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RADIATION HAZARD MONITOR

OPERATING AND MAINTENANCE MANUAL FOR MODEL 3

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TABLE OF CONTENTS

			Page
1.	INTRODUCTION		1
	1.1	Scope	1
	1.2	Purpose	1
	1.3	Description of Instrument	1
	1.4	Summary of R-F Radiation Hazard Standards	1
2.0	INSTALLATION		6
	2.1	Selection of Operating Site	6
	2.2	Handling	6
3.0	OPERATION		7
	3.1	Introduction	7
	3.2	Power Sources	8
	3.2.1	General	8
	3.2.2	Adjustment of the Instrument to Use Available Power Line Voltage	9
	3.2.3	Power Switch	9
	3.3	Loading the Recording Paper into the Pen Recorder	10
	3.4	Selecting the Output Indicator	10
	3.5	Placing the Microwave Radiation Hazard Monitor Into Operation	15
	3.5.1	General	15
	3.5.2	Applying Power	16
	3.5.3	Bridge Balance	16
	3.5.4	Interpretation of Readings	17
4.0	THEORY OF OPERATION		18
	4.1	Concept	18
	4.2	Description of the Sensor	19
	4.3	Functional Description of the Instrument	20
	4.4	Field Pattern Considerations	20
5.0	MAINTENANCE		21
	5.1	General	21
	5.2	Calibration	21
	5.3	Bridge Excitation Voltage Adjustment	21
	5.4	Testing the Sensor	28

G

LIST OF FIGURES

Figure No.	Description	Page
1-1.	Instrument in Operating Position	2
1-2.	Radiation Exposure Curves	5
3-1.	Specification Control Drawing for Pen Recorder	11
3-2.	Loading Instructions for Pen Recorder	13
5-1.	Instrument, Indicator Unit Protruding from Cabinet	22
5-2.	Front View of Indicator Unit	23
5-3.	Left Rear Corner of Indicator Unit	24
5-4.	Right Rear Corner of Indicator Unit	25
5-5.	Sensor	26
5-6.	Schematic of Radiation Hazard Monitor, Model 3	27
5-7.	Data Sheet	29

1. INTRODUCTION

1.1 SCOPE

This manual contains information on the application, installation, operation and maintenance of the Microwave Radiation Hazard Monitor.

1.2 PURPOSE

The purpose of the Microwave Radiation Hazard Monitor is to measure and record the levels of field strength due to microwave radiation which may cause bodily harm. The method of measuring the r-f radiation field strength used by this instrument differs radically from the normal method which utilizes an antenna and detector. The normal antenna-detector method of measuring field strength gives a reading of the field strength at the antenna location which is the vector sum of all of the r-f propagation paths to this particular antenna location. At microwave frequencies due to the scattering of the transmitted r-f signal, it has been shown by experimental tests that the antenna-detector type measurements can be as great as 15 db in error. This error results in readings which are less than the actual field strength and bodily harm can result before the true field is determined. The measuring technique used by the Microwave Radiation Hazard Monitor described in this Operating and Maintenance Manual measures the r-f energy which flows through a specified volume. This technique measures the power in each of the signal vectors which make up the received signal and adds the power in each vector in a scalar fashion to indicate the true field strength. This method of operation is similar to the operation by which the r-f field heats the human body, i.e. the human body is heated by each of the scattered, radiated, wave fronts which pass through the body volume. The theory of operation for this Microwave Radiation Hazard Monitor is described in detail in Section 4 of this Operating and Maintenance Manual.

1.3 DESCRIPTION OF INSTRUMENT

An external view of the equipment with the Sensor Unit in operating position and the front access door open is shown in Figure 1-1. The

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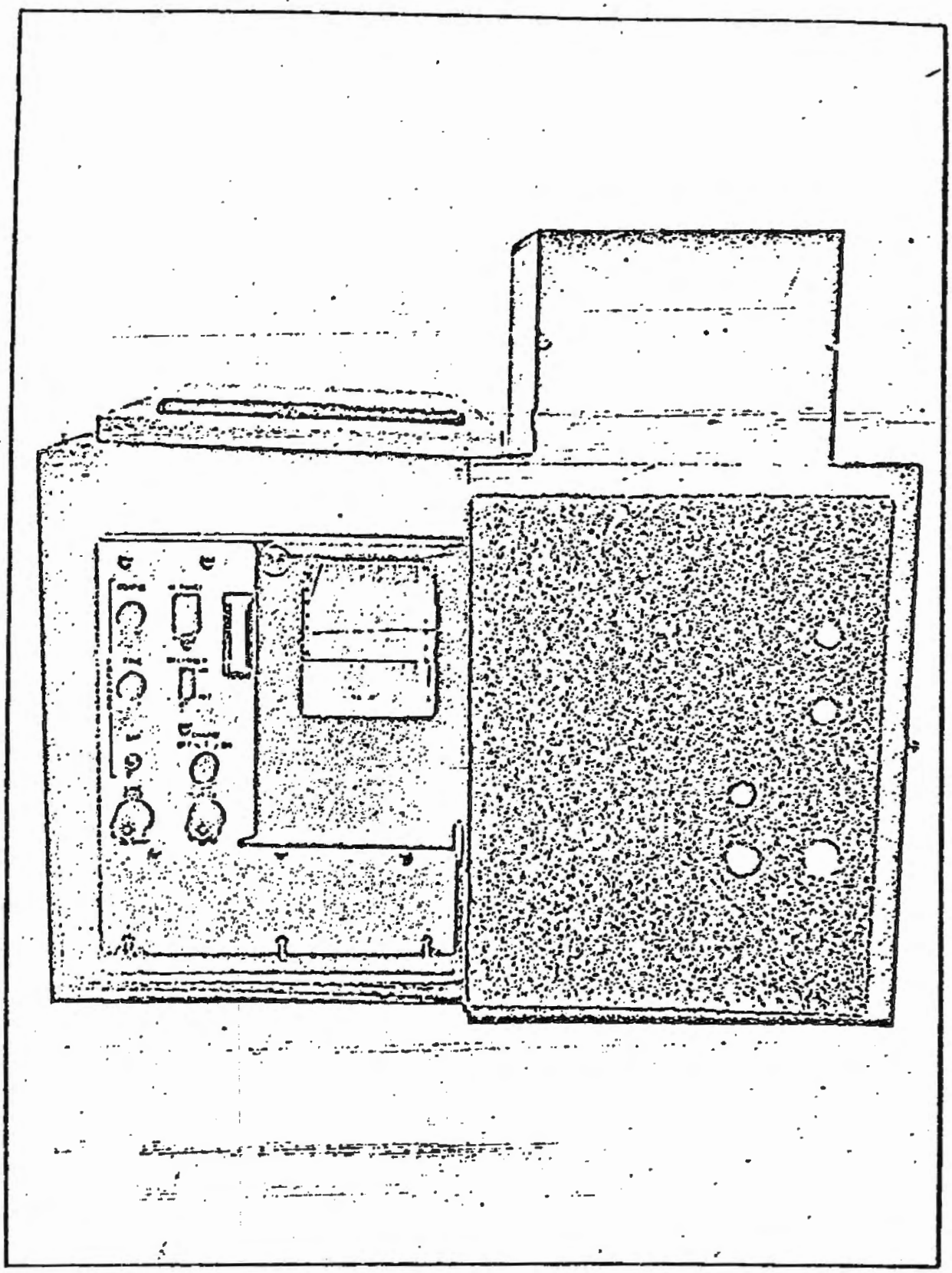


Figure 1-1. Instrument in Operating Position

cabinet measures 7-3/8 inches x 15-1/4 inches x 10-1/2 inches high. when both doors are closed, and complete instrument weighs approximately 23 pounds. The instrument consists of three units, the Housing Unit (cabinet), the Indicator Unit, and the Sensor Unit. The Sensor Unit is a black rectangular plastic box which is raised above the top of the cabinet for operation and lowered into the cabinet and the top door closed for bridge balance adjustment. The Indicator Unit is visible through the open front cabinet door.

To service or replace the Sensor Unit, it may be detached from the Housing Unit by removing the wooden panel on the bottom of the cabinet just below the Sensor Unit. This wooden panel is held in place by four wood screws. When this panel is removed, it will be seen that three miniature coaxial cables and a tether are the only items limiting movement of the Sensor Unit.

The recorder is mounted so as to appear as part of the Indicator Unit front panel. Also located on the Indicator Unit front panel are a radiation indicating meter, a recorder "on-off" switch, a power switch, two fuse extractors, bridge balance adjustment controls and a high range indicator light.

1.4 SUMMARY OF R-F RADIATION HAZARD STANDARDS

There is a wide variety of radiation hazard standards and the attached discussion is by no means complete. However, the following listed standards offer a guideline that can be used for personnel safety.

The standards for radiation hazard and/or safety are not as yet fixed standards; however, the branches of the Armed Forces have adopted tentative specifications which they are in the process of approving. There are two standards under consideration; one, jointly by the Navy and ASA, and the second a joint consideration by the Army and the Air Force.

The ASA/Navy proposed standard[1] in essence sets the following levels:

---

[1] Proposed Standard ASA/Navy, see Appendix

Hazard Power Level = P

$$P(mw/cm^2) = \frac{60}{T\,(minutes)}$$

Safe Power Level for Time $\geq$ 6 minutes

$\leq$ 10 mw/cm^2

The Army/AF proposed standard[2] calls for the following:

Hazard Level = P

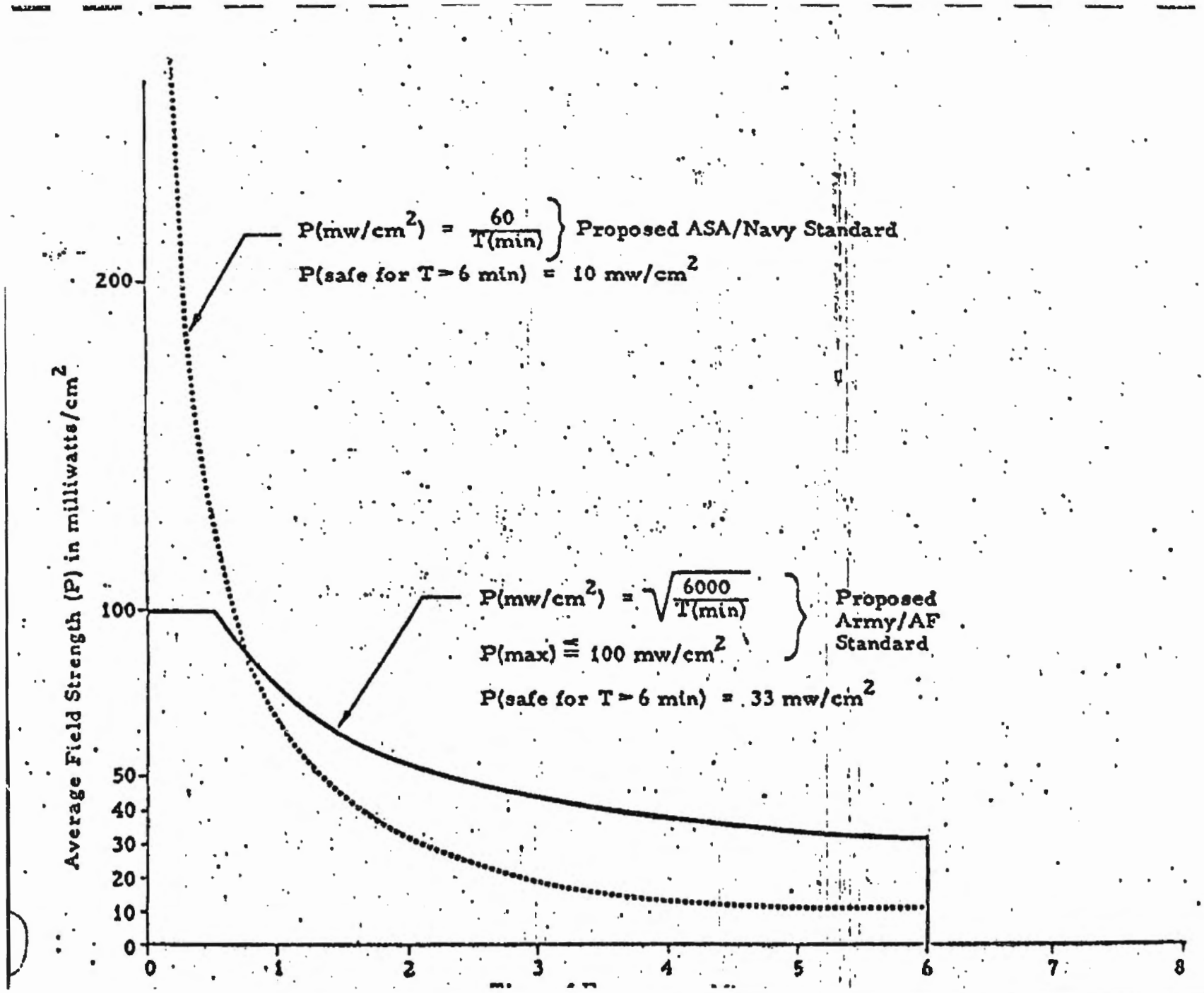
$$P(mw/cm^2) = \sqrt{\frac{6000}{T(minutes)}}$$

Hazard Power Level (mw/cm^2) for zero time exposure
= 100 mw/cm^2

Safe Power Level (mw/cm^2) for time greater
6 min $\leq$ 33 mw/cm^2

These two curves are plotted for comparison in Figure 1-2. Interestingly enough, these two standards do not vary appreciably between the safe limit and an exposure time of 30 seconds or more.

[2]Result of personal conversations between BBC personnel and repre-


$P(mw/cm^2) = \frac{60}{T(min)}$
Proposed ASA/Navy Standard
P(safe for T = 6 min) = 10 mw/cm²
$P(mw/cm^2) = \sqrt{\frac{6000}{T(min)}}$
Proposed Army/AF Standard
P(max) = 100 mw/cm²
P(safe for T = 6 min) = .33 mw/cm²
Average Field Strength (P) in milliwatts/cm²
200
100
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8

2. INSTALLATION

2.1 SELECTION OF OPERATING SITE

The equipment will operate directly from its internal battery or from any of three AC line voltages--115 volts AC, 160 volts AC, or 220 volts AC--at power frequencies from 48 to 72 cps. Thus input power requirements are not a major restriction in selecting an operating site. Operationally, the equipment can be operated in almost any location. The only restriction is that the instrument should not be in direct sunlight or any other directional source of heat. Sun loading on the Sensor Unit will cause unequal heating of the Sensor, interfere with the bridge balance, and result in false indications. In selecting an operation site, it will be well to keep in mind that the equipment is essentially a laboratory instrument and not an item of military field equipment.

During operation, the equipment should be placed in a location where there are no metal obstructions in the near vicinity whose elevations are above the base plane of the instrument. These obstructions may shield the r-f sensor from the radiation field, and cause erroneous readings.

2.2 HANDLING

The instrument will survive the handling normally accorded to laboratory equipment. There is nothing basic to any of the components that is fragile or requires special consideration in handling. The only consideration in handling is to remember that it should be treated like laboratory equipment and has not been ruggedized for operation in full field environments.

3. OPERATION

3.1 INTRODUCTION

This section describes in sequence the steps which are necessary to place the Radiation Hazard Monitor, Model 3, into operation. The sequence is as follows:

Reference Paragraph	Operation
3.2	(1) Internally adjust the instrument to use the available AC voltage from the local power mains. The power from the mains is used to either operate the instrument and/or to recharge its internal battery.
3.3	(2) Load the recording paper into the pen recorder.
3.4	(3) Select the output indicator to be used, that is read the internal meter or record the output on the pen recorder.
3.2	(4) Select the desired power source by positioning the front panel power switch.
3.5	(5) Turn the instrument on, using the selected power source and 4 or 5 minutes later balance the bridge using the balance controls on the front panel of the Indicator Unit.
3.5	(6) Raise the Sensor Unit into operating position and collect readings.
3.5	(7) Interpretation of readings.

The details associated with each of these steps are described in this section, and the descriptions follow the above sequence.

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3.2 POWER SOURCES

3.2.1 General

CAUTION

Do not connect this instrument to the power line mains before the voltage selector switch has been set to the available power line voltage.

The equipment will operate directly from its internal battery or from any of the three AC line voltages--115 volts AC, 160 volts AC, or 220 volts AC--at power frequencies from 48 to 72 cps.

There are three positions on the front panel power switch--an "off" position, a "charge" position, and an "on" position. In the "charge" position, the internal battery is charged from the external AC line power, and the equipment is otherwise inoperative. In the "on" position, the equipment operates from the external AC line power, and at the same time, the internal battery is given a trickle charge. If there is no connection made to the AC power line or the line voltage is too low placing the power switch in the "on" position will cause the equipment to operate from the internal battery.

The internal battery when fully charged will operate the instrument for about 12 hours with the recorder turned "on" and somewhat longer with the recorder turned "off".

Operation of the instrument from the AC mains may be continuous.

Battery recharge from a fully-discharged condition is achieved in about 24 hours during a charge cycle whose only purpose is to recharge the battery.

The battery is constructed from hermetically sealed nickel-cadmium cells. The charge rate has been selected so that they can be continuously charged without damage, and this applies to both methods of operation, i.e. charge alone, or charge and operation of the instrument. These batteries will not normally require servicing of any kind and are designed for a service life of approximately 1000 cycles of zero charge to full charge.

3.2.2 Adjustment of the Instrument to Use Available Power Line Voltage

The voltage selector switch is located on the left hand side of the Indicator Unit near the bottom. To change the input voltage selection, the Indicator Unit must be withdrawn from the cabinet (Housing Unit). To accomplish this, remove the plastic cleat at the base of the front panel of the Indicator Unit by removing the three wood screws and pull the Indicator Unit from the cabinet. The voltage selector switch is the screwdriver operated switch located at the bottom left side of the Indicator Unit. The markings 115, 160, and 220 are easily visible. The voltage selector switch is seen in Figures 5-1 and 5-3.

3.2.3 Power Switch

Control of the power applied to the instrument is achieved by means of a three position switch on the Indicator Unit front panel. The three positions are marked "off", "charge" and "on".

"OFF" position - turns off both the battery and AC line power.

"CHARGE" position - with the line cord connected between the instrument and the local power source, the battery is placed on charge. It will require approximately 24 hours to completely recharge the battery pack from zero charge. Charging beyond the time when full charge is achieved will cause no damage to the battery pack or the instrument.

"ON" position - Two modes of operation can occur in this switch position and the method of operation depends upon whether the power line cord is used. If the power cord is connected between the instrument and the local power line, the instrument operates on AC power and also "trickle" charges the batteries. Continued operation in this switch position will maintain the batteries at full charge. The second mode of operation in this switch position is from the battery. Battery operation is achieved by disconnecting the power cord from the AC line. It can be removed completely from the

instrument if desired. The battery, if fully charged, will power the unit for approximately 12 hours with the pen recorder in operation, or somewhat longer when only the internal meter is used, and the pen recorder is disconnected.

3.3 LOADING THE RECORDING PAPER INTO THE PEN RECORDER

The pen recorder is a modified Model 146 Rustrack Pen Recorder. The modification is in the type of drive motor, a DC motor is used, and the calibration of the meter scale. The meter scale has been modified to display a two cycle logarithmic reading. The recording paper which matches this scale is special. It is available from The Rust Industrial Company, of Manchester, New Hampshire as Type B3339. The Rust Industrial Company's specification control drawing for this paper is attached as Figure 3-1.

The instrument loading of this recording paper is the same as for any Rustrack Pen Recorder. The threading method is described in Figure 3-2 . Additionally, there is a threading drawing in the case of each Rustrack pen recorder. Loading can be accomplished with the recorder mounted in place.

3.4 SELECTING THE OUTPUT INDICATOR

There are two indicators available, an internal meter and a pen recorder. The Microwave Radiometer is designed to operate only one of these indicators at any time, i.e. it will not drive both simultaneously. Simultaneous drive of both the meter and recorder is not required since both indicators have meter faces which can be read directly.

The choice of meter or recorder is made by means of a slide action switch mounted on the Indicator Unit front panel.

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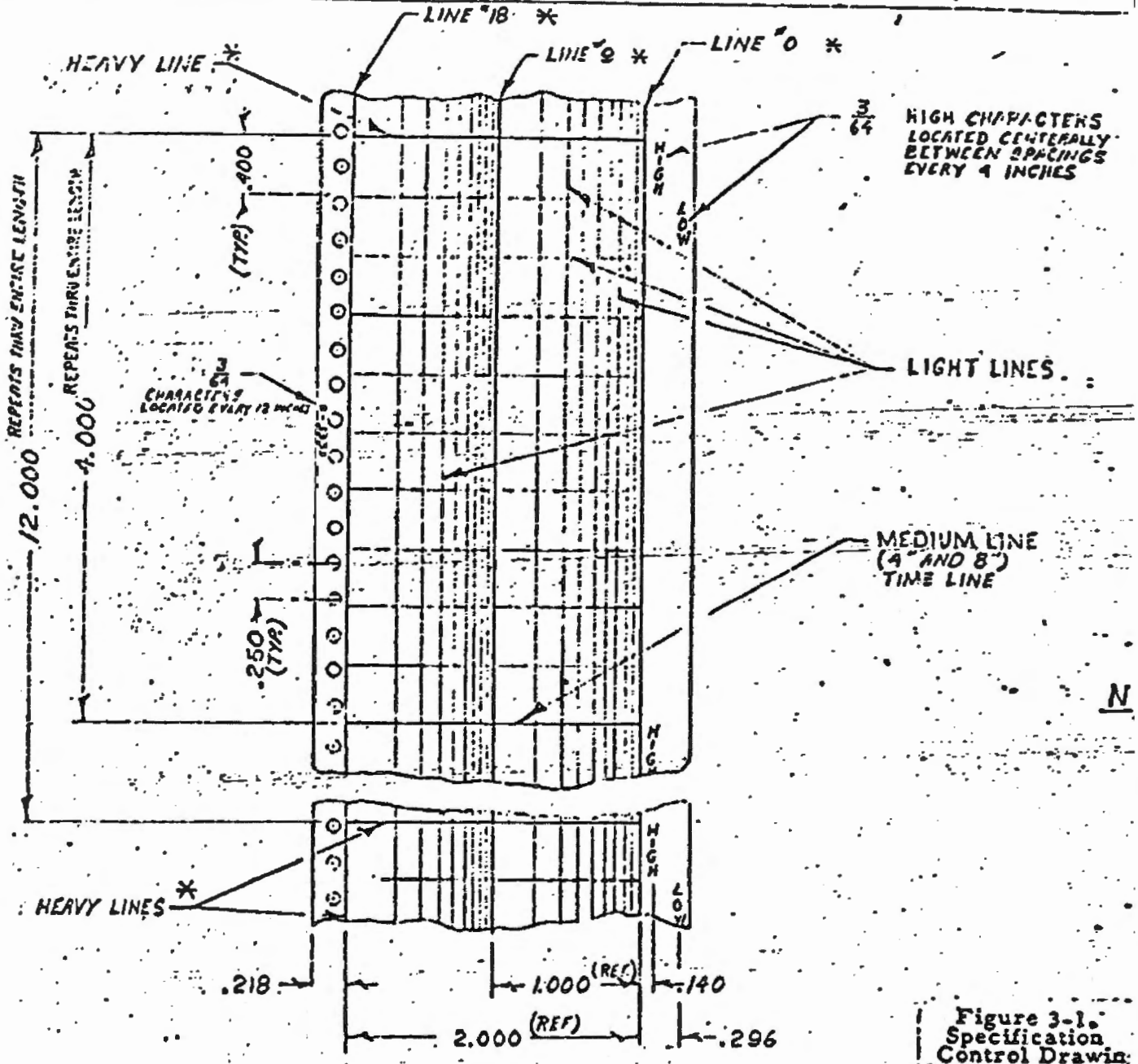

Figure 3-1. Specification Control Drawing for Pen Recorder Paper

(Sheet 1 of 2)

REV.	DATE	BY	REVISIONS
c			
b			
a			

UNLESS OTHERWISE SPECIFIED
REMOVE BURRS BREAK EDGES
TOLERANCES:
FRACT. ± 1/64" DEC. ± .005"
ANG. ± 1/4° OTHERWISE ±
DIMENSIONS ARE IN INCHES

MS. NO. UNIT NO.

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B-3339

LINE DATA TABLE

	LINE NO	DISTANCE FROM LINE NO 0	DIST. BETWEEN LINES
*	0	~	0
	1	.052	.052
	2	.108	.056
	3	.170	.062
	4	.241	.071
	5	.323	.082
	6	.422	.099
	7	.545	.123
	8	.716	.171
*	9	1.000	.284
	10	1.043	.043
	11	1.092	.049
	12	1.146	.054
	13	1.209	.063
	14	1.285	.076
	15	1.379	.094
	16	1.500	.121
	17	1.677	.177
*	18	2.000	.323

LESS OTHERWISE SPECIFIED ON THIS DWG. THE LOWING DWG. SHALL APPLY: B-2729 PAPER PATTERN "E"

IGHT (WIDTH) OF LINES
IGHT: .0015 - .0025
EDIUM: .004
EAVY: .006 - .007
ERICK (*) INDICATES HEAVY LINES
NE LINES DO NOT COINCIDE WITH SPROCKET HOLES

TOL. SHALL BE NON-ACCUMULATIVE

APPROVED
FOR PRODUCTION
JAN 4 1966

Figure 3-1.
(Sheet 2 of 2

PER, SPECIAL 2 CYCLE LOG
(P.O. # B3023) SO-146

SCALE FULL

MATERIAL SEE NOTE #1

FINISH ~

DATE 1-4-66
DRAWN M.G.
CHK'D
APP'D

DRAWING NUMBER B-3339

A

OW TO LOAD AND SET CHART PAPER IN RECORDER

(Operating power disconnected)

1. Unscrew knurled thumb-screw at upper left corner of front panel and swing recorder open.
2. Push the two retaining clips up; remove empty supply roller and take-up roller with cardboard spool supplied.
3. Insert supply roller into cardboard spool of chart paper so that the perforations in the paper are adjacent to the roller's knurled shoulder.
4. Remove piece of masking tape to release end of chart paper (reuse tape in step 5). Roll out approx. 8 inches of chart paper, keeping perforated edge to the left and back (dark) side up.
5. Keeping edges of chart paper in alignment with ends of cardboard spool, attach end of chart paper to cardboard tube* on the take-up spool with the piece of tape saved from step 4. Roll up several turns of chart paper on take-up spool, with chart side (graph over white) out and visible.
6. With an angular motion (see Fig. 1) slide the loop of paper between the right side plate and the pointer guard.

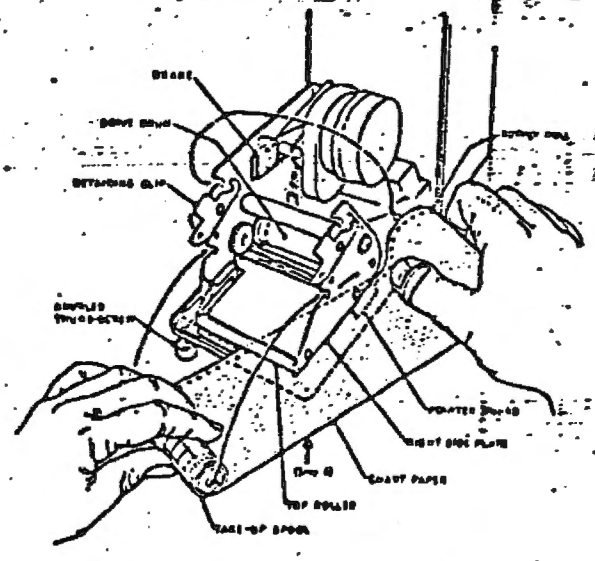

Figure 1. Loading Chart Paper

* An initial cardboard tube is shipped in place with the recorder, its use permits removal of the chart paper roll after recording is completed. Subsequent tubes are available from the used-up supply roll; should be transferred to the take-up spool for reloading.

7. Bring take-up spool up so that chart paper lies smoothly over top roller, place take-up spool end pivots in their slots.

8. With left thumb, squeeze brake aside, insert end pivots of supply roll in their slots while taking up excess of chart paper loop and engaging paper perforations with the sprocket nubs on the drive drum. Release brake.

9. Push down on retaining clips, locking supply and take-up spools in their places.

10. Disengage gear train on left side of recorder chassis (see Fig. 2) by pressing gear train unit in direction of arrow inscribed thereon.

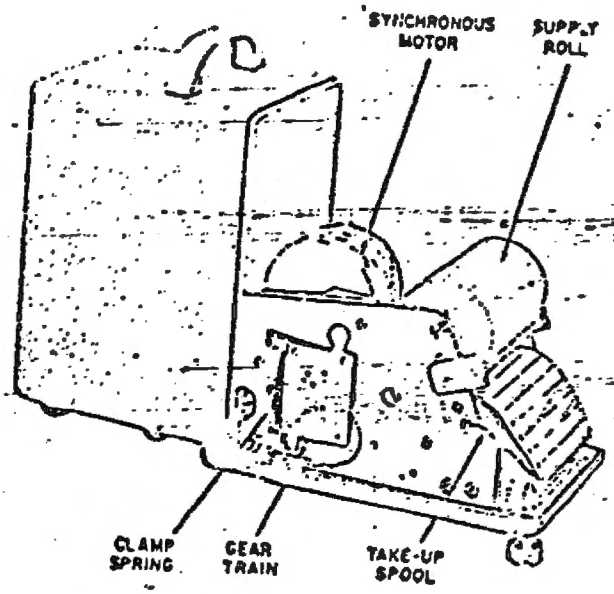

Figure 2. Left Side View of Recorder

11. While gear train is disengaged, pull take-up spool in its take-up direction until the desired starting time LESS TWO HOURS just appears on the front of the TOP roller. This operation should take-up all the slack in the chart paper and align the ACTUAL desired time with the scale on the front of the recorder. Check sprocket nubs for positive engagement.

12. Close recorder, engage knurled thumb-screw and tighten.

13. Apply power and signal and begin recording.

14. Check for proper operation about 15 minutes after start of recording.

15. When chart paper roll is exhausted, reload at once.

3.5 PLACING THE MICROWAVE RADIATION HAZARD MONITOR INTO OPERATION

3.5.1 General

CAUTION

Do not connect the instrument to the local power lines until the voltage selector switch has been set to the available line voltage. Otherwise the power supply and/or the battery pack may be destroyed.

The previous sections 3.1 through 3.4 have described how the Microwave Radiation Hazard Monitor is adjusted to use the locally available electrical power, how the pen recorder is loaded and how either the internal meter or the pen recorder is selected to indicate the measured power. When the above adjustments have been accomplished, the instrument is ready for use.

The different ways the Microwave Radiation Hazard Monitor may be placed in operation are listed below and cross referenced to the applicable paragraphs of this Operating and Maintenance Manual which describes in detail the particular adjustments and/or the output indications.

(A) Using the Internal Battery and the Indicating Meter

Component	Position	Section
Power Line Cord	Disconnected	3.2
Recorder Switch	OFF	3.4
Power Switch	ON	3.2

(B) Using the Internal Battery and the Paper Recorder

Component	Position	Section
Power Line Cord	Disconnected	3.2
Recorder Switch	ON	3.4
Power Switch	ON	3.2

(C) Using the Power Line and the Indicating Meter

Component	Position	Section
Power Line Cord	Connected	3.2
Recorder Switch	OFF	3.4
Power Switch	ON	3.2

(D) Using the Power Line and the Paper Recorder

Component	Position	Section
Power Line Cord	Connected	3.2
Recorder Switch	ON	3.4
Power Switch	ON	3.2

(E) Charge Battery

Component	Position	Section
Power Line Cord	Connected	3.2
Recorder Switch	Not applicable	3.4
Power Switch	Charge	3.2

3.5.2 Applying Power

The operation of this instrument is essentially the same whether the power source used is the internal battery or the AC power mains. When the power switch is rotated to the "on" position, and the indicating meter has been selected, the range change light will blink for a few seconds, and the meter will read upscale. The same output indication will be noted when the pen recorder is used as the output indicator. In this case, the range change indicator (event marker) will record a change of scale for several seconds before stabilizing to the correct range. After power has been applied for four or five minutes, bridge balance should be checked and adjusted if necessary.

3.5.3 Bridge Balance

There are three bridge balancing controls on the front panel of the Indicator Unit, a coarse resistive balance, a fine resistive balance and a capacitive balance. The resistive balance should be checked and these two controls adjusted if necessary four or five minutes after each time the equipment is turned on. After the initial bridge balance adjustment, the balance should be checked perhaps twice at 10 or 15 minute intervals. If adjustments are needed, care should be taken to avoid overshooting the mark by intentionally adjusting less than all the way to zero indicator meter reading. The resistive balance controls are finger knobs while the capacitive balance control is a screwdriver adjustment. The capacitive balance control will rarely require adjustment except when Sensor Units are interchanged.

To accomplish bridge balance, the Sensor Unit should be completely lowered inside the cabinet and the top door closed. With the recorder turned off, the balance controls should be adjusted for minimum indicator

meter reading, taking care to avoid overshooting the mark as mentioned above. This adjustment can also be accomplished with the recorder turned on by adjusting for minimum recorder indication.

3.5.4 Interpretation of Readings

The field strength of the radiation field is indicated on either the internal meter or the pen recorder. These two readings are identical within the indicating accuracies of the meter, and it is immaterial as to which method is used. The scales of the output indicators, indicator meter or pen recorder are identical. They are calibrated to indicate the r-f radiation field strength in mw/cm^2. There are four logarithmic scales which are calibrated to indicate 0.05 to 0.5 mw/cm^2; 0.5 to 5.0 mw/cm^2, 5.0 to 50.0 mw/cm^2; and 50.0 to 500.0 mw/cm^2. One full scale deflection of the meter's needle reads across two of the four logarithmic scales; thus one range change is required to present all four scales. This range change is accomplished automatically. When the field strength is greater than 5.0 mw/cm^2, the instrument automatically changes ranges and presents the two upper logarithmic scales, i.e. 5.0 to 50.0 and 50.0 to 500.0 mw/cm^2. The range change is indicated by a flashing light on the front panel of the Radiometer sensor when the indicator meter is in use and by a recording channel (event marker) when the pen recorder is in use.

The sensor has a thermal time constant and the output reading is the average power value. The averaging time is approximately 1 second. The rapid switching of indicator position during the tail-off for the high range cases is due to automatic range changing. The range change indicator will show high range signal present for a longer period than the signal is present due to the thermal time constant of the sensor.

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4. THEORY OF OPERATION

4.1 CONCEPT

The concept of operation of the Microwave Radiometer is very simple in principle. It operates in a manner which is almost opposite from the way a normal radio receiver operates. In the normal radio receiver, the antenna is designed to have a low insertion loss so that a majority of the intercepted r-f energy will be delivered to the r-f detector. The advantage of the normal receiver's operation is that it delivers a maximum amount of energy to the detector for demodulation and recovery of the modulated intelligence. The recovery of intelligence is the main purpose of a communications system. Its disadvantage is that the antenna delivers to the detector, for vector summation, voltages from each of the radiated signal rays which have arrived at the particular antenna location via a multiplicity of paths. The vector summation which results from this multipath situation can and does result in cancellation or suppression of portions of the received signal. In practice, to maintain an adequate signal level at a communications site, the well-known techniques of space and polarization diversity are used.

The Radiation Hazard Monitor on the other hand is not required to demodulate any signals but instead it must accurately measure the indident field strength at a particular point. The Microwave Radiation Monitor accomplishes the above requirements by using a sensor which is essentially a very "lossy" antenna. This sensor achieves both the effects of polarization and space diversity by adding, as scalar quantities, the power received from all of the various r-f multipath signals which arrive within its effective volume. Its manner of operation is very similar to the way the human body captures r-f radiation, and this operation is achieved by winding a sensor (antenna) which consists of a series of high loss conductors which are evenly distributed. These "lossy" conductors are linearly coupled to the electromagnetic field, and when excited by the electromagnetic field, a current flows which is proportional to the field strength. This current causes I^2R heating of the "lossy" conductors which changes their temperature and their resistance. A measure of

the change of resistance is an accurate measure of the incident field strength.

The sensor is implemented in practice by winding a continuous length of very small diameter wire evenly distributed over the surface of a sphere, the length of the wire being much larger than the circumference of the sphere. The wire is selected to have a high temperature-coefficient-of-resistance; i.e. a small change in temperature of the wire will produce a large change in the resistance of the wire. It is then possible to measure the change in temperature caused by the heating effect of the incident electromagnetic field strength simply by measuring the change of the resistance in an impedance bridge.

A temperature change in the sensor element can also be caused by a change in the ambient temperature. The effect of ambient temperature is compensated for by having an identical sensor which is at the same ambient temperature as the sensor, but isolated from the electromagnetic field. This reference sensor is placed in the comparison arm of the impedance bridge; thus, ambient temperature effects are greatly reduced.

Further, in order to maximize the change in temperature, which a small incident electromagnetic field would cause, the sensor and its reference element are placed in an evacuated chamber which decreases the thermal coupling of the antenna to the outside ambient.

4.2 DESCRIPTION OF THE SENSOR

The sensor which is used in the Microwave Radiation Hazard Monitor consists of two, 2 inch sensor spheres, mounted inside of two larger diameter bell jars which have been mounted base to base on a glass mounting fixture which also provides electrical feed-through connections. A photograph of the sensor is shown in Figure 5-4. The interiors of the bell jars have been evacuated. Each of the sensor spheres have been wound with 60 inches of 0.0005 inch diameter Balco wire. The windings on the 2 inch spheres are controlled so that each sensor is nearly identical to the other. This is necessary so that each sensor will have the same thermal impedance with the ambient. Inside the bell jars and between

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the two sensors is mounted a microwave absorbent material whose purpose is to r-f shield the sensor used for thermal comparison. An absorbent material is used to reduce any reflection of the received signal which would result from this shield. It must be remembered that this instrument will add the power of all received signal vectors regardless of source, and a reflected signal would distort the field pattern of the sensor.

4.3 FUNCTIONAL DESCRIPTION OF THE INSTRUMENT

The instrument consists of two sensors--one exposed to the incident microwave radiation and the other shielded from it. The two antennae (sensors) are connected in a bridge circuit in a manner such that thermal effects are canceled but microwave radiation is detected. The bridge is excited from an AC power source. The AC bridge unbalance voltage is passed through a narrow band filter centered at the excitation frequency and amplified. The amplified signal is then processed in parallel by an automatic range change gate and a logarithmic network. The logarithmic network output is connected to either the indicating meter or the pen recorder according to the operator's choice.

4.4 FIELD PATTERN CONSIDERATIONS

All of the outside metal parts of the major subassemblies of the Microwave Radiation Hazard Monitor are covered with a material that absorbs microwave radiation. This is done so that the presence of the instrument within the radiation field will not disturb the distribution of the field in a way that an erroneous reading may result. Without the absorbing material, there would be reflections of the r-f energy from metallic portions of the instrument, and these reflections have the effect of changing the sensors' antenna pattern. As supplied, the measured pattern is hemispherical for frequencies above 2 KM and a distorted hemisphere in the frequency range of 1 to 2 KMC.

5. MAINTENANCE

5.1 GENERAL

Figures 5-1 through 5-4 are photographs of the equipment from which various instrument adjustments can be located. The voltage selector switch can be seen in Figure 5-1 and also in Figure 5-3. The calibration adjustment is seen in Figure 5-4. The bridge excitation voltage adjustment is seen in Figure 5-3. Finally, the voltage regulator adjustment is seen in both Figures 5-3 and 5-4.

Figure 5-5 is a photograph of the Sensor and its housing. When the Sensor is installed in this housing, the unit so constituted is referred to as the Sensor Unit.

Figure 5-6 is a schematic wiring diagram of the entire instrument.

5.2 CALIBRATION

Calibration of the Indicator Unit Scale factor is accomplished by raising the Sensor Unit to its operating position and placing the Sensor Unit in a radiation field of known power density. A field density of about 200 microwatts per square cm is suggested. Calibration may then be accomplished by adjusting the calibration potentiometer which is located on the right hand side of the Indicator Unit. This calibration adjustment is a 30 turn screwdriver adjustment potentiometer which is reached by withdrawing the Indicator Unit from the cabinet. This may be done by removing the black plastic cleat at the base of the Indicator Unit front panel which is held in place by three wood screws. There is an arrow on the right hand side of the recorder case identifying the calibration adjustment; also this adjustment may be seen in Figure 5-4. Calibration adjustment should only rarely be necessary.

5.3 BRIDGE EXCITATION VOLTAGE ADJUSTMENT

The instrument was delivered with the bridge excitation voltage set at the maximum value of 68 volts peak to peak. If for any reason it is desired to adjust this excitation to a lower voltage, this control is

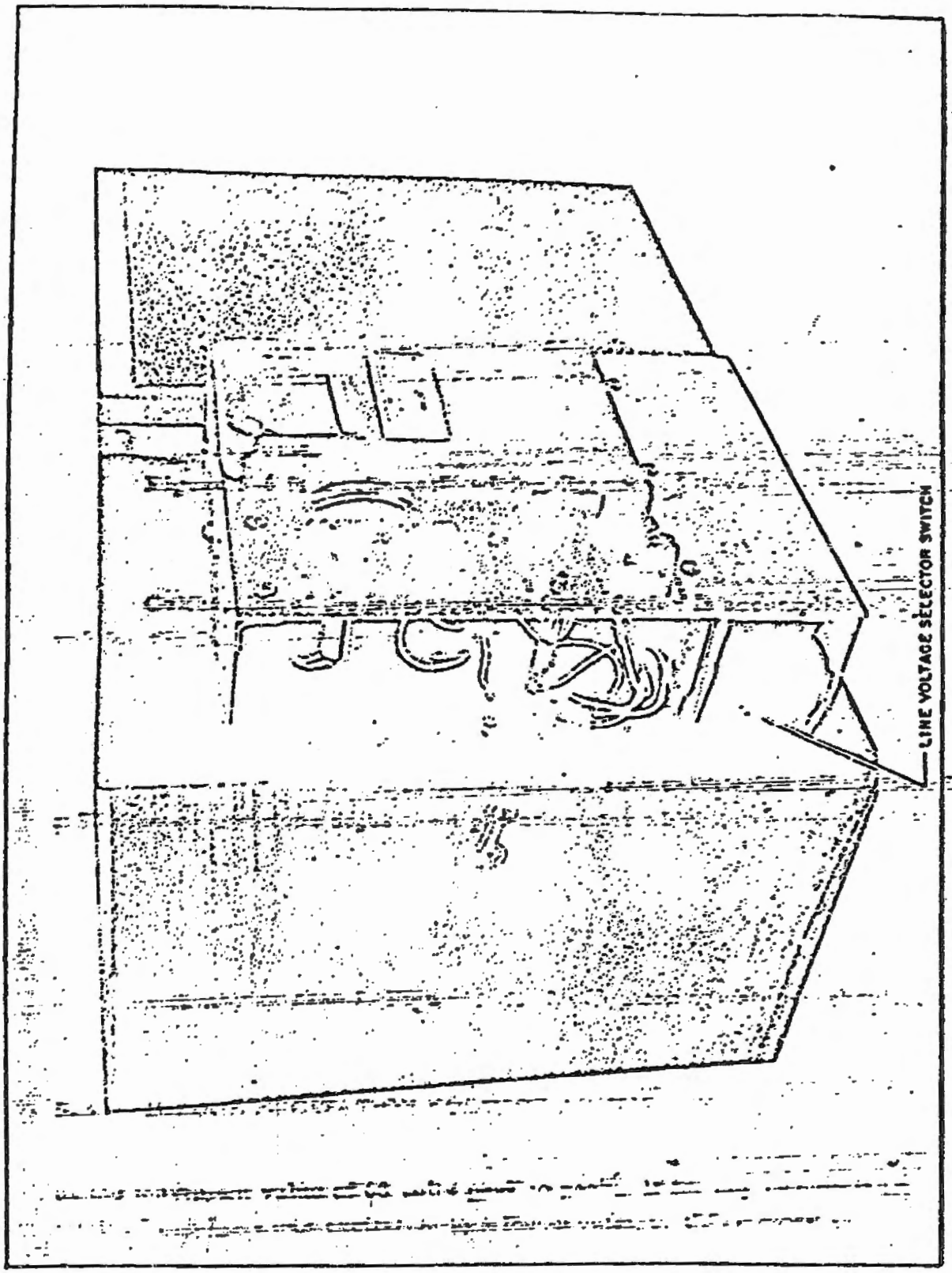

Figure 5-1. Instrument, Indicator Unit Protruding from Cabinet

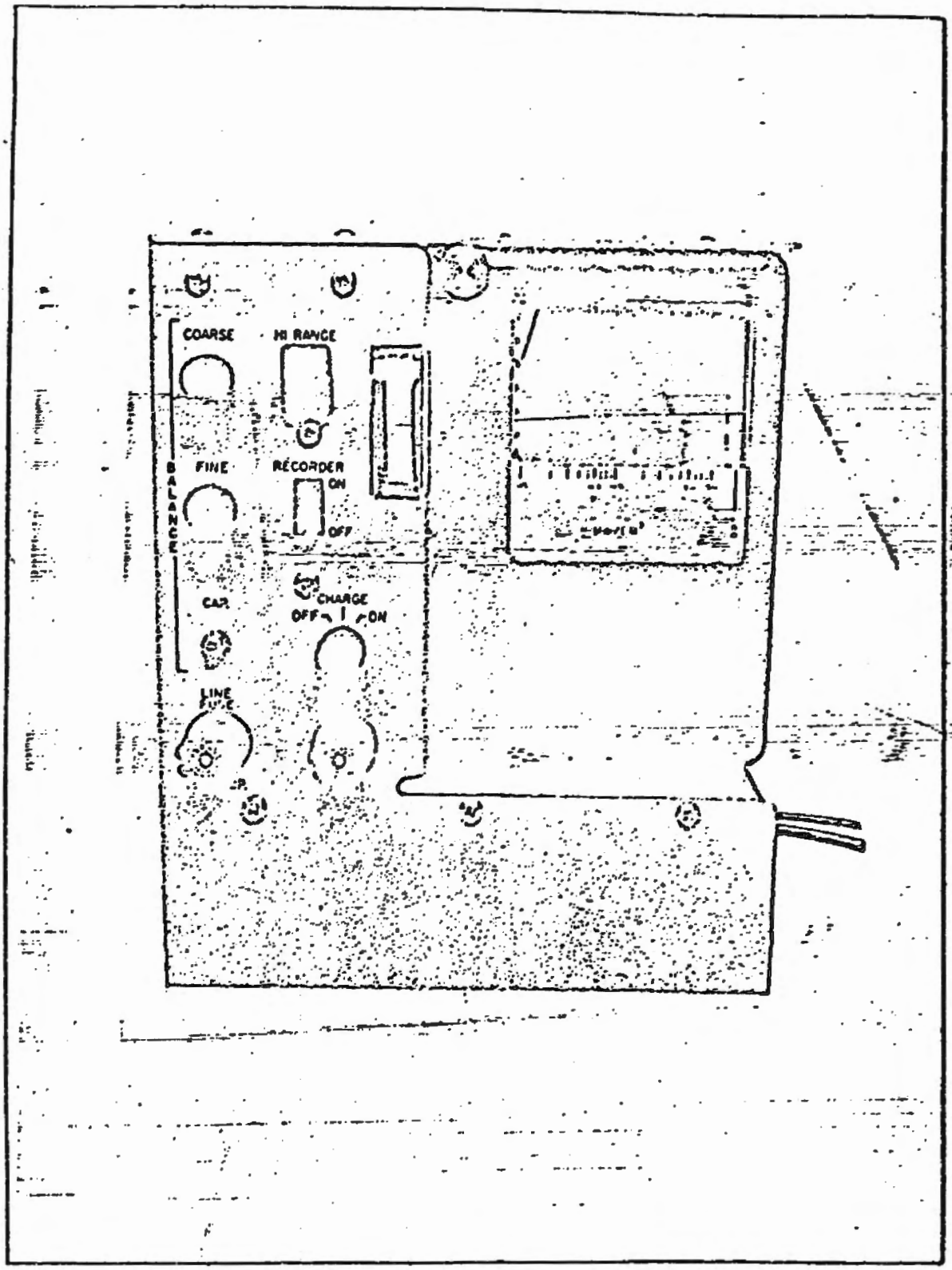

Figure 5-2. Front View of Indicator Unit

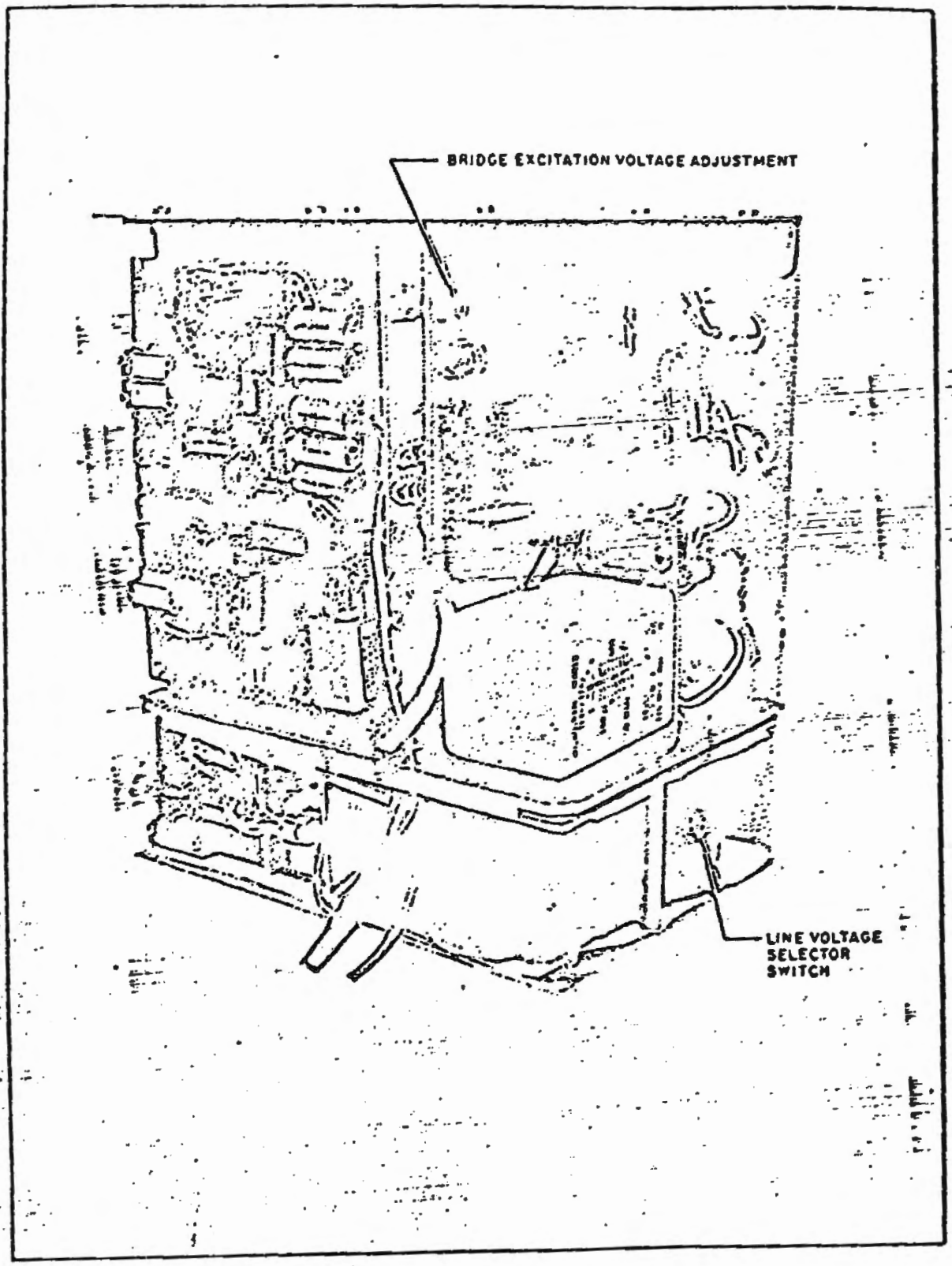

Figure 5-3. Left Rear Corner of Indicator Unit

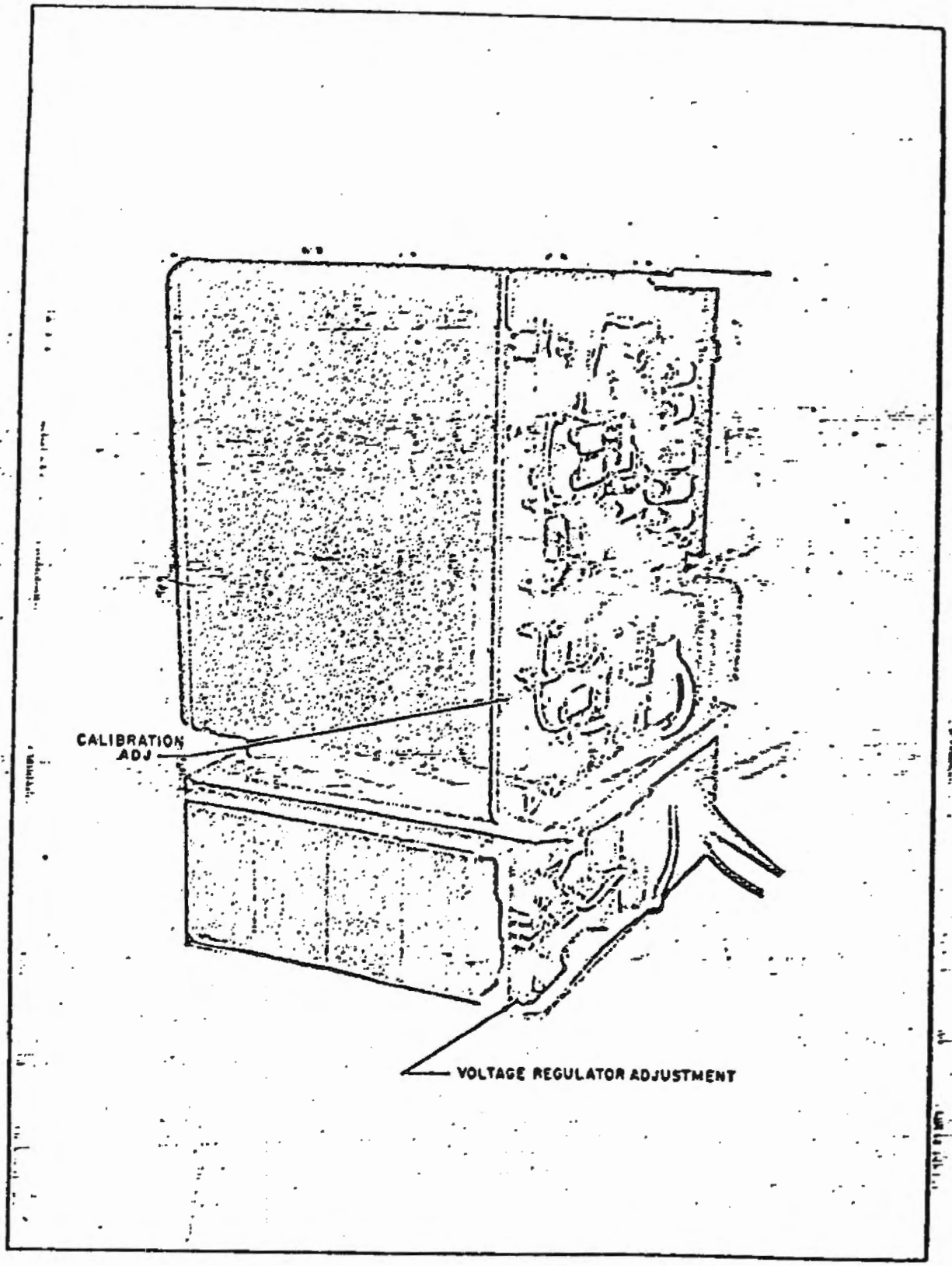

Figure 5-4. Right Rear Corner of Indicator Unit

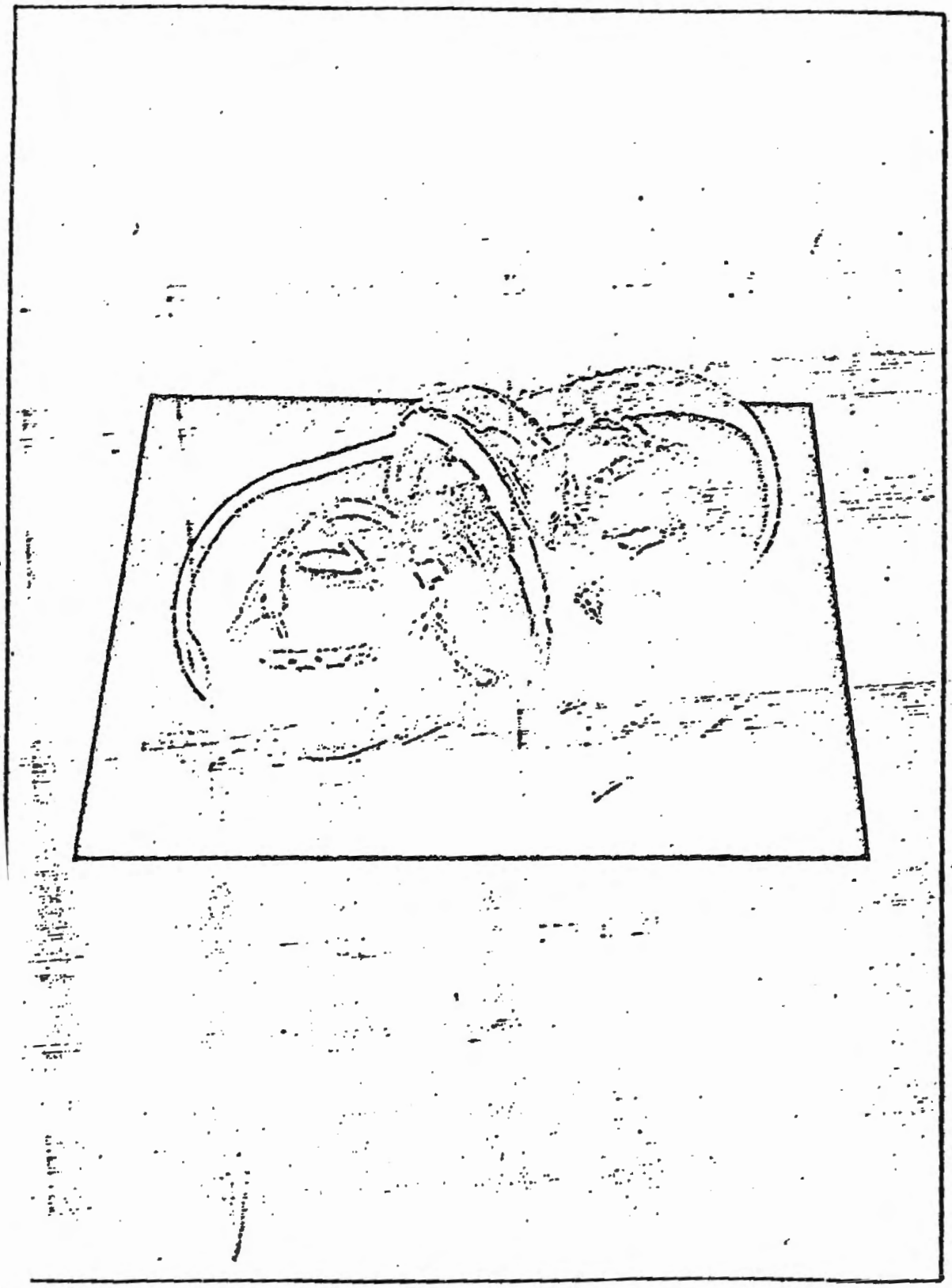

Figure 5-5. Sensor

identified in Figure 5-3. The voltage may be measured at the secondary (terminals 4 and 5) of the bridge drive transformer which is seen in Figure 5-3 just below the line cord plug. Either side of this transformer secondary may be temporarily connected to case (common ground) for the purpose of this adjustment, if desired. It must be remembered that the waveform at this point is a nominal square wave and therefore the type of voltmeter used must be taken into account in interpreting readings. That is, an average reading meter will respond differently than an rms type meter. A peak reading meter is not recommended because of the short lived oversboot spikes produced by passing the square wave through the transformer. A calibrated oscilloscope could be used for approximate measurements.

5.4 TESTING THE SENSOR

It is relatively easy to test the Sensor and determine whether the evacuation is still effectively providing adequate sensitivity at this point in the circuit. To accomplish this, remove the wood panel on the bottom of the cabinet. This panel is held in place by four wood screws. When this panel is removed, disconnect the three miniature coaxial cables from the Sensor Unit. Connect a measured 35 volts DC between the center connectors of coaxial jacks A and B on the Sensor Unit and measure the DC current drawn by the Sensor. The lower the current, the better the vacuum and, therefore, the greater the sensitivity of the Sensor. DC currents greater than 6 milliamperes at 35 volts DC indicate a poor vacuum. Figure 5-7 is a data sheet relating results of previous tests of the Sensor delivered with the instrument.

00022011

SENSOR TEST DATA

Date of Initial Data
2-13-67

Part No. SV-3

Serial No. G101

Cold Resistance

Exposed Antenna 2420

Reference Antenna 2450

	Voltage Volts	Current MA	Remarks
67	35	6.8	Ambient Pressure
7	35	4.4	Evacuated, not completely Cooled
7	35	4.55	Cooled (9.20 AH)
7	35	4.63	Recycled (10.25 AH)

(12)

[redacted] F H

27 February 1967

MEMORANDUM FOR: [redacted] F

SUBJECT : Recommendation to [redacted] F on Biological Measurements of TUMS Radiation Effects

1. The [redacted] F assembled by Mr. [redacted] D on 10 February 1967, has been charged with the task of working up a list of studies to be performed on personnel assigned to the United States Embassy in Moscow which would be most likely to reveal any biological or performance effects which could result from exposure to the TUMS radiation. The group was also instructed to submit its recommendations by 27 February 1967, said recommendations to be limited to existing standardized tests which could be implemented during the next two months.

2. With respect to the overall test effort, the [redacted] F [redacted] F recommends at the outset that unless some clear-cut positive gain in terms of interpretable and reliable results, either positive or negative, is a reasonable expectation of this short term ad hoc approach, that it would be better to not do the studies at all. In any F case, [redacted] recommends that considerable thought be given to the possible consequences and security risks of conducting the study and that commensurate thought be given to the establishment of a plausible cover for doing the tests. There is every reason to believe that in the normal course of events non-American members of the diplomatic corps in Moscow will become aware of the testing and that soon thereafter it will become known to the press corps. It is suggested that one approach might be to put the whole thing on a military performance study basis, beginning with control group testing of Military Attaches in Washington, then in Helsinki, Warsaw and Moscow, and including State personnel on a "voluntary" basis in Helsinki, Warsaw and Moscow as non-military comparison groups.

[redacted] G

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3. It is understood that the other members of the F will be recommending a spectrum of studies designed to measure behavioral and performance parameters. The F conditionally recommends the following study on Moscow Embassy personnel only as potentially of use in detecting transient physiological changes which reportedly result from exposure to low power levels of microwave radiation. The test and conditions are set forth below:

a. Measurement of Serum Complement Levels.

This measurement is based upon the observation of a reduction (10% - 20%) in serum complement titers in guinea pigs exposed to 10 MW/CM^2 and 20 MW/CM^2 of microwave (x-band) radiation for a period of six (6) hours. See attachment.

It is recommended that serum complement titers be performed on new arrivals at the Moscow Embassy and at the end of one week exposure to the microwave environment. Each subject will serve as his own control. These paired studies should be compared with complement serum titers on the same individuals after removal from the microwave environment for a period of seven days.

4. This recommendation is made with the assumption that this test can be performed in the Embassy. Further, this recommendation is made only on the condition that a reliable cover for conducting the test can and will be established.

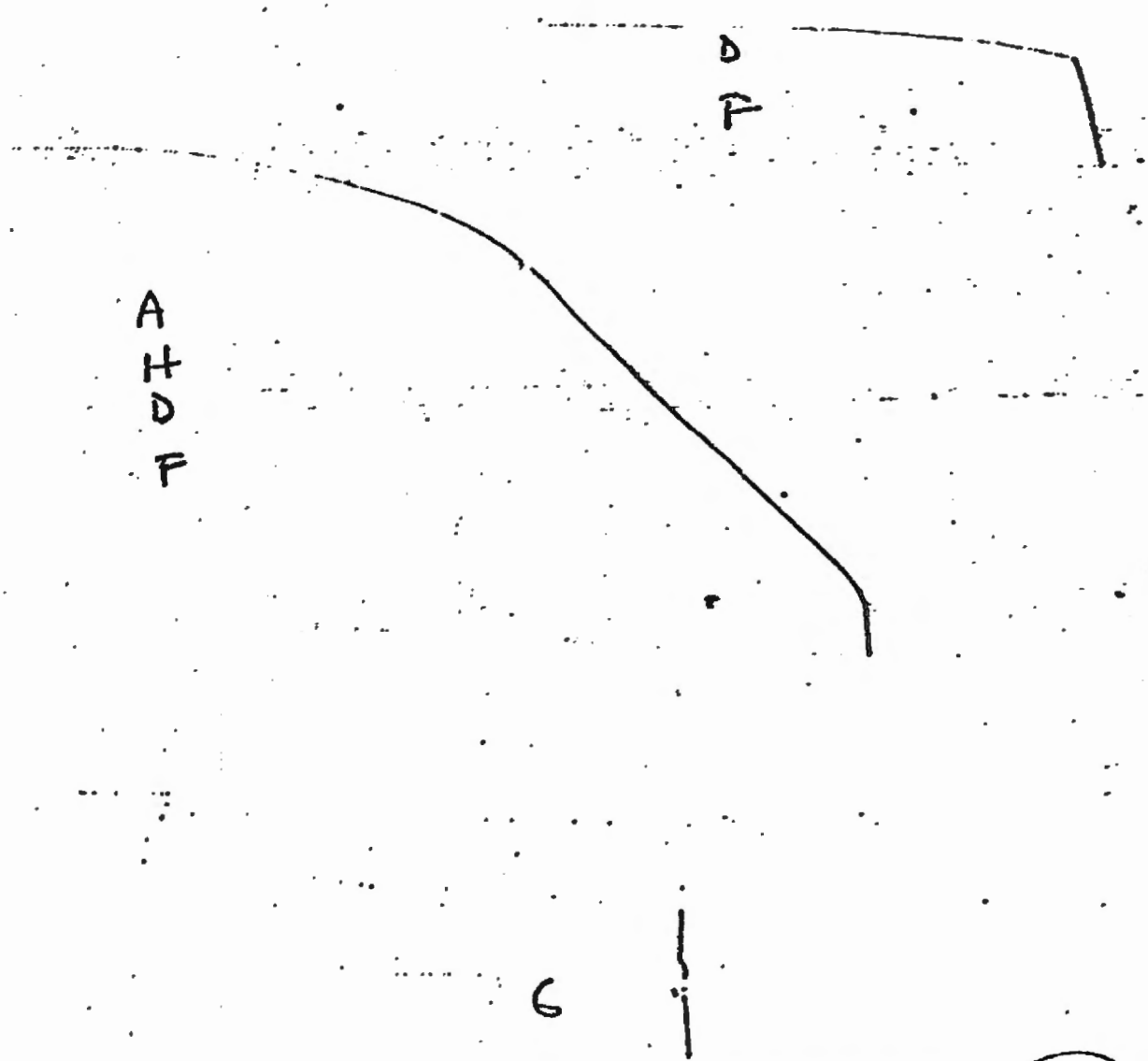
5. The rationale for recommending this test rests upon the fact that if the radiation power density of the work and habitation environment is in the milliwatt per square centimeter range, this test, which provides adequate experimental control, may show a transient biological effect. There is no proof that such an effect would be harmful but the burden of proof would be on the side of anyone contending that it was not harmful. And this would be exceedingly difficult to show.

6. On balance, however, if the environmental power density is in the microwatt per square centimeter range, there is no reason to believe that this test, or any other test performed within the restrictive confines of this particular work environment, would show positive results. Even under the best of experimental conditions it is exceedingly doubtful that any United States experimental group would be able to confirm in humans what they have failed to accomplish in experimental animals, and that is to confirm Soviet claims of producing measurable biological and psychosomatic changes with microwatt power levels of microwave radiation.

(13)

7. Therefore, if the average radiation power density is found to lie below one-tenth of a milliwatt per square centimeter and there are no significant surges of power above this level, it is recommended that the serum complement titer measurements not be done. Under such circumstances we do not believe that anything is to be gained, even in a negative sense, by this test.

8. In sum, if the power level is above one-tenth of a milliwatt per square centimeter, F recommends that the serum complement titer test be performed as described above. If the power level is below one-tenth of a milliwatt per square centimeter, F recommends that the test not be done.



Copy 2

BIOLOGICAL EFFECTS OF MICROWAVE RADIATION*

A

* For presentation at the B] meeting B] 1964, in B]
← B]

BIOLOGICAL EFFECTS OF MICROWAVE RADIATION

This study was done to investigate the biological effects of X-band microwave radiation waves -- on the serum and central nervous system of guinea pigs. X-band microwaves are 3 cm waves of the electromagnetic spectrum.

Many studies have been performed on the biological effects of short wavelength electromagnetic radiation such as gamma rays, X-rays, and ultraviolet radiation. Relatively few studies have been done on low intensity microwave radiation. Application of microwave radiation to problems in communication, ranging, and medicine has made it desirable to assess the biological effects of low intensity microwaves. The first slide gives an outline of the electromagnetic spectrum, to show where the 3 cm wavelength occurs in relationship to the remainder of the spectrum.

Microwave radiation is electromagnetic radiation of frequency from about 1,000 to 30,000 Mc. This includes the L-, S-, X-, K-, Ku-, and C-bands of radar. These bands are named rather arbitrarily. They designate frequency ranges of available klystrons and magnetrons.

The objectives of the study described here were the determination of immunological and CNS effects of 3 cm microwave radiation. To achieve this end our experimental plan included ten radiation groups that were scheduled for different procedures weekly. On DAY ONE, animals were irradiated and bled for serum complement titration. On DAY SEVEN, we bled animals for serum complement titration to compare each animal to itself and to assess temporary radiation effects. On DAY FOURTEEN, animals were given intradermal injections of neural

(12)

tissue to cause autoimmune disease. In most animals, serum complement was studied after disease symptoms appeared, usually before DAY 28 in irradiated animals.

Six female Hartley strain guinea pigs were used for each of the ten radiation experiments. The average weight was 350 g. For each radiation experiment, three of the animals were placed in a polystyrene cage in a radio-frequency anechoic chamber, as shown here. Cage dimensions were 26 x 26 x 21 cm. Microwave radiation was introduced to the chamber through the horn (shown here), and power rating was calculated according to distance from the horn. No food or water was available to the animals during irradiation. The control and experimental animals were handled in identical fashion except for exposure to microwave radiation. Control animals were held in the anechoic chamber while the experimental animals were irradiated, but were not exposed to the microwave radiation.

This table summarizes our results on serum complement levels as titrated by a standard immunological method with sheep cells. These figures represent the highest serum dilution giving complete hemolysis in the standard complement titration test. The higher the number, the higher the serum complement level. It will be noted that the serum levels on the irradiated animals are lower -- over 10 per cent lower -- than those of the control groups on the X-band irradiated animals.

The chart shows two different wavelengths which were used: X-band microwave radiation of 3 cm, and L-band, or 10 cm wavelength. The X-band-

irradiations were performed continuously for 6 hr at a power density of 10 milliwatts per sq cm and 20 milliwatts per sq cm. Since some heat is produced by X-band radiation, we set up L-band radiation experiments (L-band produces much more heat in vivo) to check if the biological changes were due solely to a thermal effect or to some other facet of microwave radiation.

L-band irradiations were carried out at three different exposure times and power densities: 36 min. at 100 milliwatts per sq cm, 115 min. at 31 mw/cm^2, and finally the same power density employed with X-band irradiations, 6 hr at 10 milliwatts per sq cm. The first L-band irradiation at 100 milliwatts power density killed the animals in less than a half hour. On complement titration of the serum from the L-band irradiated guinea pigs, we noted no change in serum complement levels or electrophoretic pattern of the irradiated serum. The complement levels on the L-band irradiated animals were about the same as the L-band control, and exactly the same as the serum complement levels of the X-band control group. We decided on the basis of these experiments that L-band (10 cm microwave) radiation does not change serum complement levels. Therefore, the complement depression found after X-band radiation was due to a microwave effect that was not heat.

Our methods of collecting serum for these complement tests were as follows: the control and experimental animals were bled by intracardiac puncture immediately following the irradiation period, and the complement levels on the serum of each animal were titrated the following day. One week following radiation, the control and irradiated animals were again bled by intracardiac

puncture and the complement levels titrated again. In this way, each animal served as its own control, and we could assess the permanency of the complement depression. At the second titration, one week following radiation the complement levels are nearly identical. A comparison of mean serum complement figures indicates a P less than 0.001 calculated by the Student "t" test for X-band irradiated and control groups on DAY ZERO. Behavioral responses to the X-band microwave radiation were also noted. Guinea pigs irradiated at 10 and 20 milliwatts power density positioned themselves at the rear of the polystyrene cage. A higher defecation response by irradiated animals was also noted. Both positioning and defecation response could be a result of the heat stress, although the statistically significant increase in defecation response during irradiation could also mirror central nervous system changes.

Aliquots of the serum samples taken for complement studies were run on a Beckman-Spinco paper electrophoresis apparatus. Ten microliters of each serum sample were run for 18 hr at 3 milliamps constant current in pH 8.6 veronal buffer. The stained strips were examined for differences in serum migration patterns but no marked differences were observed in any irradiated animals when compared with controls. This negative finding in electrophoretic analysis could be expected. The small changes in serum complement would not be shown because complement represents such a small per cent of the total plasma protein material. Furthermore, complement decrease could represent an inactivation without actual protein loss.

Since the complement level showed an immunological change as a result of X-band microwave irradiation, it was decided to test the animals in their response to allergic encephalomyelitis (EAE).

The autoimmune disease allergic encephalomyelitis is a central nervous system pathology in which the animal becomes allergic to its own neural tissue and myelin loss results. External symptoms in the guinea pigs include ataxia, paralysis, and emaciation.

Between one to two weeks following irradiation, all the animals, control and radiated, were injected intradermally with an EAE-inducing mixture, bovine spinal cord homogenate and Freund's complete adjuvant, 1:1. Two tenths milliliter of this mixture was injected into the footpad of each guinea pig. Using crude whole-cord extracts as the EAE-inducing mixture, we obtained about 60 per cent incidence of the disease in the control animals. The control animals that did develop the disease contracted it in an average time of 14.9 days, which is just about the average time found in previous work. The irradiated animals, however, showed both increased susceptibility to the autoallergic disease, over 90 per cent incidence, and faster development, only 9.7 days.

EAE occurred more readily in L-band irradiated animals than in the L-band controls, although no serum complement change with L-band was observed. This could be due to the small sampling of L-band irradiated animals (only six lived) or to thermal injury that increased susceptibility of the animals to EAE while not affecting complement levels.

To SUMMARIZE GENERALLY:

Ten groups of six guinea pigs were subjected to low power microwave radiation to assess biological changes incurred.

There is, first, a significant lower of serum complement levels in guinea pigs soon after three cm X-band irradiation, but these levels gradually return to normal. The susceptibility of these same guinea pigs to allergic encephalomyelitis induced by intradermal injection of neural tissue and adjuvant was significantly increased over the controls. Finally, the defecation response of the animals during the irradiation period was increased.

DEVELOPMENT OF ALLERGIC ENCEPHALOMYELITIS (EAE)

Radiation Wavelength, Power Density and Time	Controls Days before Signs of EAE	Irradiated Days before S of EAE
X-Band 10 and 20 mw/cm2 6 hr. (7 groups, 6 in each)	Mean: 14.9 days	Mean: 9.7 day
L-Band 31 mw/cm^2, 115 min. 10 mw/cm^2, 6 hr. (3 groups, 6 in each)	Mean: 13.3 days	Mean: 9.1 day

SERUM COMPLEMENT CHANGES IN X-BAND AND L-BAND IRRADIAT

Radiation Wavelength, Power Density and Time	Control Mean serum Complement Levels Day 1	Control Mean serum Complement Levels Day 7	Irradiate Mean Serum C plement Leve Day 1	Irradiate Da
X-Band 10 and 20 mw/cm^2 6 hr. (7 groups, 6 in each)	Mean: 4.4	Mean: 4.4	Mean: 3.3	Me 4
L-Band 31 mw/cm^2, 115 min. 10 mw/cm^2, 6 hr. (3 groups, 6 in each)	Mean: 4.5	-	Mean: 4.4	

C00022011

[redacted] C/MBSD

[redacted]
13 February 1967

MEMORANDUM FOR THE RECORD

SUBJECT: Meeting with [redacted] Dr. Joseph Brady and Dr. Joseph Sharp, Walter Reed, on Project TUMS, 10 February 1967

1. Dr. [redacted] and [redacted] were requested to meet with Subject officers at [redacted] on this date to participate in the development of a research program to be carried out on U.S. Embassy personnel in Moscow for the purpose of detecting any biological or behavioral effects which could be caused by exposure to the Moscow signal.

2. Mr. [redacted] stated that he had been directed by the [redacted] to establish a program of research studies and to present them on 15 February 1967 (Wednesday). The studies are to be carried out within the next month, or perhaps two, by one or more persons who will travel to Moscow for that purpose.

3. The meeting yielded the following proposed studies:

a. Behavioral/Performance Studies:

1) Discrimination Thresholds
Visual
Auditory

2) Reaction Time
Avoidance (non-noxious)

3) Vigilance Performance

4) Attention Span

5) Cognitive Ability

6) Dynamic Muscle Strength

7) Critical Flicker Fusion

[redacted]

b. Physiological/Biochemical

1) New tests - none

463

2) Dr. Brady was asked to obtain the results of all the previous studies, i.e., chromosomal, etc., performed and to report to Mr. [redacted] before 15 February.

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C00022011

SUBJECT: Meeting re Project TUMS; 10 Feb 67

c. Concerning other studies, it was agreed that measurements such as anxiety scales, analysis of prevalent complaints and job performance decrement would be useless unless similar studies could be made on control groups in other U.S. Embassies behind the Iron Curtain.

4. I pointed out that unless some clear-cut positive gain could reasonably be expected to result from these studies, it would be better not to do them at all. In any case, considerable thought should be given to the establishment of a plausible cover for doing the tests because in the normal course of events the [redacted] will learn of the testing and subsequently the press corps will learn of it, probably within two days of beginning testing. I suggested that the whole thing might be put on a military personnel performance basis, beginning with control group testing of Military Attaches in Washington, then in Helsinki, Warsaw and Moscow and including State personnel on a "voluntary" basis in Helsinki, Warsaw and Mexico as non-military control groups. Testing of returnees should also be seriously considered.

5. A draft working paper will be made available for review, probably on 14 February.

6. Dr. [redacted] and I will prepare a memorandum containing our recommendations to [redacted]

[redacted]

C00022011

15 Sept 65

MEMORANDUM FOR: [redacted]

SUBJECT : Request from Department of State Concerning Contracting Assistance for Project TUMS Radiometer Development

1. Attached is a request from Mr. Theodore Vea, Office of Security, Department of State, requesting assistance in contracting for a medical hazards radiometer for Project TUMS. The timely development of a suitable radiometer for this project is important [redacted] to the Department of State. I believe the use of your good offices and of the professional competence of your officers at [redacted] in this case would materially assist the Department of State in meeting its deadlines and accomplishing its tasks as the department principly responsible for Project TUMS.

2. Attached is a copy of the [redacted] contract proposal cited by Mr. Vea and a memorandum of preliminary discussions between Mr. Vea and [redacted] personnel arranged by Dr. [redacted]

3. I would appreciate very much your favorable consideration of Mr. Vea's request.

[redacted]

[redacted]

464

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Director F

Director F

Initiation of New Task with A for an H.F. Radiation Hazard Monitoring System, H

1. The F has been tasked by the Department of State, through the F to develop an H.F. Radiation Hazard Monitoring System as described in A Proposal H dated 13 August 1965.

2. It is therefore requested that a new task be issued to A for the work described as Phase I H. Requisition NSB CC-160 is attached for this purpose, encumbering B under allotment H. These funds are reimbursable to the Agency under Department of State Fund B Allotment H Obligation H (Paragraph 5, Attachment 1).

3. The work to be performed under this task and Agency association shall be G The project engineer is Mr. D F

D

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F
H

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SEP 1983

RELEASED

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C00022011

(3) CONFIDENTIAL 6.1

[redacted] H

15 September 1971

MEMORANDUM FOR: [redacted] F

SUBJECT: [redacted] A F

1. In answer to [redacted] D questions concerning the A preliminary report by [redacted] on biological effects of microwaves, I suggest the following: A

a. [redacted] F can easily keep track of this work through [redacted] A We are now making arrangements to be placed on distribution.

b. The power levels are in fact many orders of magnitude higher than the TUMS signal measurements.

c. The research reported here appears to be quite basic, thorough, and of good quality.

2. I have passed the original material on to Dr. [redacted] D for his comments as you requested.

[redacted] D F

466

RELEASED SEP 1983

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6

CONFIDENTIAL

Effects of Microwaves on the Behavior of Primates

I. Statement of Problem

Because of the scarcity of information on the effects of low intensity microwave radiations on CNS functioning, the following initial experiment is proposed. It is assumed that the effects, if any, will be subtle. Therefore, the behavioral bioassay techniques must be sensitive to subtle somatic changes. Techniques similar to those proposed here have been shown to be adequate for psychopharmacology and brain physiology studies and are felt to be adequate for the initial studies on the effects of low intensity microwaves, i.e., below 4 milliwatts/cm^2. In addition, these methods should yield first approximations on sensory discrimination, temporal interrelationships, fatigue factors and various crude homeostatic mechanisms such as water intake-output, body weight, and, possibly, body temperatures.

II. Methods

a. General procedure: Male primates (macaca mulatta) will be trained to perform various tasks for their daily ration of water and food. After obtaining a high level of stable performance, each animal will be exposed to various microwave environments. It is expected that any effect of this exposure will be reflected in one or several of the behavioral and/or physiological indicators. After exposure, each animal will be maintained on the same program for one week to determine any latent effects. At the

conclusion of all experiments, selected animals will be sacrificed for anatomical and physiological study.

b. Behavioral performance procedures: Each animal will be trained to perform three different tasks. They are: 1) a progressive ratio technique which will require the animal to press a manipulandum a progressively increasing number of times for each succeeding pellet of food. 2) a differential reinforcement -- low rate (DRL) schedule of reinforcement which requires a single response after a specified duration in order to receive the allotted food pellet. If the response is made too "early" the timer which controls the reinforcement contingencies will be reset and the animal must wait for the specified time to elapse before again responding. 3) a "time out" period during which the animal must make no response in order to move into the next reinforcement condition. Each of these three discriminately different performance requirements will be signaled to the monkey via a series of colored lights or changes in an auditory signal. For example, a tone of 8,000 cps will indicate to the trained monkey that he is in the time out condition and must avoid responding for three minutes in order to be switched into the DRL condition. When the monkey has waited through the three minutes, a 9,000 cps tone will indicate the DRL component is now operative and he must time his responses in order to be reinforced. After five successful responses the 8,000 cps tone will again be switched on and the monkey must wait, without responding, for another three minutes after which a yellow light indicates the progressive

ratio component is in operation. The conditions which the monkey must meet to get out of the progressive ratio component are of an either-or nature. Either the animal "runs" through the entire five steps of the ratio, i.e., puts out a total of 2,580 responses for five pellets of food, or, exceeds a post-reinforcement pause duration which has been empirically derived. What this latter condition means is that following reinforcement there is a predictable pause before the animal starts to work on the next higher ratio. If he should exceed a duration which under normal control condition was never reached, he will be automatically switched into the time out component and then on to the DRL component. The entire cycle is then repeated. It is felt that the progressive ratio component taps fatigue and motivational variables which are relatively free from complex CNS function. Since the DRL component will yield information on the proficiency of being able to keep track of time by some internal mechanism and is relatively free from motivational variables, it should yield information on "higher nervous activities."

c. Metabolic and physiological procedures: Of course, the total food intake will be determined by efficiency of the behavioral performance. At various intervals the monkey will be signaled via a green light that by pressing a nose key he can receive a specified quantity of water. The amount and time of drinking will be measured. Urine will be collected on a 24-hour basis and total body weights taken before and after each exposure. Various methods of remotely determining body temperature will be investigated. The method of choice should measure temperatures of 0.1°C.

d. Microwave exposure procedures: Microwave characteristics will be determined by non-WRAIR personnel, but should be so chosen as to optimize the probability of causing measurable somatic (hence behavioral) effects. The duration of any one exposure will be less than 10 hours and no more than 30 successive exposures for any one monkey. Details of the exposure parameters should be finalized and submitted to WRAIR for planning purposes.

II. Treatment of Results

a. All behavioral data will be evaluated quantitatively. That is, no attempt will be made at "clinical interpretation" or "general evaluation of activity," etc. For example, the quantitative evaluation of the data collected from performance on the progressive ratio will be handled in the following manner:

1. The particular ratio where the animal finally stops working for his next pellet of food will be determined.
2. The speed with which the animal "runs off" each of the ratios (response time) and,
3. The duration of the post-reinforcement pause for each of the various ratios will be recorded.

b. The efficiency of the behavior in the DRL component will be determined by plotting the interresponse times for each DRL session. This will give not only an efficiency rating, but an opportunity to explore the effects on a relatively complex task over a 10-hour period.

c. The latency and accuracy of responding following a stimulus change, e.g., from one tone to another, will provide preliminary information of alertness and perceptual acuity.

d. Changes in food and water intake, urine (and possibly steroids) output, body weight and temperatures will all be related to behavioral pertubations and microwave manipulations.

IV. Conclusions and Future Experiments:

a. If no behavioral or physiological changes are detected by the above techniques, one of three courses are open:

1. Conclude the experiments and do no further work.
2. Design different and, perhaps, more sensitive behavioral and physiological techniques using the same or different organisms.
3. Increase, or in some other way, alter the microwave environment to further optimize any effects on already monitored systems.

b. The design of future experiments, if, indeed, there are to be any, should rest upon information obtained from the initial studies. However, it is felt by WRAIR that some definitive statement about what kind and how much negative information is necessary to terminate these experiments.

C00022011

TO: File

DATE: July 20, 1964

OM:

COPIES TO:

CT: Trip Report

This report summarizes the June 24, 1964, through July 7, 1964, visit of Dr. [redacted] to the customer's facility.

Objectives:

The purpose of this initial trip included the following objectives:

1. To acquaint key members of the [redacted] team with the sponsor's personnel involved in this program.
2. To study the present methods of stress measurement and chart interpretation.
3. To obtain data samples for manual analysis prior to the availability of magnetically recorded test data.
4. To discuss the implementation of the automatic recording equipment.
5. To investigate means of collecting supplementary test data; e.g., the operator's comments, operator code, subject code, etc.
6. To examine the availability and potential of biographic and psychological data in this study.

These objectives were accomplished as described in the following section.

Work Accomplished

The major part of the first week and one-half was devoted to work with the Keeler polygraph and its application. First, we were subjected to the device; then we were instructed in the physiological parameters measured, application of the sensors, and the adjustment and operation of the equipment. We then received a concentrated course on chart interpretation and the types of tests performed. While there are classic patterns indicative of stress for each of the three measured parameters, no absolute criteria is known to specifically distinguish either the presence or amount of stress. Rather, a norm must be established for each test record (not person), and deviations from this norm used as an indication of stress. The type of test (e.g., Peak of Tension, 3-5-8, etc.) will also modify the manifestation of stress. Identification of normal patterns and the interpretation of deviations form the basic problems in pattern recognition.

Having gained some appreciation of the factors involved in chart interpretation, we proceeded to select some 125 samples for manual analysis. These are to be reproduced and copies sent to [redacted] for use in evaluating the digital transformations to be performed on the analog data prior to input to the pattern recognition program.

Various methods of collecting supplementary data from the examiner and correlating this information with the analog data were discussed. The primary considerations in this area are to identify the question, the time correlation of each question, and the operator's comments on the response without imposing new or additional tasks on the examiner during the interview or modifying the present techniques. It was tentatively decided that a voice operated switch would be provided to mark the chart during each question and answer and simultaneously record a timing signal with the analog data. Following the interview, the operator will fill out a form, similar to the attached sample, to provide the necessary information identifying each test and the time cues. [redacted] group have been asked to give some thought to this proposed interview form and be prepared to discuss modifications during the August visit.

EKG records made during examinations and correlated with the usual parameters were briefly studied. Problems of pickup artifacts and cross-coupling between the ED and EKG measurement equipment were also discussed.

The latter period of the visit was spent discussing biographic and psychological factors which effect the test results. It is felt that such tests as the CPI, MMPI, or PET B, may provide significant information in interpreting response patterns.

However, the tests used in this study should correspond to tests used by other investigators in this field. Therefore, it is necessary to determine which tests are normally given to company employees, the various grades receiving these tests, and the availability of test results.

Follow-Up Required:

1. [redacted] is to see that selected charts and EKG book are reproduced and forwarded by 24 July.
2. EKG probes will be shipped to [redacted] as soon as possible.
3. [redacted] will get information regarding psychological testing.
4. Someone from [redacted] group should investigate procedures to be used in getting tabulated interview data transcribed to punched cards. We would also like to know as soon as possible whether binary coding, Hollerith code, or both, is available.
5. Next visit planned for mid-August.

INTERVIEW DATA SHEET
(To be Completed by Examiner)

Subject ID # _____ Date _____

Examiner ID # _____ Chart # 1 2 3 4 5 6 7 8 9 10

General Class of Respondér? BP Resp ED Degree?
1 1 1
Type of Test _____ 2 2 2 Suggest Subject "attitude"
3 3 3 pre-test.

TEST INFORMATION

Cue #	Type of Cue			Significance				Artifacts		
	Quest #	Ans.	Noise	None	Quest	Strong	KL	Reset ED	Sub Moved	Misc.
1										
2										
3										
4										
'										
'										
'										
n										

Comments _____

Related to Specific Questions? _____

_____

_____

Related to Test in General: _____

_____

_____

Number of Cues Listed on Interview Data Sheet? _____

Number of Cues Noted on Chart? _____

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ubject I.D. # _____ Date: _____

xaminer I.D. # _____ Time _____

eneral Class of Responder: Type of Test _____

esp. N M S ED N M S BP N M S

hart # _____ Number of Cues on Chart _____

ue Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
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C00022011

23 MAY 1963

MEMORANDUM FOR: Deputy Director

SUBJECT : : Requirement for Research in the Life Sciences

1. Recently, reports from various sources on life science research in the Soviet Union have been called to my attention. These reports indicate a current preoccupation by an important sector of Soviet biological science with cybernetics, telepathy, hypnosis, and related subjects. Stimulated by these reports, I would like to pass on to you some thoughts on the possible significance of these activities to the

2. Prior to the creation of the Office a small group in attempted to follow current research in the life sciences. Their particular interest was in the kind of scientific progress that indicated the feasibility of developing operationally useable systems. After ten years of following this subject, reading was that, with minor exceptions, the fields of hypnosis, telepathy, and general control of human behavior were not ready for operational applications.

3. I feel there is a need for a continuing search and reexamination of this somewhat esoteric (and perhaps scientifically disreputable) range of activities toward the end of useable techniques for the current mission has been oriented away from this sort of basic research activity and towards close-in support of operations. In the light of the reports mentioned above, I am concerned that recent reported advances in these fields may indicate more potential than we believed existed. I can perceive operational applications, for the in the areas of and in the general area of control of human behavior, should breakthroughs in our understanding of these phenomena occur.

4. I am assuming that your research group is taking this area of activity under their cognizance and they will, through their contacts in bring to our attention any indications of practical

475

utility that can be made of these techniques so that can proceed toward specific operational applications.

5. I am happy to note that are proceeding with a series of monthly meetings to developing an understanding in depth of requirements in these and other fields. This note is not meant to supplant such a series of discussions as it applies to behavioral activities. I merely want to reinforce the dependence of the on your office for these matters.

C00022011

(FTD-6243)

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Sci - Medicine

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Sol - Med, Physiology

Mar 60

109 337

C00022011

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Sci - Engr, Electronics
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83,128

JPRS: 31,018

TT: 65-31516

12 July 1965

STUDIES IN ELECTRONARCOSIS

by M. G. Anan'yev, et al

- USSR -

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JPRS: 31,018

STUDIES IN ELECTRONARCOSIS

- USSR -

Following is a translation of selections from the Russian-language book entitled Sovremennaya Tekhnika v Khirurgii: Materialy VI Nauchnoy Sessii NIIEKha i I (Present-Day Technique in Surgery: Data of the Sixth Scientific Session of the Scientific Research Institute of Experimental Surgical Apparatus and Instruments), edited by M. G. Anan'yev, A. M. Geselevich, and Yu. Ya. Gritsman, Moscow, 1965, pp. 90-99 and 162-168.

CONTENTS

	Page
Electronarcosis Under Experimental Conditions and in Clinical Practice	1
I. Electronarcosis Under Experimental Conditions	1
II. Electronarcosis Produced by Interference Currents in Clinical Practice	4
Some Technical Problems in Designing Equipment for Electronarcosis	6
Changes in Peripheral Blood During Electronarcosis in Dogs and Monkeys	8
Principal Neuromorphological Changes During Electronarcosis Under Experimental Conditions	11
Electronarcosis at the Contemporary Stage of Anesthesiology	14
Table of Contents of the Book Sovremennaya Tekhnika v Khirurgii (Present-Day Technique in Surgery)	16

ELECTRONARCOSIS UNDER EXPERIMENTAL CONDITIONS AND IN CLINICAL PRACTICE*

[Following is a translation of a series of two articles by V. L. Deryabina, V. D. Zhukovskiy, M. I. Kuzin and V. I. Sachkov, in the Russian-language book Sovremennaya tekhnika v khirurgii (Present-Day Technique in Surgery), edited by M. G. Anan'yev, A. M. Geselevich, and Yu. Ya. Gritsman, Scientific-Research Institute of Experimental Surgical Equipment and Instruments, Ministry of Health USSR, Moscow, 1965, pages 90-93.]

I. Electronarcosis Under Experimental Conditions

by V. L. Deryabina Pages 90-91

1. A comparative experimental investigation of electric currents was conducted for obtaining electronarcosis: square pulse in combination with direct current (the so-called supplementary constant component -- S.C.C.), and without this, alternating sinusoidal and interfering currents with various locations of electrodes, various operating programs and methods.

In the experiments electronarcosis equipment developed

* Participating in the experimental work were V. S. Gutkin, L. A. Kashchevskaya, N. I. Kondrat'yeva, L. A. Levitskaya, N. G. Tyshkovskaya, V. I. Unik, and Engineer Yu. B. Khudyy.)

by NIIEKnAiI (designer Yu. B. Khudyy), the industrial generator model ZG-10, and equipment for electronarcosis using interference current, model I MOLMI imeni I. M. Sechenov were used.

2. The experimental subjects were healthy mongrel dogs and macaque monkeys -- Rhesus and green marmosets. The objects of the study were pure electronarcosis, its complications and methods of overcoming them, plus combined electronarcosis in adjunct with various pharmacological preparations, with various anesthesiological methods, with and without operations. In all, six series of experiments were conducted: 77 on dogs and 10 on monkeys.

3. Of the types of current and the methods studied the most effective for obtaining electronarcosis under experimental conditions were the following: square pulse current without S.C.C., 700 cycles frequency, duration of impulse 0.24 millisecond, rapid program of feeding the orienting narcotic dosage of current, bitemporal position of electrodes and interfering current of 4,300 to 4,100 cycles (pulsations frequency 200 cycles), with temporal-occipital crossing of two pairs of electrodes.

4. The depth of the narcotized state achieved in the dog usually corresponds to the first to third level of analgesia according to Artuzio; under equal conditions the surgical stage of the first or second level sometimes is attained with monkeys, which is adequate for surgical operation.

Addition of preparations such as atropine, promedol, papaverine, magnesium sulfate, and novocaine not only remove or considerably reduce negative phenomena of electronarcosis (convulsions, vascular spasms, hypertension, salivation, etc.) but also deepen the degree of anesthesis, thereby creating better conditions for performance of operations.

5. The experiments on electronarcosis in monkeys, which we were the first to conduct in the country, and among the few published accounts in the world literature enabled clarification of their particular characteristics in regard to electronarcosis. The course of electronarcosis in the monkey, particularly during the period of entering and recovering from narcosis, approximate clinical narcosis in man. Under identical experimental conditions, electronarcosis in the monkey is much deeper than in the dog. Morphological differences in the central nervous system of the monkey are less pronounced than in the dog.

6. In the interest of further successful study

of the problem of electronarcosis as a whole, at the present time it is necessary to ensure complex, thorough investigations on this problem, concentrating attention on a series of questions: selection of the optimal characteristics and parameters of current for design of the electronarcosis equipment; selection of the best sites for location of electrodes, their material composition and means of attaching them; study of the possibilities of recording the electroencephalogram in the project of developing objective tests of the depth of the narcotized state achieved; study of the peculiarities of the anesthesiological picture and the mechanism of electronarcosis; more precise determination of the experimental and clinical methods of anesthesia by means of an electric current; study of the genesis of negative phenomena of electronarcosis and methods for their elimination; investigation of the necessary pharmacological components and composition of medicines based on the pathogenic principle for combined electronarcosis.

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II. Electronarcosis Produced by Interference Currents in Clinical Practice

by K. I. Kuzin, V. I. Sachkov and V. D. Zhukovskiy (Moscow)

Pages 92-93

1. In electronarcosis produced by square pulses of low frequency and sinusoidal current uncomfortable sensations are observed at the site of contact of the electrodes with the skin of the patient, difficult respiration as a result of general muscular spasm and laryngospasm, tachycardia, and a significant increase in arterial pressure.

2. At the contemporary stage of multi-component anesthesia electronarcosis became combined with the use of introductory pharmacological narcosis, controlled respiration, muscular relaxants, and ganglion-blocking and neuroplegic preparations. This made possible the first steps in the introduction of electronarcosis into clinical practice, overcoming muscular spasm and hindering of respiration with the strengthening of the current. Uncomfortable sensations during the passage of current and hemodynamic shifts have been retained under similar conditions.

3. It is necessary to study the possibility of application of more complex forms of impulses and higher frequencies for electronarcosis than those used earlier. One of these forms is interference current. Special equipment has been prepared for the study of the possibilities of application of interference currents in combined anesthesia for surgical operations.

4. Surgery was performed on 70 patients under combined electronarcosis using interference currents at the Faculty Surgical Clinic of I MOLMI imeni Sechenov. The duration of the operations had a maximum of five hours. Electronarcosis was conducted according to the universally accepted program for modern combined anesthesia, with the exception that the main narcotic was replaced with an interference current.

5. An interference current of 50 to 150 milliamperes and pulsation rate of 40 to 600 cycles enabled operations to be performed on 66 of 70 patients under narcosis of stages I_1 to III_3; anesthesia was inadequate in four patients.

6. Stage III_1 may be attained only by combining electric current and potentiating drugs. Electronarcosis in

pure form produced unconsciousness only for a short time in the majority of cases, enabling operations to be performed at stage I_3 of narcosis.

7. This method may occupy a definite place in modern anesthesiology, but it requires intensive further development.

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SOME TECHNICAL PROBLEMS IN DESIGNING EQUIPMENT FOR ELECTRONARCOSIS

[Following is a translation of an article by Yu. B. Khudyy, Moscow, in the Russian-language book Sovremennaya tekhnika v khirurgii (Present-Day Technique in Surgery), edited by M. G. Anan'yev, A. M. Geselevich, and Yu. Ya. Gritsman, Scientific-Research Institute of Experimental Surgical Equipment and Instruments, Ministry of Health USSR, Moscow, 1965, pages 93-94.]

1. In the production of electronarcosis a square pulse is most often used, in a frequency range of 100, 700, 1,000 and 1,500 cycles, with impluse porosity of 1:10, 1:8, 1:5, 1:3, etc. A sinusoidal current in a frequency range of 700, 1,000, or 1,500 cycles is used most often for producing electronarcosis.

2. For the purpose of conducting research on the problem of electronarcosis, the electronarcosis equipment models EN-5, EN-62 and EN-64 were built under our direction at the NIIEKhAiI. In the course of electronarcosis investigations the sinusoidal current form obtained from an industrial generator of the ZG-10 type, having a range of generated frequencies of 20 to 20,000 cycles was used under experimental conditions. In addition, investigation is being conducted at the present time at the NIIEKhAiI on interference currents, for which the I MOLMI imeni I. M. Sechenov interference current generator is used.

3. The EN-57 equipment of NIIEKhAiI produces an pulse current of rectangular shape, and at the option of the operator a supplementary constant component (S.C.C.) may be added within the limits of 0 to 50 percent of the pulse poten-

tial by changing the program of operation of the final output stage. A particular feature of the equipment is the inclusion of the subject in the cathode circuit, thus affording complete protection to the subject in the event of malfunction. This safety feature ensures safe operation of the equipment under the given program of operation, guaranteeing the life of the experimental animal.

The range of working frequencies of the EN-57 covers the entire field from 1 to 130 cycles. The duration of impulses may range from 0.005 to 8 ml/sec.

4. The EN-62 differs from the EN-57 unit in that the range of working frequencies is expanded to 100 cycles, plus the fact that in accordance with its mission the supplementary galvanic component (S.G.C.) has been excluded. The EN-64 differs from the EN-62 in that its range of generated frequencies is expanded to 1,500 cycles, plus the fact that its independent regulation has been increased to 30 milliamperes for investigation of the galvanic current component. The lower frequency limit of the EN-64 unit is 90 cycles. This unit includes separate measurement of impedence at the points of application of the electrodes for both direct current and pulse current for the conversion methods recommended by us, in which the absolute value of impedence at a given moment of the experiment may be measured.

In the EN-62 and EN064 units regulation of frequency and duration are independent of each other. The new EN-64 unit includes two pieces of equipment which are integrally mounted on a single mobile platform. The second of the two is the ZG-10 industrial unit.

5. Mathematical analysis of the Namek currents -- interference currents -- reveals that the shape of the curve at low frequency is sinusoidal, because the amplitude of the curve varies from zero to double magnitude for each cycle of frequency.

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CHANGES IN PERIPHERAL BLOOD DURING ELECTRONARCOSIS IN DOGS AND MONKEYS

[Following is a translation of an article by N. I. Kondrat'yeva and L. A. Levitskaya, Moscow, in the Russian-language book Sovremennaya tekhnika v khirurgii (Present-Day Technique in Surgery), edited by M. G. Anan'yev, A. M. Geselevich, and Yu. Ya. Gritsman, Scientific-Research Institute of Experimental Surgical Equipment and Instruments, Ministry of Health USSR, Moscow, 1965, pages 94-96.]

The aim of the present work was investigation of the peripheral blood during electronarcosis, caused by the application of square and sinusoidal currents as a function of frequency, and the methods of their application.

The peripheral blood (hemoglobin content, number of erythrocytes, leucocytes, thrombocytes, hematocrytes, viscosity, and the reaction of precipitation of erythrocytes) was investigated under dynamic conditions: before the experiment, before turning on the current, at the height of current action, and after current action. Examinations were performed on 67 dogs and 7 monkeys, and control tests were made on 19 monkeys.

Investigations of blood under analgesis (I_1 - I_3) produced by the application of a square-wave current of 980 cycles frequency without supplementary constant component (S.C.C.), with lobar-occipital location of electrodes, gradual current feed and with S.C.C. from 5 to 60 percent, and frequency 700 to 980 cycles, bitemporal positioning of electrodes, and feeding current from a narcotic dose, [revealed] fluctuations in the number of leucocytes which did not exceed the limits of

the norm*. In the leucocyte formula the neutrophilic shift was due to an increase in segmento-nuclear elements. The erythrocyte precipitation reaction remained within the limits of the norm.

In obtaining a stable analgesic effect a tendency toward reduction in the number of leucocytes (a drop of two thousand from starting values) was noted, similar to that observed by L. N. Anikina (1954) during pharmacological anesthesia.

In the cases in which analgesis was not obtained in dogs with the application of a square impluse current the blood change depended upon the impulse frequency and the S.C.C. Thus with the use of a current with frequency 920 cycles without S.C.C., with lobar-occipital positioning of electrodes and gradual current feed, changes in the number of shaped elements did not exceed the limits of the norm. At a frequency of 100 cycles, with S.C.C. of 30 percent, lobar-occipital positioning of electrodes and gradual current feed, at the height of current action the number of leucocytes increased to 16,000 (average data $p < 0.02$), the neutrophilic shift in formula due to segmento-nuclear elements gave a value of ($p < 0.01$), and the number of monocytes and eiosinophils showed a decrease of approximately twofold ($p < 0.01$).

With the application of a sinusoidal current of 920 cycles and current feed at electroshock dosage with subsequent decrease to electronarcosis dosage, no substantial changes were noted in the blood composition. Following making of the current leucocytosis was observed to the extent of 15,000 cells ($p < 0.05$), with a neutrophilic shift in the leucocyte formula due to an increase in segmento-nuclear elements and a decrease in the number of lymphocytes ($p < 0.01$).

In the cases of electronarcosis accompanied by an increase in temperature of one to two degrees Centigrade, excitation of the anical and significant shortness of breath, leucocytosis regularly was observed in the blood.

In animals dying under electronarcosis an increase in hemoglobin content, in the number of erythrocytes and leucocytes, and in blood viscosity was noted.

A state of analgesis (I_2 to I_3) was obtained in monkeys with the application of a square impulse current of 100 cycles with S.C.C., and 700 cycles without S.C.C., and with bitemporal positioning of electrodes. At the height

* [Translator's Note: Foregoing sentence appears peculiar in its original Russian.]

of current action, and after the current was broken, leucocytosis, neutrophilic shift of the leucocytic formula due to segmento-nuclear elements, and a decrease in the number of monocytes and lymphocytes were noted.

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CSO: 11473-D

PRINCIPAL NEUROMORPHOLOGICAL CHANGES DURING ELECTRONARCOSIS UNDER EXPERIMENTAL CONDITIONS

[Following is a translation of an article by V. S. Gutkin, Moscow, in the Russian-language book Sovremennaya tekhnika v khirurgii (Present-Day Technique in Surgery), Edited by M. G. Anan'yev, A. M. Genelevich, and Yu. Ya. Gritsman Scientific-Research Institute of Experimental Surgical Equipment and Instruments, Ministry of Health USSR, Moscow, 1965, pages 96-98.]

A study was made of the morphological changes of the central nervous system of animals following the action of an electric current of various characteristics: a square impulse current with constant component (S.C.C.) and without it, an alternating sinusoidal current and interference currents. The parameters of the current, the feed program and methods of its feeding to the brain, and also the conditions and method of the experiments (pure, or combined electronarcosis, with and without operation) differed in different series of experiments. The changes among the series observed by us had different degrees of expression; sharp differences in the cases in which electronarcosis was achieved, and none were noted when electronarcosis was not attained.

The central nervous system was studied in 65 dogs and 8 monkeys killed at various intervals of time after the experiment by injection of a 10-percent solution of neutral formalin into the subarachnoid space (suboccipital route). The cephalic, and individual segments of the spinal cord were fixed in a 10-percent solution of neutral formalin, pieces of the brain from the region of the cerebral cortex, medulla oblongatta, mid-brain and intermediate brain, cerebellum, and the Horn of Ammon were imbedded in paraffin and the sections were stained with hematoxylin-eosin by the method Nissel'.

Histomorphological examination enables determination of the basic categories of changes common to all experiments.

The responsible reaction of the nervous tissue under experimental electronarcosis is composed of vascular disturbances, changes of neurons and glial reaction. The moments of their appearance, degree of expression and character of reduction processes are different in different series of experiments. In other words, these changes create the definite peculiarity of each series of experiments.

The vascular disturbances appear in the form of perivascular edema with swelling of the vascular walls and occasionally delamination of the endothelium, of a multitude of minute and larger hemorrhages, vascular dystonia (paresis of some vessels and spasm of others, with the appearance of "aneurhythmic" protrusions and shapes of apparent figures, irregular convolution of vessels, etc.).

Neuron modifications are dystrophic in character. They often were reversible, but occasionally attained degrees resulting in the death of nerve cells. In this case portions of precipitation are observed at later stages at the site of dying neurons (cortex of cerebellum and of the cerebral hemispheres).

Modifications of the glia appear in the form of diffuse hyperplasia of various types of glial cells, mainly astrocytes; as a rule, glial reaction is expressed most markedly in the sections of greatest affection of neurons, where the phenomena of perivascular and perineuronal gliosis, and occasionally neurophagia are observed. In some cases the glial reaction is absent, which may be explained by depression of the reactive properties of the organism under the influence of the corresponding actions.

Morphological modifications are less markedly expressed in monkeys after electronarcosis experiments than in dogs under similar conditions. In particular, a pronounced hemorrhagic component in the form of a multitude of perivascular hemorrhages is less marked in monkeys than in dogs. This apparently is connected with anatomic-physiological peculiarities of the vascular system in different species of animals.

The main categories of morphological modifications

described in the above is, in our opinion, the result of both direct action of the electric current on the nervous system, and also arises indirectly through circulatory processes, as well as in connection with hypoxia, hyperthermia, disturbance of the metabolic processes, convulsions, etc., which occur during the experiments, especially during pure electronarcosis. In combined electronarcosis, with the addition of drugs, vascular disturbances are less pronounced. The decrease in dystrophic modifications of neurons under the action of electric current is produced through selection of its optimal characteristics. From the foregoing it follows that at the present time realistic ways in which the degree of expression of both dystonic modifications of blood vessels and dystrophic modifications of nerve cells of the central nervous system of experimental animals are in view.

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CSO: 11473-D

ELECTRONARCOSIS AT THE CONTEMPORARY STAGE OF ANESTHESIOLOGY

[Following is a translation of an article by K. A. Ivanov-Muromskiy, E. T. Golovan', and V. G. Mel'nikov, Kiev, in the Russian-language book Sovremennaya tekhnika v khirurgii (Present-Day Technique in Surgery), edited by M. G. Anan'yev, A. M. Geselovich, and Yu. Ya. Gritsman, Scientific-Research Institute of Experimental Surgical Equipment and Instruments, Ministry of Health, USSR Moscow, 1965, pages 98-99.]

1. The superiority of electronarcosis over the known narcotics is indisputable. It has the characteristics of speed in attaining a narcotic state and recovery from this state; lack of consequences and complications inherent in pharmacological narcosis; action concentrated mainly on the brain; considerable limitation of contraindications; good control properties.

2. We must agree with the opinion of R. Smith and D. Cullen (1962) that electronarcosis still is in the period of trial and error. The phases of generalized excitation, unpleasant sensations at the site of application of electrodes, laryngospasms and elevated blood pressure (albeit transitory) that unavoidably appear to various degrees under the ordinary methods of electronarcosis compel many clinicians to harbor a sceptical attitude toward the possibilities of introduction of this method into practice.

The difficulties confronting investigators are aggravated by the lack of standard methods, by the obtaining of different pictures of narcosis with identical parameters of impulse currents, the lack of universal theoretical con-

cepts of the mechanism of electronarcosis based on the latest neurophysiological and biocybernetic data.

3. Selection of the optimal parameters of a narcotizing current ensures an insignificant shift in homeostasis of the organism under experimental conditions. In this respect the following may be recommended: test impulse frequency 1 kilocycle with impulse duration of 0.1 to 0.3 m/sec, lowering the potential gradient in the impulse, and a constant component equal to 20 to 25 percent of the impulse. Also suggested are orbital (glaznichnoye) positioning of the electrodes and "massaging" introduction of current with the aid of a process we have named the "polyelectrotonus."

4. Generalization of the materials obtained in the literary data provides the possibility of developing the hypothesis previously expounded by us (1953-1957) on the mechanism of electronarcosis, and to represent it as a systemic reaction of the organism in which the leading role is played by autoregulation of the cerebral cortex, realizing a program of protection of an ultrastable system from factors of the external medium.

5. At the present-day stage of anesthesiology it is possible to utilize electronarcosis as a link in combined anesthesia. At the present time, on the basis of still relatively small clinical experience, it is possible to introduce into clinical practice a modulated impulse current of 100 cycles frequency, and also "interference currents," in combination with injection of narcotics and relaxants. For the prevention of burns at ordinary doses it is necessary to exclude the constant component of the impulse current and to utilize hydrochlorinated silver electrodes in a porolon envelope. In its present imperfect form electronarcosis may find extensive application in extern anesthesiology, with extensive burns, for determining the action of poisons.

6. The experimental-clinical work performed by us may serve as the basis for further search for methods ensuring loss of consciousness in all cases of narcosis, and the abolition of narcosis by injection. The basic requisites for development of automatic electronarcosis have been secured.

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TABLE OF CONTENTS OF THE BOOK SOVREMENNAYA TEKHNIKA V KHIRURGII (PRESENT-DAY TECHNIQUE IN SURGERY)

[Following is a translation of the Table of Contents of the book Sovremennaya tekhnika v khirurgii (Present-Day Technique in Surgery), edited by M. G. Anan'yev, A. M. Geselevich, and Yu. Ya. Gritsman, Scientific-Research Institute of Experimental Surgical Equipment and Instruments, Ministry of Health USSR, Moscow, 1965, pages 162-168.]

	Page
Foreword	3
M. G. Anan'yev, S. I. Babkin and N. N. Anteshina, New Surgical Equipment and Instruments	5
G. V. Astaf'yev, S. I. Babkin, A. M. Geselevich, and Yu. Ya. Gritsman, Suturing Equipment and Its Place in Present-Day Surgery	9
O. S. Shkrob and A. S. Tatevosyan, Experience in the Application of Suturing Equipment in Pulmonary Surgery	11
S. L. Libov and M. R. Rokitskiy, Operations on the Lungs with Application of the NIIEKhAII Suturing Equipment	12
M. I. Perel'man and V. D. Kolesnikov, Application of Suturing Equipment in Lung Surgery	14
Ya. G. Rozinov and M. Strel'nikov, Method of Use of Suturing Equipment in Lung Operations	15

A. V. Grigoryan, B. P. Fedorov and L. M. Nedvetskaya, Application of Mechanical Suturing in Radical Lung Operations 17

I. K. Svinkin and A. S. Al'bert, On the Technique of Extensive Intrapericardial Pneumectomy with Application of the UAP-20, UUS-23 and UKB-25 Units 18

E. A. Stepanov and S. P. Orlovskiy, Application of the UKL-40 and UUS-23 in Lung Resection in Children 19

A. K. Raskina and L. A. Migal', On the Method of Sutural Closure of Bronchial Fistulae with the UKL Apparatus 20

G. K. Tkachenko, B. S. Bashev, Yu. M. Bryakin and N. S. Volkov, Experience in the Application of Suturing Equipment in Chest Surgery 21

N. D. Garin and A. Kh. Trakhtenberg, Application of the UKL-60 and PKS-25 Units in Pulmonary and Cardiac Operations in Connection with Cancer 22

S. I. Babichev and T. P. Androsova Experience in the Application of the UTL-70 Unit in Lung Surgery 23

G. D. Vilyavin and B. A. Berdov, Suturing Equipment in Surgery of the Gastrointestinal Tract 25

P. I. Androsov and A. A. Strekopytov, Equipment for Sutural Closure of Tissues by a Double-Layered Hidden Suture and Experience in Its Clinical Application 26

T. V. Kalinina, The Fate of Mechanical Stapled Suture Applied by Various Devices in Anastomoses of the Alimentary Tract 27

M. P. Vilyanskiy, L. V. Polyektov, A. G. Barbanchik, N. N. Tsygankov, G. K. Chulovskiy and S. I. Griko, Mechanical Suturing in Abdominal Surgery 29

L. S. Zhuravskiy, Experience in the Application of Mechanical Suturing 31

S. Ye. Murlaga and I. U. Laptun, Our Experience in the Application of Suturing Equipment in Surgery 32

V. I. Kukosh and Yu. V. Kisel', Several Problems of the Application of Suturing Equipment and Their Combinations in Gastric Resections in Connection with Ulcerous Diseases 34

L. V. Poluektov, Experience in the Application of Suturing Equipment in Surgical Treatment of Diseases of the Incised Stomach and Complications Following Gastroenterostomy 35

A. S. Shevchenko and M. Ya. Tarnovich, Mechanical Suturing in Gastric Resection with the Use of the NIIEKhAII Suturing Apparatuses 37

A. V. Korshunov, Experience in the Application of Mechanical Suturing in Gastric Resection in a Rural Hospital 38

T. A. Kunitsyna, On the Method of Application of the PKS-25 39

A. G. Barbanchik, On the Use of the PKS-25 Unit in Gastrectomy and Resection of the Cardial Region of the Stomach 40

M. I. Kuzin and V. G. Ryabtsev, Experience in 100 Total Gastrectomies with Application of the PKS-25 Unit 42

K. I. Myshkin, Complications Connected with Application of the PKS-25 Device 43

V. I. Kukosh, T. N. Mikhaylova, Ye. M. Budarina, Yu. V. Kisel' and N. F. Volkov, Experience in Application of Mechanical Suturing Devices in Stomach and Esophagus Resection in Connection with Cancer 45

M. G. Akhalaya, Hidden Suturing in Surgery of the Esophagus and Stomach 46

T. V. Kalinina and V. S. Kasulin, Method of Application of the KTs-28 Device for Suturing the Large or Small Intestine to the Rectum 47

Ye. S. Smirnova, Kh. F. Gureyeva and Yu. L. Rozanov, Anterior Resection in Cancer of the Rectum and Distal Portions of the Sigmoid, With Application of the KTs-28 Device 48

Kh. F. Gureyeva, Experience in Clinical Application

of Mechanical Suturing of Anastomosis in Resection of the Rectal and Distal Portions of the Large Intestine 49

A. N. Burtsev, A Device for Superpositioning Lateral Esophageal Anastomoses (Esophageal-Intestinal, Esophageal-Gastric) Without Using Auxiliary Sutures of Soft Ligatures 50

R. V. Bogoslavskiy and G. A. Kameristyy, Fundamentals of Mechanical Suturing in Intrastcminal Resection of the Rectum 51

Yu. A. Ratner, N. A. Kolsanov, R. K. Kharitonov, N. G. Bashirova, V. N. Dmitriyevskiy and B. L. Yelyashevich, Application of Suturing Devices in Intestinal Operations 53

A. I. Borisov, Application of Suturing Devices in Operative Treatment of External Intestinal Fistulae 54

N. A. Sviridov, Application of Suturing Devices According to the Materials of the Tula Oncological Dispensary 55

S. S. Nesterov, The UKL-60 Mechanical Suturing Apparatus in Resections of the Pancreas 56

M. Z. Sigal, Transillumination Control of Tantalum Mechanical Suture 57

G. V. Astaf'yev, Experimental Investigation of Wall of Organs of the Digestive Tract and Method of Determining the Slack of Sutures 58

G. N. Zakharova, B. I. Nikiforov, B. F. Orlovskiy and Ye. A. Roslova, Experience in the Application of Mechanical Suturing in Operations on Blood Vessels on the Gastrointestinal Tract 60

Yu. V. Bazilevskaya, Application of the Vascular Suturing Device In Trauma of Blood Vessels of the Extremities 62

I. I. Shimanko, Experience in the Clinical Use of the Vascular Suturing Device in Defects of the Blood Vessels and Their Consequences 63

N. N. Kapitanov, N. P. Petrova and N. V. Yurasova, Shunting, Prosthetization and Suturing In "Patches" in Blood Vessels with the Aid of a New Device 64

L. P. Shtuchnaya, Experience in the Application of Mechanical Suturing of Blood Vessels 65

I. K. Ivinskaya, Alloplasty of the Aorta of the Growing Organism with the Use of Mechanical Suturing under Experimental Conditions 67

V. Amosova, Superposition of Mammary-Coronary Anastomosis with the Vascular Suturing Device ASTs-4 68

O. M. Matyugina, Experience in the Application of Vascular Suturing Devices in the Superpositioning of Venous Porto-Caval Anastomoses Under Experimental Conditions --

V. P. Aratskiy, Superpositioning of Azygo-Atrial Anastomosis with the USTs-3 Vascular Suturing Device 69

V. I. Frantsev and A. S. Artyukov, Indications for the Use of Mechanical Suturing in Surgical Treatment of Open Arterial Flow 7[illegible]

O. R. Bogomolova, Pathohistological Changes in the Aorta Wall Arising After Superpositioning of Mechanical Sutures 72

S. I. Sinyakin, Experience in the Utilization of Vascular Suturing Devices (ASTs-4, USTs-3) for Restoration of the Permeability of the Fallopian Tubules under Experimental Conditions 74

R. I. Iokton, Operating on the Urinary Bladder with the Use of the UMP-74 and UMP-75 Suturing Devices Designed by the NIIEKhaII --

V. I. Gudkov, Mechanical Suturing of the Ureter in Plastic Operations in Connection with Hydronephrosis --

A. I. Prozument, Blind Mechanical Suturing of the Urinary Bladder with the UMP-75 Device 7[illegible]

A. F. Uchugina and L. I. Kazimirov, Application of the Vascular Suturing Apparatus in Plastic and Reconstructive Operations on the Ureter 78

V. I. Kukosh and A. F. Uchumina, Mechanical Suturing of the Vascular Stem of the Kidney in Nephrectomy 79

V. I. Anan'yev, T. A. Sultanov and I. P. Berezin, Oxygen Barochamber and Perspectives of its Utilization in Medicine --

A. P. Kolesov, V. S. Uvarov, V. A. Belov and Ye. V. Kolesov, Preliminary Experience with Oxybarotherapy in Surgical Clinical Practice 83

I. M. Epshteyn, and V. V. Gorodilova, Perspectives of the Application of the Oxygen Barochamber for Therapy of Oncological Patients and Several Problems of Control of the Oxygen System in Tissues of the Organism 84

K. M. Rapoport, Treatment of Subjects Suffering from Carbon Monoxide Poisoning with Increased Atmospheric Pressure, and Postoperative Aeroemboli 85

R. Ya. Gershtenkern and Yu. B. Kochetovskiy, Pathogenic Foundations and Preliminary Experience in the Therapy of Subject exposed to Extended Crushing Effects of Oxygen under Increased Pressure in the Barochamber 87

M. Z. Sigal, On Adequate Oxygen Regimen During an Operation 89

V. L. Deryabina, V. D. Zhukovskiy, M. I. Kuzin and V. I. Sachkov, Electronarcosis under Experimental Conditions and in Clinical Practice 90

Yu. E. Khudyy Some Technical Problems of Designing Equipment for Electronarcosis 93

N. I. Kondrat'yeva and L. A. Levitskaya, Change in the Peripheral Blood During Electronarcosis of the Dog and Monkey 94

V. S. Gutkin, Basic Neuromorphological Changes During Electronarcosis Under Experimental Conditions 96

K. A. Ivanov-Muromskiy, E. T. Golovan' and V. G. Mel'nikov, Electronarcosis at the Contemporary Stage of Anesthesiology 98

B. S. Bobrov, S. A. Mushegyan and N. A. Super, New Devices for Artificial Blood Circulation and Experience in Their Experimental and Clinical Use 100

A. V. Trubetskoy and M. Ya. Ruda, Experimental Investigation of a Method of Counterpulsation 102

S. A. Mushegyan, N. A. Super, L. A. Levitskaya, L. A. Kashchevskaya, N. S. Dzhavadyan, L. N. Ivanova, L. A. Balyuchnik, N. I. Unik, V. S. Gutkin and L. N. Martynov, Application of Artificial Blood Circulation Equipment of the NIIEKhAII for Conduct of Long-Term Parallel Perfusion Under Experimental Conditions 1[illegible]

L. A. Levitskaya, S. A. Mushegyan, L. A. Balyuchik, and N. A. Super, Changes in the Morphological Composition of Peripheral Blood During Extended Perfusion 105

N. V. Akimova and Yu. A. Nesterenko, Biochemical Changes in the Blood of Adult Patients with the Use of the AIK-60 107

F. V. Ballyuzek, V. I. Skorik, I. G. Fedorova and G. R. Kvetsinskiy, Present-Day Principles of Designing Apparatus for General, Regional and Reanimation Perfusion 1[illegible]6

G. K. Lebedeva, On the Problem of the Functional' Qualities of the AIK-63 1[illegible]

V. P. Osipov, Comparative Clinical Characteristics of Equipment for Artificial Blood Circulation of Crawford-Senning, the ISL-2 and the AIK-60 110

F. G. Uglov, V. M. Zubtsovskiy and V. A. Voinov, Comparative Evaluation of Equipment for Artificial Blood Circulation 112

S. L. Libov, M. R. Rokitskiy, V. A. Sonkina, I. Z. Klyavzunik, O. S. Misharev, I. N. Savvateyev, Ya. S. Epshteyn, N. N. Spivak and S. G. Gurfinkel', Some Aspects of the Application of Artificial Blood Circulation Devices of NIIEKhAII 113

Ye. A. Stunzha and V. Ye. Shepel', Artificial Blood Circulation with the AIK-60 and AIK-63 Units 1[illegible]5

V. G. Dergachev, Experience in the Application of Artificial Blood Circulation Equipment of the NIIEKhAII (AIK RP-64) for Complete Perfusion of Young Children 116

P. P. Alekseyev, V. G. Larionov, A. G. Kovaleva and V. I. Romanov, Results of Treatment of Malignant

Neoplasms with Chemotherapy by the Method of Local Regional Perfusion --

M. P. Vilyanskiy, L. V. Poluektov, K. V. Kaygorodova, Yu. A. Kotserov and A. I. Kolesnikova, Role of Regional Perfusion with the AIK RP-62 Equipment in Treatment of Diseases and Damage of the Lower Limbs 118

I. K. Rykalin and V. I. Semenov, Preliminary Experience with Combined Therapy of Sarcoma of the Extremities with Application of the Method of Regional Perfusion 119

R. Ya. Gershtenkern, Treatment of Extended Crushing of Regional Perfusion under Experimental Conditions 120

A. N. Novikov, N. D. Garin and A. Kh. Trakhtenberg, Chemotherapy of Cancer of the Lung by the Method of Perfusion with the AIK RP-62 Apparatus 121

M. M. Averbakh, N. I. Gerasimenko, S. A. Mushegyan, N. A. Super, V. K. Apakidze, E. L. Blokh and A. P. Davydov, Prerequisites for Chemotherapy of Diffuse Destructive Forms of Tuberculosis of the Lungs by the Perfusion Method 122

Yu. N. Bokarev, Several Problems of the Organization of Operations with Artificial Blood Circulation 124

Ye. B. Gorbovitskiy, Yu. K. Kozlov and A. S. Tkachenko, A Domestic Apparatus for Hemodialysis and Its Introduction into Medical Practice --

V. K. Shlimak, Mathematical Modeling of Processes in the Artificial Kidney 126

I. M. Epshteyn, M. I. Kuzin, N. I. Sorokina, Ye. K. Chilingaridi and L. N. Kuz'min, 700 Hemodialysis Operations with the Domestic "Artificial Kidney" Equipment, Designed by NIIEKhAII 128

N. D. Levushkina, Ye. K. Chilingaridi and Ye. B. Gorbovitskiy, Change in Osmotic Pressure, Urea and Creatinin, Serum and Cerebrospinal Fluid During the Course of Hemodialysis in Patients with Acute Renal Insufficiency 129

N. I. Sorokina, Ye. K. Chilingaridi, B. D. Verkhovskiy, N. D. Levushkina, Yu. K. Kozlov, Ye. B. Gorbovitskiy and A. S. Tkachenko, Complications During Hemodialysis Operations 131

G. P. Kulakov, A. M. Meliksn, K. M. Mendel'son, A. V. Trikashnyy and V. N. Shabalkina, Some Problems of the Application of the Artificial Kidney 132

S. G. Orel, Some Problems of Utilization of the "Artificial Kidney" Equipment of NIIEKhAiI 133

K. T. Ovnatanyan, P. S. Sernyak, V. Ya. Safronov, P. V. Novosad, K. I. Mkayelova and M. N. Sergiyenko, Experience in the Application of the "Artificial Kidney" Equipment of NIIEKhAiI in the Control of Renal Insufficiency 135

P. P. Alekseyev, V. P. Kozlov, and S. Ya. Yakushev, Complex Treatment of Acute and Chronic Renal Insufficiency with Application of the "Artificial Kidney" Equipment of NIIEKhAiI in the City of Smolensk 137

E. D. Kostin, A. S. Pevzner, O. I. Sandler, and M. M. Smolenskiy, Operating Requirements Set for the Hemodialysis Equipment 139

L. A. Kashchevskaya and V. I. Unik, Testing the Quality of Celophane Membranes for the "Artificial Kidney" Equipment 140

B. G. Gol'dina, Some Pathoanatomical Data on Acute Renal Insufficiency Treated by Hemodialysis 141

A. A. Chervinskiy, Yu. I. Malyshev, A. M. Demonts'yeva, G. V. Kondranin and L. P. Teplova, Experience in Working at the Kidney Center and in Application of the "Artificial Kidney" Equipment 143

N. T. Terekhov, V. V. Volkov and V. A. Chistyakov, Experience in Treatment of Acute Renal Insufficiency with the Aid of the "Artificial Kidney" of NIIEKhAiI 144

M. F. Sakayeva and R. M. Urazayev, On Clinical Use of the "Artificial Kidney" Equipment of NIIEKhAiI 146

Ye. B. Gorbovitskiy and D. G. Ravich, On the Efficacy of Fractional Peritoneal Dialysis 147

K. G. Anan'yev, V. P. Perepelkin, G. V. Shelukhanov, A. A. Denisova and V. A. Pankov, Composition Materials in Medical Technique and the Perspectives of Their Use 149

B. A. Samotokin and V. I. Grebenyuk, Experience With, and Perspectives of Application of Chemical Materials in Neurosurgery --

V. A. Pankov, I. P. Rotenberg, A. I. Trubnikov and V. M. Padalka, Application of Porous Composition Materials as Bandaging Material 151

N. S. Koroleva, Study of the Possibility of Application of Composition Materials in Tracheal Surgery 153

A. A. Shayn, Application of Polyethylene Prosthetics for Intubation of the Esophagus 154

N. V. Maygorodova and A. S. Zinov'yev, Experience in the Application of Porolon in Liver Resection 155

M. G. Akhalaya, Methods of Suturing Blood Vessels with the Aid of Composition Material Structures 156

V. A. Pankov, G. V. Shchegalova, V. M. Padalka and L. A. Vol'f, On Utilization of Antimicrobial Polyvinylalcohol Fibers in the Preparation of Bandaging Materials 157

Ye. A. Nikhamkina, On the Problem of Prosthetization of the Ureter with Plastic Materials Under Experimental Conditions 159

- END -

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TREATMENT OF DISORDERS OF THE NERVOUS SYSTEM BY ELECTRICALLY INDUCED SLEEP

by K. O. Ivanov-Muromskiy

- USSR -

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TREATMENT OF DISORDERS OF THE NERVOUS SYSTEM BY ELECTRICALLY INDUCED SLEEP

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[Following is the translation of a section of the Ukrainian-language booklet Splyachyy Mozok (The Sleeping Brain), by K. O. Ivanov-Muromskiy, Kiev, 1964, pp 64-76.]

The Science of Triumphant Life

The great scientist agitatedly looked into the face of the man lying before him. The year was 1918. In the psychiatric hospital where I.P. Pavlov had come to study the mentally ill it was cold and there was little food. But this patient had no sense of all the difficulties of the time -- he slept, had already been sleeping his extraordinary slumber these...twenty-two years. He was fed through a tube and carefully looked after.

Finally, the patient began to move, and then he raised himself up and began to speak. The sleep of lethargy was over. The patient told Pavlov that he had understood everything, had heard everything, but had felt a "terrible, irresistible burden" which would not let him move even a muscle.

The scientist observed other patients, who had come down with the dreadful mental illness of schizophrenia. Many of them stayed fixed for a long time in some immovable position.

Of course, I.P. Pavlov could not keep from pondering the nature of these phenomena. But the main task of physiology is to forge weapons to battle for the life and health of man. It was not without good cause that I.P. Pavlov called it the "science of triumphant life."

Investigation of the vital processes in normality enables their peculiarities under pathological conditions to be explained, when the organism has fallen ill. It was in just this way that the school of I.P. Pavlov discovered the defensive role of inhibition in the central nervous system. The cortical cells, which have the greatest reactivity, must be exposed to the greatest danger of destruction -- exhaustion. To save them from perishing this furious rate of metabolism must be slowed down and it must be directed toward restoring its expended energy reserves. This inhibition which prevents our cortical neurons from the exhaustion which sets in when the limit of our capacity for work is passed occurs daily in the form of sleep.

The cortical cell has a limit to its capacity for work, beyond which, in order to prevent excessive functional outlay on the cell's part, inhibition starts. More than thirty years ago the great physiologist wrote that the limit to the working capacity was not a constant value, but one which changes both acutely and chronically -- in fatigue, hypnosis, illness, and age. This inhibition, which might be called extralimital (to incorporate the idea of limit introduced above) sometimes appears suddenly and at other times manifests itself only when above-maximum stimuli are repeated. This inhibition also has its analogue in the lower divisions of the central nervous system.

This analogue to extralimital inhibition on the periphery is the "pessimum" with which we are already familiar. As early as 1891 one of N.Ye. Vvedenskiy's works drew attention to the fact that pessimum inhibition protected muscle tissue from an excessive flow of nerve impulses. Much later, in the 1930's, E.A. Asratyan pointed out that the pessimum and extralimital inhibition are related phenomena.

Can extralimital inhibition revive the nerve cell?

We believe that it can.

Numerous and very accurate experiments have shown that parabiosis is not only not, as many thought, accompanied by "energy burning," but, on the contrary, during parabiosis the metabolic processes are reduced, heat production is decrease, and the efficiency of the reflex apparatus is restored.

Prof. A.A. Zubkov has even drawn the conclusion that parabiosis results from the surplus production of energy-rich phosphorus-containing compounds. Starting from concepts of neural apparatus as generators of nonlinear oscillations he considers that in the case of parabiosis the autooscillatory generators lock themselves into a surplus power supply. This original point of view can be met with a number of rejoinders, but this approach to solving the problem is worth attention. Let us mention, by the way, that even Aristotle associated sleep and alimentation processes (his idea was that sleep arises from the "exhalations" which come from food).

Extralimital inhibition, of course, does not occur only in the case of ordinary sleep. In various states which are burdensome to the organism the nerve cells try to pull themselves through by covering themselves with protective inhibition, as with a shield -- in hunger or cold, overheating or lack of oxygen, during the effect of brought from the outside or generated within the organism, and under the effect of radiation.

It may encompass only delimited regions, say, those that control motor and speech activity. And then the person is immersed in a state of lethargic sleep. In another case the "surrogate" for nervous system activity, as Pavlov called inhibition, is not switched on at all -- and illness starts.

Pavlov made the logical conclusion -- the neurons require assistance, protective inhibition must be stepped up or "poured" from the individual divisions over the whole brain and brought back to its normal channel. Prof. E.A. Asratyan later called this process whole-protective inhibition.

And here is Pavlov's closest student, M.K. Petrova, using sleep and bromine in morbid conditions of the animal nervous system and immediately obtaining results. Moreover both nervous disturbances and diseases of other organs -- ulcers, eczemas, alopecia, malignant and benign tumors -- are also treated.

At the same time another student of the great scientist, Prof. O.G. Ivanov-Smolenskiy, director of the psychiatric clinic at the Pavlov Laboratory, is entrusted with setting up sleep therapy for schizophrenics. It should be said that even earlier clinical practitioners endeavored to treat psychotics and neurotics with protracted narcotic sleep, but the soporific was used at random and success often alternated with failure. But when matters became goal-directed and the solid ground of an orderly theory was felt beneath our feet success stopped being a random affair.

In the 1920's foreign psychiatrists began to use protracted narcosis to relieve excitation in the mentally ill. It started to be successfully used for this purpose in the USSR from 1934 on the initiative of Prof. V.P. Protopopov. But the high toxicity of the narcotics employed very often led to serious disturbances of the respiratory and cardiovascular systems, and frequently was the cause of death.

In the thirties Clorette proposed a special mixture for narcosis. It was also decided to use this mixture in the Pavlov Clinic, not, however, only for excited patients, as was done before, but in cases where it was necessary to deepen an already existing inhibition.

As early as 1935 the first results of "sleep" therapy convinced O.G. Ivanov-Smolenskiy of the need for revising the method and tactics of its employment. The prolonged toxic narcosis was replaced by therapeutic sleep, or the prolongation of ordinary sleep, which was brought about by barbiturates of low toxicity. The advisability was acknowledged of combining therapeutic sleep with other methods of treatment (electric and insulin shock, injection of stimulants like caffeine and phenomine), especially in schizophrenia, alcoholic psychosis and cerebral trauma.

Sleep therapy began a vigorous development. Later, during the Great Patriotic War [World War II], it was extensively used in injuries to the central nervous system and traumatic and burn shock.

The terrible pain, so-called causalgia, tormented those wounded having damaged peripheral nerve trunks. Every touch, loud noise, or merely light caused such suffering that the person shrieked. Such a wounded person could sit for days with the affected extremity in a pail of water (this alleviated the pain) and his head wrapped in a quilt in order to protect himself from light or loud noise.

Here, too, sleep therapy gave the patients a reprieve from pain and illness. D.O. Lapitskiy, a student of Prof. L.L. Vasil'yev, started from the idea of the parabiotic origin of causalgia and proposed applying the positive d.c. pole to the painful spot (anelectrotonus). The method proved to be effective -- after five to ten treatments at a low current (up to 5 ma) 72o/o of the patients reported that the pain had disappeared or significantly decreased.

After the war narcotic sleep began to be successfully used to

treat ulcerative or hypertonic patients. Enthusiasm for "sleep therpy" rapidly grew. Hundreds of printed works appeared, whose authors described cases treatment of different diseases by sleep. Interesting findings of biological experiments were published. Prof. S.N. Braynes, for example, succeeded in inhibiting the aging process in dogs by therapeutic sleep.

What diseases did they not try to treat with sleep! And it must be said that besides the enthusiasm for the new method the atmosphere of a cult of the individual made itself felt with its dogmatic incompatibility with other views in regard to something once "sanctified" on high. Sober voices were drowned in a sea of adulation.

In 1955 Prof. O.G. Ivanov-Smolenskiy that the advance of sleep therapy would not depend on "creeping empiricism" ("it is possible it might help even here"), but on carefully weighed demonstrations, proper choice of type of sleep, and organization of the conditions for sleep therapy.

But, "more catholic than the pope himself," opportunists and simple enthusiasts vulgarizing Pavlov's concept in their enthusiasm did their work. The slow process of discreditation began. In addition it became very quickly apparent that prolonged slumber induced by a soporific frequently led to complications (headache, vomiting, visual and aural sensory illusions, and pathological shifts in blood and urine). The patients' temperatures often rose and normal activity of the gastrointestinal tract was disturbed.

The rush was on to seek out new means for inducing sleep.

First of all was enlisted the aid of hypnosis, conditioned-reflex sleep, caused by a combination of various light and sound stimuli plus the action of soporifics and the use of conditioned reflexes developed during our lives. The Kiev physician and author P.Ye. Beylin and the collective of the Nazarovskiy-Rayon Hospital consulted by him initiated the use of these methods.

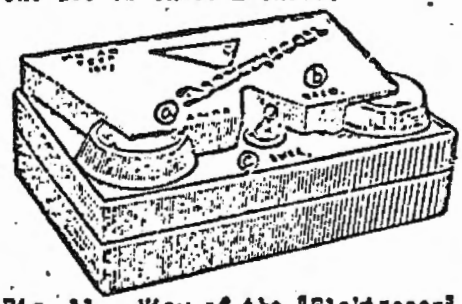

Fig. 11. View of the "Elektroson" ("Electrosleep") Transistorized Unit Developed in Biocybernetics Division, Academy of Science, Ukrainian SSR. This apparatus is demonstrated at the Exhibition of Achievements of the National Economy in Kiev. Powered by portable or flashlight batteries. Frequency and pulse duration can be changed to allow for individual differences in type and condition of patient's nervous system. Key: (a) Amplitude (b) Frequency (c) Switch.

But here, too, there were many instances of lack of moderation and excessive faith in the thaumaturgical properties of sleep, even in cases where its use could give no perceptible affect.

Electrically induced sleep, which quickly found recognition in the Soviet Union and countries of popular democracy, proved to be very promising. This method aroused serious interest in the United States, England, Italy, Japan, Brazil, Austria, the German

Federal Republic, and other countries. Perfected equipment was created, including a small transistorized unit developed in the Divison of Biological Cybernetics of the Cybernetics Institute of the Academy of Sciences, Ukrainian SSR (Fig. 11).

Analysis of thousands of case histories indicates the effectiveness of electrosleep in some forms of schizophrenia, hypertonic and ulcerative diseases, neurosis, the incipient stages of atherosclerosis, in brain injuries and the sequelae of encepalitis, cases of neurodermitis (eczema), bronchial asthma, toxic pregnancy, speech disturbances in children, etc.

Prof. G.V. Sergeyev, for example, treated 350 patients in different stages of hypertonia with electrosleep. The result was a reduction in arterial pressure, improvement in sleep, and restoration of working capacity in 211 and restoration of working capacity without reduction of blood pressure in 118. The therapeutic effect was insignificant in only 8o/o of the patients. It is, by the way, observed even when the individual does not fall asleep (and this is almost always the case in the first sessions). The therapeutic effect of electrosleep is especially clearly manifest in combination with certain medicaments -- bromine, reserpine, insulin, etc.

Electrosleep also copes rather well with other assignments -- protecting brain cells against pre- and postoperative "discharge," alleviating the effect of the harmful impulses which bombard the brain during operation under local anesthesia.

As the observations of Drs. S.R. Roytenburd and O.M. Rashkovskiy and of the author of this booklet have shown, all patients who underwent the electrosleep procedure preoperatively, and particularly during operation, withstood the operative intervention -- during the operation their pulse, respiration, and blood pressure "jumped" substantially less than did those of others. And their postoperative period also took a smoother course.

Under district hospital conditions, however, L.G. Zhukovskaya seven years ago for the first time approved the sleep-inducing method which we proposed and called (frankly speaking, very grandiloquently) radiosleep.

It was not by chance that we arrived at this method. The fact is that patients' attitude toward electrosleep, especially to the first step, is a bit tense. This is natural, too -- almost everyone remembers being "hit" by a current, and here electricity is being "passed" through one's head.

This is the reason that from the first steps in electrosleep therapy we refrained from applying electrodes to the eyeball (this frightened the patient even more), but bandaged them to the forehead and occiput. And still the psychological "resistance" still remained.

Cannot sleep be induced, we reflected, without applying electrodes to the head? Cannot, for example, an ultrahigh-frequency electric field be employed? But UHF, to use the abbreviation, is rather extensively utilized in medicine for the deep heating of tissues in various inflam-

matory processes (furuncles, highmoritis, pulmonary abscesses, etc.), in neuralgia, radiculitis, certain neurovascular diseases, illnesses of the spinal cord and brain, and bronchial asthma.

Most scientists have associated the therapeutic effect of the field with the heat generated, although researchers have emphasized the presence of a non-thermal "specific" UHF influence chiefly effectuated through the nervous system. Only of late years with the development of radar technology, which, as is known, operates at superhigh frequencies, has the action of this region of electromagnetic radiation spectrum on the human and animal organism begun to be deeply studied.

It has been found that, depending on dosage and place of action, now the inhibitory, now the excitatory process can be made to be predominant in the central nervous system.

Medicine has begun to use the UHF impulse field for treating hypertonia, neurosis, and certain other illnesses. Here the field acts for several microseconds and then there is a pause 1000 times longer than the impulse. The result is that strong impulses (up to 15 kw) get into the body and cause extralimital (parabiotic) inhibition, but the thermal effect, because of the long pause, is revealed to be very insignificant.

Then came alarm signals. Foreign scientists gave the information that when monkeys were irradiated with waves close to a meter in length at a generator power of only 100 w brain damage was detected. And one American scientist stated in 1960 that in the 350-500 Mc frequency range he had observed the specific effect of "individual" frequencies. Individuals who had been tested told of feeling "pulsation in their brains, ringing in their ears, and a desire to sink their teeth in the nearest experimenter."

We nevertheless decided to test the effect of a discontinuous UHF field at very low powers. The field parameters were to be substantially different -- in the direction of reduced power and pulsation frequency -- from those used in medicine.

Experiments on animals and on ourselves demonstrated the harmlessness of the procedure. Then Dr. Zhukovskaya used this method to treat a young woman tormented with insomnia and receiving no help from soporifics, even in large doses.

Placing the electrodes 5 cm from the patient's temples we generated a UHF field between them which was broken several score times a second. In seven minutes the patient fell asleep. The apparatus was switched off in 15 min, but the woman kept on sleeping for several hours. A positive aspect of "radiosleep" also proved to be the simplified method of procedure.

Meantime electrosleep had already won the confidence of patients and people stopped fearing "electrization." But our radiosleep unit was not always reliable in action and for this reason we lost interest in it.

But the idea of "radiosleep" was taken up by Prof. O.S. Putilin, Head of the Physics Department of Kishinev Medical Institute, L.Ya. Rabychev, physician and neuropathologist, and Engineer L.P. Kernitskiy, who in 1958 devised an instrument which they called a "remote impulse unit for

electrohypnosis."

Along with the interrupted UHF field they used a source of infrared (heat) rays, a blue-colored lamp, and a buzzer. Bundles of light, heat, and sound impulses were emitted in synchronization with the UHF field pulsation. The soporific effect of the electrical factor was here amplified; influence was exerted on the visual, dermal, and aural analysers.

These are, of course, only first attempts. There is no denying that it is possible to select parameters for the physical agents such that under any conditions healthful sleep will be induced. But in modern medicine the therapeutic role of inhibition is still far from being completely utilized. And the question is not merely one of correctly choosing the method of producing sleep and the tactics of using it.

In our time we can no longer believe that the nervous system, particularly its higher levels, "organizes" disease. While paying the cerebral cortex its due we cannot now reduce the origin of the pathological process merely to the appearance of "congested foci of excitation" in it, as was done until quite recently. The essence of disease lies in the shift in homeostasis -- the dynamic stability of the self-regulatory systems of the organism on all levels, from the cellular to the organic. Of especial significance here is the functional displacement of the neurohumoral mechanisms -- the form of physiological process regulation in which the neural impulses and the substances transported by the fluids circulating in the organism act in succession.

I.P. Pavlov taught that disease is the organism's reaction to stimulation by environmental factors which leads to injury and defence against it. He called the latter the physiological measure of defence.

On the basis of the physiological is engendered the pathological -- the new qualitative state of the organism where it operates by new, quantitatively and qualitatively rigidly defined laws. We must take into consideration that the organism falls ill as a whole and that the nervous system in any disease is always a part of this whole.

Prof. M.M. Amosov is right -- disease is composed of two elements, displacements of the norm (positive feedback) and accommodation thereto (defence, negative feedback). This state is characterized by its own peculiar play of the basic neural processes -- excitation and inhibition, the operation of the reflex apparatus peculiar to and inherent in the given pathological process. According to I.P. Pavlov's ideas the substance of the study of the reflex mechanism reduces to effectuating spatial relationships and determining the routes over which stimulation propagates and gathers.

By interrupting at our discretion the paths of circulation of "pathological information," regulating its extent at the various levels of the organism, and dissolving the pathological conditioned-reflex connections we will be able to thrust the "program" of convalescence on the organism.

This is a matter for the future, but we are now already able to assist in the solution of many problems of controlling groups of cells

or organs and in liquidating a number of pathological processes when we use the relatively local effect of chemical substances or electric impulses.

It is therefore important to utilize the protective function of inhibition not merely as sleep or narcosis, but also as the destruction of the pathological complex which is first put together somewhere on the periphery and as a method of balancing the neural processes in the center, and, finally as a means of changing the reactivity of the cells, tissues, and the entire organism as a whole.

To illustrate we will point out the data obtained by Academician O.D. Speranskiy and his students. The experiments in question very graphically define the role of the peripheral divisions of the nervous system. (This scientist developed a theory of the nervous system's role in the mechanisms of falling ill, convalescence, and treatment. He admitted a number of inaccurate definitions which in their time gave rise to sharp criticism and he did not always devote enough attention to the role of the higher divisions of the central nervous system, nevertheless the enormous amount of theoretical material which he amassed should be extensively used in constructing the theory of medicine.)

It is known that overtension of the neural process in the cerebral cortex, the "skirmishing" between excitation and inhibition, leads to the appearance on the animal body of ulcers, eczema, and other so-called trophic disturbances.

Experiments indicate the significance of disturbance of the normal functioning of the cerebral cortex for the genesis of a morbid process. But to reduce the matter merely to that would be to simplify the facts.

Here a dog's sciatic nerve has been severed. In this case a trophic ulcer of the extremity rarely occurs. But it is worthwhile to accompany this severance with injection of a drop of formalin or bile into the nerve — and an ulcer will develop in all experiments as a result of the supplementary stimulation of the peripheral portion of the analyser.

Sever the auricular nerves of guinea pigs. The next day you will see that in most of them the ear has atrophied and dropped down, while some of the experimental animals have not reacted to the severance at all. Nevertheless it is worthwhile severing, say, their sciatic nerves, when the ear of each one will atrophy.

Tetanus is known to be accompanied by continuous excitation of the extensor muscles of the extremities, but if before infection or at the moment of infection the extremity is given a bent position and is fixed in plaster the disease does not develop.

And take the therapeutic effect of a local injection of novocaine (the so-called novocain blocks proposed by Prof. O.V. Vishnevskiy) in diseases of the internal organs. Directly opposite results may be attained by action on the receptors. Interesting experiments have been made. It has been demonstrated that when some of the internal receptors in rabbits infected with tuberculosis are put out of action by novocain injections the tubercular process shows up earlier than in animals of

the control group and takes a graver course. But the slight stimulating action of a novocain block on the vegetative nervous system delays the development of the tubercular process and favors a lighter course for the disease. When this method was brought into a clinic where children with tuberculosis were being treated a positive effect was obtained in a number of cases.

What has been advanced above may be corroborated by numerous examples from the practice of clinicians. Here is one of them.

In 1953 the Soviet psychoneurologist F.D. Gorbov described some cases of "troublesome" pathological reflexes in airmen. These excellently trained, externally healthy people somehow developed a vomiting when fastening the straps of their throat-microphones around their necks and from that time were persistently pursued by it.

A delicate analysis conducted by a scientist showed that the matter was not only to change the dynamics of the cortical process, but also to change the sensitivity of the peripheral receptor field. Moreover the state of the vegetative nervous system played a great role.

The patients were cured by a very simple method -- physical pressure was exerted on the receptors of the neck and continuously increased, while medicaments were administered which depress the parasympathetic nervous system. And a physician with a dogmatic attitude toward the doctrine of protective inhibition would have put the patient to "sleep."

On the other hand inhibition of the brain may change the reactivity of the body.

The collaborators of Prof. V.S. Galkin and Prof. O.O. Vishnevskiy in their time discovered that yperite and lewisite applied to the skin of narcotized animals do not cause the usual lesion, the danger of injury by electric current is sharply reduced, the shock ordinarily caused by the transfusion of unmatched blood does not occur, and the effect of bacterial and neural poisons is significantly restricted.

After reading of V.S. Galkin's experiments the physician A.N. Ror decided to use narcosis in treating people brought into the hospital in hopeless condition after using as food a vegetable-like plant containing the powerful poison of cowbane, and the people recovered.

A therapeutic narcosis was developed and used in the postoperative period in Prof. B.I. Petrovskiy's clinic. It gets rid of the pain and is instrumental in the rarer occurrence of postoperative complications. The scientist also thinks that such narcosis is effective in myocardial infarction and should become irreplaceable when bandaging wounds in acute pain.

It must not be thought that all these qualities are inherent only in chemical narcosis. Even in 1953 we successfully demonstrated that electric narcosis prevents the manifestation of the poisonous effect of cyanide compounds on the rabbit organism, and afterwards at our suggestion L.V. Muravyov began to use electrosleep to treat acute pulmonary edema caused in dogs by sulfur dioxide poisoning.

There is no doubt but that the medicine of the future will extensively utilize the marvelous properties of inhibition. And among other

methods the position of honor will be occupied by profound inhibition of the vital functions by means of cold (anabiosis). Even now as a result of combining deep refrigoration of the brain with light refrigoration of the whole body it has been possible to claim the survival of animals after almost complete drainage of blood from the brain for a period of 1 hr to 1 hr 10 min (the brain usually dies in 5-6 min).

Let us try to imagine the medicine of our Tomorrow. In its arsenal will be automatic diagnostic machines, automatically controlled prostheses of different organisms, apparatus which emit electric impulses of differing characteristics and radiate electromagnetic fields which permit the inhibition of any part of the nervous system, and, finally, chemicotherapeutic remedies which, like a "magic bullet," find the enemy -- the disease -- in the body and exterminate it.

Medicine will arrive at these advances by basing itself on the new conquests of physiology, the cognition of the darkest secrets of the human body, and, in particular, of the state where our brain sleeps.

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EFFECTIVENESS OF ELECTRIC SLEEP TREATMENT IN CERTAIN OCCUPATIONAL DISEASES

by S. F. Shatrova

- USSR -

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EFFECTIVENESS OF ELECTRIC SLEEP TREATMENT IN CERTAIN OCCUPATIONAL DISEASES

Following is a translation of an article by S. P. Shatrova (Gor'kiy), in the Russian-language journal Gigiyena Truda i Professional'nyye Zabolevaniya (Labor Hygiene and Occupational Diseases), Vol 7, No 9, Moscow, Sept 63, pp 45-47.

Institute of Labor Hygiene and Occupational Diseases

(Received by editors 5 October 1961)

According to the theory of I. P. Pavlov on sleep and inhibition, sleep therapy in neuroses is pathogenetically valid and efficacious. At the same time it is known that sleep medically induced by pharmacological agents in some cases does turn out to have an effect upon the patient. It is necessary to exercise special caution in diseases in whose etiology is the effect of a toxic factor. For this reason the use of electric sleep in such cases takes on great importance.

Numerous studies have shown that electric sleep is analogous to physiological sleep or is simular to the state of drowsiness. The method of electric sleep first found use

in psychiatric clinics. V. A. Gilyarovskiy, N. M. Liventsev, Z. A. Kirillova in 1950 for the first time used electric sleep in the treatment of mentally-ill patients and obtained favorable results in a number of cases. S. D. Rasin and V. A. Vernikova, A. A. Golubchik and G. G. Fabish treated patients by a method of electric sleep and conditioned-reflex sleep based on electric sleep. The authors observed the best therapeutic effect in patients with a reactive state and acute asthenia. M. A. Titayeva points out the favorable results in treatment of patients with neuroses and psychogenic reactions. M. V. Rumyantseva-Russkikh, who used electric sleep in the treatment of patients with neuroses of a different type and also in insomnia not responding to the action of pharmacological agents, noted the effectiveness of this method of treatment.

It is necessary to point out that in subsequent years electric sleep came to be used not solely in the treatment of psychotic and neurotic conditions. This method found its way into clinics of neurology, internal medicine and other diseases.

Proceeding from the information cited above, we set ourselves the goal of investigating the effectiveness of the action of an impulse current in the treatment of certain occupational diseases the clinical picture of which is characterized by the presence of neurotic manifestations. So far as we know, treatment with electric sleep had not been used in an occupational-disease clinic.

We used pulse current for treating 40 patients, of whom 16 suffered with chronic tetraethyl lead poisoning, 14 with chronic lead poisoning, and 10 patients with vibration sickness. Their age ranged on the whole from 30 to 50 years. Irrespective of the nature of the disease, in the clinical picture of the diseases of all

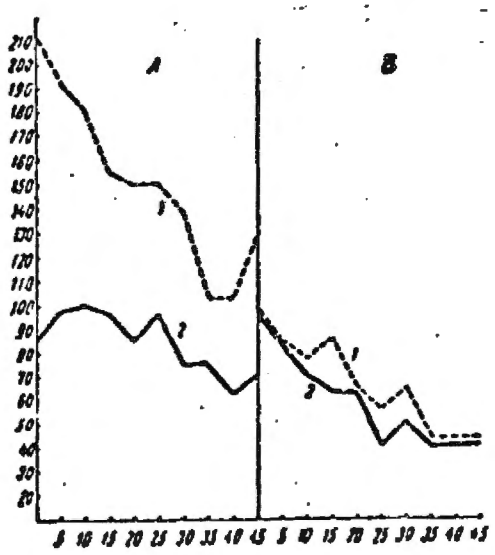
of these patients, a neurotic-state syndrome occupied the leading place, and practically all of the patients complained of sleep disturbance. In addition, headaches, malaise, and a depressed frame of mind were noted. The complaints of the patients varied somewhat depending on the type of poisoning. It is necessary to mention that in addition to the neurotic manifestations, specific symptoms peculiar only to the given poisoning were also noted.

Treatment was carried out by means of an apparatus, assembled in the experimental workshop, designed for each patient in the conventional methods. A course of treatment consisted of 10-15 treatments lasting from 15 minutes to 1 hour and 30 minutes. The frequency and intensity of the current were selected individually and amounted to 7-20 impulses per second at 0.5-0.7 mA. The effect of the impulse current on the patients was expressed in the following: from 5-7th treatment (in some cases earlier) the patients, as a rule, fell asleep during the procedure but at first their sleep was not deep enough. With every subsequent treatment sleep became deeper. Dreams appeared to some (24 patients) during the electric sleep treatments. In a portion of the subjects sleep lasted not only during the treatment, but also continued for some time after the current had been shut off.

Analyzing the effectiveness of electric sleep we evaluated it from the point of view of the effect on the condition of neuro-psychic spheres and of autonomic-vascular tone.

In studying the state of the nervous system, in addition to the usual methods of investigation(cranial, motor, sensory, and reflex spheres, coordination studies), we studied the state of the cerebral, cardiac reflexes (oculo-cardiac, clino-and-orthostatic), of autonomic-vascular innervation (dermatographia, acrocyanosis, change in

pulse, temperature, blood pressure) bilaterally. In addition to this, in studying vascular tone we resorted to special functional tests with the ingestion of phenamine and glyceryl trinitrate. The oscillometric index was determined. For studying the functional lability of the cerebral cortex, the method of adequate optic chronaxy in secondary dark adaptation was used. For estimating therapeutic effectiveness detailed studies of a simular sort were carried out before and after treatment.



Curves of adequate-optic chronaxy before and after treatment of patient R., age46. Diagnosis: chronic lead poisoning.

On axis of abscissa-time of secondary dark adaptation (in minutes), on axis of ordinate - magnitude of adequate-optic chronaxy (in m/sec.) and photo-sensitivity thresholds(in relative units); A - before treatment; B - after treatment; 1) adequate-optic chronaxy, 2) optic rheobase (photo-sensitivity thresholds).

Treatment with impulse current proved to be effective to some degree in 39 persons; in 1 subject the effect was insignificant. The nocturnal sleep of all patients improved; after 3-6 treatments sleep became more prolonged, less shallow, the process of falling asleep accelerated, interrupted sleep decreased, and sleep became "refreshing". It should be emphasized that the general condition and nocturnal sleep also improved in those cases when during the treatment the patients did not fall asleep. At the same time the patients' appetite increased, their mood improved, they became less troubled, more equable, less irritable. Many noticed a decrease in headaches and in pains in the cardiac region.

The subjective improvement in well-being, the decrease in number of complaints, the objectively observed improvement in mood and sleep were accompanied by a certain normalization on the part of cortical activity and autonomic processes.

For a more detailed investigation of the functional state of the central nervous system we used the method of adequate-optic chronaxy in secondary dark adaptation. We carried out these observations before and after treatment with electric sleep. Study of adequate-optic chronaxy was carried out in 9 patients. In all, 180 studies were carried out. For investigating the adequate-optic chronaxy under conditions of secondary dark adaptation we used an adequate-optic chronaxymeter constructed by Prof. P. O. Makarov "OX - 3". The usual experimental procedure was carried out. For illustration a graph is presented (see figure).

If before treatment with electric sleep the curves mainly had an irregular shape, with marked variations, the initial and terminal magnitudes exceeded 130 m/sec, the phase of stabilization was absent, then after treatment the variations became less marked, initial and terminal magnitudes were reduced and did not exceed (with the exception of one

case) 130 m/sec, in 5 cases the phase of stabilization was present.

Examination of the oculo-cardiac, normal and pathognomonic reflex before and after treatment revealed some sort of normalization of these reflexes after treatment. The oscillatory index in all of the patients increased and became on an average 3 - 5 mm higher than before treatment.

The results of special functional tests with the intake of phenamine and glyceryl trinitrate also testify to the improvement in vascular control after treatment with electric sleep. In carrying them out we used the methods suggested by Ya.Yu. Shpirt. The patient was given glyceryl trinitrate (0.0005 g) or phenamine (0.015 g). After the intake of glyceryl trinitrate, for 2 hours every 5 - 10, then 30 minutes, and after the intake of phenamine for 2 hours every 30 minutes the blood pressure was repeated measured. All blood pressure changes were recorded oscillographically. For purposes of comparison the indices of maximal variations of the arterial pressure were studied. These variations, in patients examined by the conducting of functional tests before treatment with electric sleep, were significant. In isolated patients these displacements reached 20 - 35 mm. After finishing a course of treatment the fluctuations of maximal pressure in all of the examined patients did not exceed 10 mm after the intake of phenamine and glyceryl and only in one patient the minimal arterial pressure was reduced 15mm after the intake of glyceryl trinitrate.

It should be noted that we carried out electric sleep treatment in combination with certain other methods commonly used in the treatment of patients with one, or another poisoning; however, the use of soporific substances was completely excluded, which permits us to attribute the normalization of sleep to the favorable effect of the impulse current. As for the

long-range results of electric sleep treatment, followed in 32 patients for 2 years, it should be pointed out that in 15 of them improved general state of being and sleep were enjoyed for 2 - 5 months after treatment and 17 individuals felt well for 8 - 9 months.

Thus the data obtained permits the following conclusions to be made:

The method of electric sleep can be recommended in occupational-disease clinics for treatment of those poisonings and occupational diseases in which the clinical picture of neurotic reactions predominates. Therapeutic effectiveness is shown in improvement of sleep, of the general state of being and of the patient's frame of mind. In this connection there is observed a certain normalization of indices of autonomic-vascular control (cerebral-cardiac reflexes, oscillatory index, and other indices of the state of irritability of higher centers in the central nervous system. Obviously a "supporting" course of electric sleep treatment should be repeated in a number of cases.

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METHODS USED IN ADMINISTRATION OF ELECTRICALLY INDUCED SLEEP

by M. M. Zheltakov, et al

- USSR -

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METHODS USED IN ADMINISTRATION OF ELECTRICALLY INDUCED SLEEP

[Following is a translation of Chapter VI and the Table of Contents of the Russian-language book by M. M. Zheltakov, Yu. K. Skripkin, and B. A. Somov entitled Elektroson i Gipnoz v Dermatologii (Electrically Induced Sleep and Hypnosis in Dermatology), Medgiz, Moscow, 1963, pp 99-113 and 307-308.]

Chapter VI, Methods used in Administration of Electrically Induced Sleep.

Various methods for the application of electrically induced sleep have been described in the literature. V. A. Gilyarovskiy, Yu. Ye. Segal', N. M. Liventsev, and Z. A. Kirillova (1954) distinguished between the following types of treatment with electric sleep: 1) long periods of treatment in which the current was applied for a period of up to two hours; 2) medium periods of treatment in which the current was applied for 40-60 minutes; 3) short periods of treatment or conditioned reflex sleep, in which the current was applied only until the moment that the patient fell asleep.

In all types of treatment sleep continued until natural awakening and had an average duration of 2-3 hours.

According to these authors, a conditioned reflex sleep induced electrically is very effective in psychiatric clinical use for the treatment of neuroses, reactive conditions, and persistent asthenic and astheno-depressive states.

According to M. G. Anan'yev, Ye. V. Gurova, and I. V. Golubeva (1957), in order to accelerate the onset of sleep on

application of a pulse current, deep direct action of the current on the brain, such as that which takes place when the electrodes are applied to the eyes and the back of the head, is not necessary. On the other hand, a parallel arrangement of the electrodes on the skin of the head side by side in the same plane (both of them on the forehead) precludes deep passage of the current, in the opinion of the authors. Experimental investigations made it possible to subject to thorough study this problem from the standpoint of reinforcement of the reflex action and reduction of the direct action of the current on the brain.

O. V. Kerbikov (1955) in the treatment of mentally diseased patients applied a current with a strength of 5-15 ma, a frequency of 1-20 pulses per second, and a pulse duration of 0.2 - 0.3 millisecond.

Banay (1952) in the treatment of schizophrenia patients applied Reyter apparatus with the following pulse current parameters:

1) Frequency: usually 30 pulses per second. The frequency of the current was regulated during the procedure, i.e., either increased or reduced. However, the author did not make use of the possibility of individual regulation of the current frequency depending on the functional state of the nervous system and the degree to which neurotic disturbances were pronounced; 2) Current strength from 1.5 - 2.5 to 11 ma. In a number of cases the initial current strength reached 2-3 ma.

In carrying out treatment with electrically induced sleep of patients with remote after-effects of closed cranial-cerebral trauma in the stage of decompensation, Ye. I. Lebedinskaya (1957) employed the following pulse current parameters (on a "GIF" apparatus): frequency 5 pulses, duration of pulse 0.2 millisecond, current strength 8-25 ma. In connection with this method, the best therapeutic effect was observed in patients with disturbed sleep due to insufficient magnitude of protective inhibition. When weakness of nervous processes was present, as indicated by persistent insomnia, a longer course of treatment with electrically induced sleep was required in order to obtain a therapeutic effect.

In the treatment of 164 patients with residual manifestations of spring-summer (tick-born) encephalitis, S. S. Magazanik (1957) recommended application of a pulse current with frequency of 10 cycles and pulse duration of 0.1 - 0.5 millisecond. The duration of applications of electrically induced sleep varied within the limits of 30-60 minutes and duration of treatment amounted to 12-15 days. Pulse current

with the characteristics mentioned, as had been established in electroencephalographic studies by the author, exerted a beneficial effect upon the bioelectric activity of the brain.

In the opinion of A. I. Nazarenko and T. A. Savel'yava (1957), who applied electrically induced sleep for the treatment of tumors of the stomach and the duodenum, good therapeutic results were obtained by applying the following method: arrangement of the electrodes on the eyes and the back of the head, current of rectangular shape (NIIEKhAII apparatus) and a current strength of 0.5-2 ma. The treatment was carried out in the morning and during the day (from 1100 to 1300), and the patients received up to 20 electric sleep sessions in the course of treatment.

I. S. Robiner (1957) assumes that the favorable functional shifts produced in the central nervous system under the effect of a pulse current persist after the application of the current has been discontinued. Experimental investigations by this author indicate that the positive effect of the pulse current on the nervous system persisted for a longer time when the action of the pulse current was longer. These observations lead to the conclusion that application of several fractional treatments during a day, by increasing the total period of action of the pulse current, bring about a strengthening and possibly a retention of the favorable shifts in the functional state of the nervous system which have been produced as a result of treatment with electrically induced sleep.

S. R. Roytenburd (1957), who applied electrically induced sleep in the surgical department of a rayon hospital, increased the duration of sleep (in combination with the regular night sleep) to 14-16 hours per day. The patients were treated for 3-5 days before the operation and 3-4 days after the operation.

As had been established by V. I. Rusakov (1957), who observed 167 patients with neurotic, asthenic, and astheno-depressive conditions, the duration of electrically induced sleep was 2-3 hours. In Rusakov's opinion, the best parameters of the pulse current are sub-threshhold doses with a frequency of 5-10 pulses per second. Upon excessive pulse current dosages apathy, weakness, listlessness, and intensification of morbid symptoms (side effects of electrically induced sleep) were observed. To treat insomnia, Rusakov, on modifying the method, applied evening electric sleep sessions (before the night's sleep), whereafter the patient remained in bed until morning. No sleep-inducing drugs nor suggestion

therapy were administered to the patients during the course of treatment.

In the treatment of 338 patients with high blood pressure, G. V. Sergeyev (1957) used a pulse current with the following characteristics: constant polarization, rectangular shape of pulses, pulse duration 0.2 millisecond, current strength (with respect to its amplitude values) varied within a 15-18 ma, range frequency of pulses 18 per second. The current strength was both increased and decreased slowly within 3 minutes. Electrical sleep sessions were conducted daily after breakfast from 1100 to 1300 for a duration of 30 minutes to two hours. The first 2-3 procedures were conducted without cutting in the current, until the patient became accustomed to the sensations of the attached electrodes. The total number of procedures during the course of treatment amounted to 17-20. Positive results in the treatment with electrically induced sleep of persons who had high blood pressure were obtained whenever the method was applied in cases in which the basic nervous processes were disturbed and there was no pronounced manifestation of excitation processes..

L. V. Dymetskaya (1954) applied a frequency of 12-16 pulses per second and then changed to lower frequencies, down to five pulses per second. During the first few treatments the most favorable frequency for the patient was selected. This frequency was then applied in all subsequent treatments. We do not quite agree with this procedure, because it is advisable to increase the current frequency somewhat as the neurotic disturbances are alleviated and reduce it when the neurotic disturbances become stronger.

In the treatment of patients at psychiatric clinics, a good therapeutic effect was obtained by applying a current of low frequency, i.e., 2-5 pulses per second.

For patients with after effects of an open trauma of the cranium, currents of medium frequencies had the greatest effect, i.e., currents with 10-12 pulses per second (N. M. Liventsev, V. S. Vozdvizhenskaya, and A. F. Strelkova, 1954).

At therapeutic clinics, pulse current with a higher frequency, i.e., 80-100 pulses per second, was used successfully.

For instance, L. A. Studnitsina (1957) applied a current with the following characteristics: rectangular shape of pulses, constant polarization, length of pulses 0.2 - 0.3 millisecond, frequency 10-15-80 pulses per second, current

strength 8-17 ma. The negative electrode was placed on the closed eyes and the positive electrode on the mastoid processes.

The inhibitory effect of the current increased with increasing frequencies, but at the frequency of 80 pulses per second some patients with a pronounced weakening of the basic nervous processes suffered from headaches and general weakness after the treatmehts. The length of treatments was adapted to individual patients: for patients with small weakening of the excitation-inhibition process, the length of treatments was 1-2 hours, while in the case of patients with a pronounced weakening of excitation and inhibition processes, electrically induced sleep continuing for 20-50 minutes was applied. The treatments were applied in the ward from 1000 to 1200 in the morning four to six times per week. The course of treatment consisted of 10-20 individual treatments.

An apparatus developed by U. B. Khudyy (1957) generates current with the following characteristics: 1) pulses of rectangular shape with the possibility of changing the frequency in the 1-20 cycles range at lengths of pulse amounting to 0.2 - 0.3 milliseconds; 2) a pulse current of rectangular shape with the possibility of changing the frequency within a range of 40-100 cycles at pulse durations of 0.8 - 1.4 milliseconds; 3) a pulse current of combined shape with the possibility of changing the frequency within a range of 1-130 cycles at pulse durations of 0.3-1.2 milliseconds. Two- and seven-channel equipment of this type is available. An improvement that has been embodied consists of automatically wetted electrodes designed on the principle of a non-spilling inkwell.

S. S. Magazanik (1956) used a "GIF" apparatus. The pulse frequency was 1-20 cycles. In a number of cases the patients were treated with a current at a pulse frequency of 10 cycles, a pulse duration of 0.3 - 1 millisecond, and a current amplitude of 10-15 ma. Soft electrodes having the shape of spectacles and ear flaps were used; the latter were applied in the region of the mastoid processes. Altogether about 1,500 individual treatments were applied without any complications or side effects.

The complete harmlessness of electrically induced sleep treatments was emphasized by V. I. Rusakov (1956). The author treated with electrically induced sleep patients suffering from insomnia. The patients were treated under ambulatory conditions by the following original method.

The ambulatory patients were subdivided into groups.

Towards 10 P.M. they came to the dispensary and spent the night there after application of electrically induced sleep for 2 hours. The advantages of this method consist in temporary elimination of conflict situations that may arise at home and the absence of undesirable phenomena which result from the application of sleep-inducing drugs.

The wards in which electrically induced sleep was applied were isolated from noise and ventilated. Electrically induced sleep was applied daily except on holidays. Four patients were treated simultaneously. The duration of an individual treatment was two or three hours. Altogether the patients received 15-20 individual treatments. The current strength was adapted to individual requirements according to generally accepted principles.

R. L. Syrkina in the treatment with electrically induced sleep of patients with an acute trauma of the cranium varied the current strength within the limits of 0.2 - 0.3 ma. At this current strength sleep resulted in the majority of patients. Higher current strength was applied by M. V. Rumyantseva-Russkikh (1959) in the treatment of neuroses: the current strength was 18-22 ma at a frequency of 1.5 - 135 cycles, depending on the degree to which neurotic disturbances were expressed. It was established by the author that the application of a pulse current with these characteristics brought about improvement of sleep on the 4th - 7th day after treatment had been initiated.

In another communication M. V. Rumyantseva-Russkikh (1958) reported on the treatment of patients with various types of neuroses by applying a current strength of 5-25 ma at a pulse frequency of 5 - 135 per second. Individual treatments were continued for periods of 15 minutes to 2 hours. Criteria of the reaction to current strength were a sensation (under the electrodes) of vibration in the region of the back of the head, light prickling under the eye electrodes, a feeling of pressure in the eyes, etc. The best results were obtained at a length of treatment amounting to 1.5 hours. A conditioned reflex to time was developed after 7 - 10 treatments.

A current of lower frequency (5-12 pulses per second) was most effective in patients with sharply expressed symptoms of neurasthenia: an increase in the frequency of the pulse current from 5 - 12 to 100 cycles produced in these patients a less sound sleep at night and increased irritability. Currents of higher frequency were applied in the case of patients who had neurotic disturbances of a less pronounced type. Thus,

in five patients, a positive therapeutic effect was observed only when the frequency was increased from 10 to 100 cycles. According to the author, the current strength presumably does not play a decisive role and should be modified depending on the individual sensitivity of the patient.

V. A. Gilyarovskiy and N. M. Liventsev (1950, 1958) also emphasized the importance of the pulse frequency for bringing about inhibition in cells of the cerebral cortex. According to the data reported by these authors, the best effect was obtained on using frequencies within the range of 5-25 cycles.

In order not to make the equipment too complicated with respect to control, the pulse duration was made constant by them within limits corresponding to the motor chronaxy of the central nerve formations. The pulse duration was 0.3 - 0.5 millisecond. Longer pulses produced unpleasant sensations, while shorter pulses were not very effective. It is recommended that the current be made as strong as possible in order that action be exerted on the nerve cells and that diffuse inhibition, i.e., sleep, be produced. The necessity is emphasized of taking care that the sensations arising when the current is increased in order that the optimum individual dosage of current strength may be selected do not have an unpleasant character.

According to observations by V. A. Gilyarovskiy and his co-workers, the average current strength in an electric sleep treatment was 10-12 ma and the lowest dosage was 6-8 ma.

As typical for the electrically induced sleep method (in contra-distinction to electric anesthesia) the author regards an action of a current of low strength, the upper limit of which is the threshold at which disturbing or disagreeable sensations arise in the regions through which the current is passed. The electrodes were attached to the eyes and to the back of the head. Of interest are also the following data given by the author. Out of 1,000 patients observed 276 did not fall asleep during the treatments, 285 exhibited sleepiness, 62 fell asleep after the current was cut out, and 377 slept during the treatment. The current strength was somewhat reduced after unpleasant sensations were felt in the region through which the current was passed.

A. I. Nazarenko and T. A. Savel'yeva (1958) applied the following method in the treatment of gastro-intestinal ulcers with a NIIEKhAiI apparatus and other equipment: the electrodes were placed on the eyes, the shape of the pulses was rectangular, and the current strength was 0.05 - 2 ma at a pulse

frequency of 100 per second. Slectrical sleep therapy was carried out simultaneously on four patients in small wards. The therapy was usually applied between 1100 and 1300. The length of the first treatment was 30 minutes; then the length of the individual treatments was gradually increased to 2 hours.

The Bulgarian authors Vranski, Ivanov, Kasabov, Marinov, and Korueva (1954) applied a weak pulse current at a frequency of 2.5 cycles.

According to N. S. Smeleva and associates (1959), in the treatment of eczema and neurodermatosis a current with a frequency of 8 or 12 pulses per second, a pulse duration of 0.2 - 0.3 milliseconds, rectangular pulse shape, and a current strength of 1-2 ma should be applied.

S. R. Roytenburd (1956) in electrical sleep therapy applied an Ml-3 apparatus developed by K. D. Ivanov-Muromskiy (1955) with special blocking which prevents the current strength from exceeding 0.03 ma. The humming of one of the power transformers was subsequently used as a conditioned reflex stimulus. The electrodes were applied to the forehead and to the back of the head. Treatment of 3-6 patients was carried out simultaneously in a darkened room. Beginning with the 3rd to 6th treatment, reflex reaction to the sound developed. The sound emitted by the apparatus was imitated by the humming of a sound generator. In this manner conditioned reflex sleep was produced. The patients slept an average of 14-16 hours per day, including the night's sleep. The sleep during the night was improved under the effect of electrically induced sleep.

In administering electrically induced sleep for the treatment of obliterating endoarthritis by means of a NIIEKhAII apparatus, S. R. Roytenburd (1958) developed an original method of treatment under ambulatory conditions. The author started from the premise that by the application of ambulatory therapy of this disease the stagnation of blood circulation in the legs, which is unavoidable in treatment under stationary conditions, is eliminated. Another advantage of this method of treatment was that the patient could remain in his accustomed surroundings. In treating with electrically induced sleep patients with obliterating endoarteritis, the author applied a pulse current with a strength of 0.3-0.8 ma. An individual treatment usually continued for 1.5 hours. All patients showed an increased length and normalization of the night's sleep. Application of this method indicated that a therapeutic effect is obtained even in patients who did not sleep

during the treatment. This again indicates that a pulse current exerts a neurogenic action. The complete harmlessness of electrically induced sleep therapy is emphasized.

M. Z. Konovalova (1957), in treating 122 patients with acute closed cranial-cerebral traumas, administered individual treatments twice per day. The first treatment continued for 45-60 minutes and the time elapsed between treatments was 3-4 hours. The patients were subjected to 10-20 treatments, depending on the clinical course of the disease. Conditioned reflex sleep was induced after 5-7 treatments in which a current was applied. The conditioned reflex sleep was induced during the same hours as sleep under the action of pulse current. All procedures applied in inducing electric sleep were carried out; the electrodes were attached, but the current was not cut in. As has already been pointed out, conditioned reflex sleep developed under the condition that the patients had been subjected for at least 5-7 times to electrically induced sleep.

In the treatment of patients with light traumas or traumas of medium severity, electrically induced sleep was successfully applied in combination with small doses of sodium bromide, soporifice given at night, and other types of treatment.

A. S. Zubova (1957) established that inhibition of nervous activity in the form of sleep is achieved in schizophrenia patients at low current strength (0.1-1.5 ma) and a duration of individual treatments amounting to 1.5 hours.

K. N. Afonskiy and M. I. Fel' (1957), in developing equipment for the induction of electrical sleep, took into consideration the necessity of altering the frequency of pulses. On this principle, they designed an apparatus with an extensive frequency range. This design makes it possible to select the characteristics of electric pulses which produce the best effect. This was achieved by means of a multivibrator. Application of a multivibrator made it possible to modify the characteristics of the oscillations generated by simple switchings over and regulation.

It is assumed by D. V. Afanas'yev (1957) that a shortcoming of electrically induced sleep consists in an insufficiently strong action on the organism of the patient. As a result, an insufficient therapeutic effect is exerted in a number of cases. To reduce this shortcoming, the author recommends the following method:

a) An intensified variant of electrically induced sleep (on the application of which headaches develop, however);

b) "Condensed procedures" (application of individual treatments 4-5 times per day).

The application of these methods bring about summation of the action of subsequent treatment with the residual effect of the preceding treatment. The methods in question are based on the principles of summation of irritations formulated by N. Ye. Vvedenskiy and the effect of the time factor pointed out by A. A. Ukhtomskiy. In practice D. V. Afanas'yev's method produced good results in the treatment of the effect of abstinence in narcotic addicts.

N. M. Shcherbakov and B. V. Bologov (1956) described the apparatus for producing electric sleep, which they designed. As the "EM - OPNI," where the pulse is bell-shaped in V. A. Gilyarovskiy's apparatus it is rectangular and in D. V. Afanas'yev's apparatus it is trapezoidal. In the apparatus described, the pulse frequency is constant and equals 100 per second. N. M. Shcherbakov (1955, 1958) regards acquisition of a rhythm as the basic principle of electrically induced sleep therapy and the leading factors in it are as follows: a) electro-tonic effects observed also in ordinary galvinization; b) normalization of the rhythm of impulsation in the central nervous system by acquisition of the rhythm of the pulses being applied; c) protective inhibition (the latter is not regarded as essential by the author, because therapeutic action is achieved even in cases when the patient does not sleep).

In the opinion of a number of authors (A. Ye. Shcherbak, 1937; A. R. Kirichinskiy, 1935, and others), with the transcerebral or ocular-occipital arrangement of the electrodes, the current enters into the cranium through slits and openings in the eye hollows and also through the thin bones which form the walls and the back of the eye hollow as well as through the large temporal opening and the thin cellular bones of the mastoid processes. This is the best method of introducing the current into the cranium and for making it penetrate into the substance of the brain. Research by V. A. Gilyarovskiy, N. M. Liventsev (1950, 1955) and others indicated that the current passes through the soft tissues surrounding the cranium as well.

In experiments on animals Kleinsorge, Rosner, and Dressler applied electrically induced sleep on 1,000 guinea pigs and 50 rabbits, using a current with the following

characteristics: a rectangular current shape with a delayed rise, current strength 1-5 and 1-40 ma, frequency 6-18 pulses per second, pulse duration 0.3 - 0.6 millisecond. These authors attach great importance to the factor of suggestion in electrically induced sleep therapy under clinical conditions.

The procedure of I. M. Vish and V. P. Larionov (1957), who applied electrically induced sleep in the treatment of alcoholism consisted of the combined use of electrically induced sleep hypnosis, and apomorphine, whereby in contrast to our procedure (1956), hypnotic suggestions were made first, and then electrically induced sleep was applied.

The method applied by us was as follows. We used two "Elektroson" apparatuses designed by N. M. Liventsev and manufactured by the experimental workshop of the Physico-Chemical Division of the State Institute of Physical Therapy, Ministry of Health USSR. An apparatus of this type is designed for the simultaneous treatment of four patients. On one of them, which is of an older design, the frequency of pulses is regulated by means of a potentiometer that is common for all four channels, while the current strength is regulated individually for every patient of the four who are treated simultaneously.

In the other, improved apparatus both the current strength and the frequency is regulated for every patient, i.e., every patient of the four treated simultaneously can be given current with a different pulse frequency (from 1 to 130 cycles). In this apparatus a potentiometer that regulates the pulse frequency is provided for every channel of the four (Fig 11). The current strength in both models of the apparatus is measured in milliamperes according to the indications of the green line serving as pointer of the oscillagraph tube. The current supply was from the city power line.

The principal part of the apparatus is a blocking generator, which is a self-exciting generator of oscillations of the relaxation type without tuning in the anodic or principal circuit and with a strong feedback (Fig. 12). A general view of the control panel of the "Elektroson" apparatus is shown in Fig. 13.

When an electrically induced sleep treatment is applied, the principal characteristics of the pulse current of low frequency and low strength applied to induce sleep are as follows:

a) frequency of pulses in the apparatus of old design

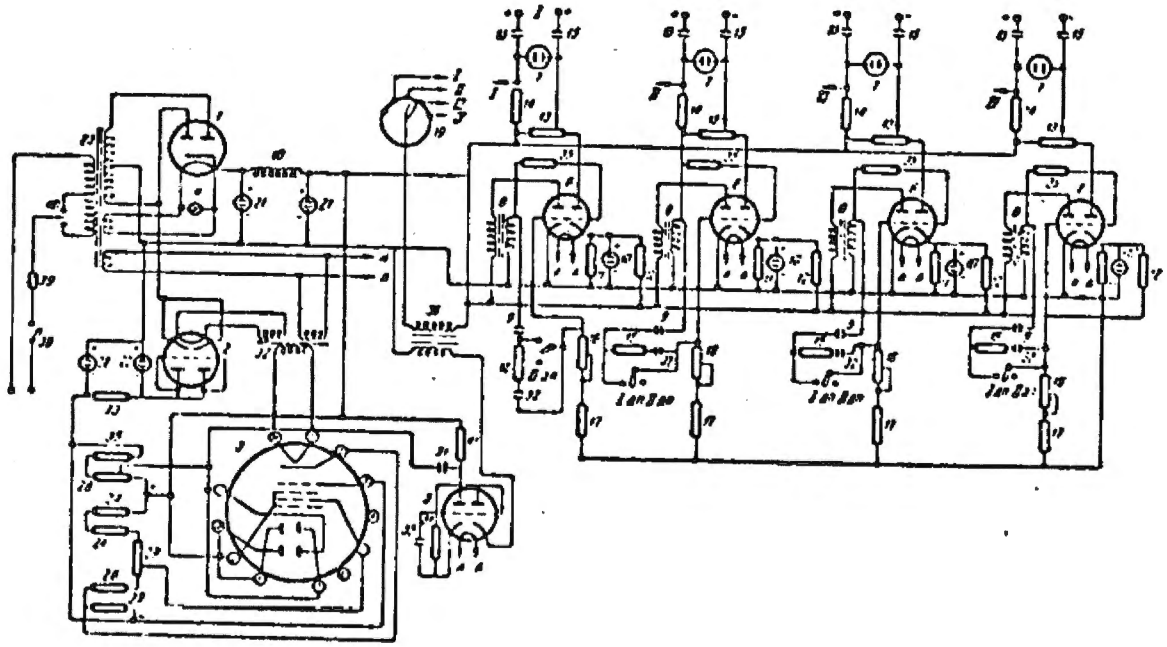

Fig. 12 (p 110)

Circuit diagram of apparatus for electrically induced sleep with separate frequency control in every channel.

1-80 cycles per second and that of the new design 1-130 cycles (we selected a frequency depending on the degree to which neurotic disturbances were pronounced and the functional state of the nervous system of patients, generally from 5 to 90 cycles);

b) the duration of the pulse was constant (within the limits of 0.2 - 0.3 milliseconds);

c) the shape of the pulses was rectangular and the polarity constant;

d) the current strength was one to 50 ma (averaging 8 - 23 ma for men and 4 - 20 ma for women).

The negative electrode having the shape of spectacles was placed on the eyes and the positive electrode in the form of earmuffs on the mastoid processes. A tight fit of the electrode masks to the skin was secured (Fig. 14).

The electrodes (piece of absorbent cotton placed in corresponding grooves of the masks) were moistened with a physiological salt solution or warm water. In the case of patients who had inflammatory conditions on the skin of the face or in the region of the eyes (erythema, edema) treatments were carried out after these conditions were alleviated. As a liquid for moistening electrodes warm water was usually applied in the case of such patients. This did not reduce the effectiveness of electrically induced sleep. As the negative eye electrodes dried, they were moistened by means of liquid from a pipette.

After the electric current had been switched on, a current passed from the eyes to the back of the head. When treatment with electrically induced sleep was applied, the current strength was regulated individually not only for every patient, but for every application. The current strength was established at a level at which no unpleasant sensations resulted from its passage, and the onset of sleep was not interfered with thereby.

The reaction of patients to swtiching on of the current consisted in a sensation of weak and pleasant prickling, stroking, light vibration, twitching, and goose flesh in the region in which the eye electrodes were attached, more rarely in the region in which the ear electrodes were attached. These sensations did not reach a degree at which they were unpleasant. This is a condition which limits the current strength which is simultaneously controlled according to the

oscillograph of the "Elektroson" apparatus for each of the four channels separately, i.e., for every patient of the four who are simultaneously treated with electrically induced sleep and hypnosis.

We increased the current strength to the optimum magnitude (which does not produce unpleasant sensation in the patients) and decreased the current strength to zero at the end of the treatment. As a rule we gradually increased the current strength for the majority of patients from treatment to treatment and sometimes during individual treatments.

[Captions to figures not reproduced here]

Fig. 11 [p. 109] General view of refined apparatus for electrically induced sleep with individual frequency control for each of four patients receiving electric sleep treatment simultaneously.

Fig. 13 [p 111] General view of distribution panel of the "Elektroson" apparatus.

1 - oscillograph tube; 2 - frequency control dial; 3 - dial for regulating pulse current strength; 4, 5, 6 - jacks for cutting in of electrodes and the cut-in electrodes; 7 - controlling device for frequency control dial; 8 - frequency control dial switch; 9 - channel control switch; 10 - connection to network.

Fig. 14 [p 112] Position of electrode masks on eye-socket region and the mastoid processes.

Table of Contents

	Page
Preface	3
Introduction	5
Part 1. Electrically Induced Sleep	
Chapter I. Brief historical outline of the development of the theory of electrically induced sleep	8
Chapter II. Therapeutic application of electrically induced sleep	10
Electrically induced sleep in psychiatry	11
Electrically induced sleep in neuropathology	14
Electrically induced sleep in therapy	20
Electrically induced sleep in surgery, obstetrics, and gynecology	27
Electrically induced sleep in dermatology	31
Chapter III. Physiological nature and mechanism of action of electrically induced sleep	40
General information	40
Effect of current upon brain tissue	43
The depth of electrically induced sleep	49
Effect of electrically induced sleep upon metabolism	52

	Page
Mechanism of action of electrically induced sleep and ganglion-blocking agents	56
Chapter IV. Effect of electrically induced sleep upon some physiological indices of the organism	62
Results of pletismographic investigations	62
Initial pletismogram and the effect of treatment with electrically induced sleep upon unconditioned vascular reflexes	63
Effect of treatment with electrically induced sleep upon conditioned vascular reflexes ..	68
Effect of electrically induced sleep upon electroencephalogram indices	74
Effect of electrically induced sleep upon the magnitude of sensory chronaxy	78
Effect of electrically induced sleep upon magnitude of arterial pressure and epicutaneous reactions	79
Chapter V. Indications for administration of electrically induced sleep in dermatology	80
Chapter VI. Methods for administration of electrically induced sleep	99
Part 2. Hypnosis	
Chapter VII. Historical outline of development of the theory of hypnosis	114
Chapter VIII. Therapeutic use of hypnosis in dermatology	137
Chapter IX. Hypnosis and sleep in the light of I. P. Pavlov's teachings	157
Chapter X. Effect of hypnosis upon physiological processes in the organism	166
Chapter XI. Mechanism of the therapeutic action of hypnosis	187

	Page
Chapter XII. Indications for administration of hypnosis in dermatology	198
Chapter XIII. Combined application of hypnosis and conditioned reflex therapy	205
Conditioned reflex sleep	210
Chapter XIV. Classification and determination of degree of depth of hypnosis	211
Chapter XV. Methods for application of hypnosis	219
Part 3. Combined application of electrically induced sleep and hypnosis	
Chapter XVI. Methods	235
Electrically induced sleep in combination with soporific drugs	241
Electrically induced sleep in combination with conditioned reflex sleep	242
Chapter XVII. Physiological prerequisites for application of electrically induced sleep in combination with hypnosis	244
Chapter XVIII. Therapeutic results obtained by combined application of electrically induced sleep and hypnosis	251
Treatment of patients with eczema and neurodermatosis	251
Normalizing effect of electrical sleep therapy and hypnosis upon the duration and depth of sleep in patients with eczema and neurodermatosis	253
Action of electrically induced sleep in alleviating itching	259
Intensification of depth of the hypnotic state in patients with eczema and neurodermatosis under the effect of electrically induced sleep	263

Page

Treatment of patients with psoriasis, lichen ruber, nettle rash, and other dermatoses .. 271

Complex treatment of patients with neurodermatosis, eczema, and other dermatoses by means of hypnosis, electrically induced sleep, and corticosteroids 275

Chapter XIX. Results and prospects 281

Bibliography 288

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Table of Contents

D. V. Petrovskiy and V. S. Kryloy. The Current Status of Vascular Surgery. 1

V. N. Koslovskiy. Lipoid and Protein Metabolism in Patients with Arteriosclerosis 9

G. V. Sergeyev. Electric Sleep as a Method of Neurotropic Treatment of Essential Hypertension 15

K. A. Rappoport. Hygienic Evaluation and the Use of Underwear Made of Chlorin (Vinyl Perchloride) for Therapeutic Purposes 20

The Current Status of Vascular Surgery

Professor B. V. Petrovskiy, Lenin Prize winner and active member of the Academy of Medical Sciences USSR, and V. S. Kryiov.

From the Department of Hospital Surgery (Head-- Professor B. V. Petrovskiy) of the First Moscow Medical Institute imeni I. M. Sechenov.

At the present time, restorative vascular surgery has made considerable achievements and is on the road to rapid development. The surgical successes observed in the past 10-12 years on the aorta and main vessels are explained by the prolonged period of development undergone by vascular surgery as well as by progress in the technique and in drug chemistry. The combination of these three aspects has made it possible for the surgeon to perform operations which very recently seemed impossible.

The main aim of any operation on a blood vessel is preservation of its function, and the main function of a blood vessel is that of carrying blood. The surgeon now can not only preserve the existing function, but can also restore the passage of blood through a blood vessel which has been impaired through trauma or disease.

In previous years many surgeons in various countries worked out vascular suture in detail. In this field, a great contribution was made by Russian surgeons, Napalkov, Tikhov, Dobrovol'skaya, Kravtsov and Sofeiskov. However, the illustrious development of vascular suture at that time did not afford the possibility of using it clinically on a broad scale, because the imperfection of the instruments, needles, suture material as well as the absence of anticoagulants, making it possible to produce a temporary artificial hemophilia to the necessary degree and for the necessary period of time, led to the fact that the percentage of cases of thrombosis was high, and vascular suture could be used by only individual ingenious surgeons.

Replacement of a vascular defect is necessary in all operations in which this defect is more than two-three centimeters long. All attempts at transplantation, aside from transplantation of the patient's own vein in exceptional cases, met with failure, partly for reasons presented above and partly because of infection in the wound, with which it was impossible to cope before the advent of antibiotics.

Attempts at vascular transplantation, ineffective for long years, since the time of Carrel, eventuated with the triumph of the idea of transplantation at the end of the 1940's. Defects in the aorta and peripheral arteries began to be filled in successfully with preserved vascular homotransplants, and for a long time they performed the functions of a blood vessel. Defects in preserved homotransplants which became clear in the course of time gave rise to new methods of preservation, particularly, the freeze-drying method, which afforded the possibility of preserving the blood vessel for a year or more.

Along with the improvement of vascular homotransplantation

another trend was developed, the utilization of inert arterial prostheses. Attempts at using arterial prostheses were made at the end of the past century (Payr, Kirtse, Carrel); however, these attempts were without results, because metal, glass, and rubber tubes inevitably thrombosed. The successful solution of this most difficult problem became possible only with the advent of plastics, when the cardinal property of polymeric materials was demonstrated-- their resistance and chemical unreactivity. This made it possible to approach the problem of foreign bodies in the organism from a new angle.

Synthetic arterial prostheses created in the past five years become, so to speak, a part of the body after transplantation, "grow into" it. Being porous, these prostheses are pervaded with connective tissue. Each fibre of the prosthesis is surrounded by a cuff of the recipient's connective tissue, so that on the basis of the transplanted plastic prostheses a new vessel is formed. This new vessel will be more of an auto- than a heterotransplant. In its wall the prosthesis fibres play the part of a strong frame, an elastic stroma. For this reason modern permeable arterial prostheses are called "frame" prostheses.

In the course of time defects and advantages of prostheses over homotransplants were demonstrated. Freeze-dried homotransplants undergo arteriosclerotic changes after transplantation to the body. The elastic membrane of the homotransplant not uncommonly thins out, becomes fragmented and can lead to the formation of an aneurysm even 20 months or more after the transplantation. Prostheses made of plastics are devoid of these defects. However, the elasticity of the plastic tube is less than that of the homotransplant.

The elasticity of the prosthesis depends on the technical method of its preparation, the method of knitting and the quality of the treatment of the finished prosthesis. The best method of giving elasticity to prostheses is that of crimping. Crimped prostheses are more elastic, making it possible to transplant them to sections of blood vessels which under ordinary conditions are constantly subject to bending (the iliac artery over the hip joint, the popliteal artery).

Porosity is of a very great importance for the fate of the transplanted prostheses. During the operation excessive porosity leads to a very considerable hemorrhage through the wall of the prosthesis during the first few minutes after it is connected into the circulation, before the fibrin depositing on its walls makes this prosthesis impermeable to the blood.

At the Hospital Surgical Clinic of the First Moscow Medical Institute imeni I. M. Sechenov vascular alloplasty has been developed experimentally since 1936. More than 200 experiments have been performed on the transplantation of various types of plastic prostheses into defects in the aorta and peripheral arteries on frogs (V. S. Kryley, D. D. Venediktov, N. S. Yarmolinskiy). The experimental work made it possible to demonstrate the best materials and shapes of prostheses.

At the present time, experimental studies are being made for the creation of inhomogeneous prostheses which have two kinds of fibres in their walls. Some, strong fibres, would remain in the body permanently,

Whereas others, which would be resorted, would create the necessary density of the wall for the period in which the prosthesis is being included in the circulation and immediately after the operation. In this way, during transplantation the prosthesis would have greater density of the wall, but afterwards only a comparatively thin framework of strong plastic fibres would remain in the wall.

Plastic prostheses also have a number of other advantages over homotransplants, namely, simplicity of storage, sterilization, the possibility of having a set of such prostheses of the necessary calibers and shapes at hand all the time. Plastic prostheses can be prepared in the form of the prosthesis for the entire aortic arch together with its branches or for the thoraco-abdominal section of the aorta with the branches going to the internal abdominal organs.

The use of arterial prostheses has confronted surgeons and biologists with a number of new biological problems which at the present time are far from being completely solved; however, the information which we now have at our disposal makes it possible in a number of cases to perform reconstruction operations quite successfully on the aorta and on the arteries with the use of transplants. No little part in the success of these operations is played by the use of anticoagulants, particularly heparin. For a certain period of time after the operation, it is necessary to protect the prosthesis against the coagulation of the blood in it by means of the creation of artificial hemophilia. After a certain time, it is essential to replace the heparin with other anticoagulants of the coumarin series, which the patient continues to take, sometimes for many months or years. In some types of operations, particularly in operations for the thrombosis or embolism of blood vessels, where the patient already has a pronounced tendency toward increased blood coagulation, the use of considerable doses of anticoagulants is an inevitable condition for the success of the operation.

A new chapter in this problem was the use of fibrinolytic preparations which possess the power of dissolving even thrombi which have already formed. These preparations-- fibrinolysin and plasminogen sufficiently early and in adequate doses can dissolve intravascular thrombi. Plasmin treatment is just beginning to be included in the arsenal of surgeons, but the future of these preparations promises to be fruitful.

Aneurysms of the ascending aorta and aortic arch until recently were not operated on. At the present time, we can prevent the danger of sudden death of patients with aneurysm of the thoracic aorta (both the ascending portion and the arch). If the aneurysm begins directly at the aortic valves, the operation of excision of the aneurysm and replacement of the aortic defect with a prosthesis can be performed only with an apparatus for extracorporeal circulation because compression of the aorta in the ascending portion for the time necessary for the operation creates serious problems of assuring blood supply to the brain for this period. A complete extracorporeal circulation is recommended. Whereas the venous blood from the right side of the heart

goes through catheters placed in the venae cavae into an apparatus in which it is oxygenated. After this, the blood is returned to the body through a catheter inserted into the innominate and left common carotid arteries and through a catheter inserted into the left femoral artery. In this way, the problem of providing the brain and the lower portions of the body with a blood supply during the operation on the ascending aorta is solved. Some authors (Hanson, de Bakey) use, in addition, perfusion of the coronary arteries during the period of extracorporeal circulation for the purpose of preventing myocardial hypoxia.

If the aneurysm affects the arch of the aorta, leaving an adequate segment of the aortic wall in its ascending portion, the operation can be performed without an extracorporeal circulation by means of application of a temporary external bypass from the ascending aorta to the descending aorta with an additional branch to the carotid and the innominate arteries (de Bakey). This shunt, which consists of a plastic thoron prosthesis, is sewn into the side of the aortic wall with a burglip suture, whereby the blood flow in the aorta is not interrupted (a side clamp is applied to the aorta).

Aortic aneurysms, located distal to the left common carotid artery can be excised by means of a shunt or by the use of an extracorporeal circulation; however, in this case it is done without an oxygenator. The arterial blood is collected from the left atrium through a catheter passed through the left auricle and introduced into the body through the femoral artery. Aneurysms in this location, particularly those which begin below the point at which the left subclavian artery comes off, can be excised under the protection of a temporary internal shunt, a polyethylene tube inserted into the aortic lumen through an opening in the subclavian artery.

A particularly difficult task is the surgical treatment of aneurysms located in the thoraco-abdominal portion of the aorta. As is well known, in this section the celiac axis and superior mesenteric artery come off the aorta and, somewhat below it, both renal arteries branch off. Compression of these vital arteries for a long time, necessary for placement of anastomoses between the prosthesis and the aorta, is impossible. However, plastic prostheses make it possible to resect the aneurysms in this portion also by the following method. First, a temporary shunt is applied in the region of the aneurysm by means of a plastic prosthesis of the aorta of the appropriate caliber. Then, successively all the main arteries coming off the aneurysm are sutured into this shunt: celiac axis, superior mesenteric and both renal arteries. The period of complete compression of each artery does not exceed 10-20 minutes, that is, is within limits of tolerance for these organs. After the accomplishment of this step, the connection of all the main branches of the abdominal aorta with the bypass, the aneurysm is excluded from the circulation and excised completely, and the temporary bypass with the branches to abdominal organs sutured into it is left as a permanent bypass. The principle of converting a temporary into a permanent bypass has made it possible to solve a very difficult problem of resecting aneurysms in the thoraco-abdominal region.

Compression of the abdominal aorta below the points at which the renal arteries come off is tolerated satisfactorily by the body for a relatively long period of time (up to an hour or somewhat more). This makes it possible to resect abdominal aneurysms without additional measures. For the purpose of replacing a defect in the aortic bifurcation and terminal portion of the abdominal aorta a special plastic bifurcation prosthesis is used, which makes it possible to fill in a defect not only in the aorta but also in the iliac arteries and, in necessary cases, to place an anastomosis with even the femoral arteries.

In our clinic, there were 10 patients with aneurysms of the abdominal aorta; of these, four were subjected to radical operations (three patients recovered). The excised aneurysm in these patients was replaced with a plastic bifurcation prosthesis. The proximal anastomosis was placed between the prosthesis and the aorta below the point at which the renal arteries come off; the distal anastomosis, between the branches of the prosthesis and the iliac arteries. Plastic prostheses made it possible in one case (patient D.) to place an anastomosis between the prosthesis and the iliac artery of the end-to-side type.

Plastic prostheses, the lengths of which are practically unlimited, can be used not only as transplants for filling in defects in blood vessels but also as bypasses, as new blood vessels alongside the affected ones. The principle of the bypass has proved to be exceedingly effective in a number of serious diseases of the vascular system, chiefly in sclerotic lesions, where sclerotic occlusion affects the blood vessel over a considerable extent and the resection of such a segment becomes very traumatic, and not uncommonly an intolerable procedure for the patient. In these cases, the bypass operation becomes the only chance of saving the patient.

The possibilities of vascular transplantation have radically changed the nature of the operation for aneurysms of peripheral arteries. Not uncommonly, the main aim of the operation is the restoration of the main circulation, elimination of an arterial venous anastomosis, that is, the elimination of all the basic pathological conditions existing in aneurysms, and this aim can be achieved much more easily than previously, when the surgeon could not transplant blood vessels on a large scale. The patency of arteries in arterial aneurysm can be restored by means of resection and replacement of the arterial segment with a plastic prosthesis. The aneurysmal sac thereby is excised. Under certain circumstances, the surgeon can encounter conditions in which he can perform the bypass operation with an end-to-side placement of anastomoses between the artery and the prosthesis. These anastomoses can be placed at a relative distance from the aneurysm, that is, under conditions of a relatively healthy blood vessel wall, which puts these anastomoses under good circulatory conditions and contributes to the success of the operation. In arteriovenous aneurysms the aneurysmal sac sometimes can be left after its complete and careful exclusion from the circulation. Removal of such a sac after the main circulation has

been restored and the sac itself excluded from the circulation becomes additional trauma to the patient and, therefore, cannot be accomplished.

Finally, in some forms of aortic aneurysms and aneurysms of the peripheral arteries-- arteriovenous fistulas (where a simple tying-off of the fistula is impossible because of its great size)--the operation can be performed in the following way. After isolation of the afferent and efferent ends of the arteries and veins, the fistula between the blood vessels is separated so that the defect in the vein can be sutured without complications and the integrity of the vein restored. A defect of an elliptical shape in the wall of the artery can be filled in with a patch made of the fabric of the vascular prosthesis (knitted dacron fabric). The patch is sutured into the arterial defect with a transfixion suture through all the layers with an atraumatic needle. In this variant, the operation approaches the ideal: the integrity of both the artery and vein is restored, thereby this is done with a minimum quantity of transplant.

The method of placing the patch described above is applicable also to certain forms of aneurysms of the thoracic aorta. Instead of total excision of the entire aneurysm and subsequent suturing of a tubular prosthesis into it, a tangential excision of the aneurysm is performed, if the condition of the aortic wall permits, and the aortic defect is replaced with a plastic patch. The operation becomes less traumatic, and its duration is reduced by three times. We have at our disposal experience in 15 operations for arterial aneurysms with the use of plastic prostheses.

Operations for sclerotic lesions of the aorta and peripheral main arteries have been progressively developed in recent years. Not only sclerotic occlusions of the abdominal aorta, the region of its bifurcation and iliac arteries but also sclerotic occlusions of the femoral and popliteal arteries, conditions which are frequently identified with obliterating endarteritis but which are perfectly distinct from it, have become objects for operation. Surgical assistance can be given also for sclerotic occlusion of carotid arteries which are the causes of cerebral arterial insufficiency. Isolated occlusions of renal arteries, accounting for malignant hypertension in a number of patients, have become objects of operation. The symptom complex of isolated sclerotic stenosis of the superior mesenteric artery has been distinguished, which can also be cured surgically, by means of a restorative operation, revascularization of the mesenteric artery. All these new types of operations consist of combined or isolated application of three methods of operation on the blood vessel: resection with replacement of the defect, the operation of removing the intima of the blood vessel along with the sclerotic plaque, endarterectomy, and, finally, the operation of a permanent bypass in the region of the affected blood vessel. These three types of reconstruction operations can be combined depending on the characteristics of the case.

Performance of all these operations is possible only on the basis of accurate diagnosis, that is, determination of the site of the

lesion, its extent, the nature of blood vessels distal to the site of the lesion. In the case of sclerotic occlusions the possibility of a restorative operation is conditioned by the fact that such occlusion of the blood vessel is almost never complete and, as a rule, remains localized for a long time. Therefore, the distal segment of a blood vessel, patent to the blood and of adequate length and caliber, remains. The operation consists of utilizing this distal segment of the blood vessel and restoring the main blood flow through it. The successful operation entirely eliminates the ischemia of corresponding organs or parts of the body, that is, while being symptomatic in its principle it is, at the same time, a "curative" operation.

At the present time, we have performed 25 operations with the use of plastic prostheses for a sclerotic occlusion of the bifurcation of the aorta and iliac arteries, the Leriche syndrome. Mainly, a permanent bypass aortic-femoral shunt operation has been used. This operation, completely restoring the blood flow and being "curative," is less traumatic than aortic resection. The results, studied in some cases as long as two and a half years, are very stable. In the remote postoperative period we have not observed a single case of thrombosis of the prosthesis.

We have also performed 33 operations for sclerotic lesions of the femoral and popliteal arteries. The operation of the permanent bypass here has also completely displaced resection and transplantation previously performed. The results are also very satisfactory; however, the number of cases of thrombosis of the transplant is greater (five failures in 33 operations in the early postoperative period).

Among the many methods of diagnosing aortic lesions and lesions of the main arteries, the most important is x-ray contrast study of the aorta and blood vessels (aortic angiography). This study makes it possible to obtain data concerning the localization of the lesion, its form and character, information about the condition of the distal vascular bed and the condition of the collateral circulation, and in some cases makes it possible to judge the condition of the blood vessel wall. With a correctly performed arteriogram it is possible to determine the indication for operation and the nature of the future operation. Serial study of the blood vessels is particularly valuable; however, in practice a single x-ray film is perfectly adequate. We have described the technique of x-ray contrast study of the aorta and arteries in previously published articles (see Klinicheskaya Meditsina /Clinical Medicine/, No. 2, 1961).

Numerous functional methods of studying the aorta and peripheral vascular bed unfortunately are of subordinate significance, because they give no indications of the site of the lesion and permit judging the condition of the circulation in the organ or extremity only very approximately. Various methods of recording the volumetric pulse (plethysmography, rheovasography) are of value only when used by comparison, and at the current level do not make quantitative determination possible. Sphygmography, which makes it possible to judge the elasticity of the blood vessel wall (the rate of propagation of the pulse wave),

is of a certain value. The method of clearance of radioactive sodium (the "sodium clearance" test) can give summary data about the degree of circulation in various areas. The most effective method, making it possible to characterize circulatory disorders quantitatively for various main blood vessels is direct determination of the blood pressure and the pressure gradient in various areas. However, this method requires arterial puncture with a needle and cannot always be used. Determination of the mass of passing blood with various flowmeters is a very promising method but it has hardly come out of the experimental realm. Undoubtedly, the development of functional methods of diagnosis will even further extend the possibilities for reconstruction operations on blood vessels.

Along with improvement in the diagnosis of vascular lesions further improvement of vascular transplant prostheses is necessary. This work is being conducted along two lines: first, by means of improvement of biological homo- and heterotransplants and, secondly, by means of the creation of new, more perfect plastic prostheses-- inhomogeneous prostheses consisting of nonabsorbable materials and absorbable substances of biological origin which serve only temporarily, for the period of "implantation" of the graft into the body of the recipient.

The development of reconstructive surgery of the blood vessels depends not only on the successful development of scientific and research problems mentioned above but also, to a considerable degree, on the solution of organizational problems. The problem of supplying surgeons with modern instruments for operations on blood vessels is a very poignant one. The list of apparatus, drugs and instruments necessary for diagnosis of and operation on vascular lesions is very extensive. It includes special adaptations for serial aortic angiography and the creation of perfect x-ray contrast agents which are not toxic, as well as the creation and industrial production of perfect instruments for operations of blood vessels, atraumatic needles, and, finally, good vascular prostheses.

Organization of large, well equipped and specialized departments for patients with vascular lesions is absolutely necessary. This will make it possible to work out scientifically and at a more rapid rate the most important current problems of arterial and venous pathology and perfect a practical aid to the population for these diseases.

Lipoid and Protein Metabolism in Patients with Arteriosclerosis

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One of the most important problems of modern medicine is the problem of arteriosclerosis, which, according to A. L. Myasnikov, "is the result of prolonged and gradually build-up disorders of the cortico-visceral regulation of protein-fat-, particularly cholesterol, metabolism." In connection with this, considerable attention has been given to the study of disorders of lipoid and protein metabolism in patients with arteriosclerosis.

We have set before ourselves the task of studying the condition of the lipoid and protein metabolism in patients with arteriosclerosis according to certain biochemical blood indices: by cholesterolemia, the lecithin-cholesterol ratio, lipoproteins and protein fractions, and studying the possibility of utilizing these indices for the diagnosis of arteriosclerosis.

There were patients with arteriosclerosis, chiefly of the coronary arteries of the heart, without signs of circulatory disorder, without inflammatory or necrotic processes and without pronounced kidney or liver pathology, under our observation. For the most part, these were men from 35 to 65 years of age; in the majority of cases, from 40 to 60 years.

A. L. Myasnikov, D. F. Il'inskiy and other authors point out that hypercholesterolemia, as a rule, is observed in patients with more active and rapidly progressive arteriosclerosis. P. Ye. Lukomskiy found hypercholesterolemia in 56.7 per cent of 450 patients with coronary arteriosclerosis. According to the data of workers at the Institute of Internal Medicine of the Academy of Medical Sciences USSR, the frequency of increased cholesterol in the blood in arteriosclerosis was found to be equal to 76 per cent (A. L. Myasnikov).

At the same time, a number of authors point to the absence of a connection between the level of blood cholesterol and degree of development of arteriosclerosis (Steele, Peterson and others) (Table 1).

We determined the cholesterol content in the serum of 1,021 patients with arteriosclerosis.

The serum cholesterol was determined by the Bloor micromethod. A cholesterol content in the serum within limits of 150-200 milligrams per cent was taken as normal. As is seen from Table 1, the cholesterol content in the serum was found to be increased in 56.3 per cent of the cases with arteriosclerosis, and in 43.7 per cent it was within normal limits or even decreased (9.8 per cent). In the literature, there is mention of age variations in the cholesterol content of the serum of healthy persons. For example, it is believed that the greatest increase in the cholesterol content in the serum of healthy

Table 1

Cholesterol Content in the Serum of Patients with Arteriosclerosis

Холестерин (в мг %) (1)	Всего больных (2)	
	(3) число	%
(6) До 150	99	9.8
151—180	171	16.7
181—200	176	17.2
201—250	333	32.6
251—300	196	17.5
301—350	47	4.6
351—400	8	0.8
(4) Свыше 400	5	0.5
(5) Итого . . .	1021	100

1. Blood cholesterol (in milligrams %); 2. total patients: 3. No.: 4. over 400; 5. total; 6. under 150.

men is observed at the age of about 55 (N. V. Skuner). On comparing the blood cholesterol level and age of patients with arteriosclerosis, we, like P. Ya. Lukomskiy, noted that the cholesterol content in the serum of patients of different ages differs little. The number of patients with hypercholesterolemia in various age groups amounts to 51.6 to 56.6 per cent.

We studied the effect of essential hypertension on the cholesterol level of patients with arteriosclerosis, because there are controversial data on the subject. Thus, M. K. Furtsio found an increased cholesterol content in the serum of 23 out of 44 patients with arteriosclerosis (52.3 per cent), and an increase in the cholesterol content in combination with essential hypertension was noted in 33 out of 44 patients with arteriosclerosis (75 per cent). I. Ye. Lukomskiy did not find any essential difference between the cholesterol content of the serum of patients with arteriosclerosis with and without essential hypertension.

On the basis of a study of the serum cholesterol level of 461 patients with arteriosclerosis and essential hypertension and 560 patients with arteriosclerosis but without essential hypertension, the conclusion was reached that hypercholesterolemia in these groups of patients is encountered in approximately the same percentage of cases: in 56.3 per cent of patients with arteriosclerosis and essential hypertension and in 54.6 per cent of the patients with arteriosclerosis but without essential hypertension.

Considerable importance is ascribed to the interrelationship between the serum cholesterol and phospholipid (lecithin) content. In

is believed that the lecithin holds the cholesterol in an emulsoid state and prevents its being deposited on the blood vessel walls. We determined the lecithin content in the blood by the Bloor method; lecithin-cholesterol ratio figures above one were taken as normal. Of 812 patients a reduction in the lecithin-cholesterol ratio was observed in 57.6 per cent.

At the present time, it has been established that blood lipoids are not in the free state but rather in combination with proteins in the form of giant molecules, lipoproteins.

By means of electrophoresis, we isolated two fractions: alpha-lipoproteins, in which the lipids (cholesterol, lecithin and fatty acids) are bound to alpha-globulins, and beta-lipoproteins, in which the lipids are bound to beta-globulins. Alpha- and beta-lipoproteins have different chemical compositions, possess different physical chemical properties; their significance in the pathogenesis of arteriosclerosis is different. Alpha-lipoproteins contain a large quantity of protein and a considerably smaller quantity of cholesterol than beta-lipoprotein; the lecithin content in the alpha- and beta-lipoproteins is approximately the same.

Lipoproteins, particularly beta-lipoproteins, are unstable compounds. Lipoproteins, particularly coarsely dispersed (beta-lipoproteins), passing through the blood vessel wall and breaking down into their constituents, play a part-- these words are apparently omitted in the morphogenesis of arteriosclerosis. Insoluble components-- cholesterol, fatty acids, are retained in the blood vessel wall and cause infiltration of it, which is the first morphologic expression of arteriosclerosis (N. N. Anichkov, N. V. Okunev, Page and others).

We studied the lipoprotein content in the serum of 215 patients with arteriosclerosis. The lipoproteins were determined by means of paper electrophoresis with preliminary staining of the serum with a saturated solution of Sudan black in alcohol (McDonald and Barnes).

Beta-lipoproteins amounted to 61 to 65 percent in the sera of 23 healthy persons from 26 to 48 years of age; we accept these indices as normal.

The results of the investigation of serum lipoproteins of 215 patients with arteriosclerosis are shown in Table II.

From Table II it is seen that in 95.3 per cent of the patients with arteriosclerosis the beta-lipoprotein content was elevated.

M. V. Barina and M. Yu. Malikova found an increased content of beta-lipoproteins in 48 out of 49 patients with coronary sclerosis. P. Ye. Lukomskiy noted an increase in the beta-lipoprotein fraction in 192 (96 per cent) of 200 patients with coronary arteriosclerosis. Fisher, who made 4,526 determinations of the lipoprotein content in patients with arteriosclerosis, found an increase of beta-lipoproteins in [illegible] per cent. Comparing the results of the investigation of cholesterol and the lecithin-cholesterol ratio in 215 patients with arteriosclerosis with the indices for the beta-lipoproteins of the blood, we noted an increased beta-lipoprotein content in many patients with a normal cholesterol level in the serum (which was previously pointed out by

Table II

Beta-lipoprotein Content in the Serum of Patients with Arteriosclerosis

Beta-lipoproteins (in %) (1)	(2) Total patients	
	(3) No.	%
70–75	10	4.7
76–80	71	
81–90	118	95.3
91–97	16	
(4) Grand total	215	100

1. Beta-lipoproteins (in %); 2. total patients; 3. No.; 4. grand total.

F. Ye. Lukomskiy) and a normal lecithin-cholesterol ratio.

Therefore, increase in the content of the blood beta-lipoproteins is a more frequent sign than hypercholesterolemia or reduction of the lecithin-cholesterol ratio.

Recently, considerable attention has begun to be given to the study of disorders of protein metabolism in patients with arteriosclerosis. M. G. Kritsman and M. V. Bavina noted a reduction of the albumin fraction and an increase in the level of beta- and gamma-globulins in experimental arteriosclerosis in rabbits. V. M. Zaytsev, through electrophoretic study of protein fractions of blood in 10 patients with general arteriosclerosis, found a reduction in the albumin content and an increase in the globulin level, chiefly of beta-globulin, in the majority of them. Ye. V. Sidorova and A. A. Volokushina found a reduction in total protein in 90 out of 150 patients with arteriosclerosis, while in the protein fractions of 39 out of 52 patients they found changes in the direction of globulin. F. Ye. Lukomskiy, through a study of protein metabolism in 200 patients with coronary sclerosis, observed a marked reduction in the albumin fraction and an increase in all fractions in 44.6 per cent; the alpha- and gamma-globulins were found to be particularly increased; the alpha- and beta-globulins were increased to a somewhat lesser degree.

We determined the protein fractions by the method of paper electrophoresis in 341 patients with arteriosclerosis. The total protein was determined refractometrically.

On the basis of a study of the protein fractions of the total protein in 23 healthy persons, the following figures were taken as

normal: a total protein of 7-9 per cent; albumin, 55-65 per cent; alpha$_1$-globulin, 3-5 per cent; alpha$_2$-globulin, 7-5 per cent; beta-globulin, 11-13 per cent; gamma-globulin, 15-16 per cent (Table III).

Table III

Protein Fractions in Patients with Arteriosclerosis

Content of protein fractions (1)	2. Albumin		3. Alpha$_1$-globulins		4. Alpha$_2$-globulins		5. Beta-globulin		6. Gamma-globulin	
	absolute numbers	%	absolute numbers	%	absolute numbers	%	absolute numbers	%	absolute numbers	%
8. Increased	--	--	291	85,3	183	53,6	47	13,7	172	50,5
9. Normal	140	41,1	47	13,8	124	36,4	121	35,3	113	33,2
10. Decreased	201	58,9	3	0,9	34	10,0	173	50,9	56	16,3
11. Total	341	100	341	100	341	100	341	100	341	100

1. Content of protein fractions; 2. albumin; 3. alpha$_1$-globulins; 4. alpha$_2$-globulins; 5. beta-globulin; 6. gamma-globulin; 7. number of patients; 8. increased; 9. normal; 10. decreased; 11. total.

As is seen from Table III, in the majority of patients with arteriosclerosis we, like other authors, found hypoalbuminemia, an increase in the alpha$_2$- and gamma-globulin fractions and particularly in the alpha$_1$-globulin fractions. The total protein content was within normal limits in almost all patients.

Conclusions

1. In patients with arteriosclerosis more or less pronounced changes in the biochemical indices of the lipoid and protein metabolism are observed (increase in the beta-lipoprotein fraction, reduction of the lecithin-cholesterol ratio, hypercholesterolemia, hypoalbuminemia, increase in the alpha$_1$-, alpha$_2$- and gamma-globulin fractions).

2. Of all these indices of the lipoid and protein metabolism the most common in patients with arteriosclerosis is an increase in the blood content of the beta-lipoprotein fractions (in 95.3 per cent).

3. Determination of serum lipoproteins in combination with certain clinical signs, including the data of examination by instruments, can be used in the diagnosis of arteriosclerosis.

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Electric Sleep as a Method of Neurotropic Treatment of Essential Hypertension

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The electric sleep [electrosleep] method consists of acting on the central nervous system with a weak low frequency pulsating current with orbito-mastoid placement of the electrodes.

Problems of the method and technique of application of electric sleep have been analysed in previous studies. In the study of higher nervous activity and its disorders in patients the following methods were used: 1) the clinical method of questioning and observation of the patient's behaviour; 2) conditioned motor reflexes with speech reinforcement (by the A. G. Ivanov-Smolensky method); 3) conditioned and unconditioned vascular reflexes with plethysmographic recording (a variant of finger plethysmography).

At the Institute of Internal Medicine of the Academy of Medical Sciences USSR treatment with electric sleep was given to patients with essential hypertension with definite signs of neurosis and sleep disorders.

Depending on the disorder of higher nervous activity, the patients were divided into three groups (Table I).

Electric sleep treatment was given to 350 patients with essential hypertension. Thirteen persons were in stage IA; 52, IB; 192, IIA; 76, IIB; 17, IIIA.

From Table I, it is seen that it is not possible to find a close-cut interrelationship between the condition of higher nervous activity and the stage of essential hypertension.

The main indices in the evaluation of the results of treatment with electric sleep were the following: a) reduction of blood pressure; b) normalization of sleep; c) improvement in the general condition.

According to the results of electric sleep treatment all the data can be divided into four groups (Table II).

As is seen from Table II, the clinical effectiveness of electric sleep treatment of patients with essential hypertension in 21% persons (group A) was characterized by restoration of the ability to work and normalization of sleep with a pronounced reduction in blood pressure. One hundred and eighteen persons (group B) completed electric sleep treatment with good general clinical results but without reduction in blood pressure. In 13 persons (group C) only a certain prolongation of sleep without improvement of it was noted in the absence of a reduction in blood pressure. In eight persons (group D) electric sleep treatment gave no results.

Table 1

Distribution of Patients by Higher Nervous Activity Groups and Stages of Essential Hypertension

(1) Группы высшей нервной деятельности	(2) Число больных по стадиям гипертонической болезни					(3) Всего больных
	IA	IB	IIA	IIB	IIIA	
(4) Умеренное снижение силы обоих нервных процессов, незначительное снижение степени их подвижности без выраженной неуравновешенности	6	15	86	21	6	127
(5) Отчетливое снижение силы и подвижности обоих нервных процессов. Неуравновешенность их с периодическим преобладанием процесса возбуждения	6	37	113	55	11	218
(6) Резко выраженное преимущественное торможение вместе при резком и стойком преобладании процесса возбуждения. Выраженное нарушение подвижности обоих нервных процессов	2	—	2	—	—	4

1. higher nervous activity groups; 2. number of patients according to stages of essential hypertension; 3. total number of patients; 4. moderate reduction in the strength of both nervous processes; slight reduction in the degree of their mobility, without pronounced imbalance; 5. distinct reduction in the strength and mobility of both nervous processes. Imbalance of these processes with periodic predominance of the excitatory process; 6. weakening chiefly of the inhibitory process with marked and persistent predominance of the excitatory process. Pronounced disorder of mobility of both nervous processes.

It was found that the protective therapy method (electric sleep) gives a beneficial effect in patients of the first and second groups. In patients who we categorized in the third group according to the condition of their higher nervous activity, electric sleep treatment is not successful.

By means of the Ivanov-Smolenskiy method, we made a simultaneous parallel study of higher nervous activity of patients with essential hypertension, which was not directly related to the vascular system or its nervous regulation, using the method of vascular reflexes with the use of plethysmographic recording (a variant of finger

Table II

Results of Electric Sleep Treatment of Essential Hypertension

(1)	(2)	A	B	C	D
Stage of essential hypertension	Number of observations	(3)	(4)	(5)	(6)
I	13	4	6	1	2
II	62	32	14	4	2
IIA	120	145	43	3	1
IIB	78	24	47	3	2
IIIA	17	6	5	2	1
(7) Total...	330	231	115	13	8

1. stage of essential hypertension; 2. total number of observations; 3. reduction of blood pressure. Prolongation and improvement of sleep. 4. prolongation and improvement of sleep; 5. prolongation of sleep; 6. treatment without results; 7. total.

plethysmography), demonstrating disorders in higher nervous regulation of vascular tone and vascular reaction. These studies were made before and after electric sleep treatment, which made it possible for us to judge the neurodynamic changes which occurred.

This combined study was made in 40 patients with essential hypertension in stage II. In all of them there were a pronounced sleep disorder, disorder of balance and mobility of the basic nerve processes, but without marked predominance of the excitatory processes.

We divided all the treated patients into two groups: 27 persons completed the electric sleep treatment with a good therapeutic result: with a pronounced blood pressure reduction; in 13, a good general feeling of well-being, normalization of sleep were noted, but the blood pressure continued to be high.

Changes in the higher nervous activity of patients of the first group were characterized by a weakening of the association-forming function of the cortex, by a delay in the development of differentiation, of the stereotype, by disorders in forming for selective transmission of excitatory and inhibitory processes from the first signal system to the second. These changes occurred in different degrees of expression and in different combinations in 22 patients of the first group. On study of the conditioned and unconditioned vascular reflexes by the method of finger plethysmography, various

degrees of changes in one or several tests were noted in all 27 patients of this group: reduction of the amplitude of the pulse waves, prolongation of the latent period of both unconditioned and conditioned reflexes, inversion of the reaction or absence of reaction after the action of an unconditioned stimulus (cold, heat), poor reactions from the application of a conditioned stimulus ("I am applying cold," "I am applying heat") as well as depressor reactions instead of the normal pressor ones in doing simple mental work (mental counting).

Study of the higher nervous activity of patients of the second group both by the motor method with speech reinforcement and by the plethysmographic method revealed the same disorders as in patients of the first group, but their degree of expression was greater.

Control studies which we made in the same patients after electric sleep treatment gave the following results. In the first group, studied by the motor method with speech reinforcement, pathological signs were found in only four patients. According to plethysmographic data a change in the wave amplitude was noted: low amplitude noted before treatment in 19 patients was not found in a single patient after treatment. Moderate amplitude was observed previously in eight patients but after treatment with electric sleep, in only six. A high amplitude, not noted a single time before treatment, was found in 21 patients after treatment.

Pathological reactions to unconditioned and conditioned stimuli (cold, heat, mental counting) were noted before treatment in all 27 patients in a number of tests; after treatment with electric sleep, in 24 patients but only on separate tests. Thereby, it should be noted that there was a particular reduction in the number of pathological vascular reactions in patients of the first group in response to conditioned stimuli. While after treatment various pathological reactions to unconditioned stimuli were found in 22 patients, they were found to conditioned stimuli in only two. The reaction to mental counting was abnormal before treatment in 21 patients; after treatment, in six patients.

Therefore, in the first group, which completed electric sleep treatment with a good therapeutic result and pronounced reduction of blood pressure, positive changes were observed both in the general higher neurodynamics and in higher neurovascular regulation. In patients of the second group, who completed electric sleep treatment with good general clinical results but without pronounced reduction of blood pressure, the following was established.

According to the data of the motor method with speech reinforcement, pathological changes before treatment were found in 10 out of 13 subjects; after treatment, in five. According to the data of the plethysmographic method, no pronounced changes were found in the direction of normalization of the vascular reflexes. A low pulse wave amplitude before treatment was noted in 11 patients; a moderate one, in two; a high amplitude was not observed at all. On a control study of these patients after electric sleep treatment, a low amplitude was found in four patients; moderate, in five and a high amplitude, in

four. Conditioned and unconditioned pathological reflexes, noted before treatment in 13 patients, remained in all after treatment but were less pronounced.

An abnormal vascular reaction to mental counting before treatment was noted in 11 patients; after treatment, in five.

Normalization of the conditioned pathological vascular reflexes, observed in a considerable number of patients in the first group (the pathological vascular reflexes, both unconditioned and conditioned, remained unchanged in patients of the second group) is interesting.

The observations presented permit us to conclude that in the study of higher nervous activity of patients it is advisable to determine the condition of the higher nervous activity as a whole and changes in higher nervous regulation of organs or systems of organs affected by this disease separately. In a patient with essential hypertension, a detailed study is needed of the higher nervous regulation of the vascular system. The latter is of essential importance, because, as has been pointed out by I. P. Pavlov, aside from the general disorders of processes of higher nervous activity, "sick points" occur in the higher cerebral centers of the patients.

The pathological changes at these points may be considerably different from changes in other centers of the central nervous system both in their nature and in their degree. Changes of higher nervous activity under the influence of treatment are different with respect to all of its centers and with respect to the "sick points" in particular. These differences are not only of theoretical significance for understanding cortical neuroses and their tendencies toward producing effects on functions of various organs and systems but are also important in a practical respect in the sense of selecting a treatment method and evaluating its results.

There is reason to believe that electric sleep as a method of protective therapy in patients of the first group normalizes the processes of general higher nervous activity, simultaneously exerting a beneficial influence on the "sick points" of the cortex and the immediate subcortex at the locations of the centers for higher vascular regulation. In patients of the second group, the normalizing influence of electric sleep on nervous processes of the general higher nervous activity is not associated with beneficial influence on the "sick points" of the cortex and the immediate subcortex, which is responsible for the maintenance of the pathological vascular unconditioned and conditioned reflexes as well as the absence of a hypotensive effect. This gives us reason for concluding that neurotropic therapy (electric sleep) exerts different effects on the general higher nervous activity of patients and on the "sick points", which in essential hypertension is related to centers of higher neurovascular regulation.

Possibly, in patients with essential hypertension an important part in the disorders of neurovascular regulation is played by disorders not only in the higher centers of the central nervous system but also at the periphery.

Therefore, in the combined therapy of a number of patients with essential hypertension it is sound to act on the higher regulatory vascular centers as well as on the lower nervous apparatuses.

Hygienic Evaluation and the Use of Underwear Made of Chlorin (Vinyl-Perchloride) for Therapeutic Purposes

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For two years we have studied the hygienic properties of knitted underwear made of the synthetic substance, chlorin, which has been called "therapeutic underwear."

Chlorin is one of the polyvinyl chloride derivatives, $(CH_2-CHCl)_n$, containing 62-65 per cent chlorine. Until recently, the question of using chlorin for the production of clothes fabric remained moot.

Underwear and clothing made of polyvinyl chloride fiber first began to be used in France (roville [1]), and later (made of a vinyl-perchloride resin) in other countries also. In the medical and textile periodical press there are a number of reports on the therapeutic effect of articles made of polyvinyl chloride fibers in rheumatic fever, arthritis, neuralgia and trauma (Denier, Rocher, Froger, Taenbner).

At the present time, a study has been made of Soviet chlorin articles with the aim of selecting the best models for mass production (B. Z. Kirsanbteyn, A. D. Freivolitalova, K. A. Rapoport and co-authors). For the purpose of studying the main hygienic properties specimens of chlorin knitted fabrics made in the USSR were used (see table). An assortment of underwear knits made of cotton, wool and rayon served as controls. The nap fabric made of chlorin was of the greatest thickness.

In the table the results are given of a study of the moisture absorption, vapor permeability, total thermal resistivity and air permeability of chlorin.

As is seen from the table, the moisture absorption of the knit made of chlorin was 10 times or more less than that of cotton, wool, or particularly rayon, under conditions of low relative humidity, under conditions of comfort for the microclimate under the clothes, and under conditions of maximum humidity. The vapor permeability of the chlorin knit was almost two times greater than that of control fabrics made of natural and synthetic fibers. This means that the chlorin knit readily permits the passage of evaporated perspiration, which should contribute to keeping the underwear dry and, therefore, should increase its heat-protective properties.

From the table it is seen that the thermal resistivity (heat insulation) is greatest in the case of fabrics made of nap chlorin. This synthetic nap fabric has the greatest porosity with a low volume weight and a low degree of water permeability, that is, it has a considerable supply of stationary air, which is responsible for its great heat-protective effect. Fabric made of No 40 chlorin yarn (spun) also

Hygienic Properties of Chlorin

(1) Вариант ткани	Гигроскопичность в % при относительной влажности воздуха: (2) 25	100	(3) Паропроницаемость (в мг/см² в час)	(4) Толщина ткани (в мм)	(5) Коэффициент термического сопротивления $\frac{\text{°C} \cdot \text{см}^2 \cdot \text{час}}{\text{ккал}}$	(6) Воздухопроницаемость см³/см² в сек
(7) Полотно мелкое хлориновое из пряжи № 40 + 20	1,2	1,4	4,6	1,20	0,231	2,0
(8) Полотно мелкое из хлориновой пряжи № 40	6,1	0,7	4,3	0,90	0,247	8,5
(9) Полотно платированное полотно из хлориновой пряжи № 50 и пряжи № 40	0,1	1,1	5,2	0,73	0,207	14,7
(10) Полотно полотно из филаментарной хлориновой пряжи № 60	6,1	1,6	4,3	0,49	0,220	30,0
(11) Полотно полотно из хлориновой пряжи № 60	6,1	1,1	5,4	1,65	0,240	12,0
(12) Полотно полотно из хлопчатобумажной пряжи № 40	4,7	13,2	2,4	0,51	0,234	4,0
(13) Полотно полотно из шерстяной пряжи № 52	7,1	16,0	2,6	0,52	0,240	6,6
(14) Полотно полотно из искусственного шелка № 60	7,1	19,3	2,6	0,40	0,220	30,0

1. fabric variants; 2. moisture absorption in % with a relative humidity of: 3. vapor permeability (in milligrams per cm per hour); 4. thickness of the fabric (in mm); 5. coefficient of thermal resistivity in $\frac{\text{°C} \cdot \text{cm}^2 \cdot \text{hour}}{\text{kcal}}$; 6. permeability to air in $\frac{\text{cm}^3}{\text{cm}^2 \text{ sec}}$; 7. loop-pile, chlorin [all yarns]; 8. loop fabric made of No 40 + 20 yarn; 9. loop fabric made of No 40 chlorin yarn; 10. loop plaited fabric made of chlorin No 60 thread and No 40 yarn; 11. loop fabric made of filament chlorin No 60 thread; 12. rib fabric made of No 60 chlorin yarn; 13. loop fabric made of cotton No 40 yarn; 14. loop fabric made of woolen No 52 yarn; 15. loop fabric made of No 60 rayon.

has better thermal properties than woolen and cotton knits, while the plaited fabric made of chlorin No 60 thread (continuous filament) and No 40 yarn (spun) is warmer than the knitted cotton fabric. Therefore, underwear can be obtained from chlorin which is warmer than woolen

underwear. It should also be noted that with respect to liquid-droplet moisture, according to the data of a study of capillarity, moisture capacity, and evaporation, chlorin is closer to wool than to cotton or rayon.

With the aim of determining the chemical stability of chlorin, based on its chemical structure a determination of free chlorine and chlorine-containing substances was made after heating the chlorin samples to body temperature. Free chlorine was not found, but before laundering the presence of chlorine-containing substances was detected in new articles, and the quantity of these substances decreased appreciably along with the reduction in the odor of chlorine with launderings.

For purposes of checking the physiological-hygienic and therapeutic properties of chlorin underwear three experiments of wearing the underwear were performed among outpatients in the Clinic of Nervous Diseases of the First Moscow Medical Institute imeni I. M. Sechenov and in the Rheumatic Cardiological Clinics of the First City Hospital imeni N. I. Pirogov and the Children's Polyclinic No 25 of Leninskiy Rayon in Moscow. (In the performance of these experimental tests of wearing underwear among the patients neuropathologist O. P. Voyevodina and rheumatologists K. M. Kogan and S. G. Gorelik participated).

In all, there were 72 persons under observation (47 adults and 25 children). There were 26 patients with rheumatic fever; 15, with chronic tonsillitis; nine, with polyarthritis; eight, with radiculitis; 14 persons had lumbago, spondylosis, myositis, residuals of poliomyelitis, Buchterew's disease or asthma. In the majority of patients pronounced signs of polyarthralgia were noted. As a rule, for the experiment of wearing the underwear each patient was issued a set of knitted underwear made of chlorin, and in the case of pain in the small joints of the hands or feet, stockings, socks or mittens made of chlorin yarn. More than 200 knitted chlorin articles of female, male and children's apparel were tested.

During the experiment of wearing the chlorin underwear hygienic observations consisted of a study of the heat protective properties of the underwear, successful elimination of perspiration and the presence of electrostatic phenomena. For this purpose, a measurement was made of the skin temperature, the intensity of perspiration (according to the data of the cutaneous electrical resistance), the temperature and humidity of the air under the clothes, the sign and magnitude of the electrostatic charge on the underwear when it was worn. In addition, the patients were questioned concerning how they felt, the therapeutic effect of the chlorin underwear, the sensations of heat, and the skin was examined.

The majority of patients (94 per cent) noted that when they wore the chlorin underwear there was an appreciable reduction and in some cases a complete disappearance of painful sensations. This is in complete agreement with a large number of letters received by the Krasnaya Zarya Knitting Mill, which makes the chlorin underwear. At the Clinic of Nervous Diseases three out of 24 patients observed noted the

therapeutic effect of the chlorin underwear. Thereby, complete elimination of the pain occurred in one patient; appreciable improvement, in nine, and slight improvement in 13 patients.

Of 22 adult patients with rheumatic fever, 21 stated that there was a therapeutic effect of chlorin underwear: 10, good; 11, satisfactory; no effect in one patient. Twenty-three out of 25 children noted a reduction of painful sensations. Objective signs of clinical examination of a group of patients with chronic rheumatic fever before and after the experiment of wearing the underwear (analysis of blood, urine, electrocardiogram, phonocardiogram, and blood pressure) remained without dynamic changes.

As a rule, the reports of a therapeutic effect were given after wearing the underwear for one-two weeks. Even earlier, the heat protective properties of the underwear were noted. A distinct advantage of chlorin underwear over ordinary underwear was found during the first laundering of this underwear, when the patients changed back to underwear made of natural yarn.

Some patients noted an increase in painful sensations, which were rapidly replaced by relief, during the first few days of wearing the chlorin underwear, particularly at night in places covered by the underwear. In patients with polyarthralgia of rheumatic origin, where there was a reduction of pain in places covered by the underwear the pain continued in places which were not covered by the underwear, or an increase in them was even observed. Thus, with reduction or disappearance of pains in the elbow or knee joints pain was found in the small joints of the hand, feet, fingers, which were eliminated through wearing experimental mittens or socks made of chlorin. We observed the phenomenon of radiation of pain in one patient with radiculitis and in four patients with rheumatic fever. There were no general cardiovascular symptoms in connection with the experiment of wearing the underwear which would make the subjects stop using it.

As the result of the experiments of wearing the underwear, we became convinced that chlorin underwear did not cause irritation of the skin, but part of the subjects sometimes noted unusual tactile sensations in the form of pricking and slight burning.

The chlorin underwear was more quickly dirtied by skin excretions than the ordinary underwear; however, this contamination was not accompanied by a more abundant growth of the bacterial flora of the skin than in the case of underwear made of natural material. The chlorin underwear should be laundered more often than once a week.

Study of the skin temperatures, perspiration and microclimate under the clothes during the wearing of experimental underwear revealed the presence of indices of comfort, characterizing the great heat-protective properties of chlorin underwear. The average skin temperature (400 observations) on the chest, back and loins was equal to 34.3-34.6 degrees, and on the extremities (foot, hand), 30.9-32.5 degrees, being higher than similar figures for the extremities in control experiments with cotton underwear by almost three degrees. The

thermal properties of nap chlorin underwear were considerably greater not only than those of other chlorin articles but also of knits made of high quality wool. The average relative humidity of the air under the clothes was 41 per cent in the case of experimental underwear; in the case of a control cotton underwear, 40 per cent. This is evidence to the effect that despite the water-repellent nature of chlorin, the elimination of perspiration was not encumbered. Determination of the perspiration level in comparative experiments with natural underwear did not show any unfavorable characteristics of chlorin underwear. Despite the fact that chlorin underwear is distinguished by a low degree of absorption, nevertheless it readily transmits perspiration excreted by the skin because of its high vapor permeability (see table). During the course of wearing the chlorin underwear it did not become moist, and therefore did not cause chilling; on the other hand, the patients noted the sensation of pleasant dry heat.

Along with the great heat-protective properties and hydrophobic nature of it, the chlorin fiber, in contrast to natural fibers, causes the accumulation of a large negative electrostatic charge on the surface of the fibers when it rubs against the human skin. By measuring the density of the charges of static electricity of the chlorin underwear on a person, figures of the order of 250-500 volts per centimeter were obtained. In the case of slight friction, a field voltage of one-two kilovolts per centimeter was found, whereas the charge of the underwear itself was usually at the level of 50-150 volts per centimeter. Therefore, during the use of this underwear the slight production of electrostatic charges occurs through friction of the underwear against the skin. Thereby, we also observed an increase in the air ionization. Articles made of nap fabric had the greatest charge; then came articles made of spun and plaited fabrics. After contamination of the underwear with skin excretions, the magnitude of the charge decreased, but after laundering the original charge was regained on the surface of the dry underwear. With wearing of the chlorin underwear during the course of the year, no reduction in the magnitude of the charge was observed.

Static electricity in the underwear and clothes made of polyvinyl chloride occurring from friction exerts a therapeutic effect in the opinion of French authors (Deridder, Rocher and Proger). Taubner, a German investigator of vinyl-perchloride underwear, connects the therapeutic effect of the latter chiefly with the thermal properties and with the evaporation of perspiration without cooling.

By using the method of determination of the circulation time by means of a radioactive sodium isotope, we observed an increase in the circulation in the skin and in the muscles of patients after the application of cuffs made of chlorin nap fabric. Apparently, a certain physiotherapeutic effect of chlorin underwear should be explained by the influence of the combination of great thermal-protective properties with its water-repellent nature, good vapor permeability and the presence of a considerable and stable negative electrical charge on the circulation.

In conclusion, we should consider a property, most typical of the new types of synthetic materials for clothes as well as for chlorin, the absence of a hydrophilic tendency, from a hygienic standpoint. The hygienic requirement that moisture (perspiration) be removed from the skin surface with the aim of protecting against cooling and for the purpose of realizing the excretory function of the skin is an indubitable one. Skin moisture is usually absorbed by the layer of underwear because of the hygroscopic nature and capillarity of fabrics made of natural substances. In this case, the underwear moistened with perspiration must be changed frequently. It would seem that the absolute hydrophobic nature of chlorin would be unfavorable for the body because of the retention of perspiration on the skin. However, because of its high degree of vapor permeability the perspiration is excreted through the underwear without difficulty, because of which dry underwear is maintained next to the skin.

At the present time, Soviet industry is producing chlorin therapeutic underwear in a very limited assortment and only for the adult population. The experiment of wearing the underwear showed that for therapeutic and prophylactic purposes not only the development of the mass production of underwear, stockings and mittens made of chlorin yarn is necessary for adults and children but so also is the further perfection of Soviet materials for clothes made of polyvinyl chloride.

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