed Sources of urinary non-bacterial ATP are free, soluble ATP, and ATP in red and white blood cells, the latter sometimes being present in urine Removal of nonbacterial ATP is accomplished by first rupturing the red and white blood cells of the urine sample, thereby releasing the ATP in a free, soluble state All the free, soluble non-bacterial ATP is then hydrolyzed by the addition of an ATPase enzyme The above steps do not affect any bacterial cells present

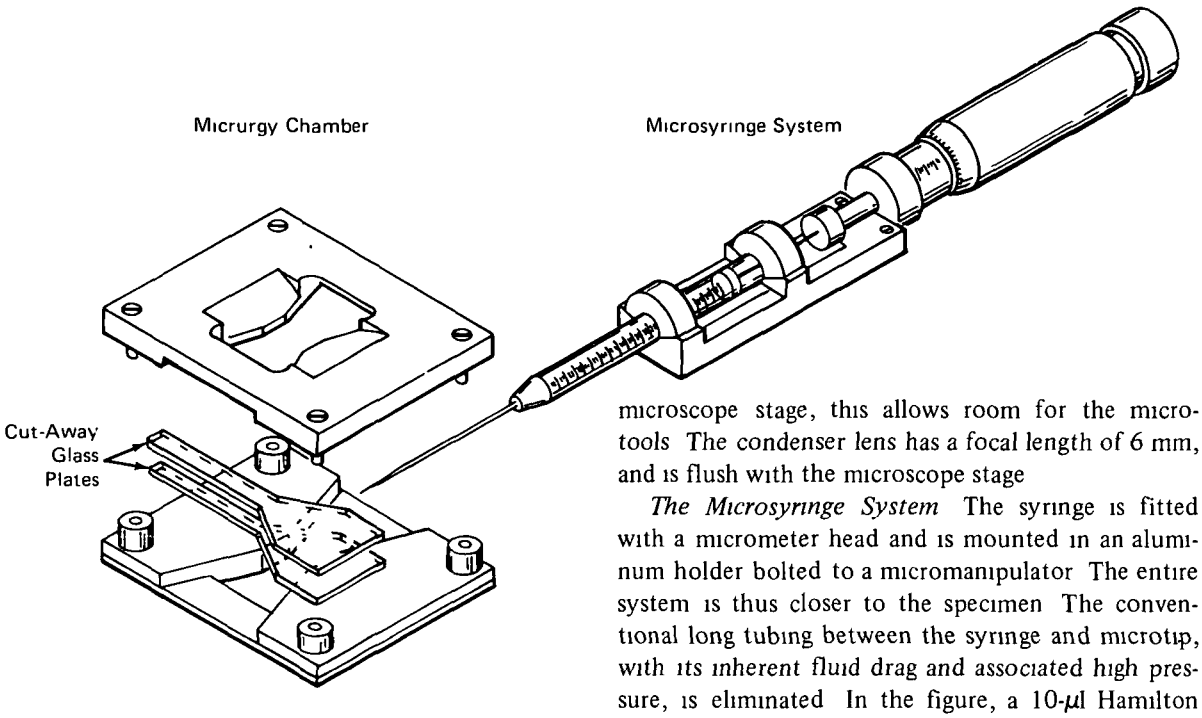
After removing the non-bacterial ATP from the urine sample, the ATPase is inactivated and the bacterial cells ruptured (ATP released) by the addition of an acid The acid is then neutralized by the addition of a buffer at a pH necessary for optimal luciferase activity The urine sample is combined with a luciferase-luciferin mixture, and the light emitted from the resultant bioluminescent reaction is detected and recorded by a photometer system. If all of the reaction components are maintained in a concentration in excess of the ATP, the light emission is directly proportional to the amount of ATP introduced A direct relation can then be drawn between the magnitude of the light emission and the ATP concentration using a standard calibration curve for comparison The number of bacteria equivalent to the concentration in the urine sample can be obtained by dividing the ATP concentration by 3×10^{-10} μg, the average ATP content of a bacterial cell

The method developed is adaptable to determining bacterial levels in other aqueous body fluids such as lymph fluid, plasma, blood, spinal fluid, saliva, and mucous Further, it is particularly applicable to measuring bacterial levels in aqueous body fluids which have, in addition to the bacteria, both free, soluble ATP, and non-bacterial cells containing ATP.

Source E. W Chappelle and G L Picciolo
Goddard Space Flight Center
(GSC-11092)

Circle 15 on Reader Service Card.

MICROSYRINGE AND LIQUID MICRURGY CHAMBER FOR CELL EXAMINATION



A liquid micrurgy chamber was designed to allow amoeba specimens to be flattened sufficiently in a plane microscopic field to enable a clear view of all the nuclei - the design also eliminates spherical aberration and evaporation without adding the problems of anoxia or oil toxicity

A microsyringe was designed which moves the entire system closer to the specimen for improved operator control

The Micrurgy Chamber The chamber is made from two glass slides, supported by metal plates which are separated by rubber spacers at their corners Screws passing through these spacers hold the plates together The lower plate is brass, and the upper is stainless steel, beveled to permit changes of microscope objectives without refocusing Adjacent surfaces of the plates are recessed to make room for microtools

Two standard 7 62 x 2 54 x 0 102 cm (3 x 1 x 1/25-inch) glass slides are cut away as shown and are attached with a thin film of petrolatum to the opposing surfaces of the chamber The chamber is designed so that the specimen lies 6 mm above the microscope stage, this allows room for the microtools The condenser lens has a focal length of 6 mm, and is flush with the microscope stage

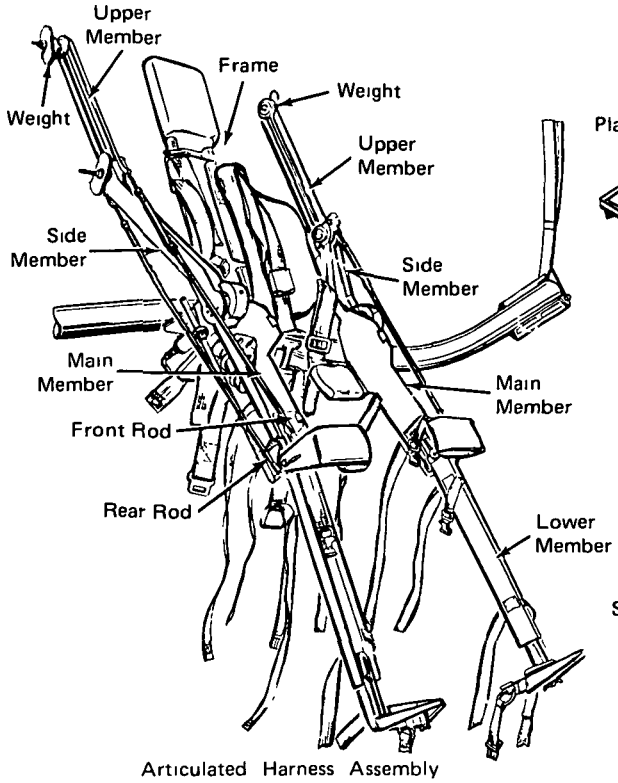
The Microsyringe System The syringe is fitted with a micrometer head and is mounted in an aluminum holder bolted to a micromanipulator The entire system is thus closer to the specimen The conventional long tubing between the syringe and microtip, with its inherent fluid drag and associated high pressure, is eliminated In the figure, a 10-μl Hamilton syringe has been modified by cutting off the plunger button and mounting that end of the plunger in a micrometer head with a clamp The syringe needle is removed and an additional piece of thick-wall capillary glass tubing can be fused to the syringe barrel to increase the working distance between the micromanipulator and the chamber. A 27- to 30-gage metal needle is inserted with its sharp end in the extended barrel, where it is sealed in place with Kronig wax cement The glass micropipette, made with a shank of some 2 to 3 cm, is sealed with Kronig cement onto the needle

The micrurgy chamber is a versatile instrument which can also be used for (a) measurement of the volume of single cells, (b) a counting chamber using a ruled grid, (c) ultraviolet radiation of parts of single cells, using quartz instead of glass, and (d) laser irradiation of parts of single cells

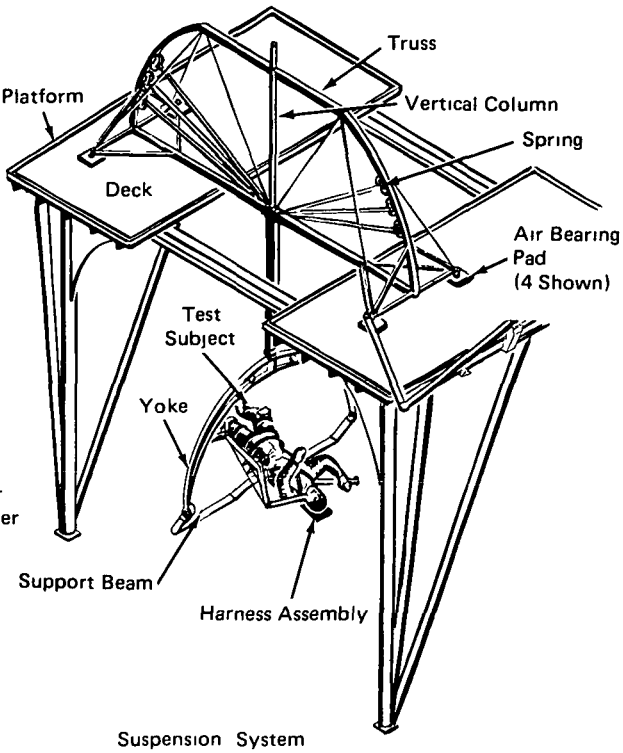
Source E W. Daniels
Biological and Medical Research Division
Argonne National Laboratory
(ARG-251)

Circle 16 on Reader Service Card.

ZERO-G SIMULATION SYSTEM FOR THERAPEUTIC APPLICATION



Articulated Harness Assembly



Suspension System

A system has been designed and patented that is useful in the therapeutic retraining of damaged muscles, or as a walking support during therapy

The zero-G simulation system consists of an articulated harness assembly for containing the patient, and a suspension system for supporting the harness assembly in such a way as to counterbalance the exertion of external forces on the patient

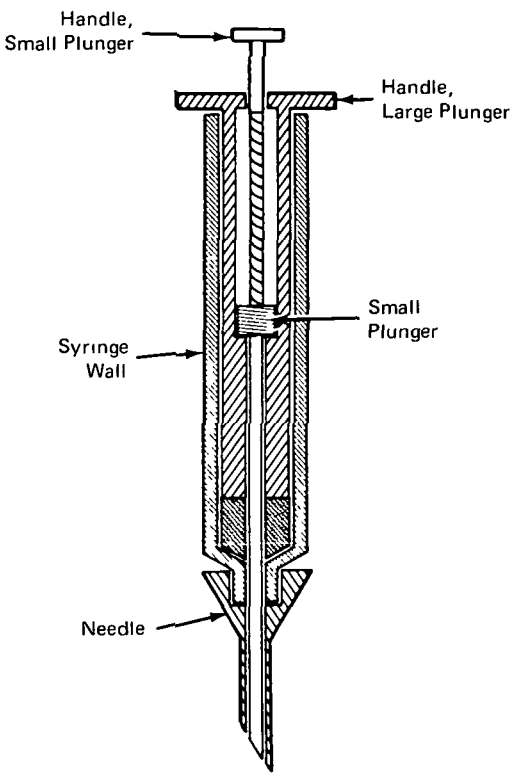
The zero-G simulation mechanism is mounted on a platform secured to the floor The platform contains two separated decks and a truss which spans the separation and is supported on the decks by air bearing pads A sliding vertical column extending down through the separation is suspended from the truss At the lower end of the vertical column is a center-journaled semicircular yoke to which a free rotating support beam is mounted The harness assembly is secured to a plate mounted midway on this support beam Special constant-force springs are attached between the truss and the vertical column to counterbalance the weight of the column and its load

The articulated harness assembly design permits the upper limbs to counterbalance the lower limbs, creating an interaction similar to that of walking The assembly is composed of a frame for supporting the head and back of the patient, and two pivoting articulated side members, one on each side of the frame at the approximate location of the patient's hips Each side member contains a main member, an upper member, and a lower member, all connected by pivot joints The upper and lower members on a side are connected with front and rear rods so that, when the patient pivots, the lower member (strapped to his leg) and the upper member (strapped to his arm) pivot in opposite directions. Weights are attached to the uppermost ends of the main members and the upper members to effectively counterbalance the weight of the patient's legs and the attaching harness

Source D H Dane
Marshall Space Flight Center
(MFS-14671)

Circle 17 on Reader Service Card

COMBINATION SYRINGE PROVIDES AIR-FREE BLOOD SAMPLES



Air-Free Syringe

This syringe combines a standard syringe and a spinal needle in a new and unique manner to secure air-free samples of blood Current practice to minimize the effects of small air bubbles requires the use of a very small needle which contains a solution such as heparin prior to drawing out the blood However, this latter technique can result in contamination of the sample Another method for avoiding air bubbles has been to fill the needle with oil to exclude air prior to obtaining the sample, but this presents the danger of oil embolism. The combination syringe obtains air-free blood samples because the air bubbles become insignificant when samples greater than 1 cc are drawn.

Hospital research laboratories and manufacturers of automated laboratory and microanalysis equipment should be interested in this novel device.

Referring to the figure, the needle of the syringe is inserted into a vein in the standard manner. The small plunger is slowly drawn away from the inserted needle. During this procedure, the long, thin center section moves and allows blood to fill the needle. The action of this plunger is stopped when the inner small plunger enters the detent at the level of the large plunger. The large plunger is then slowly pulled to fill the remaining portion of the syringe To remove blood from the syringe, the large plunger is pushed forward

No venous blood sampling device presently used permits the initial drawing of a sample of blood without introducing a small air bubble This technique could also be used to provide bubble-free fluids for other kinds of analyses

Source S L Pool
Johnson Space Center
(MSC-12320)

No further documentation is available

ANALYSIS OF CALCIUM IN BLOOD SERUM

Volumetric titration, the standard method for determining the level of calcium in blood serum, requires large samples and a great deal of manipulation More recent methods by atomic-absorption spectrophotometry, although rapid and accurate, require large samples and serum protein can clog the jets

A differential-absorption spectrophotometric technique has been developed that, using murexide, gives a highly precise analysis of calcium in volumes of serum as small as 0 01 ml The method of additions and proper timing allows compensation to be made for fading, variation in type of serum or plasma, and aging of the specimen The method is very rapid, especially for large numbers of samples, precision and accuracy are within 1 5%

The levels of calcium are measured on a double-beam recording spectrophotometer with 1 0-cm silica

cells The indicator solution contains murexide at 0 1 mg/ml in a mixture of 2% water in propylene glycol The optical density is used as a check on the concentration of the dye, 1.5 ml of indicator in 2.5 ml of 0.044M KOH, compared to a reference cell containing H_2O, should read approximately 1 4 absorbance units (A), at 545 nm, 5 minutes after addition to the KOH solution The working calcium standard is the stock solution diluted 1 10 with water to give a calcium concentration of 0 1 g/liter The calcium concentration of the diagnostic reagent is 10 5 mg%

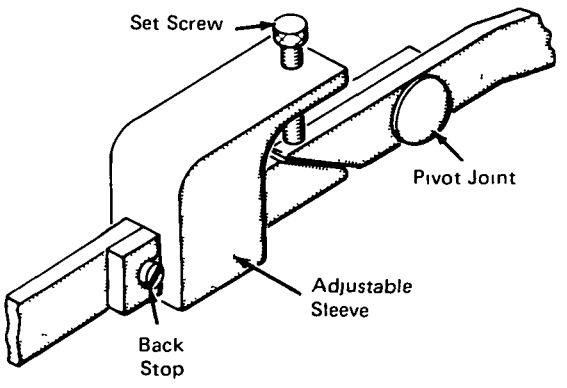
In the analysis, 2 5 ml of 0 044M KOH is pipetted into two 7-ml selfcapping polyethylene vials A 10 1 to 15 1 sample is pipetted into one of the vials, and the pipette is rinsed with the contained solution The murexide indicator (1 5 ml) is added to both vials in rapid succession with a commercially available repipet dispensing unit, then the solutions are mixed by repeated inversions, slowly enough to avoid foaming

The solutions are then placed in clean, dry cells before the absorption peak of the sample solution is read against the reagent blank at 497 nm, 5 minutes after addition of the dye The ratio of absorption by the sample to absorption by an equal volume of standard calcium solution (0 1 g/liter), multiplied by 10, equals the concentration of calcium in the sample (in milligrams percent) The rapidity of operations allows three samples and a reagent blank to be dispensed and run at 1-minute intervals without loss of accuracy

Source F H. Ilcewicz and R B. Holtzman
Radiological Physics Division
Argonne National Laboratory
(ARG-10246)

Circle 18 on Reader Service Card.

ADJUSTABLE HINGE PERMITS KNEE MOVEMENT IN PLASTIC CAST



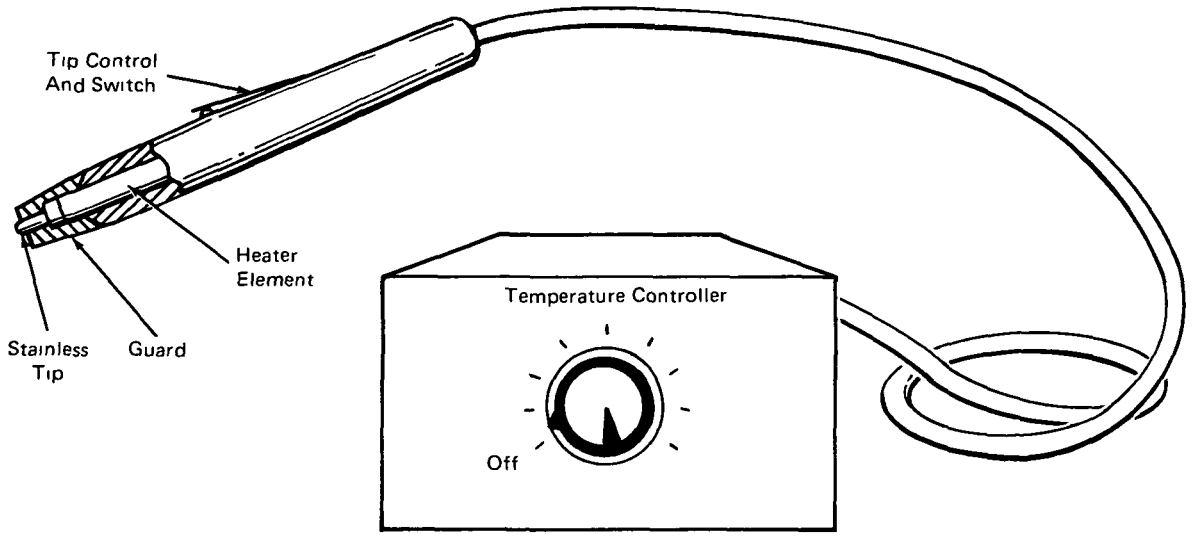
A metal knee hinge, designed to be installed in a plastic leg cast permits movement of the knee joint and eliminates the stiffness that results from use of a conventional solid cast Prior art used a knee hinge of flat stock material that was bulky, difficult to adjust, and subject to binding within the plastic cast

This metal knee hinge is equipped with an adjustable sleeve that can be slipped over the pivot joint to lock the brace into an immovable position The sleeve can also slide back to a stop pin where a degree of movement is allowed The extent of allowable movement or travel is determined by the setting of a set screw that is mounted in the top of the adjustable sleeve The screw can be adjusted to allow approximately 35° of travel from the locked position The other knee hinge on the inner side of the leg cast is equipped with a straight sleeve as are most braces

Source W E Maley
Marshall Space Flight Center
(MFS-1756)

Circle 19 on Reader Service Card.

HAND-HELD DEVICE TO RELIEVE HEMATOMA PRESSURE: A CONCEPT



The relief of excessive pressure buildup (hematomas) beneath fingernails and toenails caused by ruptured blood vessels is normally obtained by an involved surgical procedure The nail area is scrubbed clean, the member is anesthetized by freezing with ethyl chloride or by digital block with a local The nail is then pierced with a sterile drill or heated hypodermic needle, neither technique being devoid of psychological trauma on the part of the patient

This concept involves a device, that simplifies the operative procedure, in the form of a self-contained portable instrument with an instantly variable heating tip, adjustable depth settings and a variety of interchangeable tip sizes for cauterizing small areas and relieving pressurized clots.

The device consists of a temperature controller with integral battery and a surgical tool connected to it by appropriate wiring The surgical tool consists of a heating element, removable and interchangeable stainless steel tip, and a combination tip depth control and switch, all contained in a plastic case

To operate, the affected area is cleaned and coated with a standard disinfectant but need not be anesthetized The tip is adjusted to make a penetration through the nail but not sufficient to contact any tissue thereunder The heating element is activated and, after a 3-second interval, the instrument is brought to bear lightly on the nail above the hematoma The heated tip burns easily and quickly through the nail without noticeable discomfort to the patient and provides instant relief

Source L J Raggio and T. L. Robertson of
Rockwell International Corp
under contract to
Johnson Space Center
(MSC-599)

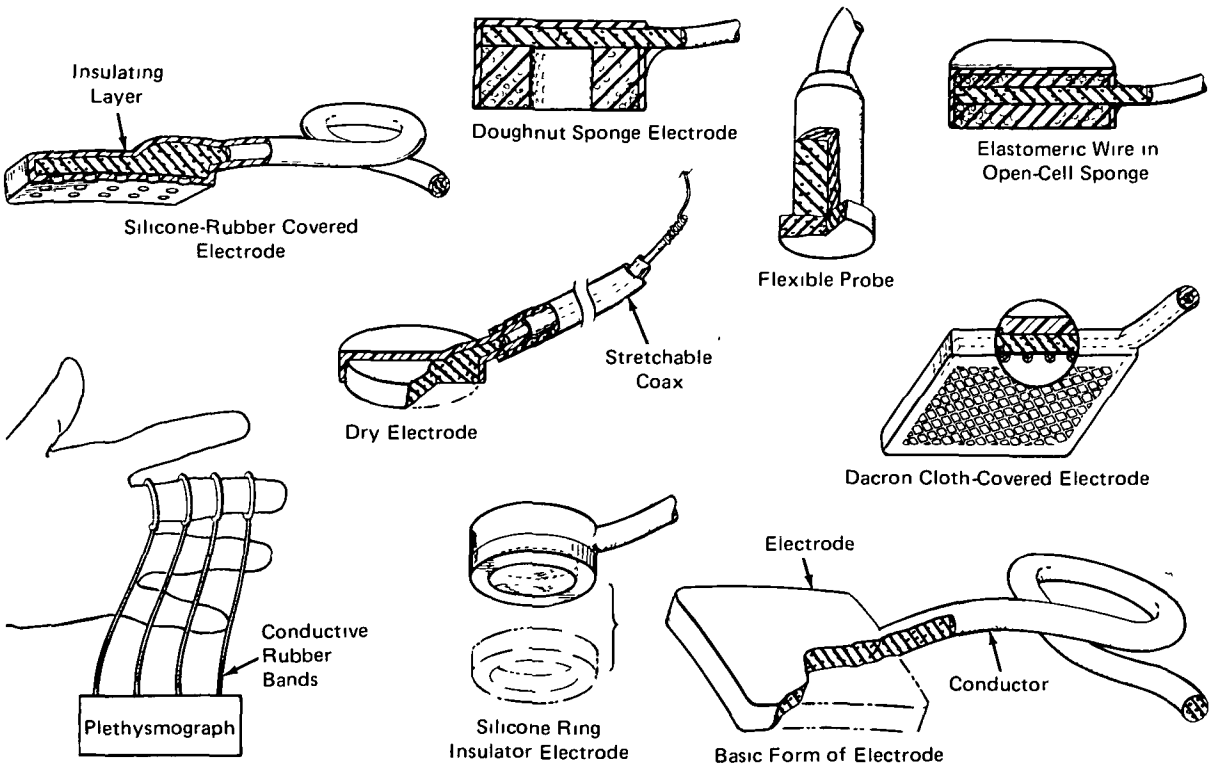
Circle 20 on Reader Service Card.

SOFT, FLEXIBLE BIOMEDICAL ELECTRODES AND WIRES

These are flexible, uniformly conductive, comfortable, and easily applied biomedical devices that conform snugly to body contours during patient activity

A soft, flexible electrode is fabricated from an elastomer impregnated with a conductive powder, and can be configured into any shape, including a wire shape to connect the electrode directly to an electrical instrument or to a conventional metallic wire

As shown in the figure, the device consists of the electrode and a conductor, both formed of silicone



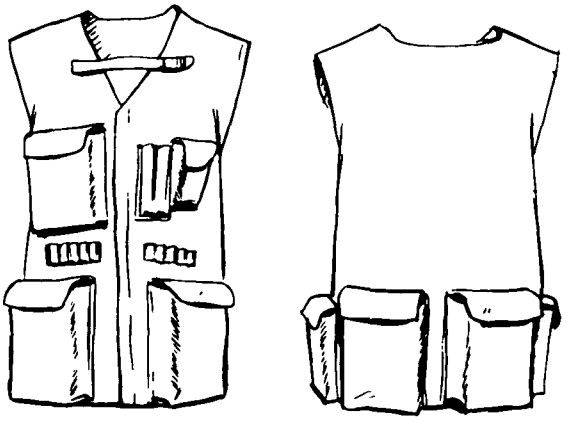
SEVERAL POSSIBLE ELECTRODE CONFIGURATIONS

rubber as the elastomer and loaded with silverplated particles as the conductive material The electrode can be molded or cut to fit over any irregular body contours and to accommodate body location and type of measurement. A wide variety of electrode configurations can be fabricated using accessory materials such as silicone rubber sponge, silicone rubber adhesives, or adhesive bandages Electrodes and "wires" made of the impregnated elastomeric material are suitable for implantation and connection to implanted telemetry equipment The impregnated elastomeric wire is not only flexible but stretchable. in some cases up to 40% of its length, while maintaining excellent conductivity This is a significant improvement over the normal metallic lead wires, which always present the danger of breaking at the junction with the electrode Where external electrodes are used, improved contact with the skin can be obtained with sodium chloride electrolyte paste or jelly In this case, the electrode can be designed with wells in which the electrolyte is placed It is not always necessary to use an electrolyte paste, since the electrode moves with the skin. Long-term monitoring of relatively motionless bed-ridden patients can be accomplished with the electrode alone Use of the electrode without the wet electrolyte avoids the problem of periodic replenishment and the discomfort of a continuously damp interface with the skin. The dry electrode does result in a higher impedance, but this is readily handled with a high input-impedance amplifier Previous studies with electrodes have shown that silver-silver chloride provides the lowest galvanic potential when used with a sodium chloride jelly The chloride ions provide the mechanism by which the biopotentials are sensed A layer of silver-silver chloride can be plated on the elastomeric electrode surface by conventional electroplating using a 10% HCl solution with silver wire as a cathode and a 6-V power source Plating on the electrode does not alter its flexibility Insulation can be provided on any part of the electrode by spraying, dipping or brushing with nonconductive silicone rubber.

Source S A Rositano
Ames Research Center
(ARC-10268)

Circle 21 on Reader Service Card

SPECIAL VEST BROADENS TREATMENT CAPABILITY



A universally sized vest, with specially tailored pockets designed to hold medical supplies, has been developed to provide first aid/first care medical teams with a broadened on-site capability, particularly during disaster situations The vest (see figure) has spaces for a full complement of required materials which are easily accessible, a depleted vest can be exchanged quickly for a fully equipped vest, and most important, additional logistical support is not required A trained paramedic could treat four or five victims, and groups of trained paramedics equipped with these vests could handle disaster situations Prior to this development, medical supplies were carried by hand or in a bag, and treatment during disaster conditions was comparatively slow

The vest is made of nylon, tough fibrous materials, and polyvinyl chloride, and could last indefinitely Pocket flaps, front closure, and a retention adjustment strap are secured by "velcro" (hook and pile material) which facilitates rapid donning, doffing, and adjustment. Sufficient pockets exist for all standard medical items such as tourniquets, airway pharyngeal rubber tubes, all sizes of bandages, scissors, and medications Medical disaster units at airports, Civil Defense, and related agencies should be interested in this item

Source G S Johnson of
Trans World Airlines, Inc
under contract to
Kennedy Space Center
(KSC-10577)

No further documentation is available

Patent Information

The following innovations, described in this Compilation, have been patented or are being considered for patent action as indicated below.

Sensing and Display Improve Brain Wave Monitoring: A Concept (Page 3) ERC-10233

This invention is owned by NASA, and a patent application has been filed Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to

Patent Counsel
NASA Headquarters
Code GP
Washington, D. C. 20546

Multimode Ergometer System (Page 4) MFS-21044, 45, 46

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to

Patent Counsel
Marshall Space Flight Center
Code A&PS-PAT
Marshall Space Flight Center, Alabama 35812

Automatic Bio-Sample Bacteria Detection System (Page 7) GSC-11169

Inquiries concerning rights for the commercial use of this invention should be addressed to.

Patent Counsel
Goddard Space Flight Center
Code 204
Greenbelt, Maryland 20771

Electronic Sleep Analyzer (Page 11) MSC-13282

Title to this invention, covered by U.S. Patent No. 3,205,101, has been waived under the provisions of the National Aeronautics and Space Act [42 U.S C 2457 (f)], to Baylor University, Waco, Texas 76703.

Adenosine Triphosphate Used to Measure Urinary Tract Infection (Page 21) GSC-11092

Inquiries concerning rights for the commercial use of this invention should be addressed to

Patent Counsel
Goddard Space Flight Center
Code 204
Greenbelt, Maryland 20771

Zero-G Simulation System for Therapeutic Application (Page 23) MFS-14671

This invention has been patented by NASA (U.S. Patent No 3,516,711). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to

Patent Counsel
Marshall Space Flight Center
Code A&PS-PAT
Marshall Space Flight Center, Alabama 35812

Soft, Flexible Biomedical Electrodes and Wires (Page 26) ARC-10268

This invention is owned by NASA, and a patent application has been filed Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to

Patent Counsel
Ames Research Center
Mail Code 200-11A
Moffett Field, California 94035

NASA-Langley, 1973

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— NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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