## APPROVED FQR SNELASSEIERSE. CASE 06-1104.

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# Project Whirlwind Servomechanisms Laboratory Massachusetts Institute of Technology Cambridge, Massachusetts 

SUBJECT: BI-TEEKLY REPORT, PART I, JULY 9, 1948
To: 6345 Engineers
From: Jay W. Forrester
1.0 WHIRLITIND I COMPUTER ELEMESTS

### 1.1. Listed by. Block Diarram Number <br> 104 Control Switch

(H. Fahnestock)

Sylvenia's circuit sohematics of the control switch have been approved with minor corrections. It has been decided to add indicator lights to show the selected line and aid in trouble shooting.

107 Operation Matrix
(J. A. O'Brien) (Control Fulse Output Units)

Tests on the prototype have been completed, and recommended changes have been forwarded to Sylvania, The test specifications for this unit are being typewritten in a rough draft form for review and consideration.

110 Frequency Divider
(H. Fahnestock)

Sylvania has praotically completed the revised layout for the frequency divider.

201 Storage Switch
( $\mathrm{J}_{0} \mathrm{~A}_{\circ} \mathrm{O}^{1} \mathrm{Brien}$ )
The work on the storage ewitch output amplifier has been turned over to $M_{\text {. Hayes. An attempt to use }}$

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201 Storage Sultch (Continued)
a grounded grid amplifier in the application has been given up because the input impedance and gain requirements were contradictory.
(M. Heyes)

Work is now being done on a three tube amplifier which employs only two tube sockets. Tubes tentatively being considered are the 5687, a twin triode, and a 6LS.

203 Flip-Flop Storage
(R. H. Gould)

Testing of the flip-flop storage prototype panel has begun in cooperation with J. Terzian of Sylvania.

300 Arithmetic Control
(N. H. Taylor)

The testing of the divide control panel has been delayed due to the lack of the power distribution system. An outside vendor was making these power strips but failed to deliver on schedule. Our own shop will now supply them.

302
Acoumulator
(G. C. Sumner)

The blook schematic of the AC-O Auxiliary Panel. B-32492, has been issued. The corresponding circuit schematio and the block diagram of the AC-0 aigit are underway in the drafting room.

303/ B-Register - In-Out Register
403
(R. H. Gould)

Engineering Yote 131 mm the teating of the $\mathrm{B}^{-}$ Register prototype panel is ready for publication. Sylvania Memorandum 60-54 will give instructions for testing procedure and data shoets with limits. It will be published in about a week.

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404/ Comparison/Cneak Register
601
(H. Pahnestook)

Block schematics of the comparison register and oheok register have been completed. The circuit schematic is in preparation.

### 1.2 System Fngineoring

### 1.21 Power Control and Distribution

(c. W. Watt)

Panel seleotion equipment. All parts have been fabrisated and assembIy will begin next week.

Fuace Indication Panels. A prototype panel was reoeived from Sylvania on duly 8 . It will be cheolsed and tested.

Fixed roltage eritohing panel. A layout of the panel holding the releys needed to suitch the voltages not normally varied has been reoeived from Syivania. At least six of these panels will be needed.

Digit interlock panel. A layout has been reoeived from Sylvania for this panel, which provides the on-off control of all voltages for two digits. Iwo of these panels will be needed.

Wuch discussion has gone on about methods of turning on the power supplies for the oomputer. A schematic is now ready for discussion that provides for three console push-button switches, "off," "standby," and "on," with power failure, blown fuses, or emergency stop overriding these controls. Proper filament sequencing will be provided in a filament sequencer being designed by C. $R_{0}$. Wieser. In the "standby" position all filement power will be on and plate power off, and when the "on" button is pushed the plate voltages to the power supplies will be applied sequentially through a sequence timer. The supplies may be placed in the standby condition from either "off" or "on," and "on" from either "off" or standby. In "off" all plate and filament power is removed fram power supplies or computer.

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1.21 Pcrar Control and Distribution (Continued)
(A. E. Hunt)

Power Bay. Development of the power bay is about parallel with the development of the oircuitry involved.

All detalls necessary for the construction of the bay should be ready in another two to three weeks.
(C. W. Watt)
D. C. Filter Penel. Drawings of the D. C. filter panel have been made, and a prototype panel is being builit. There will be one such panel in each rack of the computer.
1.22 Power Cabling
(C. W. Watt)

Dramings of representative cables have been made and sent to three companies, Gavitt, Walthem Horological, and Harvey-Melle, who will submit bids for the fabrication of all the preformed D. C. cables. Quotations from all three are expected next week on a total quantity of about 400 cables.

### 1.23 Video Cabling:

(C. W. Watt)

A proposal was received from Sylvania on a method of marking video cables. A discussion with Knowlton and Anderson of Sylvania brought out several points of importance, and a revised proposal is being worked up by Sylvania to include not only cable marking but also oabling schedules and charts to be provided in the service manual and for cable fabrication and installation.
1.24 Driver Panels

Register Driver
(N. H. Taylor)

The Sylvania layout on register drivers was reviewed and $s$ ame changes have been suggested in mounting the pulse transformers to allow more space for the other components. These changes are being incorporated but production of the prototype unit has already been started. It is hoped that the prototype will be completed by July 16 th before the Sylvania vacation. If not, we will complete the construotion at our M.I.T. shops, and teat during Sylvania's vacation.


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1.24 Dirfoer Panela (Continued) (C. A. Romland)

A sohematic of Register Driver Panel Type II has been submitted to the drafting room. This panel plus three Type I register driver panels will fulfill the register driver requirements for flip-flop storage.
1.25 Time Schedules
(R. A, Osborne)

All time sohedules have been posted to July 1. Prints will be distribpted to thase ooncerned within the next few days.

All sohedules will receive their regular semianmal revision as of July 1 to bring them into line with ohanges in plans. A new mirlwind I schedule form has been prepared running from July 1, 1948 thr augh June, 1949, and will be filled out for all activities showing ourrent status (ourrent work on schedule as of July 1) and future plans as now antioipated for the next fiscal year.

### 1.3 Auxiliary Bquipment <br> 1.31 Pover Supplies

## (C. R. Wieser)

Glow-tube references have been substituted for the thermal references in the 2-IVA Sorensen regulators. Compounding has been incorporated to compensate for filter and line drop. Teste indicate satisfactory operation, and the regulatora will be installed on the plus 150 and minus 150 volt lab supplies in the next few days.

The $75 \mathrm{H} . \mathrm{P}_{\text {. }}$ motor-generator set is installed on its new bed. Alignment of the two mahines should be done next week. The reactars for the motor have been delayed by material procurement diffioulties at Reytheon.
(J. J. Gano) (C. R. Wieser)

Filament voltage regulator for five-digit multiplier A regulator to maintain constant voltage for the filament supply of the multiplier has been designed and suocessful



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### 1.31 Poures Grmolted (Contimued) <br> The regilator uses a Diehl FPRe5-11 motor to drive a variac which regulates the primary voltage of a booster transformer. A glow tube is used for referenoe. Constant valtage will be maintained with as much as a twenty-five volt drop in the supply.

(W. S. Rogers)

The 50 EVA Alternator, single phase, for WaI filaments is being reconditioned and tested for early delivery.

Raytheon has furnished a print showing the data needed for mounting and ofrouit layout for the AC isolation reactor installation. A oontaotor has been ordered to disconneot these reactors from the ofrouit during starting.

Lab system DC and $A C$ outlets were extended to the Computer Room, part for permanent WWI and part for tomporary prelifinary testing.

## (L. J. Vardone)

Variable Voltage. The control field windings of the auplidyne were sent out to be rewound into ones having one half the number of turns. A center tap will be on each control field winding so that one quarter of the original turns may be had if neoessary. Frequency and phase response measurements will continue when the windings are received.

The oircuits for the control field windings are being modified in order to obtain the best operating characteristios.
1.32 Air Conditioning
(J. C. Prootor)

Construction of the penthouse for the air conditioni equipment is to be started Monday, July 12. This work should take about two weeks.

Carrier has been notified that the penthouse will be completed in about two weeks, and they will endeavor to have fithal drawings oompleted and the remainder of the equipment delivered by thet time.


## APPROVED FQRR $18 \operatorname{lig}$ REEASE. CASE 06-1104.

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1.4 Gnolassified
(J. C. Proctor)

Sprincler System Alterations. The alteration of the sprinicler system was completed last week, and the installation aheoked by the Roolarood engineer.

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Nomorandan M-530
WII Draning List
(H. Fahneatook)
WIII Elements

Master Clook
101 Pulse Generator
102 Program Counter
105 Program Register
104 Contral Switch

105 Operation Matrix \&
107 Operation Tining Matr'ix
106 Time Pulse Distributor
106 Time Pulse Distributor Counter
106 Time Pulse Distributor Outpat
109 Clock Pulse Control
110 Frequency Divider
111 Synchronizer
112 Restorer Pulse Generativ
200 Storage
201 Storage Switch
203 Flip-Flop Storage Outpht
203 Flip-Flop Storag' Regíter
301 A-Register
301 AmRegister Zero Digit

302 Acoumulator
${ }_{\text {Dheok }}^{\text {Blogem }}$

B-37169-1

| A-37155 | B-32385 | B-32335-1 |
| :---: | :---: | :---: |
| 8-57032-3 | B-32215 | D-51516-3 |
| C-57067-2 | B-89289-1 | D-31276-6 |
|  | T600S00-4 | $\begin{aligned} & \text { (260csco } \\ & \text { (w60cs } 00-1 \\ & \text { 260cs00-2 } \end{aligned}$ |

S600M00 Z600M00-1-B
B-37068-3 T60PD00-8-B
T60PDOO-8-A Y60PDOO
T60PDOO-4-A 260PDO0-1-A
B-39817 SB-39817-1
A-31574 B-32264 R-31729

|  | B-32209 | D-31909-8 |
| :---: | :---: | :---: |
| C-37156-1 | B-31150 |  |
| C-57121-1 | C-31152 | SC-39492 |
| C-37060-4 | B-32269 | B-31635-3 |
| C-37057-3 | B-32268 | E-31621-3 |
| 0-57056-2 | B-31211-3 | D-31276-6 |
| (C-37056-2 | B-31574 | D-31573-1 |
|  |  |  |
| D-57096-5 | D-31218-2 | E-31275-3 |

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| :---: | :---: | :---: | :---: |
| WWI Drawing List |  |  |  |
| Winr Elements | $\frac{\text { Bloak }}{\text { Dhegram }}$ | $\begin{aligned} & \text { Mlock } \\ & \text { Sohomatio } \end{aligned}$ | $\frac{\text { Cirouit }}{\text { Schematio }}$ |
| 303 B-Register | $\begin{aligned} & \text { C-37097-3 } \\ & \text { C-37069-3 } \end{aligned}$ | B-31212-3 | D-31277-2 |
| 304 Sign Control * |  |  |  |
| 308 Divide Eeror Control |  | B-31576-1 | E-31619-1 |
| 305 Step Counter | C-37074-5 | D-31828 | D.31813 |
| 306 vultiply a |  |  |  |
| 307 Shift Control |  | B-31532-2 | E-31588-2 |
| 308 Divide Control |  | C-31552-1 | R-31718-2 |
| 309 Special Add Memory \& AcO Carry |  | C-31575-2 | E-31632-1 |
| 310 Point Off Control |  | B-31600-3 | E-31717-2 |
| 403 Inmout Register | C-37119-2 | B-32354-1 | D-31277-2 |
| 404 Comparison Register | C-37120-2 | B-32578 | B-32576 8 |
| 601 Check Register | C-39816-1 | B-32577 | E-32576 |
| Bus Driver, Arithmetic Element |  | A-32297 | D-31727-4 |
| Bus Driver, Flip-F1op Storage |  | A-32296 | D-31726-4 |
| Register Driver |  | B-32207 | E-32261-1 |
| Contral Pulse Output Unit |  | R60CPOO | S60CPO0-1 |
| Fuse Indication Panel |  |  | W60PP00-7-B |
| WWI Power Conneotor Pin Connections |  |  | C-31955-2 |
| Voltage Variation Panel |  |  | 760PP00-6 |

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## WWI Installation Drawing List

## (C. W. Watt)

The following drawings oorer the installation of panels, recks, and wiring in WWI. This list will be kept up to date and added to as time goes by.

| Dranfing Ho. | Title |
| :---: | :---: |
| D-51793 | Typioal Rack Arrangements, F1ip-F1op Storage and Arithmetic Element Racks. |
| D-37559 | Cabinet Allocations, Computer Room, Berta Building. |
| D-37548 | Layout-Cabinet Bay Locations Computer Room, Barta Building. |
| D-37549 | Layout - Bay Cabling Duots and Sprinkler <br> System - Computer Room, Barta Building. |
| D-37553 | Layout - Overhead Lighting, Computer Room. |
| D-37558 | Layout - Air Conditioning Equipment and Duct work in Penthouse. |
| D-37562 | Plan D. C. Power Cabling, Computer Cabinets, WII. |
| D-37563 | Elevations - D. C. Power Cabling, Computer Cabinets, WWI. |
| D-37566 | Plan, A. C. Filament Cabling. Computer Cabinets, WWI. |
| D-37668 | Plan, Interlock Relay and Indicator Light Cabling, Computer Cabinets, WWI. |
| D-37561 | Layout - Computer Room Ground System. |

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### 2.0 WHIRUIND I RESEARCH

2.1 Cirouits
2.10 Pulse Standarising Circuit
(H. Kenosian)

Work on this circuit has been ocmpleted. A memorandum on it will be isaued.

### 2.11 Flip-Flop Design and Stability <br> (R.L. Best)

As a first step in investigating "stalling", a setmup has been made to determine the manner in which a filp-flop starts after a rest period of time suffioient for the output coupling capacitors to discharge. It has been found that it takes of the order of 100 clook pulses, 1 He p.r.f., to start a flip-flop. Other tests will follow.

### 2.16 Basic Cirouits

(J.M. Hunt)

The performance of a commonly used variation of the basic gate tube circuit, that in which a single gatetube drives another gato tube plus a trigger tube, is being investigated. This gate tube cirouit is p.r.f. sensitive, the magaitude of the first pulse being considerably smaller than that of ropeated pulses of high p.r.f.

Since severe input oircuit loeding oan be caused by trigrer tubes grid ourrent a slight modification of the basio T.T. oircuit has been devised to eliminate the neoessity of driving the T.T. grid positives with respect to the oathodes at usable signal levels. In most instanoes T.T. input oircuit loading is not seriously objeotionabie, although the circuit revision can be utilised if neceseary in extreme cases to oliminate any objectionable loading offeot.
2.2 Components
2.22 Pulse Transformers
(J.M. Saleer)

The rough copy of the translation of "Der Impulee transformator" by Dr. Grael has been ocmpleted.


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2.23 Vacuum Tube Studies
(D.R. Brown)
Ted Clough and Dick Fallows visited the Sylvania Radio Tube Plant at Emporium, Pa. on July 6th. N.J. Reite is being transferred to a different plant, and R. W. Slinkan is now responsible for the 7AK7.
The engineers at Emporium have examined a number of type SR-1030 tubes and have found them satisfactory in all respeots. In going from the SR-1030 to the 7AK7 a number of changes wore made which resulted in somewhint different oharacteristies. In their effort to correct the diffioulties associated with the 7AK7 the SR-1050 has never been exactly duplicated. They are now preparing to duplicate the SR-1030. They hope to process several humdred tubes July 15 and 16 just before vaontion ocmences. The tubes processed on those dates will be sent to us without tests.

## (A.I. Susakind)

Plate, soreen, and control grid ourrents of $7 \mathrm{AKF}^{\prime} \mathrm{s}$ with oontrol grid voltages ranging fram -15 to +15 volts are being measured using pulse methods.

## (R.L. Ellis)

The testing and preparation of tubes has been espeoially heavy. Since the last bi-meekly report, over 400 tubes have been propared. This includes, testing, recording data and marking. Also 250 tubes have been partially processed. These will be completed Monday or Tuesday.

### 2.24 CryBtal Reotifiers

(D.R. Brown)

The specifications for the type D-358 orystal reo tifier have been changed from speoifications announced origtmally. The rorward ourrent at 1 volt has been changed from 7.5 ma to 6.7 ma . The beck ourrent at 20 volts has been changed from $20 \mu_{a}$ to $40 \mu_{a}$. These ohanges have been incorporated in the specirications sheet.
(A.K. Susakind)

Preliminary measurements had indicated that heat conduction through orystal reotifier pigtalls fram power dissipating elements affected the orystal rectifier beok



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2.24 Gryatal Riectifiors (cont)
( $A_{0}$ K Suss)ind)
the vioinity of the power dissipating elemonta was negligible. The baok resistance of orystal rectifiers used in FF-1 was found to be only slightly changed by the heating of the components in that oirouit during operation.

### 2.8 Systoms

2.31 Five-Digit Kultiplier
(J.J. $\left.0^{\circ} \mathrm{Brien}\right)$

All flip-flop circuits of the Five-digit multiplier have been modified. They now have a 1200 chm cathoie resistor instead of 820 ohms, and usa 7 AD 7 tubes instead of 6AG7.

These cirouits operate satisfactorily.
(K.H. Taylor)

A means of regulating the filament aupply to account for wide changes in line voltage is being provided by R. Wieser. As soon as this is availeble the five-digit uultiplier will be placed on life test using the new equipment for counting errors.

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### 3.0 SPECINL CIRCULTS

### 3.2 Tost Bquitpmont

( $\mathrm{H}, \mathrm{B}$, Brerett)

Daring this period TSSC epprovel was eranted for the deaign of a combination Delay Line and Pulse Standardizing unit and for the parchase of a number of Varlacs for sylvania production test netups.

### 3.21 Standard Teat Equipment


A souree of clock and restorer pulses was get up using standard test equipmont, including a clock (Yode? 2), gate and dolay unit, 2 regiater panels, and a pulso mixer. The outputs provided restorer pulses whose interval and period were fixad by deley setting of the delay unit and clock pulses which vere ahut off during restorers and whose frequency was contimoushy variabls up to 3 megaegcles. It is interesting to note that the reatorer poriod and interval were unaffected by the clock pulse frequency, and were always locked in with the clock pulse frequency.

A less elaborate set up vas tried using a loag delay on the gate and delay unit to divide the clock pulse frequency, delaying the and carry from the delay unit with another, and mixing the input and output of the second deley unit to form restorers. This aetup saved one register panel, but itif upper frequency liwit vas one megacyele, and the dolay controls hed to be re sot as the frequency was changed.
(R. L. Beat)

The scope synchronizers are nov coming out of the shop. An engineering note will be iscued shortiy dosoribing them.
(H. Kenosian)

Cathode Follover Probe, Some of the mechanical dotails have been modified. Teat on the prototype will be completed as soon as these changes have been incorporated.

Voltege Calibrator. Legout of the prototype 1a nov complete and ready for construction.


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### 3.21 Standard Test Eruipment (cont.) (i. ITenosian)

Clock Puleo Genorator Yodol 2. Calibration charte have been prepared, and will be installed this wcok.

Gate Trbe Panol. Prototype of this unit is now under construction.

Coder. Final tests have been completed in this unit. Construction of several of these units has been hold up due to lack of toggle switches.

Puleo Deley a Standardizor (Sb-39939). a penal containing two pulse-standardizing oircuits is being constructed for test. Provision will be made for inserting any deisired delay line so that it will be possible to obtain amall fixed delays.

## (N. H. Taylor)

Instruction Manpals. 价. R. Rathbone will be in charge of preparing instruction manuals for such items of standard test equipment as are now svailable. His Hamorandum, y-529, outlines the nature of this work.

Due to an ecror in ordering the "Henry" amplifiers from Sylvania, we will only have four of these amplifiers instead of the ten which we previously ardered. Additional units will have to be constructed in our shops.

### 4.0 BHOCX DHAORIVS

## (R. R. Everett)

The lateat revisions of the WVI block diagrams have been graded Grade II and will be issued this coming weok.

The Block Diagram group will make an intensive study of these diagrams and the MiI production drainings and block sohemstice in ordor to diseover any inconsiatencies or orrors that may have occurred during the last fov monthe. The drawings will then be re-issued, probebly Grade III. This study is expected to talso 6 to 8 weeks.

> (R. P. Mayer)

The three parts of the ESF Control Meaorandum, M-521, M-522, and 1-523 are nearly ready to be issmed.

About tweaty-five of the latest bloak diagrase are being graded Grade II. The following is a list of those drainging that have already been greded, including those that were graded some timo ago, but not incinding TIming Dlagraas (which are Grade II).


| B-37002-4 |
| :---: |
| D8-37071-5 |
| -31614-3 |
| M8-37124-2 |
| CB-37123-2 |
| B-57098-4 |
| B-57159-1 |
| A-37255-1 |
| CB-57067-2 |
| 08-37066-3 |
| CB-37135-1 |
| \% 6 |
| $\cdots 7$ |
| - 8-1 |
| 31974 |
|  |
| B-37068-1 |
| B-39817-2 |
| 4-37154-1 |
| (18-37121-1 |
| CB-37057-3 |
| C8-37060-4 |
| 4-37061-5 |
| D8-37072 |
| CB-37056 |

## $\therefore$ APPROVED FOR UNBLÁÁSELEEASE. CASE 06-1104.

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### 4.0 BYOCX DTMORAYS

(R. R. Iverett)

The latest revialione of the WWI block diagrams have been graded Grade II and will be issued this coming veek.

The Block Diagram group will make an intengive study of these diagrass and the WMI production drawings and block sohematics in order to discover any inconalstencies or orrore that may have occurred during the last few monthe. The drawings will then be ro-issued, probably Grade III. This study is expected to take 6 to 8 veeks.
(B. P. Mayer)

The three parts of the EST Control Menorandim, M-521, M-522, and K-523 are neariy ready to be ismed.

About twenty-five of the latest bloak diagrans are being graded Grade II. The folloring is a list of those dravings that have alroady been graded, including those that were graded some time ago, but not including Timing Dlagraas (which are Grade II).

| Parallel Digit Computer Codes syatem Blook Dlagram Control Functions (11at) | $\begin{array}{r} B-37002-4 \\ \mathrm{DB}-37071-5 \\ 2-31614-3 \end{array}$ |
| :---: | :---: |
| Bus Conneotions | CB-37124-2 |
| Bas Conneotions by' Racks | CB-37123-2 |
| 100 Main Control | B-37098-4 |
| Master Clock | B-37159-1 |
| 101 Pulse Generator | A-37155-1 |
| 103 Progran Register | OB-37067-2 |
| 104 Control Switch | OB-37066-3 |
| Operation Matrix I | CB-57135-1 |
| 105) " - II | -6-1 |
| ${ }_{8}^{105}$ " III | * 7-1 |
| - " - IV | -8-1 |
| 107) " - | 32974 |
| * $\quad$ VI |  |
| 106 Time Pulse Distributor | B-37068-1 |
| 109 Clook Pulse Control | B-39817-2 |
| 110 Prequency Divider | -37154-1 |
| 201 Storage sultch | C8-37121-1 |
| 203 IF Storage Sections | CB-37057-3 |
| - " Oufyut Sections | C8-37060-4 |
| " . Control Sections | A-37061-5 |
| 300 Arithmetic Flement | DB-37072-7 |
| 301 A-Rogistor | CB-37056-2 |



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Page 17
4.0 BHOCX DTACPMY (cont.)
( $\mathrm{R}_{\mathrm{E}}$ P. Mager)


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Memorandian $\mathrm{K}-530$

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5.0 Gisacime noyions
(G. C. Stumer)

Menorandia M-512 outilinen the investigation to be made on trouble location. Tarther study of the goneral protilem contimos.

