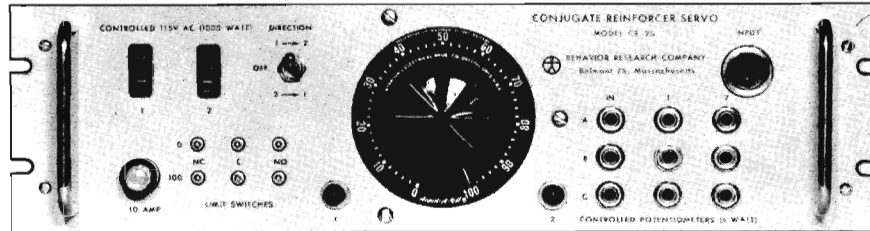




CONJUGATE REINFORCER SERVO MODEL CR-2S



1.0 GENERAL DESCRIPTION

The model CR-2S is an electro-mechanical servo of high quality and reliability designed for conjugately programming all stimuli of interest in human behavioral research as a direct function of response rate. It contains a reversible motor which drives four electrically isolated voltage controllers:

- 1) One 115 volt AC adjustable transformer for controlling projection lamps, heaters, air conditioners, fans, room lights, etc.
- 2) One high resistance potentiometer for controlling TV receiver picture tube brightness, the amplifier stage of audio equipment, etc.
- 3) Two low resistance potentiometers for controlling two separate audio output stages (for example, TV, radio, stereo tape players, etc.)

One CR-2S will control up to four different stimuli in any arrangement of increasing or decreasing functions of the rate of a single response (i. e. the higher the rate, the darker the room lights, the brighter the image on a TV screen, the lower the sound of the TV speaker, and the softer the white noise masking stimuli). It is also ideally suited for single operandum preference testing of narrative and dynamic reinforcers.

A single panel-mounted switch selects reinforcing, attenuating or extinction contingencies for all stimuli without rearranging input and output connectors. The switch will stop the potentiometers at any position for stimulus calibration and monitoring.

Limit switch terminals provide for external report of the number of times and duration that the stimuli are full on or full off, and for automatic testing operations. Panel-mounted glow lamps, and the position of a pointer on the dial, indicate the intensity of the controlled stimuli and the momentary position of the potentiometers at any time.

The CR-2S servo is designed to integrate with standard operant conditioning equipment without internal duplication of parts, enabling maximum economy and range of equipment use. When used with a Grason-Stadler E783F pulse former, an E1100H timer, and an E783B relay, it comprises a complete conjugate programming circuit for as many as four independent stimuli contingent upon a single operant response covering the usual range of human, rat and pigeon response rates (from 30 to 600R/min.) in 8 steps.

2.0 SPECIFICATIONS

Power Requirements	115V AC, 50 to 60 cycles, 8.5 watts
Adjustable Transformer	115V AC, 1000 watts, 0 to 115 volts, 10 amps (indicating fused)
Controlled Potentiometers*	A. 100,000 ohms, 5 watts *Potentiometers of other resistance values can be factory substituted on special order
	B. 10 ohms, 5 watts can be factory substituted on special order
	C. 10 ohms, 5 watts at slight additional cost.
Output Connectors	115V AC receptacles, three contact phone plugs
Terminals	NU-WAY studs
Size	5 1/4" x 19" panel, for relay rack mounting, depth 9 3/4"
Finish	Gray, chrome handles for carrying and bench support
Accessories Supplied	Input cable, 2 range pins, motor oil, 4 rack screws, 3 NU-WAY studs
Shipping Weight	22 lbs.



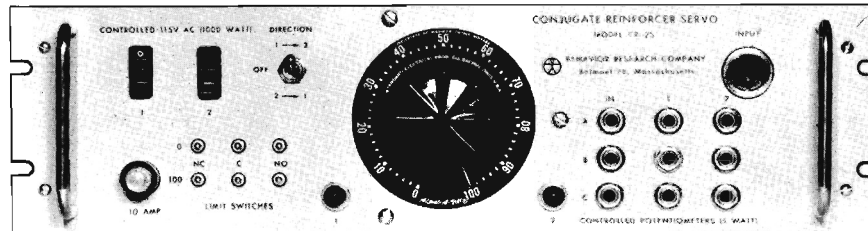
CONJUGATE REINFORCER SERVO
MODEL CR-2S
INSTRUCTION MANUAL

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Accessories Supplied	Input cable, 2 range pins, motor oil, 4 rack screws, 3 NU-WAY studs
Shipping Weight	22 lbs.

4.0 OPERATING INSTRUCTIONS

Detailed instructions for each of the many applications of the CR-2S are impossible to anticipate and therefore the responsibility of the operator. However, instructions for two representative applications are provided below as samples to familiarize the operator with the functions of the CR-2S.

The remainder of these instructions describes the function of CR-2S components.

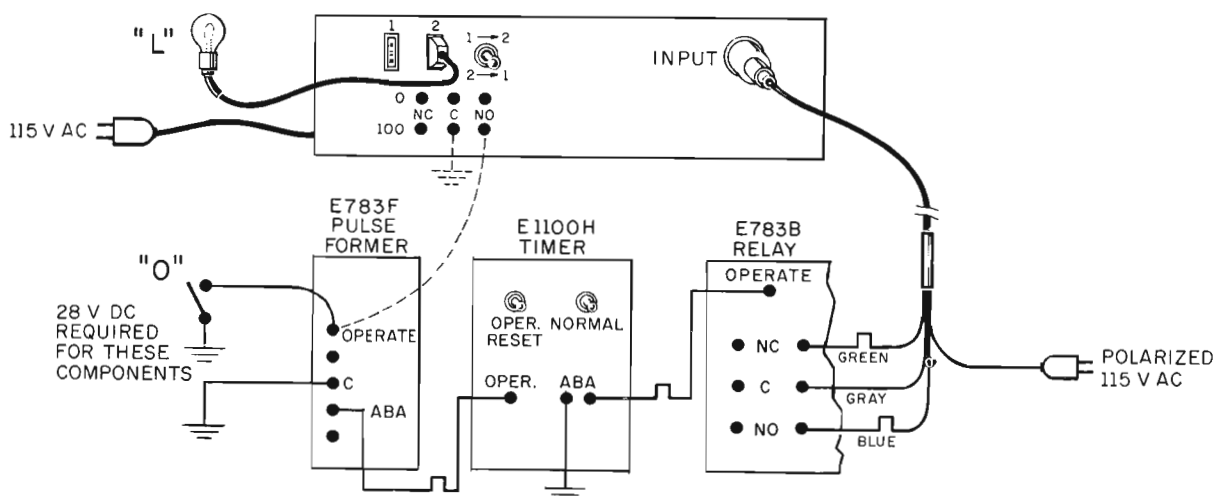
4.1 Stimulus Intensity Control Application. For controlling intensity of appropriate stimuli by switch closures alone as a function of the duration of switch closure, no other operant conditioning equipment is required and the following instructions apply:

- 1) Attach female connector on input cable to CR-2S INPUT.
- 2) Snap NU-WAY fasteners on input cable to NU-WAY studs on suitable terminal strip (3 NU-WAY studs for manufacturing a suitable strip are supplied as accessories).
- 3) Insert male polarized 115V AC plug on input cable into a polarized AC source.
- 4) With the DIRECTION switch in the 1-2 position, connecting the blue to the gray input lead drives the pointer from position "1" to position "2". Connecting the green to the gray lead drives the pointer from position "2" to position "1". (CAUTION: Because at certain positions of the pointer, one of the colored leads will be at a potential greater than ground potential, the terminals should be covered.)
- 5) With the DIRECTION switch in the OFF position, the motor is inoperative and can be stopped at an intermediate position.
- 6) With the DIRECTION switch in the 2-1 position, the direction of pointer rotation is reversed.
- 7) Connecting the terminals to a suitable operandum will control the pointer and potentiometer positions as a function of response duration.
- 8) Any 115V AC stimulus up to 1,000 watts (e.g. room lights) can be controlled by plugging its power lead into receptacle "1" or "2" of the CONTROLLED 115V AC output. The adjustable transformer input plug on the back of the CR-2S should be inserted into a non-polarized 115V AC receptacle to provide power to operate the lights. This power is fused at 10 AMPS to protect the adjustable transformer.
- 9) Audio output from a tape player can be controlled by putting it across a two-contact phone plug inserted into the IN jack of the "B" or "C" controlled 10 ohm potentiometer. The output to a speaker or earphone should be taken by a two-contact phone plug from the two-contact jack labeled "1" or "2".
- 10) With the pointer in position "2", maximum intensity is delivered to receptacle "2" of the CONTROLLED 115V AC output and to position "2" of the controlled potentiometers.

4.2 Conjugate Reinforcing Application. The rate of a free operant response is reinforced by a conjugately programmed increase in the intensity of a projection lamp. The following standard operant conditioning components are used with the CR-2S:

- 1) A timer (for example E1100H manufactured by Grason-Stadler, West Concord, Mass.)
- 2) A pulse former (Grason-Stadler E783F)
- 3) A relay (Grason-Stadler E783B)

A snap-circuit for connecting the components is shown below:



The intensity of the lamp ("L" above) increases as a direct function of the rate of closure of the operandum ("O" above). The rate required to maintain full intensity is controlled by the E1100H timer settings shown in the table in section 4.3 below. Extinction can be programmed by throwing the DIRECTION switch to the "OFF" position. The rate of the response can be attenuated by throwing the DIRECTION switch to the 2→1 position: the intensity of the lamp decreases as the response rate increases.

The snap leads shown as dashed lines connect the limit terminals for automatic operation of the CR-2S with the DIRECTION switch in the 1→2 position for testing.

The above circuit drives the CR-2S from position "1" to "2" as the response rate on "O" increases. The pointer returns from position "2" to position "1" automatically. To have an external event drive the pointer from position "2" to position "1", insert a relay controlled by this event between the green input lead and the normally closed (NC) relay terminal.

4.3 Required Rate of Response. With the E1100H timer connected as shown above and the switches in the "OPER. RESET" and "NORMAL" positions, the second selector and multiplier can be used to select the rate of response required to keep the pointer in the 90 to 100% position shown on the dial according to the following table:

E1100H TIMER SETTING AND REQUIRED RESPONSE RATES

E1100H Setting	Seconds	1.5	1.0	.75	.5	3	2	1.5	1.0
	Mult. Secs.	1	1	1	1	0.1	0.1	0.1	0.1
Response Rate	R/min.	30	45	60	80	120	200	300	600

4.4 Direction. With the DIRECTION switch in the 1→2 position and the CR-2S connected to the standard components as shown above, responding moves the pointer from the "1" position or 0% side of the dial, to the "2" position or 100% side of the dial. In this condition voltages from the number "2" outputs (both 115V AC and controlled potentiometers) increase as a function of response rate. Therefore, if the stimulus is positively reinforcing and it is taken from the number "2" outputs, the response is reinforced. If the stimulus is positively reinforcing and it is taken from the number "1" outputs, the response is attenuated. Furthermore, if the stimulus is negatively reinforcing and it is taken from the number "2" outputs, the response is attenuated; and if a negatively reinforcing stimulus is taken from the number "1" outputs, the response is reinforced.

Any arrangement of this sort can be reversed from a conjugately reinforcing to a conjugately attenuating program by throwing the DIRECTION switch from the 1→2 position to the 2→1 position without rearranging the stimulus output connectors.

Extinction can be programmed by throwing the DIRECTION switch to the center or OFF position. This position can also be used for stopping the pointer at any position on the dial from 0 to 100% for monitoring the stimulus and calibrating its intensity.

4.5 Controlled 115V AC. The CONTROLLED 115V AC will handle 1,000 watts which will cover most stimuli of interest in human research. It is not polarized and is fused at 10 AMPS with an indicating fuse which lights when it has been overloaded. This fuse protects the adjustable transformer.

4.6 Controlled Potentiometers. The three electrically isolated potentiometers provided will cover most low voltage stimuli used in human research. Potentiometer "A" (100,000 ohms) has input and output jacks of the three-contact phone plug type with the tip and center contacts handling the voltage. This type is used to prevent the metal base of the plug from causing a shock hazard. This high resistance pot may be used for controlling TV receiver picture tube brightness or the amplifier stage of audio equipment. When used to control the amplifier stage of audio equipment, the leads should be shielded to reduce hum.

Potentiometers "B" and "C" (both 10 ohms) are provided so that two separate audio channels can be used simultaneously to reinforce or attenuate a single operant response. Stereo tape players require two isolated potentiometers. The output of audio equipment, two speakers, and earphones can be controlled by using potentiometers "B" and "C".

CAUTION: No voltages should be connected to the jacks labeled "1" or "2". Also, high voltages should not be connected to the IN jack of potentiometer "B" or "C". In connecting high DC voltages to the IN jack of potentiometer "A", the voltage should be off during insertion of the plug so that the tip and center contacts are not shorted during insertion.

4.7 Limit Terminals. The terminals labeled LIMIT SWITCHES (NU-WAY studs) provide for the readout of the extreme positions of the pointer (when the stimuli are full on or full off). The terminals labeled "0" close (the C and NO terminals are connected) when the pointer is at the 0% position. When at any other position, the C and NC terminals are connected. The terminals labeled "100" close when the pointer is at the 100% position (the C and NO terminals are connected). At all other positions the terminals labeled "100" have the C and NC terminals connected.

4.8 Range Pins. Because the servo is driven through a slip clutch, it is possible to limit the movement of the pointer to any portion of the complete dial. This is useful in solving problems of stimulus intensity matching. The two range pins supplied as accessories can be inserted into the holes on the pointer dial at any of 19 positions ranging from 5 to 95% in steps of 5%. The pointer bracketed between the two pins is then limited to covering the range of the dial enclosed between the two pins. Two holes are provided at the bottom of the dial for the storage of these range pins when the complete dial excursion is used.

5.0 MAINTENANCE

5.1 Field Repair - Transformer Brush Assembly. We recommend that field repair of the conjugate re-inforcer be limited to replacement of the brush assembly of the adjustable transformer. Standard Electrical Products Co., Dayton, Ohio, manufacturer of the adjustable transformer (their number 500BU), recommends the following procedures for replacement (**IMPORTANT NOTE: Before replacing brush, disconnect 115V AC plug to avoid shock**):

"Brush should be checked periodically for damage. Should the brush be chipped or broken, replace with a new brush assembly from the factory. Order No. for the 500 BU is A-8094. These brushes are made of special material and ordinary carbon will not function.

To replace the brush assembly, simply loosen the two brush guide holder screws. Place a piece of crocus cloth, rough side up on the commutator. Rotate rotor over crocus cloth until brush contact properly seats. Blow carbon particles from commutator. Now your unit is ready for operation."

5.2 Motor Lubricating Instructions. The motor manufacturer, Bodine Electric Company, recommends the following lubricating procedures:

5.21 Oil Lubricated Bearings (identified by two red holes in motor). Add 4 drops of recommended lubricant to oil hole of each bearing before starting. (These have been added at the factory during assembly of the CR-2S.) For normal duty (8 hrs./day 5 day week) lubricate with 10 drops of recommended lubricant every 6 months or more frequently if ambient temperature above 40°C (104°F). For more continuous duty add oil after every 2000 running hours.

5.22 Grease Lubricated Ball Bearings (identified by two metal plugs in oil holes). These bearings do not require relubrication for a period of 3 years if run in normal ambients. For ambient temperatures above 40°C (104°F), more frequent servicing is required. Relubricate by cleaning bearings and repacking with Beacon 325 Grease (Humble Oil Co.) or Equivalent.

5.23 Gear Reducer Lubrication. Gear reducer oil hole identified by Yellow paint or Yellow screw. Reducer is packed with a semi-fluid grease. Remove screw if necessary and relubricate through yellow oil hole every 3 months for normal duty (8 hrs./day 5 day week) with 20 drops of oil. Use only oil furnished with motor or recommended substitute.

5.24 Recommended Lubricants

TEMP. RANGE	RELUB. FOR BEARINGS & GEARS
0°C Ambient to 105°C Total*	1. Gulf Harmony #53 (Gulf Oil Co.) 2. Stanoil 35 (Standard Oil - Div. Amer.) 3. Caloloc Turbine Oil #15 (Standard Oil of California)
-50°C Ambient to 105°C Total*	1. Penola Aviation Instrument Oil (Humble Oil Co.)

*Total Temperature is sum of Ambient and Motor Rise

NOTE: Bottle filled with correct lubricant is furnished with each motor. Additional lubricant in bottle or bulk can be purchased from the Bodine Electric Company, 2500 Bradley Place, Chicago, Illinois

5.3 Clutch Pressure Adjustment. We recommend that clutch repairs be made at the factory. If pointer sticks at one position with motor running, clutch pressure is probably too little. To adjust clutch pressure:

- 1) Loosen the Allen Head screw located on the clutch clamp.
- 2) Rotate the clutch clamp clockwise (viewed from the motor end) to increase pressure, counter-clockwise to reduce pressure (this adjustment will usually be 1/4 to 1/2 a turn).
IMPORTANT: Do not increase pressure too much as this will produce undue wear on clutch facing and motor. Never compress spring completely.
- 3) Retighten Allen Head clamp screw.

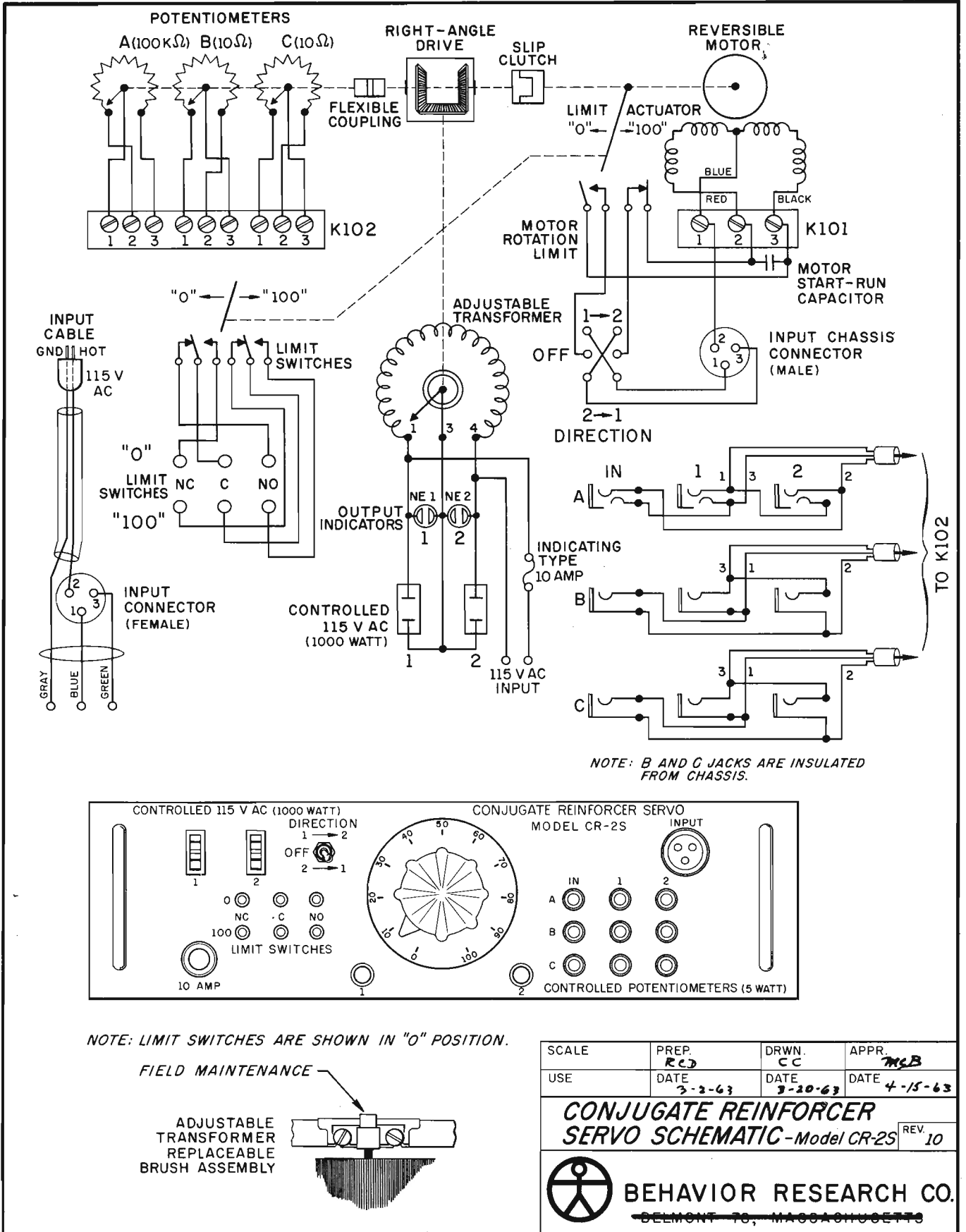
5.4 Controlled Potentiometer Replacement. To replace one of the controlled potentiometers:

- 1) Loosen the (6) wiper hub set screws.
- 2) Remove the (1) wiper shaft set screw on flexible coupling.
- 3) Remove insulated wiper shaft.
- 4) Remove the (2) Phillips Head screws that secure particular potentiometer to the mounting brackets and remove pot. (Be sure to identify the proper connection for each of the three soldered leads.)
- 5) IMPORTANT: When replacing pot, do not tighten the (2) Phillips Head screws excessively, as the bakelite casing threads are easily damaged.
- 6) After replacing the pot and replacing insulated wiper shaft and set screw, turn the pointer on the front of servo panel to the "0" position.
- 7) Rotate the three wiper hubs to their full clockwise position (viewed from the motor end) and tighten the (6) wiper hub set screws.

6.0 CONDITIONS OF SALE

6.1 Warranty. Behavior Research Company (BRC) warrants each new Conjugate Reinforcer Servo to be free from defects in material and workmanship. If an examination of this equipment, by BRC, upon pre-paid return to the factory within one year of purchase, discloses any part to have been defective, repair or replacement of the defective part will be made free of charge. We have no other obligation or liability in connection with this equipment, except as stated in the following Patent Indemnity clause.

6.2 Patent Indemnity. BRC will defend any suit or proceeding brought against the Purchaser so far as based on a claim that this equipment, or any part thereof, constitutes an infringement of any patent of the United States, if notified promptly in writing and given authority, information and assistance (at BRC expense) for the defense of same, and BRC will pay all damages and costs awarded therein against the Purchaser. In case said equipment, or any part thereof, is in such suit held to constitute infringement and the use of said equipment or part is enjoined, BRC will, at its own expense, either procure for the Purchaser the right to continue using said equipment or part; or replace same with non-infringing equipment; or modify it so it becomes non-infringing; or remove said equipment and refund the purchase price and the transportation costs thereof. The foregoing states the entire liability of BRC for patent infringement by said equipment or any part thereof.



NOTE: LIMIT SWITCHES ARE SHOWN IN "0" POSITION.

SCALE	PREP RCJ	DRWN CC	APPR. MGB
USE	DATE 3-2-63	DATE 3-20-63	DATE 4-15-63

CONJUGATE REINFORCER SERVO SCHEMATIC - Model CR-2S REV. 10

