TELETYPE

PRINTING TELEGRAPH SYSTEMS

BULLETIN 224B

DESCRIPTION AND ADJUSTMENTS

ELECTRONIC CONTROL UNIT BCUI
AND
POWER SUPPLY BPUI

TELETYPE
REG. U.S. PAT. OFF.
CORPORATION
SUBSIDIARY OF
Western Electric Company
CHICAGO, U.S.A.

Printed in U. S. A.

LIST OF EFFECTIVE PAGES

JANUARY, 1955

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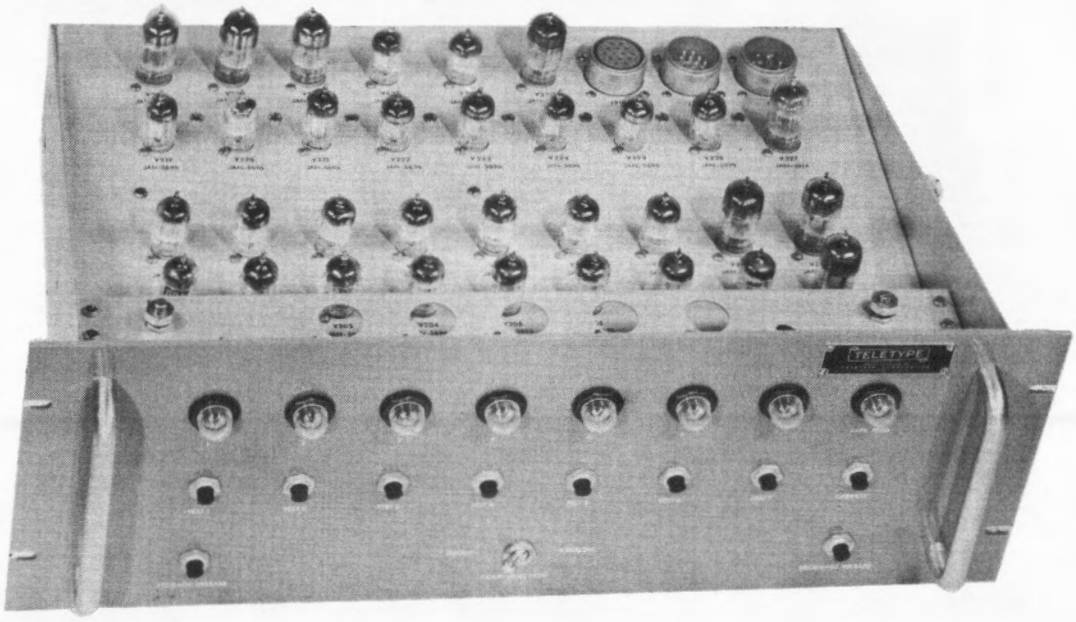
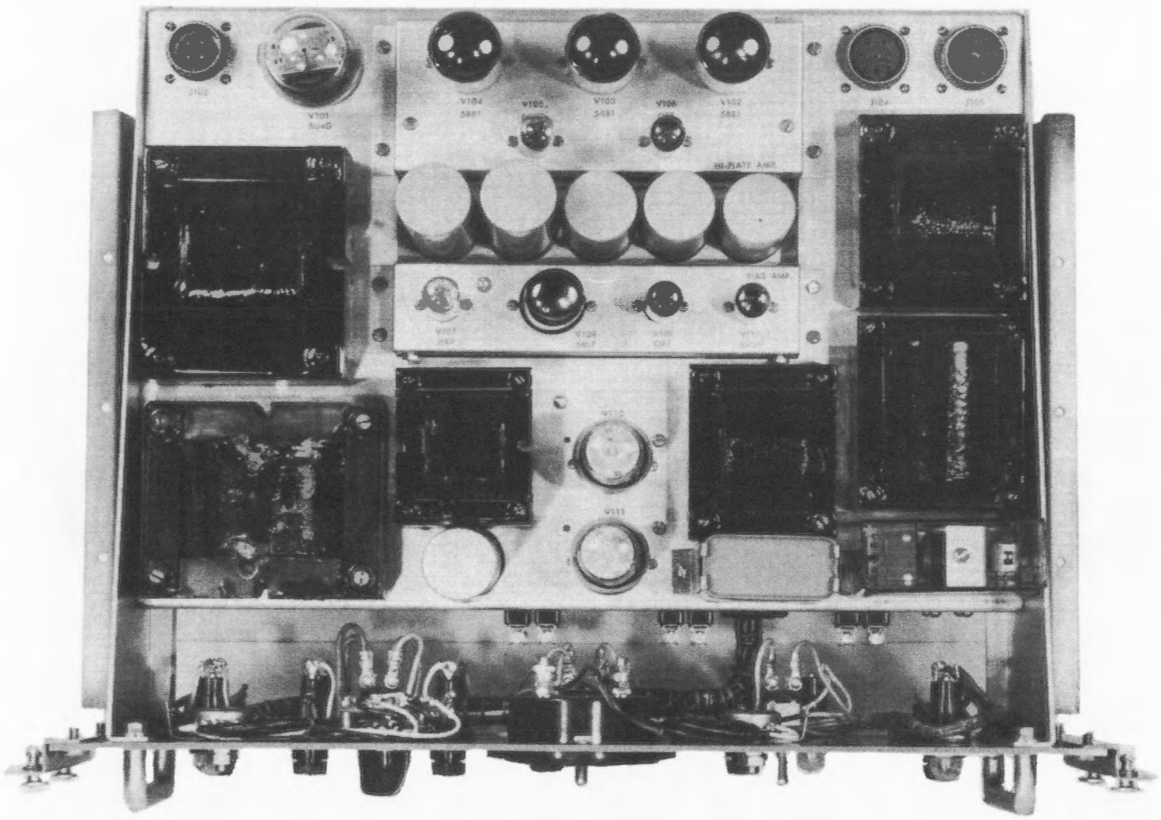


BCUI ELECTRONIC CONTROL UNIT



BPUI POWER SUPPLY

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SECTION 1

DESCRIPTION

1. GENERAL

The Electronic Control Unit BCU1 is one unit of a High Speed Reperforator System. Other units for this system are the High Speed Reperforator (Tape Punch) BRPE, the High Speed Reperforator Base BRPEB, the Motor Unit LMU, the Set of Drive Parts required and the Power Supply Unit BPU1. The Reperforator Unit operates in conjunction with the Control Unit to record in tape form the various combinations of a telegraph or similarly coded signal. The Control Unit and the Power Supply are designed to mount in a standard 19 inch relay rack. All three units may be operated from a 115 volt, 50 or 60 cycle power source.

2. ELECTRONIC CONTROL UNIT BCU1

a. The Control Unit will accept (group) simultaneous code combination signals of 5, 6 or 7 levels (5, 6 or 7 code holes in tape) with a control pulse on a multiwire basis up to a maximum rate of approximately 97.23% of the actual punch speed or 3500 combinations per minute for a punch speed of 3600 opm. These code combinations will be made up of positive pulses which vary between 30 and 100 volts in amplitude and between 10 microseconds and 15 milliseconds in duration. Also, the Control Unit will accept random or sequential code combination signals of 5, 6 or 7 levels with a control pulse on a multiwire basis at any speed up to 97.23% of the actual punch speed. These code combinations will be made up of positive pulses which vary between 30 and 100 volts in amplitude and have a duration of 10 microseconds or more. The only requirement for use with a sequential type code is that the control pulse be the last pulse received for a particular code group.

b. The input impedance of each level is large enough so as not to excessively load the signal source, i.e., at least 100,000 ohms resistance and less than 50 micromicrofarads shunt capacitance.

c. This Control Unit stores and amplifies these signals and sends them to the operating magnets of the Reperforator Unit as the latter calls for them. A tape feed pulse shall accompany each code combination sent to the Reperforator Unit.

d. Means are provided whereby any code combination may be set up manually in the Control Unit and fed through to the Reperforator Unit.

e. Control Unit consists of a front panel, chassis assembly, and connectors for cables to the other units. Operating controls and indicating devices are mounted on the front panel, and controls used for maintenance purposes are mounted on a bracket behind the front panel or on the chassis.

f. The Control Unit requires a 10 ampere at 6.3 volt ac heater supply, 150 milliamperes at +2.30 volts dc for plate supply, 200 ma continuous (300 ma for 200 millisecond intervals) at +120 volts dc for plate supply, and a negative 45 ma, 115 volts dc for bias.

3. POWER SUPPLY UNIT BPU1

a. The Power Supply Unit operates from a 50-60 cycle, 115 volt ac power source and furnishes the correct heater, bias and plate voltages to the BCU1 Electronic Control Unit.

b. The Reperforator (Punch) Unit Motor receives its ac power from the Power Supply Unit.

SECTION 2

THEORY OF OPERATION
ELECTRONIC CONTROL UNIT BCU1

1. INTRODUCTION

This section presents the physical description and theory of operation of the Electronic Control Unit of the High Speed Tape Punch System and its relationship to other units of the System. Except where otherwise stated, a Control Unit speed of 3500 operations per minute and a Punch Unit speed of 3600 operations per minute is assumed for the purpose of description and illustration.

2. RELATIONSHIP OF UNITS IN A HIGH SPEED REPERFORATOR SYSTEM

a. This system consists of an Electronic Control Unit, a High Speed Tape Punch Unit, and a Power Supply Unit. The System works in conjunction with any external apparatus that puts out intelligence in the form of positive pulses. These pulses make up code combinations, similar to telegraph or computor signals, which are fed on a multiwire basis into the Control Unit.

b. The speed at which these signals are put into the Control Unit must not exceed 97.23% the speed of the Punch Unit, expressed in opm, or 3500 combinations per minute for a 3600 opm Punch Unit. The Control Unit stores and amplifies the signals and sends them to the Punch Unit as the latter calls for them.

c. The High Speed Tape Punch is a motor driven, magnet controlled reperforator which operates continuously at 3600 (normal standard speed for direct coupled punch) operations per minute. However, tape is neither punched nor stepped unless the magnets controlling these functions are energized. Energy for the magnets is obtained from the Control Unit under the direction of a contactor. The contactor is part of the Punch Unit and is driven by the Punch motor at 3600 operations per minute. Therefore, the Punch Unit is capable of taking the code combinations out of the Control Unit at a greater rate than the external source puts them in.

3. PHYSICAL DESCRIPTION OF CONTROL UNIT

a. The Control Unit consists of a chassis, front panel, and a potentiometer mounting bracket located directly behind the front panel. The chassis is an aluminum box 3" x 10" x 17", mounted with its open side down and has a removable bottom cover plate. Side brackets are attached to the chassis and extend 2-1/2" to the front of the chassis. The aluminum front panel, 6-31/32" x 19" x 1/8", is attached to these bracket extensions and is secured thereto by handles which extend forward from the panel. The bracket for mounting potentiometers is located between the chassis and panel and is attached to the chassis side brackets.

b. Bias control and Timer control potentiometers are mounted on a bracket behind the front panel. On the front panel are mounted 8 neon lamps (7 code levels and 1 tape feed level), 10 push button switches (7 code test, 1 control test, 1 receiving release, and 1 storage release), and a code selection toggle switch. The functions of these indicators and controls will be explained in the circuit descriptions.

4. INPUT SIGNAL REQUIREMENTS

a. The minimum spacing between the beginning of the earliest arriving pulses of successive combinations must be at least .0171 seconds.

b. In order for blank combinations to be recorded in the tape, a control pulse, which has the same requirements as a code pulse, must be received on an additional level along with the code combination when receiving simultaneous signals.

c. When receiving random or sequential signals, a control pulse must end every code combination. This pulse comes in on the additional level and must have the following qualifications:

(1) The control pulse must be at least .0005 sec. in duration.

(2) There must be at least .0003 sec. between the ending of the control pulse and the beginning of the earliest arriving code pulse of the following combination.

(3) There must be at least .0003 sec. between the beginning of the latest arriving code pulse and the beginning of the control pulse of the same combination.

5. THEORY OF OPERATION FOR CIRCUITS RECEIVING SIMULTANEOUS SIGNALS

a. GENERAL OPERATION (Figure 1)

As shown by dotted lines in the block diagram, Figure 1, the Control Unit is divided into the following three sections: Receiving Section, Storage Transfer, Storage, and Receiving Release Section; Output Transfer, Output, and Storage Release Section.

(1) Referring to the block diagram, it is seen that signals of eight levels are delivered from the signal source to the Receiving Section. Seven of these make up the code combination and go directly into the first seven Receiving Tubes, V201 to V207. The eighth, which is the control pulse, goes through the Code Selection switch to the eighth Receiving Tube V208. The input signals fire the Receiving Tubes in accordance with a particular code combination.

(2) The output of the Receiving Tubes conditions their respective Storage Tubes and also triggers the Timing Univibrator, V209. V209 is one of the familiar "one shot" multivibrators, hereinafter referred to as a "univibrator." After a sufficient delay, the univibrator reverts to its normal state, at which time a positive pulse is fed through the code selection switch to the Control Amplifier, V218. The output of the Control Amplifier goes to the Storage Transfer Tube, V217A, and to the Receiving Release Driver, V217B. The output of the Storage Transfer Tube, identified as the storage transfer pulse, fires the Unlatch Tube, V231, and the Storage Tubes, V210 to V216, that had been conditioned by the Receiving Tubes. The Storage Tubes condition their respective Output Tubes, which then wait for the Punch Unit to call for the code combination that is stored. The output of the Receiving Release Driver cuts off the Receiving Release Tube, extinguishing the Receiving Tubes. The Receiving Tubes are then ready for the next code combination input.

(3) Contactor pulses from the Punch Unit come into the Output Tubes at V229B, the Contactor Pulse Amplifier. From V229B the pulse triggers a univibrator, V230, the Overlap Tube. After a sufficient delay, the univibrator reverts to its normal state, sending a pulse to fire the Output Transfer Tube, V232, which had been conditioned by the Unlatch Tube, V231. The output of the Output Transfer Tube, identified as the out-put transfer pulse, fires the Tape Feed Output Tube, V226, and the Output Tubes that were conditioned by their respective Storage Tubes. The Output Tubes deliver the code combination, along with a tape feed pulse, to the Punch Unit. The code combination is then recorded by the tape perforations. The output transfer pulse also triggers the Transfer Timer, V233, a univibrator. When the Transfer Timer reverts to its normal state, a pulse is sent to the Storage Release Driver, V229A. The output of V229A cuts off the Storage Release Tube, extinguishing the Storage, Unlatch and Output Transfer Tubes.

b. DETAILED DESCRIPTION OF CIRCUITS (Figure 2)

This subdivision covers the detailed description of circuits and refers to the schematic wiring diagram 2987WD and to the timing diagram Figure 2 (actual wiring diagram is 2986WD). In order to simplify the description, it will be assumed that the input signal consists only of a No. 1 pulse, as shown in waveform 1 of Figure 2.

(1) RECEIVING SECTION (Figure 2)

The first of the chain of five No. 1 input pulses is applied from the external source by means of connector J201 to the first control grid of V201, a type 5696 gas tube. Since the second control grid is at cathode potential, the tube is fired by the positive input pulse. C201 is an accelerating capacitor which effectively shorts out R201 at the beginning of the input pulse and allows a maximum voltage to be developed across R202. The network facilitates operation with very narrow pulses. When the tube is fired, its cathode potential rises as shown in waveform 2 of Figure 2, applying positive potential through R252 to the second control grid of V210, the No. 1 Storage Tube. This rapid rise in potential also is differentiated through C202 and C217, resulting in a sharp positive pulse which is fed to V209, the Timing Univibrator. CR201 is a germanium diode which prevents interaction among the Receiving Tubes.

(2) STORAGE TRANSFER, STORAGE, RECEIVING RELEASE SECTION (Figure 2)

(a) V209, a type 12AT7 twin triode, is a univibrator with its right side, V209B, normally cut off by negative grid potential and its left side, V209A, normally conducting with its grid at cathode potential due to grid current through R245 and R246. The presence of the sharp positive pulse on grid 7 causes V209B to conduct, decreasing its plate potential. This decrease in plate potential causes C218 to discharge current through R245 and R246, developing a high negative potential at grid 2. V209A is cut off and its plate potential rises. This rise is fed back through R242 to grid 7 of V209B, accentuating the effect of the initial positive input. The trigger action has been completed and the circuit is in a quasi-stable condition with V209A cut off and V209B conducting. This condition persists for a period determined by the time it takes for C218 to discharge to where the negative potential at grid 2 rises above the cutoff point of V209A. At this time the circuit triggers back to its normal state. R246 is a potentiometer with which the discharge time of C218 and, consequently, the operating period of the univibrator are varied. As shown in Figure 2, the instant that Receiving Tube, V201, is fired, the Timing Univibrator is triggered and, after 8 milliseconds triggers back to its normal state. This output is broadly differentiated through C219 and fed by means of the Code Selection Switch, S211, to V218, the Control Amplifier.

(b) V218, a type 12AT7 twin triode, is a convential squaring amplifier trigger circuit with its left side, V218A, normally cut off by a negative potential at grid 2 and its right side, V218B, normally conducting. Voltage division by R292 and R293 tends to put a positive potential at grid 7, but grid current limits the grid potential to the potential of the common cathode. The negative and positive pulses resulting from the differentiation of the output of V209 are applied to grid 2 of V218. Since grid 2 is already well negative, the negative pulse has no effect. The positive pulse, which occurs at the end of V209's operating period, raises grid 2 above cut off causing V218A to conduct. The accompanying drop in plate potential, which is passed on through R292 to grid 7 of V218B, and the accompanying rise in common cathode potential combine to cut off V218B. The tube remains in this condition for the duration of the positive input pulse applied to grid 2. When the pulse ceases, the circuit triggers back to its normal state. The output of plate 6 of V218 is a positive square pulse as shown in waveform 4 of Figure 2. This square pulse is

differentiated through C220 and the sharp positive pulse obtained from the leading edge is fed to V217A, the Storage Transfer tube. The output at plate 1 of V218 is a negative square pulse. This pulse is differentiated through C223 and the sharp positive pulse obtained from the trailing edge is fed to V217B, the Receiving Release Driver.

(c) V217A, 1/2 of a type 12AT7 twin triode, is a cathode follower amplifier biased beyond cut off. When the sharp positive pulse is applied to grid 2 through C220, the tube conducts and the pulse is reproduced at the cathode. This pulse, identified as the storage transfer pulse, is applied to all the first control grids of the Storage tubes and to the control grid of V231, the Unlatch tube, firing V231.

(d) Storage tubes, V210 to V216 - type 5696 gas tubes, are similar to the Receiving tubes, except that the second control grid is not tied to the cathode. Therefore, they require input at both grids in order to be fired. The positive potential applied through R252 to the second control grid of V210 by V201, the No. 1 Receiving tube, conditioned V210. The storage transfer pulse, then, appearing at the first control grid of all the Storage tubes fires only V210, the No. 1 Storage tube. As shown in Figure 2, waveform 5, the No. 1 Storage tube is fired by the leading edge of the Control Pulse Amplifier output, waveform 4. The rise in cathode potential of V210 is applied through R299 to the second control grid of V219, the No. 1 Output tube, conditioning V219.

(e) V217B, 1/2 of a type 12AT7 twin triode, is an amplifier biased beyond cut off. When the sharp positive pulse is applied to grid 7 through C223, the tube conducts and plate potential drops. This drop in potential is transmitted through R244 to V227, the Receiving Release tube.

(f) V227, a type 5814 twin triode, is a normally conducting cathode follower amplifier whose cathode potential is approximately +90 volts. This potential is the plate supply for the Receiving tubes. The tube is connected as a single triode in order to handle the large current that flows when all the Receiving tubes conduct at the same time. The potential drop from V217B cuts off V227, removing plate potential from and extinguishing any Receiving tubes that had been fired. As shown in Figure 2, waveform 2, V201, the No. 1 Receiving tube, is extinguished by the trailing edge of the Control Pulse Amplifier output, waveform 4. The Receiving Section is then ready for the next code combination.

(3) OUTPUT TRANSFER, OUTPUT, AND STORAGE RELEASE SECTION (Figure 2)

(a) V219, the No. 1 Output tube, having been conditioned by V210, the No. 1 Storage tube, awaits output transfer action which is initiated by the closing of the Punch Unit contactor. The contactor is effectively connected between terminal P and J of J202 and, when closed, applies +120 volts dc to terminal P. When open, -30 volts dc is applied to terminal P through R354 and R352. The +120 volts serve two purposes: They provide plate potential to the Output tubes and cause V229B, the Contractor Pulse Amplifier to conduct. The -30 volts also serves two purposes: it extinguishes the Output tube and it cuts off V229B. The contactor operates continuously at 3600 operations per minute, resulting in a period of operation of 16.7 milliseconds. As shown in Figure 2, waveform 6, the contactor is open for 2 milliseconds and closed for 14.7 milliseconds.

(b) V229B, 1/2 of a type 12AT7 twin triode, is an amplifier that conducts when the contactor closes and cuts off when the contactor opens. When the contactor closes, V229B conducts and its plate potential drops. This drop in potential is differentiated through C235 and a sharp negative pulse is fed to V230, the Overlap tube, C234 aids in filtering contactor bounces and stray pickups.

(c) V230, a type 12AT7 twin triode, is a univibrator with its left side, V230A, normally conducting and its right side, V230B, normally cut off. Univibrator operation was explained in detail for the Timing Univibrator circuit - Paragraph 5.b.(2). The sharp negative pulse from V229B is applied to grid 2 of V230, cutting off V230A and triggering the univibrator. The operating period of V230 is determined by the time it takes for C236 to discharge through R356 and R357 to where grid 2 rises above cut off, at which time the circuit triggers back to its normal state. The natural operating period of the Overlap circuit is about 3 ms. The output of the Overlap tube, as shown in Figure 2, waveform 7, is differentiated through C237 and applied to the second control grid of V232, the Output Transfer tube.

(d) V232, a type 5696 gas tube, requires a conditioning potential on the first control grid in order to be fired by the Overlap output. This potential is obtained from the cathode of the Unlatch tube through R366. As mentioned previously, the Unlatch tube, V231, which is also a type 5696 gas tube, is fired by the storage transfer pulse. The sharp positive pulse resulting from the trailing edge of the overlap operation fires V232, if V232 has been conditioned by the Unlatch tube. Note in Figure 2 that the trailing edge of the first of the five overlap operations shown occurs a fraction of a millisecond after the firing of the Unlatch tube and fires the Output Transfer tube. The rise in cathode potential of V232, as shown in waveform 8, serves two purposes: it is applied to the first control grids of all the Output tubes and it is differentiated through C240 and applied to grid 7 of V233, the Transfer Timer tube.

(e) The Output tubes, V219 to V226, are type 5696 gas tubes. All but the eighth, V226, require conditioning potential on their second control grids in order to be fired by the Output Transfer Pulse. The second control grid of V226, the Tape Feed Output tube, is tied to the cathode and therefore, only the Output Transfer Pulse

is required to fire it. Since only V219, the No. 1 Output tube, has been conditioned, the Output Transfer Pulse fires the Tape Feed and the No. 1 Output tubes. The magnet coils in the Punch Unit are connected in series with their respective Output tubes. Firing of the No. 1 and Tape Feed Output tube energizes the No. 1 and Tape Feed Magnet coils. No. 1 hole is punched and the tape is stepped. Waveform 10 shows the No. 1 Output tube being fired by the Output Transfer Pulse and being extinguished by the opening of the contactor. I201 to I208, type NE51 glow lamps, are fired by their respective Output tubes, indicating the presence of an output pulse. When an output tube is fired, the inductance of the magnet coil opposes an initial current flow and most of the supply voltage appears across the coil. If capacitors C224 to C231 did not bypass the coils to allow some initial current to flow, the output tubes would have difficulty remaining fired. CR209 to CR216 provides paths for the inductive discharge of their respective magnet coils when the Output tubes are extinguished.

(f) V233, the Transfer Timer, is a type 12AT7 twin triode connected as a univibrator. Its left side, V233A, is normally conducting and its right side, V233B, is normally cut off. The sharp positive pulse resulting from the differentiation of the Output Transfer Pulse is fed to grid 7 of V233, causing V233B to conduct and triggering the univibrator. The operating period of the univibrator is about .5 ms. as determined by the discharge time of C241. At the end of this time, a sharp positive pulse resulting from differentiation through C232 is sent to V229A, the Storage Release Driver.

(g) V229A, 1/2 of a type 12AT7 twin triode, is identical to V217B, the Receiving Release Driver. The positive pulse input to grid 2 causes V229A to conduct. The accompanying drop in plate potential is transmitted through R349 to V228, the Storage Release tube.

(h) V228, a type 5814 twin triode, is identical to V227, the Receiving Release tube. It is from the cathode of V228 that the Storage, Unlatch, and Output Transfer tubes obtain their plate potential. The drop in plate potential of V229A cuts off V228, removing the plate potential from and extinguishing said tubes. As shown in Figure 2, the firing of the Output Transfer tube triggers the Transfer Timer and at the end of the Transfer Timer operation, the Storage Release Driver and Storage Release tube act to extinguish the No. 1 Storage, Unlatch, and Output Transfer tubes.

c. EFFECTS OF DIFFERENCE IN INPUT AND OUTPUT SPEEDS (Figure 2)

(1) The first of the series of five No. 1 input pulses shown in Figure 2 has been followed through the Control Unit and the operation of the circuits explained. Observe in Figure 2 that the timing of the operations for the succeeding No. 1 pulses is different. Overlap operation varies and the third transfer pulse is missing. This is due to the difference in input and output speed of the Control Unit. At this time recall that the contactor in the Punch Unit operates at 3600 operations per minute and the speed at which signals are put into the Control Unit does not exceed 3500 combinations per minute. In other words, a No. 1 input pulse is fed into the Control Unit every 17.1 ms. and the contactor in the Punch Unit calls for an output of a No. 1 pulse every 16.7 ms. The difference in these two periods is .4 ms. Assume that an input pulse and a contactor closure occur at exactly the same time. The next contactor closure, however, occurs .4 ms. ahead of the corresponding input pulse and the following contactor closure occurs .8 ms. ahead of the corresponding input pulse.

(2) In order to explain the effects of this difference in input and output speed, the entire series of five No. 1 input pulses shown in Figure 2 will be followed through the Control Unit. Note, in the schematic diagram, that there is a connection from the cathode of V231, the Unlatch tube, through R356 to the grid 2 circuit of Overlap tube, V230. As has been stated, the natural operating period of the Overlap univibrator is about 3 ms. If, however, the Unlatch tube is conducting when the Overlap is triggered, the operating period is changed from 3 ms. to 2 ms., because conduction of the Unlatch tube puts a +55 volt potential in the discharge path of C236, speeding up the rate of discharge. If the Unlatch tube is fired during the overlap operation, the Overlap univibrator will trigger back to its normal state sometimes between 2 and 3 ms. Such is the case of the first overlap operation shown in Figure 2. The Unlatch tube is fired after the Overlap has been operating for about 2.3 ms. and speeds up the rate discharge of C236 at that time, causing the univibrator to trigger back to normal after about 2.5 ms. of operation.

(3) The second input pulse arrives 17.1 ms. after the first and the second overlap operation starts 16.7 ms. after the first. Therefore, the Overlap has been operating for about 2.7 ms. (2.3 + .4) before the Unlatch tube fires. The cathode potential of the Unlatch tube again shortens the overlap operation and the univibrator triggers back to normal after approximately 2.9 ms. of operation.

(4) The third input pulse arrives 17.1 ms. after the second and the third overlap operation starts 16.7 ms. after the second. This means that the Unlatch tube will not be fired until about 3.1 ms. (2.7 + .4) after the Overlap univibrator has been triggered. Since the natural operating period of the Overlap is 3 ms., it will trigger back to its normal state before the Unlatch tube is fired. Therefore, the Output Transfer tube cannot be fired by the overlap output because it has not been conditioned by the Unlatch tube. The Unlatch tube and the No. 1 Storage tube are fired about .1 ms. after the end of the 3 ms. overlap operation, and remains fired until the fourth overlap operation causes output transfer and storage release. This fourth overlap operation has an operating period of only 2 ms. because the Unlatch tube was conducting when the Overlap was triggered. Operation with the next input pulse can be followed in the timing diagram without any

trouble. As time goes on, the duration for which the Storage and Unlatch tubes store the pulse decreases until an input pulse again misses its own overlap operation and has to wait for the next one, which then results in a long storage time.

(5) The reason for this control that the Unlatch tube has over the Overlap operating period is to speed up the output transfer and release of the combination that was stored for the longest time, having missed its own overlap operation and having had to wait for the next.

(6) The net effects of the difference in output and input speeds is to cause a change in the operating period of the Overlap tube and to cause the Punch to sometimes cycle without punching or stepping tape. When the input speed is 3500 combinations per minute, this latter effect occurs approximately once every forty combinations.

6. THEORY OF OPERATION FOR CIRCUITS RECEIVING RANDOM OR SEQUENTIAL SIGNALS (Figure 3)

a. Random or sequential signals are signals in which the seven code combination pulses arrive in either random or sequential order. In each case, the code combination is concluded with an eighth level control pulse.

b. In order for the Control Unit to receive this type of signal, the Code Selection switch, S211, must be in the "Random" position. The code combination pulses fire the Receiving tubes in the normal manner, conditioning the Storage tubes and triggering the Timing Univibrator, V209. When S211 is in the "Random" position, the output of V209 terminates at S211 and is not used. The eighth level pulse, which, for simultaneous input, was the blank recognition pulse, is not fed to the eighth Receiving tube. Instead, S211 sends it to the Control Amplifier, V218, the output of which initiates storage transfer and receiving release in the usual manner. The timing diagram for random input, Figure 3, shows two seven level signals with a pulse arriving on each level. The pulses arrive in sequential order followed by a control pulse which triggers the Control Amplifier. Beyond the Control Amplifier, the operation is the same as for simultaneous input.

7. MANUAL CONTROLS TO SET UP AND PERFORATE A CODE COMBINATION

a. Means are provided whereby any code combination can be set up manually in the Control Unit and then perforated. This is a feature used to determine if the unit is operating correctly or to put supervisory signals into the tape.

b. S201 to S207, the Code Test switches, are push button switches connecting the grids of their respective Receiving tubes to positive potential. When using these switches, the Code Selection switch must be in the "Random" position. Closing a switch causes its respective Receiving tube to fire. When the desired combination is set up in the Receiving Section, S208, the Control Test switch is closed.

c. S208 is also a push button switch which connects grid of V218, Control Amplifier, to positive potential. Closing S208 triggers V218, causing storage transfer. Releasing S208 triggers V218 back to normal, causing receiving release. The remaining operations are automatic and the combination is perforated in the tape.

d. Two other push button switches, S209 and S210, are used as a means of manually extinguishing the Receiving and Storage tubes respectively. S209 grounds grid 7 of V217B, the Receiving Release Driver, causing it to conduct and cutoff V227, the Receiving Release tube. Any undesirable combination that had been set up can, therefore, be erased. Sometimes, when the Unit is first turned on, the Output Transfer tube becomes inadvertently fired and cannot be extinguished by the normal operation of the circuits. S210 grounds grid 2 of V229A, the Storage Release Driver, causing it to conduct and cut off V228, the Storage Release tube. This provides a means to manually remove the plate potential from and extinguish the Output Transfer tube.

SECTION 3

THEORY OF OPERATION
POWER SUPPLY UNIT BPU1

1. GENERAL

a. INPUT REQUIREMENTS

The power supply operates from any 115 volt, ±10%, 50-60 cycle, alternating current source. It requires 320 watts full load (not including load of ac outputs). The power factor is approximately .90. The 115 volt input circuit connects to heater, bias, plate supply transformers, Punch Unit, and two power outlets. The 115 volt ac circuit to the Punch Unit contains a 5 ampere fuse and the circuit to the two power outlets contains a 3.2 ampere fuse which is common to both outlets.

NOTE

The 115 volt ac input is not to be grounded.

b. HEATER CIRCUITS

(1) Taps on the primary winding of the heater transformer, T104, permit adjustment of the output potential in 2.5% increments, so as to match various heater load requirements.

(2) The full-load continuous duty output capacity of each of the two heater transformer secondaries is 5 amperes at 6.3 volts.

(3) A time delay relay prevents the application of plate voltage, for approximately 20-50 seconds after the power switches are turned on, until the filaments have been heated. This relay immediately unlocks upon failure of the filament potential and recycles when power is restored.

c. BIAS SUPPLY

(1) The -115 volts supply is variable from -100 to -130 volts and capable of 45 milliamperes.

(2) The regulation of the -115 volt rectifier is less than 2.5 volts with a load change from 10 to 45 milliamperes within the output voltage range of -100 to -130 volts, and simultaneous line voltage variation of plus or minus 10%.

(3) The rms ripple in the output of the bias rectifier is less than 100 millivolts at any point within the load range.

d. PLATE SUPPLIES

(1) There are two plate supplies, one a full wave rectifier supplying 230 volts, the other a full wave rectifier supplying 120 volts.

(2) The 230 volt rectifier output potential is variable over a range of 195 to 265 volts.

(3) The 230 volt rectifier supplies a maximum continuous load current of 150 milliamperes at any potential within the specified ranges.

(4) The regulation of the 230 volt rectifier is less than 2.5 volts at 230 volts with a load change from 30 milliamperes to 150 milliamperes in 10 microseconds or less and with a simultaneous line voltage variation of ±10%. Throughout the complete range specified in Subparagraph (2) above, the regulation is less than 3 volts, under the same conditions of load and line voltage variations.

(5) The rms ripple in the output of the 230 volt rectifier is less than 100 millivolts at any point within the load and voltage conditions specified above.

(6) The 120 volt rectifier supplies a maximum continuous load current of 200 milliamperes, and momentary load currents of 300 milliamperes for periods of not more than 200 milliseconds.

(7) The regulation of the 120 volt rectifier is less than 5 volts with a load change from zero milliamperes to 200 milliamperes with the input voltage constant at any point within the 115 volt ±10% range. When the input voltage is exactly 115 volts, the output is 120 volts, ±3 volts, at a load of 100 milliamperes.

(8) The rms ripple in the output of the 120 volt rectifier is less than 500 millivolts at any point within the load range of zero milliamperes to 200 milliamperes and not more than 1 volt at 300 milliamperes.

2. INPUT CIRCUITS

a. Input power is supplied from a 50 or 60 cycle 115 volt source through terminals A and C of J103 to the main switch, S101. Closure of S101 applies power through F101 and F102 (6 ampere fuses) to circuits controlled by the heater switch and the plate switch. Neon lamps, I101 and I102, type NE51, are bridged across F101 and F102 respectively, and glow if a fuse is blown. The closure of S101 also applies 115 volts ac through F105 (a 5 ampere fusetron) to an auxiliary circuit which connects to J and K of the output terminal strip, TB103. This auxiliary circuit may then be connected to pins A and C of J104 to provide 115 volts ac for the Punch Unit motor. Lamp I105, which is bridged across the auxiliary power leads, glows when the main switch is on. Absence of this glow indicates that F105 is blown. Power is provided at convenience outlets J101 and J102 also when S101 is turned on by a circuit through F106, a 3.2 ampere fusetron. Lamp I106, type NE51, which is bridged across F106, glows if F106 is blown.

b. When the heater switch, S103, is closed (S101 previously closed) power is applied through F104 (a 4 ampere fuse) to the primary of control transformer, T102, to the primary of the filament

transformer, T104, the primary of the heater transformer, T105. Lamp I104, type NE51, which is bridged across F104 will glow if F104 is blown. The circuit to the primary of the heater transformer is through contacts 5 and 6 of K101. A bimetal snap switch, K104, is heated by several turns of nichrome wire connected to the heater transformer. After a delay of from 20 to 50 seconds, the bimetal strip becomes hot enough to flip to its operated condition and close a circuit from the 6.3 volt filament transformer through the relay coil, K101. Relay K101 operates and closes a locking circuit through contacts 1 and 2 which keeps it operated as long as the filament transformer is energized. At the same time, the original circuit to the heater transformer is opened and the plate circuit controlled by S102 is prepared for closure by contacts 4 and 5 of K101.

c. After the time delay period has passed and K101 is operated, the closure of the plate switch, S102, completes the energization of the Power Supply Unit by applying power through F103 (a 4 ampere fuse) to the primaries of the plate transformers, T101 and T103. Lamp I103, type NE51, bridged across F103 will glow if F103 is blown.

3. BIAS SUPPLY (-115 volts dc)

a. Transformer T102 supplies filament power to the various tubes in the power supply and also supplies plate voltage to the bias supply rectifier tube, V107 type 6X4. The output of V107 is supplied through a choke input filter comprising L101 and C105 to a series regulator tube V108, type 6BL7. Both triodes of this tube are connected in parallel and the output voltage at their cathodes is dependent upon the bias which is supplied to their grids. R121 and R124 in the grid circuits and R122 and R123 in the cathode circuits are current limiting resistors for the protection of the tube.

b. Bias on the regulator tube's grids is provided by a voltage amplifier tube V110, type 6AU6. A voltage regulator tube V109, type OB2, is connected through R125 to the input side of the regulator triodes. A constant voltage of 108 volts is produced across V109 when it is fired. Two voltage dividers are bridged across this constant voltage tube, supplying screen and cathode voltages to V110. Another voltage divider, connected across the output terminals of the rectifier, provides a grid voltage which will vary as the output voltage varies. Since the cathode is held at constant voltage, a change in grid voltage is a change in bias and the plate voltage will change accordingly, due to the plate current through R130. The grids of the regulator triodes are directly connected to the plate of V110.

c. To realize the action of the circuit, assume that the output voltage rises slightly. Immediately, the grid of V110 rises, decreasing the bias applied to V110 since the cathode voltage is held fixed by V109. The plate voltage (grid voltage of V108) will then decrease, causing the plate resistance of the regulator tube to increase and reduce the output voltage by an amount which will almost compensate for the original increase in output voltage which was assumed.

d. Capacitor C107 provides additional filtering to the output voltage which is supplied to the terminal strip from which connections are made to the output connectors, J104 and J105.

e. The bias supply voltage can be varied by means of R134, the potentiometer on the front panel marked "INCREASE BIAS". This potentiometer varies the bias on V110 and through the action of the regulating circuits causes the output voltage to vary.

4. LOW PLATE SUPPLY (+120 volts dc)

a. The low plate supply rectifier consists of two 2050 thyratrons, V111 and V112, each connected in a leg of the center-tapped secondary winding of T103. Tubes V111 and V112 are connected as diodes with R135 and R136 limiting their screen currents. The filter circuit is essentially a choke input circuit with L102 and C109 making up the components. Capacitor C108 which is bridged across L102 forms a parallel tuned circuit to offer a high impedance to flow of 120 cycle current.

b. Resistor R137 is a bleeder resistor connected across the output leads to improve the voltage regulation. The output leads are terminated in the terminal strip from which connections are made to the output connectors J104 and J105.

5. HIGH PLATE SUPPLY (+230 volts dc)

a. Tube V101, type 5U4, functions as a full-wave rectifier and is connected across the center-tapped secondary winding of T101. Capacitors C101 and C102 are connected in series to provide the input filter capacitance. Resistors R101 and R102 are bridged across these capacitors and discharge them after the equipment is de-energized. Tubes V102, V103 and V104, type 5881, are connected as parallel triode series regulator tubes. Resistors R104, R108 and R110 in the cathode circuits, R103, R107 and R109 in the screen circuits, and R105, R106 and R111 in the grid circuits are current limiting resistors for the protection of the regulator tubes.

b. The output of the regulator tubes is taken from their cathodes and is supplied to C104, which provides additional filtering, and to the terminal strip from which connections are made to the output connectors. J104 and J105.

c. The amplifier circuit, which provides bias for the regulator tubes, is nearly identical to the circuit used in the bias rectifier, described in paragraph 3. above. V105, 6AU6 type, and V106, OB2 type, perform the same functions as did V110 and V109 respectively.

d. The high plate supply voltage can be varied by means of R116, the potentiometer on the front panel marked "INCREASE PLATE".

This potentiometer varies the bias on V105 and through the action of the regulating circuits causes the output voltage to vary.

6. FILAMENT SUPPLY (6.3 volts ac)

a. Four leads from the two filament transformer secondaries (T104) connect to the output terminal strip so that series or parallel combinations may be obtained.

b. The secondary windings are connected in series as shown in the note of the Power Supply Schematic Wiring Diagram 2989WD.

7. MONITORING FACILITIES

a. The various neon indicator lamps connected across fuses give visual indications of blown fuses. Neon lamp I105 glows when power is applied to the unit to indicate that the main switch is in the ON position.

b. Meter M101 may be switched by means of S105 to the various dc output circuits so that their potentials may be readily determined.

SECTION 4

ADJUSTMENTS
POWER SUPPLY UNIT BPU1

1. TIME DELAY RELAY

The normal time delay period, before the plate potentials are available, is set at the factory for between 20 and 50 seconds. This adjustment can be made by turning the screw located on the right side of the time delay assembly. This screw controls the tension of the snap switch.

2. BIAS SUPPLY

The bias output voltage is controlled by the adjustment marked "INCREASE BIAS" located on the front panel. Set the control for a bias voltage of -115 volts as indicated on the panel voltmeter.

3. HIGH PLATE SUPPLY

The high plate supply voltage should be set at 230 volts by means of the adjustment marked "INCREASE PLATE" located on the front panel.

4. THE LOW PLATE SUPPLY

No continuously variable adjustment is provided, but slight adjustment of the output voltage may be obtained by changing the connection of the input lead to a different tap on T103. Select the connection which gives 120 volts plus or minus 3 volts, when operating with the BCU1 (see Note 6B on wiring diagram 2989WD).

5. FILAMENT SUPPLY

No continuously variable adjustment is provided, but some control of the output voltage may be obtained by changing the input connection on T104 to a different tap. Select the connection that will supply an output voltage of 6.3 volts when the line voltage is 115 volts ac, when connected to the BCU1 (measured from chassis to terminals D and E on connector T203 of BCU1).

NOTE

For punch adjustments, refer to the High Speed Reperforator BRPE (Tape Punch) Adjustment Bulletin.

SECTION 5

ADJUSTMENTS
ELECTRONIC CONTROL UNIT BCU1

1. GENERAL

Adjustments are to be made when receiving simultaneous signals consisting of +60 volt pulses. Plate supply voltage is to be set at +230 volts dc and bias supply at -115 volts dc.

2. BIAS POTENTIOMETER

Bias adjustment potentiometer, R247, varies the bias on all Receiving tubes, the Control Amplifier, the Receiving Release Driver, and the Storage Release Driver set at -20 volts.

3. TIMING UNIVIBRATOR CONTROL

Timing Univibrator Control, R246, varies the operating period of the Timing Univibrator, V209, and is effective only when receiving simultaneous signals. This period must be long enough to allow for the possibility that the input signals might not be perfectly simultaneous and that the pulses making up the signals might not be of uniform duration. R246 must be adjusted so that the Receiving tubes are not extinguished before the complete code combination has arrived. Rotate the control counterclockwise until errors occur and then clockwise until errors occur. Set the control at the middle of the range.

4. PLATE VOLTAGE OPERATING RANGE

After adjustments 2 and 3 have been made, errorless operation should be obtained when the +230 volt plate supply is varied between +210 and +250 volts.

5. REPERFORATOR CONTACTORS

a. NO. 2 CONTACTOR MOUNTING PLATE (Figure 8)

The "No. 2 Contactor Mounting Plate" should be set so that the 0^{o} mark is opposite the reference line on the fixed "Indicator Plate".

b. NO. 1 CONTACTOR MOUNTING PLATE (Figure 8 for location of parts)

With the "No. 1 Contactor Mounting Plate" set so that its reference line is opposite the +30 mark on the "No. 2 Contactor Mounting Plate", rotate the No. 1 plate clockwise, as viewed from the rear of the punch unit, until errors occur and then back the plate up 20^{o} in the counter-clockwise direction.

NOTE

Refer to the High Speed Tape Punch (Reperforator) Adjustment Bulletin for all other punch adjustments.

SECTION 6

INSTALLATION

1. MOUNTING

a. Both the Electronic Control Unit BCU1 and the Power Supply Unit BPU1 are designed to be mounted in a standard 19 inch relay rack.

b. The front panels of the above units are each 6-31/32 inches high and 19 inches wide.

c. The Control Unit chassis extends 12-1/2 inches behind its front panel. The Power Supply Unit chassis extends 14-3/4 inches behind its front panel.

2. CABLES (Figures 5, 6 and 7)

a. Cables of correct length should be made up to interconnect the units. Refer to Figures 5, 6 and 7 for necessary cable data. "AN" type connector plugs are supplied with the equipment.

b. The leads in the cable bringing pulses into the Electronic Control Unit BCU1 at J201 and the leads in the cable between the BCU1 and the High Speed Reperforator BRPE must be individually shielded.

3. REPERFORATOR MOTOR CONNECTIONS

Pins A and C of J104 should be connected respectively to terminals J and K of TB103 to provide 115 volts ac for the Reperforator motor.

CAUTION

Make certain that only the cable from the Reperforator is connected to the ac power connector, J104.

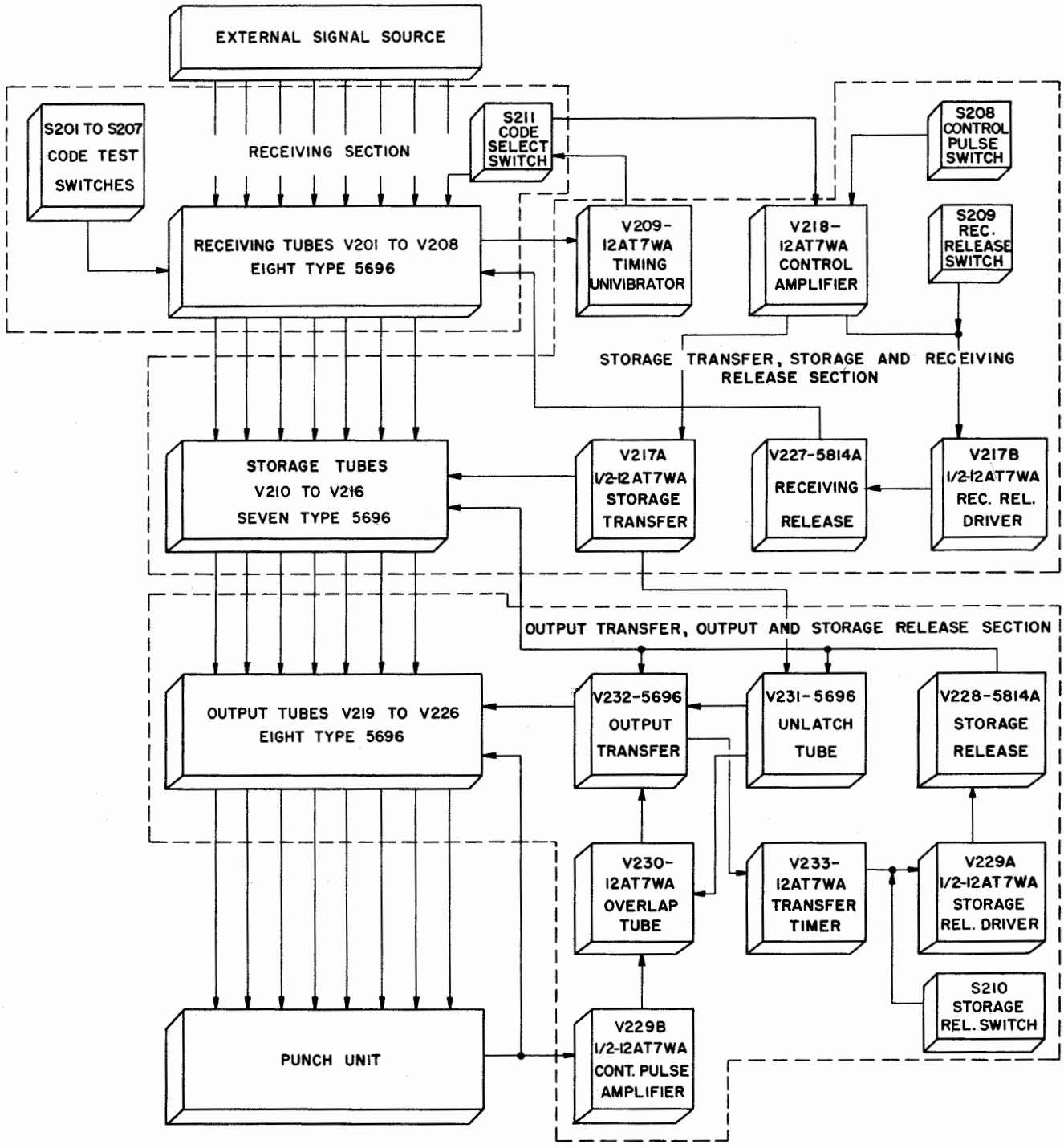
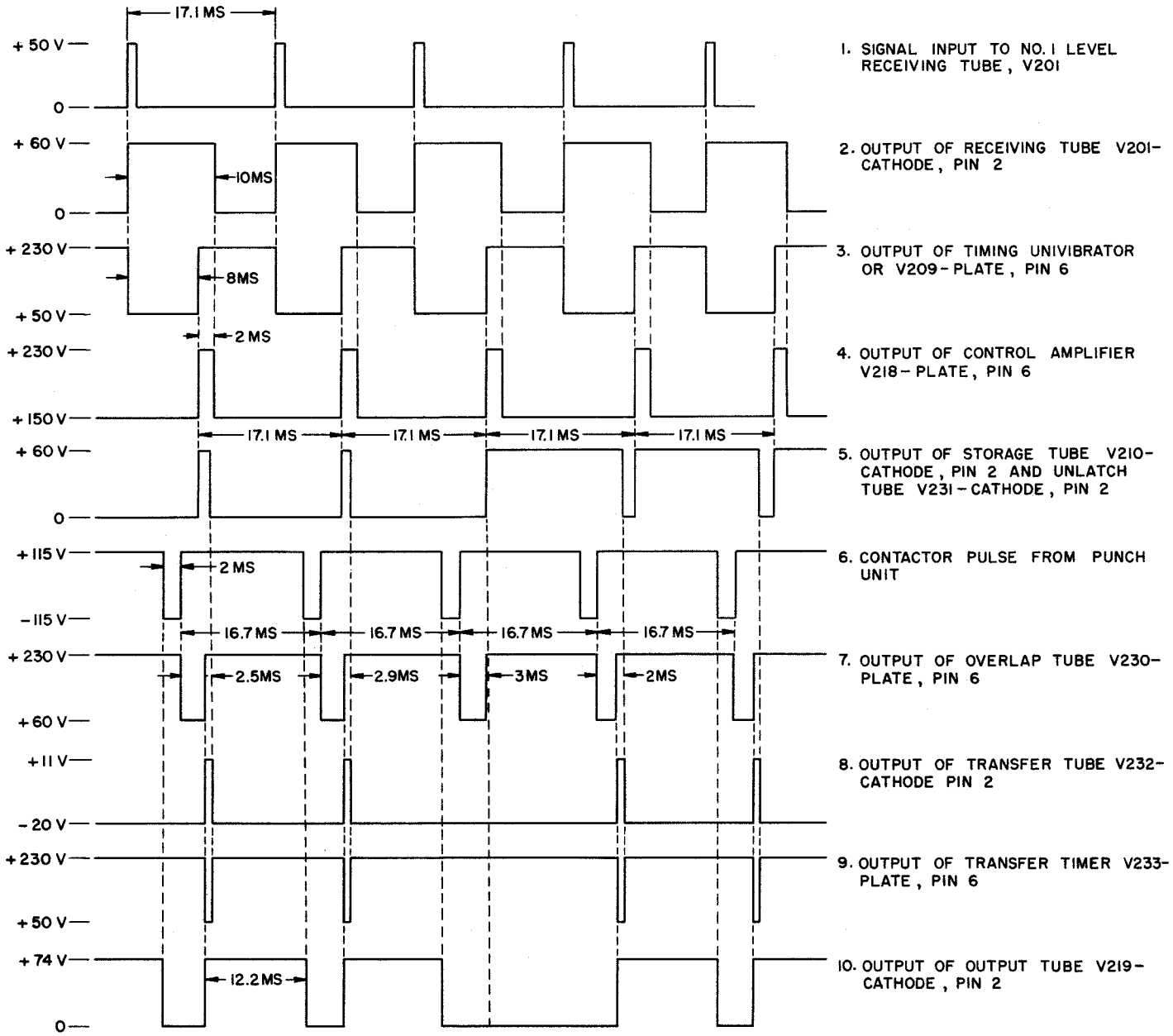


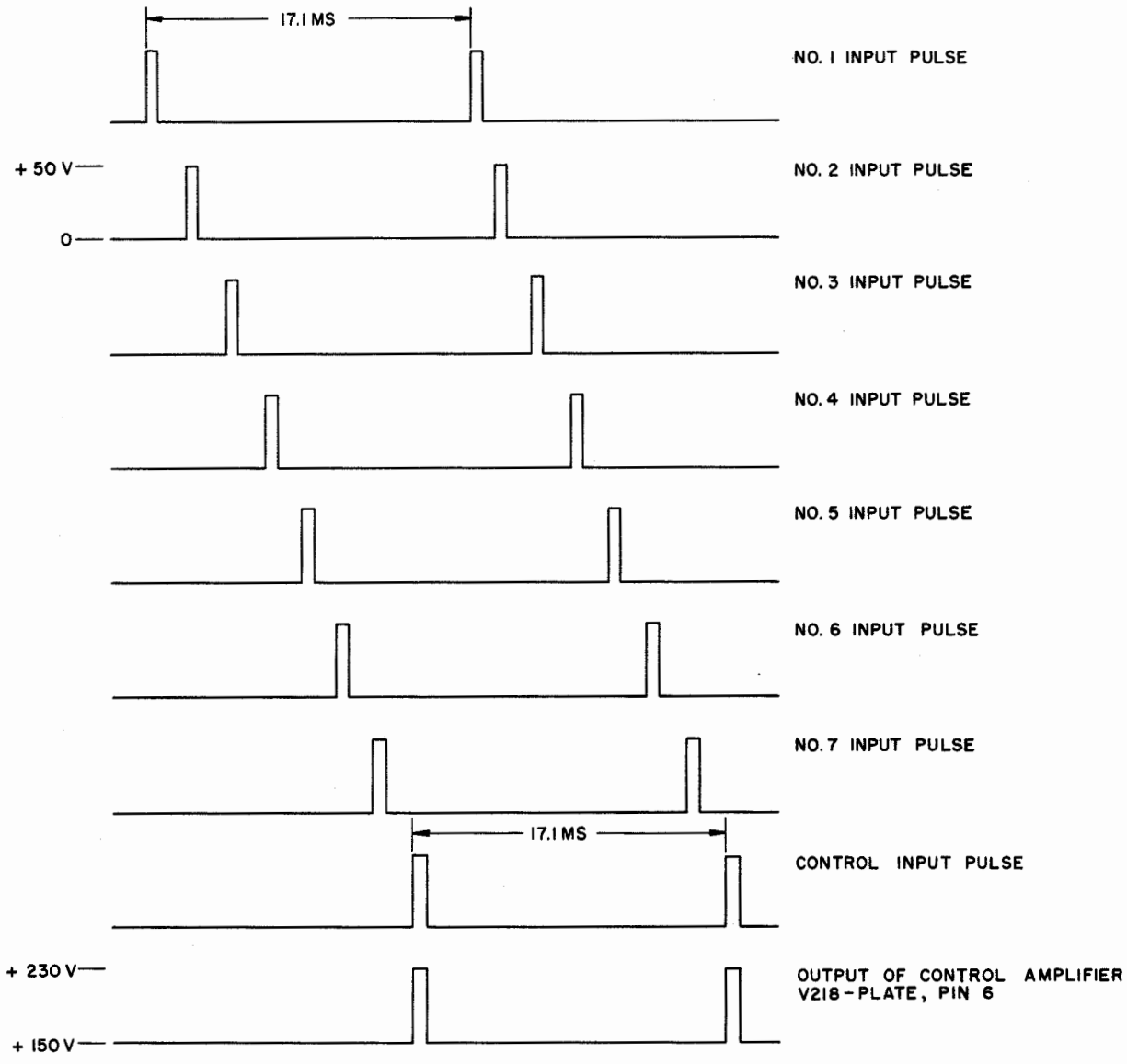
FIGURE I. BLOCK DIAGRAM OF THE BCUI ELECTRONIC CONTROL UNIT



WAVEFORMS ARE FOR TIMING PURPOSES ONLY AND DO NOT REPRESENT ACTUAL WAVEFORMS AT THE POINTS INDICATED.

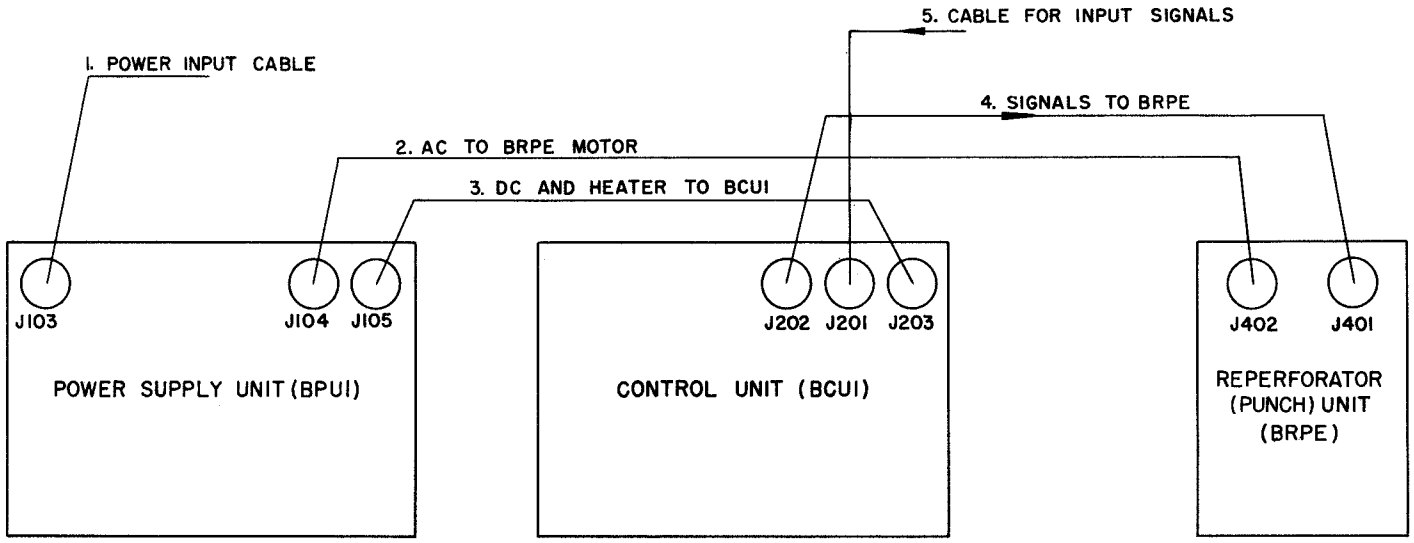
INPUT IS AT 58.3 PULSES PER SECOND.

FIGURE 2. TIMING DIAGRAM OF NO. 1 LEVEL OF THE BCUI ELECTRONIC CONTROL UNIT WHEN RECEIVING SIMULTANEOUS SIGNALS



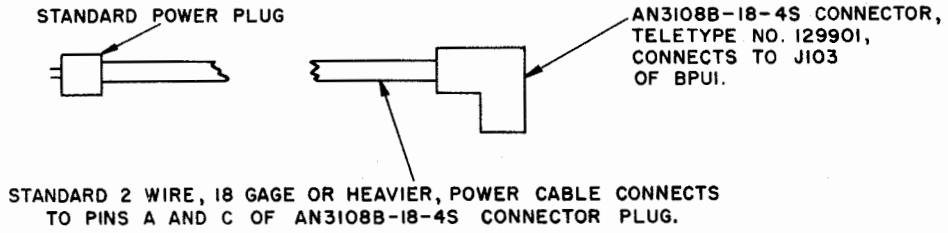
FROM THIS POINT ON, THE TIMING IS THE SAME AS FOR SIMULTANEOUS INPUT SIGNALS (FIGURE 2).

FIGURE 3. TIMING DIAGRAM OF BCUI ELECTRONIC CONTROL UNIT RECEIVING RANDOM SIGNALS

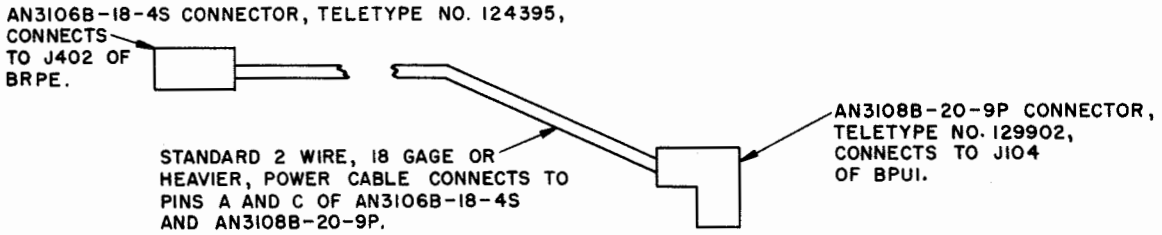


1. TWO CONDUCTOR CABLE WITH AN3108B-18-4S CONNECTOR AND STANDARD 2 PIN POWER PLUG. PINS A AND C.
2. TWO CONDUCTOR CABLE WITH AN3108B-20-9P AND AN3106B-18-4S CONNECTORS. PINS A AND C.
3. EIGHT CONDUCTOR CABLE WITH AN3108B-20-9P AND AN3108B-20-9S CONNECTORS.
4. SEVENTEEN CONDUCTOR CABLE WITH AN3108B-20-29P AND AN3106B-20-29S CONNECTORS. EVERY LEAD INDIVIDUALLY SHIELDED.
5. SIGNAL INPUT, NINE CONDUCTOR CABLE WITH AN3108B-20-27S CONNECTOR. EVERY LEAD INDIVIDUALLY SHIELDED.

FIGURE 4. INTERCONNECTING CABLE DIAGRAM FOR THE BCUI, BPUI AND BRPE

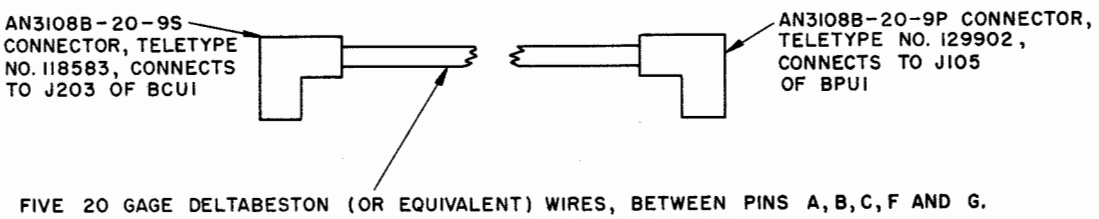


AC POWER INPUT CABLE TO BPUI POWER SUPPLY UNIT

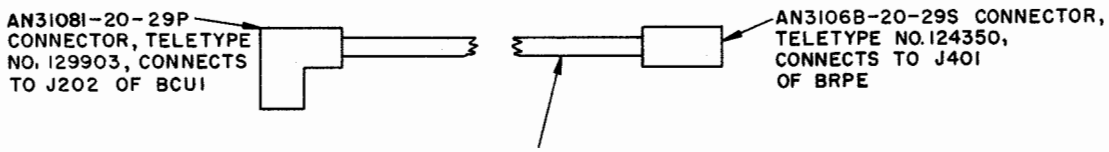


AC POWER CABLE TO BRPE REPERFORATOR MOTOR

FIGURE 5. POWER CABLES FOR BPUI AND BRPE



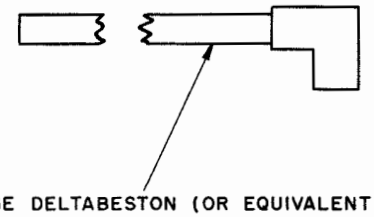
DC AND HEATER POWER CABLE TO BCUI CONTROL UNIT



SIGNAL CABLE FROM BCUI CONTROL UNIT TO BRPE REPERFORATOR

NOTE: CONNECTORS ONLY ARE SUPPLIED WITH THE EQUIPMENT. CABLES MUST BE MADE AS REQUIRED SO THAT EACH CONNECTOR PIN CONNECTS TO A SIMILARLY CODED CONNECTOR PIN AT THE OTHER END OF THE CABLE.

FIGURE 6. CABLES FOR BCUI, BRPE AND BPUI



CODE LEVEL								
1	CONNECTS	TO	PIN	A	OF	AN3108B-20-27S		
2	CONNECTS	TO	PIN	B	OF	AN3108B-20-27S		
3	CONNECTS	TO	PIN	C	OF	AN3108B-20-27S		
4	CONNECTS	TO	PIN	D	OF	AN3108B-20-27S		
5	CONNECTS	TO	PIN	E	OF	AN3108B-20-27S		
6	CONNECTS	TO	PIN	F	OF	AN3108B-20-27S		
7	CONNECTS	TO	PIN	G	OF	AN3108B-20-27S		
CONTROL	CONNECTS	TO	PIN	H	OF	AN3108B-20-27S		
GND.	CONNECTS	TO	PIN	L	OF	AN3108B-20-27S		

FIGURE 7. SIGNAL INPUT CABLE TO BCUI CONTROL UNIT

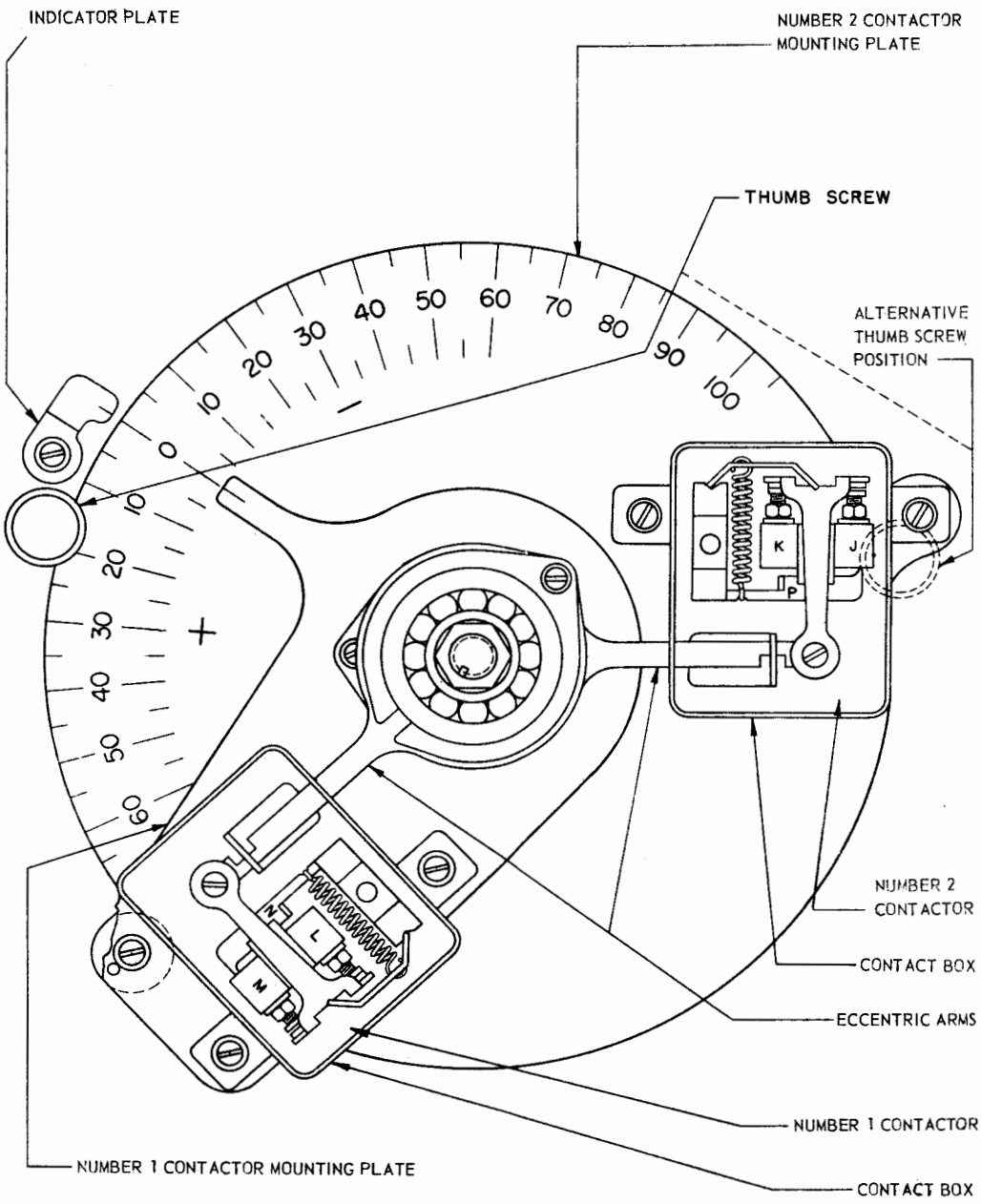


FIGURE 8. REPERFORATOR CONTACTORS