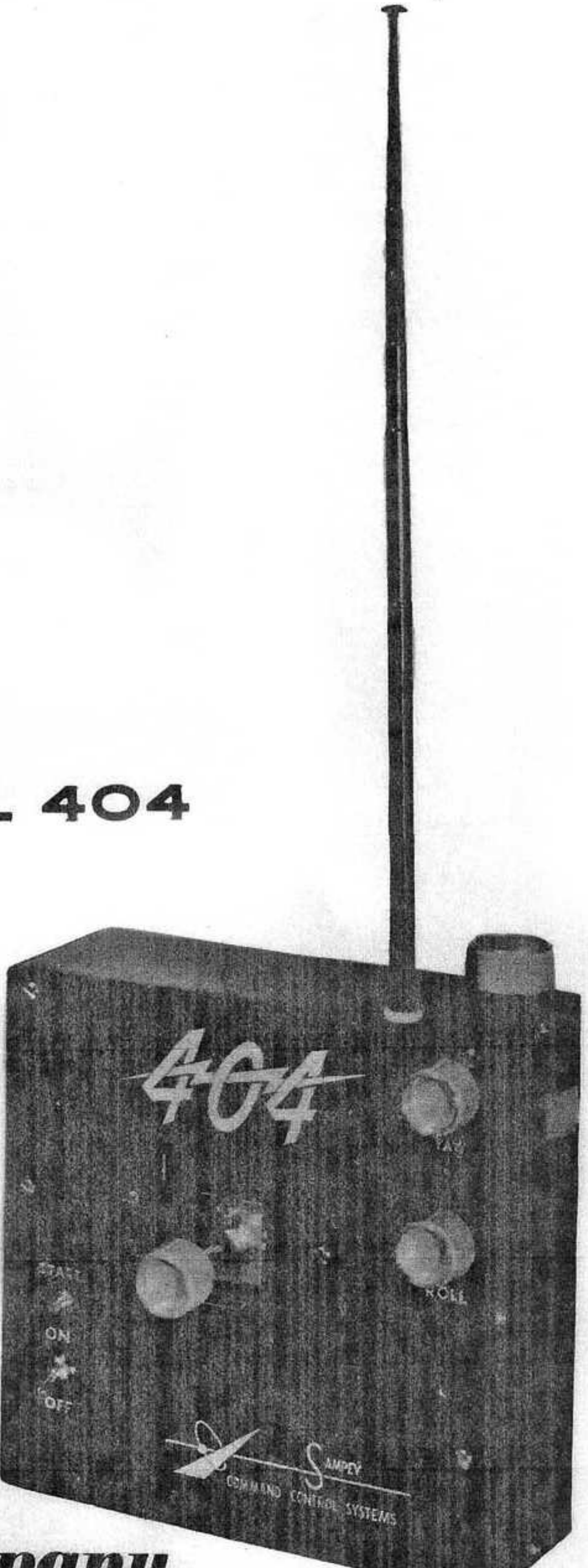
OPERATING & SERVICE INSTRUCTIONS

404

CONTROL SYSTEM MODEL 404



Sampey & Company

MANUFACTURERS OF COMMAND CONTROL SYSTEMS

TECHNICAL SPECIFICATIONS

OPERATING FREQUENCY	A. M. 26.995 MC — 54.0 MC
TRANSMISSION	Sequence transmission of 4 separate Audio Frequencies 1200, 1800, 2700, 3700 cps
POWER INPUT	1.5 Watts
MODULATION	95%
TRANSMITTER CURRENT	1.25 Amps
AIRBORNE CURRENT (4 CHN)	.35 Amps. Average
SERVO TORQUE	± 3.0 in/lbs.
SERVO ROTATION	± 45 deg./.04 Volts Input
RECEIVER SENSITIVITY	1.0 Microvolts Super-Reg. 4.0 Microvolts Super-Het.

SCHEMATIC DATA

TRANSISTORS

Q1 thru Q8, Q15, Q16, Q18, Q19, Q26, Q27, Q29 — — — 2N223 or EQUIV.

Q9, Q10	2N301	Q14, Q17	2N384
Q11	2N711B	Q20, Q23, Q24, Q25, Q28	2N35
Q12, Q13	2N404	Q21, Q22	2N217

6 Meters

C-1	47 pf
C-2	470 pf
C-3	25 pf
RFC1	22 uf
RFC2	10 uf

11 Meters

C-1	100 pf
C-2	470 pf
C-3	47 pf
RFC1	39 uf
RFC2	22 uf

SIZE & WEIGHT

RECEIVER:	3 1/4 x	2 1/8 x	1 5/8	inches	6.5 oz.
SERVO:	2 1/2 x	2 1/2 x	1	inches	2.75 oz.
POWER PACK:	2 3/8 x	1 5/8 x	2 1/8	inches	6.75 oz.
TRANSMITTER:	8 x	8 x	3	inches	3.5 lbs.

GENERAL DESCRIPTION

1—1 Introduction

The Sampey Model 404 Proportional Control System is a remote control device designed to provide four simultaneous proportional controls. The entire system consists of Transmitter, Receiver, Servos, Power Junction and Receiver/Transmitter Power Supplies. The total system employes a complement of 58 transisters, 14 didoes and 3 tubes. The Model 404 has been designed to meet the necessary environmental conditions and when treated with care will provide many years of trouble free operation.

1—2 Unpacking

After unpacking the radio equipment, examine it closely for any possible damage which may have occurred during transit. Should any sign of damage be apparent, file a claim immediately with the carrier stating the extent of damage. Carefully check all shipping labels and tags for special instructions before removing or destroying them.

1—3 Power Source

If you have purchased the necessary power packs for the system it is advisable to place the battery packs on charge for a period of 24 hours prior to operation of the equipment. The battery packs as shipped will normally have about 50 percent charge and will provide enough power for preliminary check-out if desired.

1—4 Charger

The Model 404-2c is a dual charger designed to charge at the recommended rate of the transmitter and Model 404-PP airborne power packs. Both packs may be charged simultaneously or independently. The charger supplies an output charging current rate of 80 mah and 400 mah. A full charge will be obtained after charging for 16 hours. During the charging cycle it is normal for the charger to operate warm.

1—5 Power Junction

The model 404-37 power junction is a 37 pin central power distribution plug which allows for ease of installation and versatility in operation. The junction has been color coded to match the respective plugs. Reference should be made to Figure No. 1 prior to the connection of any plugs to the junction. Always insure that the junction power switch is in the "off" position before inserting the Model 404-PP power pack plug.

INSTALLATION

2—1 Location

Mount the Receiver using foam rubber for protection. Foam rubber mounting will afford the receiver maximum protection against high impact forces. The Servos may be mounted in a conventional manner. It is not necessary to shock mount the servos unless high vibration forces are expected. All moveable control surfaces should be as free in operation as possible for precision control. Note Figure No. 4 for proper push rod connection.

NOTE: If you have purchased the Model 404-37 Power Junction and Model 404-PP Power Pack disregard paragraph 2-2 and follow the equipment connection diagram as viewed from Figure No. 1.

2—2 Airborne Wiring

Install two 2PST switches or one 4PST switch in a convenient location. (These switches may be removed for soldering after the wiring harness has been properly routed).

Place into approximate location the battery pack. This unit (Receiver and Servos) requires 14 each 1.5 or 1.2 volt batteries. We suggest using four 225 mah battery cells (NiCad) for Servo power and 10 each 100 mah NiCad battery cells for the receiver and Reference voltages. One word of importance before you begin your wiring. Keep the wiring between the battery and servos as short as possible. Always use 24 GA or 22 GA (19) strand wire for the servo voltages.

Study very carefully the wiring schematic in Figure No. 3 before making any electrical connections. Permanent damage to the Receiver or Servo Amplifiers can result with improper wiring.

in the battery circuit since it is imperative that the voltages being suppled through this switch are applied at the same time. If two 2PST switches are used, the Servo reference voltage should be supplied to the servos prior to the application 2PST switches can be thrown at the same instant. Proportional operating Servos have no means for centering and therefore, must depend upon electrical centering which comes from the battery supply reference voltage.

OPERATION

3—1 Receiver

After the wiring has been completed to the Receiver, Servos and Battery Pack, place to the "ON" position the Servo/Reference power switch or switches. The Servo actuators should move to an approximate neutral position. The Receiver has been pre-program tuned to allow neutral return of the YAW, ROLL, and PITCH servos when the Transmitter is off. The motor servo is pre-programmed to one extreme end for slow speed use.

The servo actuators may show very slght spasmodic movements. These variations in movement are the result of outside noise entering the Receiver and is normal operation. With the power switch in the ON position note and adjust the Servo actuator linkages (REF: Servo Instructions Para. 3-5) for an average neutral control surface. With this adjustment made, this is the position the Servos will take if the Transmitter signal is removed or jammed.

3-2 Receiver/Transmitter Compatibility

After the wiring has been completed, batteries installed and Servo adjustments made, the following steps shall be taken prior to test operations and flight.

a. Rotate the TRIM controls on the transmitter to a center position.

b. Rotate the MOTOR controls on the transmitter to the slow speed position.

c. Place the Transmitter into operation by placing the power switch to ON and depressing the start button.

d. Place the Receiver and Servos into operation.

NOTE: No spasmodic movements shall be observed in the Servo actuators. It must be pointed out that the control surface loads are considered part of a closed-loop servo system, therefore, evaluate your system operation with the control surfaces connected.

e. Observe the position of the servo actuators. If the servos are not on neutral position, they may be adjusted for this position with the Transmitter by small adjustments of the master oscillators. These controls can be reached from the front of the Transmitter case through four small holes, Figure No. 2. A small screw driver is required to make the adjustment. These control pots are broad tuned, so you should use care when making any adjustments. If the controls are moved too far from their assigned channel they will interfere with a co-channel. It is also possible to adjust the controls to a false center, in which case unequal travel of the servos will be noted when you move the control handle. There should be no further adjustments necessary of the master oscillator controls.

f. Move the control handle to various positions. The control surfaces should follow every movement of the stick simultaneously. Now, rotate the motor control to various positions. "THIS IS TRUE QUAD PROPORTIONAL CONTROL."

g. Check the direction of servo travel. In some installations, it may be imperative that the actuator travel be opposite in direction. If it is not desirable to change the servo actuator you may make changes in the transmitter which will provide the desired direction of travel. The travel direction may be reversed on any channel by reversing the two outside wires of the control pot in question. If change the outside pot wire going to the respective trim pot. Such a change is minor and can be performed in a few minutes. DO NOT change the wiper arm wire on the control handle pots or trim pots. They do not control direction.

3-3 Range Check

The Receiver has been tuned to the operating frequency of the Transmitter at the factory and should require no further tuning. After the receiver is mounted in the Model a short range check may be made by placing the model on the ground outdoors. This check should be made with the Transmitter antenna collapsed. Place both the airborne equipment and the Transmitter into operation. Open the throttle control to full open and while applying full right roll or full up pitch step back from the model approximately 75 to 100 ft. There should be no indicated loss of signal at this distance when holding the Transmitter in a normal manner. There should be no persons near the model during this test. If further tests are desired, the model may be held above ground and checked in the same manner as above with the antenna fully extended for a distance of about 1200 ft.

It is suggested that when mounting the receiver that the antenna be located away from all metal objects and push-rods. It should be noted that radiation checks inside of buildings is inadequate and a proportional system cannot be properly evaluated in this manner.

3-4 Tuning

Although proper tuning of a Receiver should be performed with the necessary testing equipment the alignment can, however, be performed in the field if care is used. The necessary steps may be performed using caution and carefully making the following adjustments.

a. Remove the receiver from the model and with the receiving antenna located in an approximate position as for flight place the airborne system into operation.

b. With the Transmitter "ON" and the antenna collapsed hold full rudder and step away from the model until the rudder begins to return to neutral.

c. Using a plastic tuning wand retune the RF slug through the hole in the top of the case until the rudder swings to full position again. Continue this procedure until maximum range is obtained.

It should be noted that this adjustment is critical and should be made with care for maximum performance. The same procedure should be followed when changing receiver frequency.

3-5 Servo Operation And Adjustment

The servo may be operated with any type of control system, provided the proper voltages are supplied. Figure No. 3 shows the proper wiring to the servo. Unlike other types of actuator units, closed-loop servos require certain conditions that must be maintained for proper operation. Therefore, observe with caution the following notes:

a. Do not operate the servo with no input signal wire (purple).

b. Power voltages should always be applied to the servo at the same instant a 4PST switch will work fine. Never apply ± 3.0 volts prior to ± 6.0 volts.

c. Never permit the actuator to be mechanically limited in its travel. All control surfaces must be completely free in operation for precision flying. Motor control linkages should employ an expansion joint.

Remove the top cover from the servo case. With a zero signal voltage applied to the input wire (purple) or connected to the control system, apply power voltage to the servo. After the actuator arm has seeked a fixed position, turn the power voltage off. While holding the follow-up wiper assembly (Figure No. 5) loosen the set screw holding the wiper to the actuator shaft. While still holding the wiper assembly in a fixed position, rotate the actuator arm to any desired position you wish when the input signal is at zero volts. For the 404 control system, this will be the position at which the actuator arm will rest when the transmitter is turned off. (A near zero setting has been set by the manufacturer). After making this adjustment, tighten the shaft screw and replace the case cover. **DO NOT** make this adjustment with power applied to the servo.

4—1 Transmitter Section

In the transmitter, resistor elements R-10 through R-26 make up the voltage divider chain. Incorporated into each divider is the control axis potentiometer, a trim control potentiometer and a broad tune potentiometer that provides wider voltage adjustments utilized in tuning to different multiplex receivers. All four dividers are connected directly to the 135 volt buss.

The output control voltages from the dividers are connected directly to the heart of the system, the commutator. The commutator operates as a ring counter and is very simple in operation since all four stages are identical in circuitry. This circuitry is made up of four separate one shot multivibrators. The one shot multivibrator, also called a univibrator, differs from the conventional multivibrator (which is free running) and the flip-flop (which is bistable) in that it is a monostable circuit. That is, the univibrator may be pulsed into operation, but after delivering one output pulse, it reverts to its zero output resting state after the actuating pulse has passed. Thus, the one-shot multivibrator delivers an output signal pulse each time it is triggered into operation by an input signal pulse.

To reduce some of the circuit description, only one of the common circuits will be analyzed. When the circuit is in its quiescent state, transistor Q2 conducts current because of the connection of its base to the negative terminal of the DC supply through series resistor R1, transistor Q1 is biased in the opposite direction by resistor R2. Since capacitor C2 is now in a charged state, transistor Q1 remains off. Coil L1 makes up the collector load for transistor Q1. Inclosed within this coil is a very small magnetic reed switch, which has gold plated contacts and is encapsuled in glass. As the magnetic field of the coil increases from collector current, the switch snaps closed and remains so until the collapse of this field.

When a positive pulse is applied to the collector of Q1, this reduces the negative potential at the base of Q2 and reduces the charge on C2. Transistor Q1 begins to draw collector current through coil L1. The transition is rapid, Q1 switching on and Q2 off. The reed switch is now closed.

Immediately after this switching operation, Capacitor C1 begins to discharge and as it does, the negative voltage on the base of Q2 begins to rise once more toward the supply potential. At the end of this discharge interval, Q2 again is conducting and Q1 nonconducting, the quiescent condition of the circuit. As we begin to approach our quiescent state (Q2 on) a positive pulse is generated at the collector of Q2. This pulse is coupled to the second univibrator circuit by capacitor C3 causing it to flip-flop as did the first circuit when a positive pulse was applied to its collector. Each stage is coupled together as described and so the sequence begins. First, circuit one, then two and so on until the end of circuit four. Here we do the same thing. The final positive pulse is coupled back to the first circuit and the sequence is started over and the chain reaction continues endlessly. Since the flip-flops are not free running, a starting pulse must be applied somewhere to start the operational sequence. This pulse is easily provided by coupling B voltage through capacitor C13. When the start switch is depressed. This shock is enough to jolt the commutator into operation.

With the values indicated on the schematic, the commutator operates at an average of 25 pulses per second (samples per second) however, none of the multiplex systems is considered critical, therefore, operation of the commutator from 15 to 40 samples per second would not impair the final performance.

In the transmitter each control voltage is series connected through steering diodes which provide proper isolation for each voltage channel. Channel 1 (motor) does not pass through a switch. The reason for this is that the channel 1 is the lowest voltage and can be supplied directly since all other channel voltages are higher in potential. So, if channels 2, 3, or 4 are activated, they will override the motor channel voltage. Although, it must be mentioned that the motor control time interval must still be maintained by the commutator time sequence. By employing this method the need for an additional coil and reed switch are eliminated. All control voltages, after passing through the commutator, are connected to a common buss which is connected directly to the control oscillator circuit.

The control oscillator consists of a single voltage controlled electron coupled multivibrator circuit employing two 3V4 tubes. The derived frequency of this circuit is directly proportional to the quantity of applied voltage.

4—2 Multiplex Receiver Section

The purpose of this multiplex receiver is the same as with any receiver except in this case, there has been added a few extra stage discriminators. The first function of any receiver is to demodulate the incoming radio frequency signal. However, in the Multiplex Receiver no important circuit changes are required since one important feature of sequence transmission of each tone is the ability of the receiver system to maintain an effective 100 percent modulation for each channel transmitted. A second feature sidesteps the problem of Audio Harmonic Generation that is present with systems transmitting more than one tone simultaneously.

The limiter stage of the receiver plays a very important function. It provides a constant output signal whether it be from plain noise or a high powered fifty thousand microvolt RF signal, even though AGC may be employed elsewhere within the receiver circuit.

From the limiter stage, the clipped signal is connected through series resistor R2 to the input buss of the four discriminator stages. Resistive coupling is used instead of capacitive coupling because the capacitor charging and discharging current would result in a transient bias on the input to the discriminators when the effective signal level changed.

The most important design consideration is the ability of the discriminator to select only the channel it is interested in and to retain, for a period of time, what information it has decoded. This is evident since each channel is provided with information only 25 percent of the available time.

The clipped signal is applied through isolation resistors R4 and R5 to the two filters in the discriminator. Each of these filters are tuned so they will resonant at a given frequency. As an example, the center frequency of motor channel is 1150 cps. To provide discrimination filter L3 is tuned to resonant at 1100 cps. Filter L4 is adjusted to 1200 cps. When the input frequency is 1150 cps, there will be equal transfer of energy to the following stages by each filter. Or in other words, a balanced condition will exist. But if we shift the incoming motor channel frequency more toward the resonant frequency of L4, then L3 passes a smaller portion of signal than before while L4 passes a larger amount of signal. To allow these filters to operate at their maximum efficiency, they are followed in the circuit by transistors Q20 and Q21. These transistors operate in a normal emitter follower circuit that provides a high impedance for the tuned filters. Transistors Q22 and Q23 provide the necessary amplication for their respective filters. Connected between the collector of these two transistors is potentiometer R12. Since Q22 is a PNP transistor, a negative potential is present on one side of R12. On the other side of R12 is a positive potential derived from NPN transistor Q23. With no input present to the discriminator, and R12 adjusted for a balanced condition between Q22 and Q23, the output voltage, is zero. Long as the input frequency applied is exactly between the filter resonant frequencies, the output voltage wil still be zero. But, if we shift the input frequency toward the frequency of one filter or the other, it will shift the discriminator output voltage polarity proportionally. Electrolytic capacitors C1 and C2 are charged by the burst of incoming information that is passed by the filters and will remain in a near charged state, thereby allowing the circuit to retain a derived voltage over the time period between the frequency burst.

4—3 Servo System Section

A closed loop servo system is an error reducing, closed loop, automatic control device so designed that the output element or output quality follows, as closely as desired, the input to the system. The output is caused to follow the input by the action of the servo controller upon the output element in such a way as to cause the instantaneous error, of difference between output and input to approach zero. All servo systems are dynamic systems containing at least one feedback loop which provides an input signal proportional to the deviation of the actual output from the desired output. This property distinguishes servo systems from open loop automatic control systems.

posed of an error sensing circuit, amplifier, motor and load. The input differential DC signal, or error, is amplified by the servo and amplifier and applied to the motor. The motor output drives the load and feed back potentiometer which provides the feedback displacement signal necessary to complete the loop.

The input error signal to the amplifier is presented at the base of Q24 which has been shunted by R1. In a static condition (one in whch all voltages are balanced) the base and emitter voltage of Q24, error sensing differential stage, is such that driver transistors Q28 and Q29 are turned off. If voltage other than zero is applied to the base of Q24, the change of Q24 condition causes current to flow through the motor winding by the "turn on" operation of either Q28 or Q29. As the motor rotates, it displaces the wiper arm of FP-1 potentiometer. The feedback voltage from FP-1 voltage causes Q24 to drive in opposition to the polarity of the input signal. When the voltage ratio of the emitter is equal to the input voltage, current through stops.

The gain of the differential amplifier is effectively controlled by resistor R2 to ground. If the value of R2 is lowered, the overall displacement ratio of the amplifier would be increased. The actual displacement would also increase due to the IR drop through FP-1 which determines the feedback voltage ratio. This value of FP-1 is chosen since it permits the use of the same voltage supply, supplying the discriminator circuits. R3 and R4 are connected in series with FP-1 to allow a more linear tranverse action.

To provide the proper damping, a simple form of rate damping is employed. This action is provided by coupling through R6 the back voltage of the motor to the error sensing stage.

The value of the damping ratio required is significant in the determination of the servo performance. The following table shows four conditions of damping ratio:

Values of Damping Ratio	Damping	Remarks
0	None	Sustained Oscillation
<1	Under Damped	Fast Response with Overshoot*
1	Critically Damped	Intermediate Response With No Overshoot
>1	Over Damped	Slow Response

*The first overshoot to a step displacement input is related to the Damping ratio as shown in the following table.

Damping Ratio	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
Overshoot —%	69	50	38	26	16	10	5	1.5	.9	0

Since both overshoot and response are important, a compromise value of ratio between 0.5 and 0.6 is selected. This provides an overshoot percentage of 10 through 16 percent. Although this overshoot value may appear to be quite high, experience has shown that variations in components, gear trains and coupling linkages to control surfaces will provide a certain amount of mechanical damping. This most important advantage of having the servo system underdamped is the error at null is held to within 2.0 percent.

4—4 Airborne Power Pack Section

The model 404-PP is an airborne power supply designed to supply all of the necessary voltages to power the 404 Proportional Control System. The Power Supply consists basically of four 800 mah sintered-plate rechargeable Nickel-Cadmium batteries. These four batteries supply the necessary operating current to power the closed-loop Servos. Powered also from these batteries is a 6 Volt output converter which is utilized in supplying the requirements of the Receiver and Servo reference voltages. The power converter employes two transistors, transformer, bridge rectifier and two zenier diode regulators. The input voltage of ± 3 Volts is increased by the converter to ± 6 Volts regulated to within 1%, regardless of the charge state or the load imposed on the batteries or the output voltage.

The converter and batteries are inclosed in a high impact plastic case weighing approximately 6.5 ounces. Dimensions are 2½ x 2¼ x 1 5/8 inches. The Power Pack is not sensitive to vibration and can therefore be mounted in any position.

IMPORTANT

Momentary Loss of Signal During Flight

In some model installations an electrical noise condition may be present that will cause momentary loss of signal during flight. It is important that the user be aware of the possibility of this condition even though RF range test have indicated normal range.

Static noise is an odd phenomenon of radio and when it occurs near an RC Receiver the results can become an ever increasing problem whose origin may never be suspected.

Proportional operating receivers require the reception of signal information 100 percent of the time when this signal is interrupted for any period, deviations will begin to occur. Although this condition may not always avail itself it can become present during certain propagated attitudes of flight and during engine vibration. The rate at which this condition exists will of course depend upon the ampitude of static noise being created within the area of the receiver. It is therefore important that all necessary steps be taken to eliminate any potential areas that may be suspected of being capable of generating static noise.

It is recommended that the following precautions be taken during the installation of the equipment prior to flight.

a. DO NOT USE LONG LENGTHS OF METAL PUSH RODS.

b. ALWAYS CONNECT METAL TO METAL WITH SOME SORT OF INSULATOR SUCH AS A NYLON CLEVIS CONNECTION.

c. NEVER ALLOW METAL TO COME INTO CONTACT WITH OTHER METALS THAT MAY BE CAPABLE OF GENERATING STATIC NOISE.

d. KEEP THE RECEIVING ANTENNA AS FAR FROM METAL AS POSSIBLE.

e. RELOCATE THE RECEIVING ANTENNA IN ANOTHER AREA IF DROP-OUT OF SIGNAL IS NOTED DURING FLIGHT.

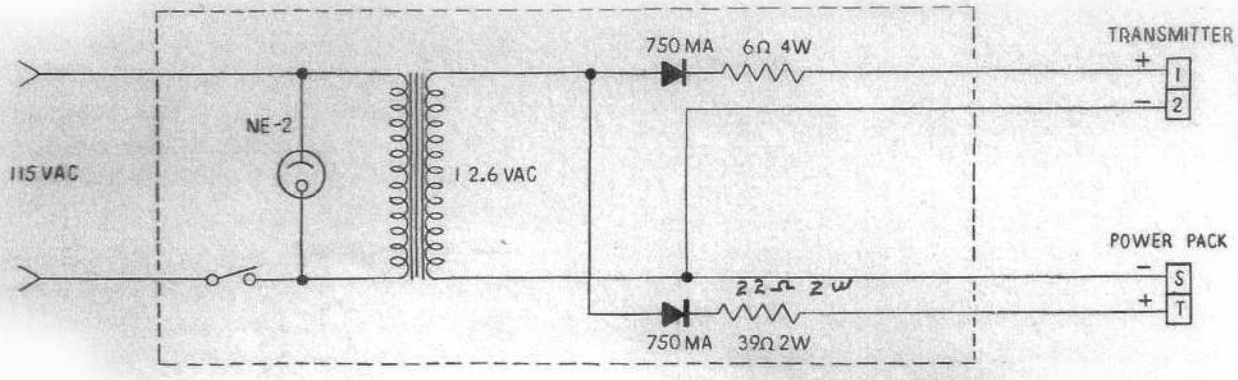
WARRANTY

"The Sampey Company warrants each new radio product manufactured by it to be free from defective material and workmanship and agrees to remedy any such defect or to furnish a new part in exchange for any part of any unit of its manufacture which under normal installation, use and sevice discloses such defect, provided the unit is delivered by the owner to our factory or authorized agent, intact, for examination, with all transportation charges prepaid within ninety days from the date of sale to original purchaser and provided that such examination discloses in our judgment that it is thus defective.

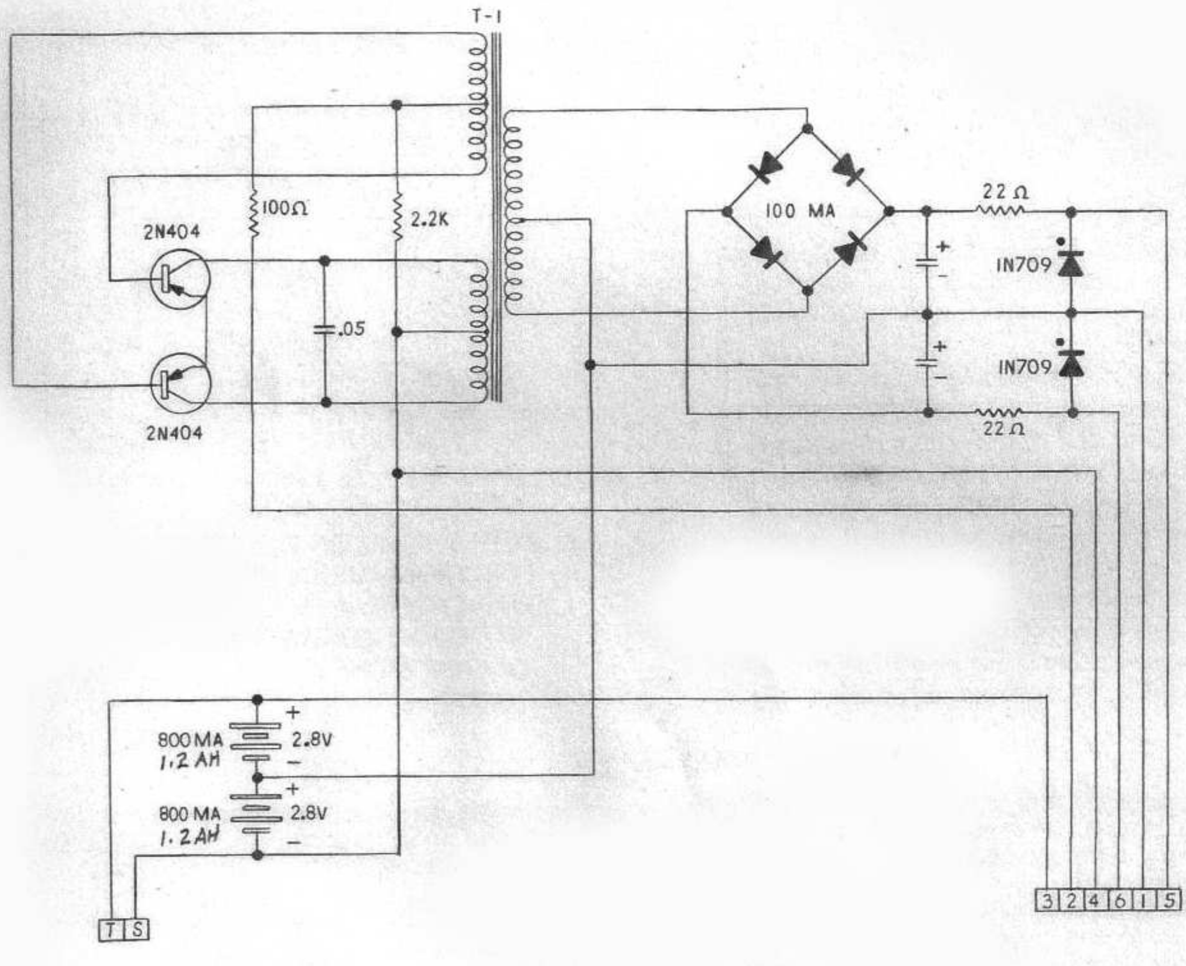
This warranty does not extend to any of our radio products which have been subjected to misuse, neglect, accident, incorrect wiring not our own, improper installation or to use in violation of instructions furnished by us, nor extend to units which have been repaired or altered outside of our factory or authorized agent.

Any part of a unit approved for remedy or exchange hereunder will be remedied or exchanged by the authorized agent or our factory sales division without charge to the owner.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for us any other liability in connection with the sales of our radio products."

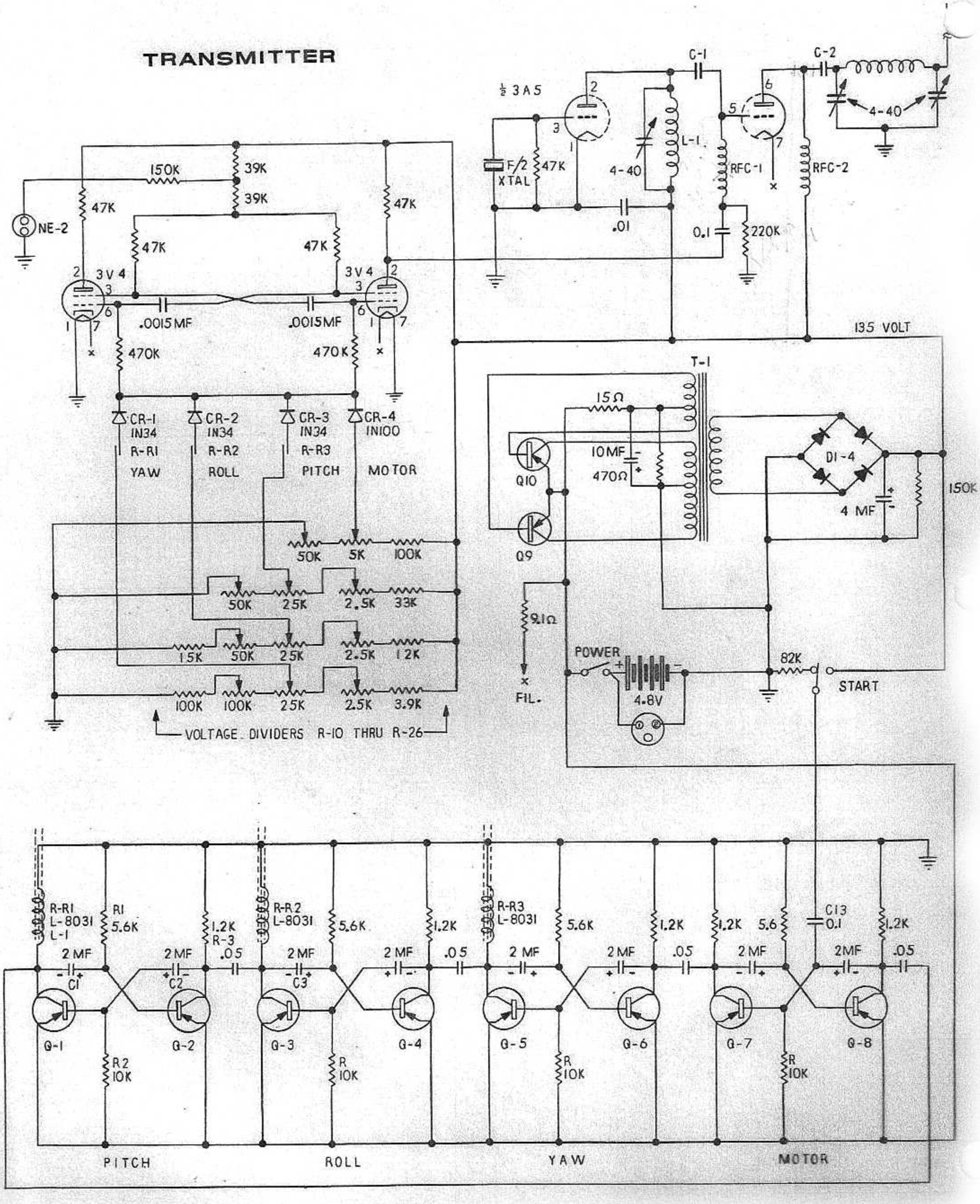


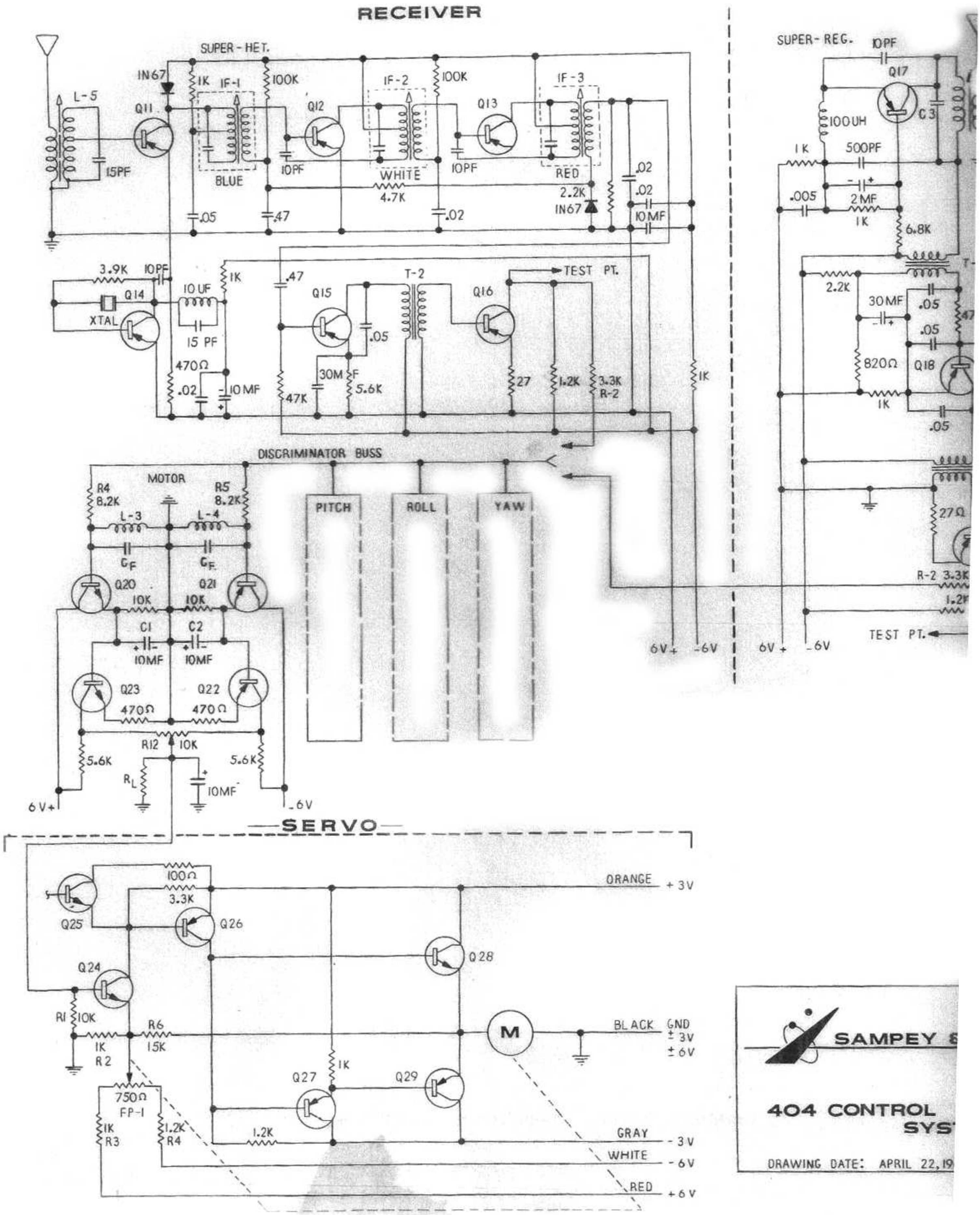
MODEL 404-2C CHARGER



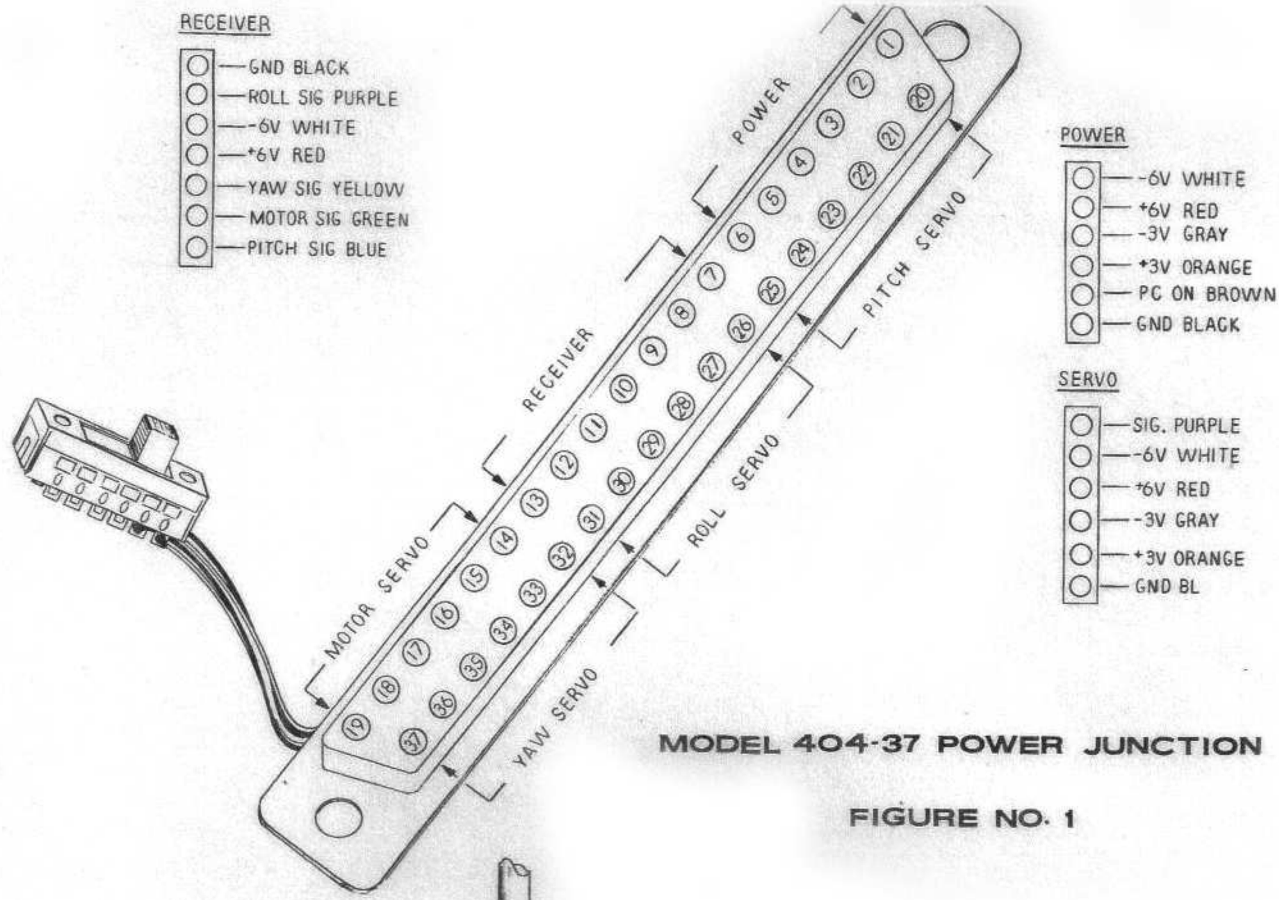
MODEL 404-PP POWER PACK

TRANSMITTER



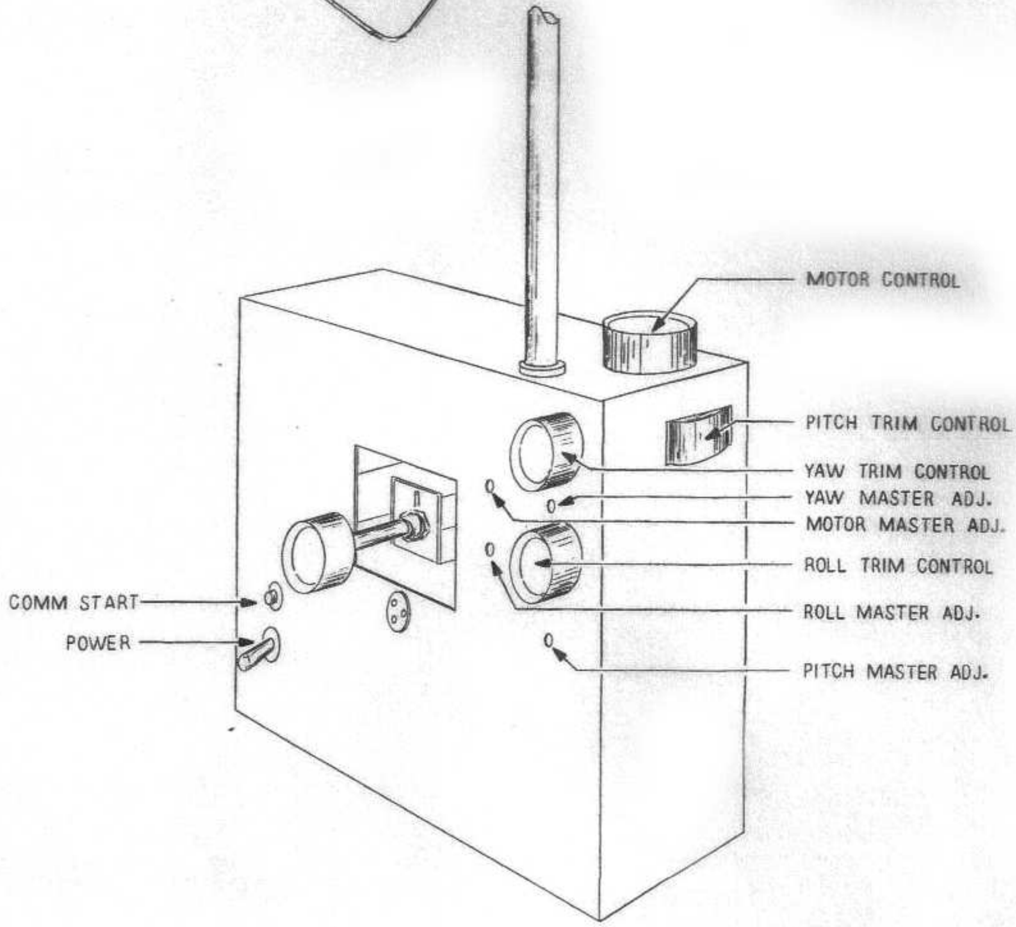


RECEIVER
SUPER-HET.
SUPER-REG.
IN67
L-5
Q11
15PF
1K
IF-1
BLUE
100K
Q12
10PF
IF-2
WHITE
4.7K
Q13
IF-3
RED
2.2K
.02
10MF
.05
.47
3.9K
10PF
Q14
XTAL
10 UF
15 PF
470Ω
10 MF
Q15
T-2
Q16
TEST PT.
30MF
5.6K
47K
27
1.2K
3.3K
R-2
DISCRIMINATOR BUSS
PITCH
ROLL
YAW
MOTOR
R4
8.2K
R5
8.2K
L-3
L-4
CF
Q20
Q21
10K
C1
C2
10MF
Q23
Q22
470Ω
R12
10K
5.6K
RL
6V+
-6V
Q17
100UH
C3
500PF
2 MF
.005
6.8K
820Ω
Q18
27Ω
SERVO
Q25
100Ω
3.3K
Q26
ORANGE
+3V
Q28
Q24
R1
10K
1K
R2
R6
15K
M
BLACK
GND
±3V
±6V
Q27
Q29
750Ω
FP-1
1K
R3
1.2K
R4
GRAY
-3V
WHITE
-6V
RED
+6V
SAMPEY
404 CONTROL
SYS
DRAWING DATE: APRIL 22, 19



MODEL 404-37 POWER JUNCTION

FIGURE NO. 1



TRANSMITTER FUNCTION CONTROLS

FIGURE NO. 2

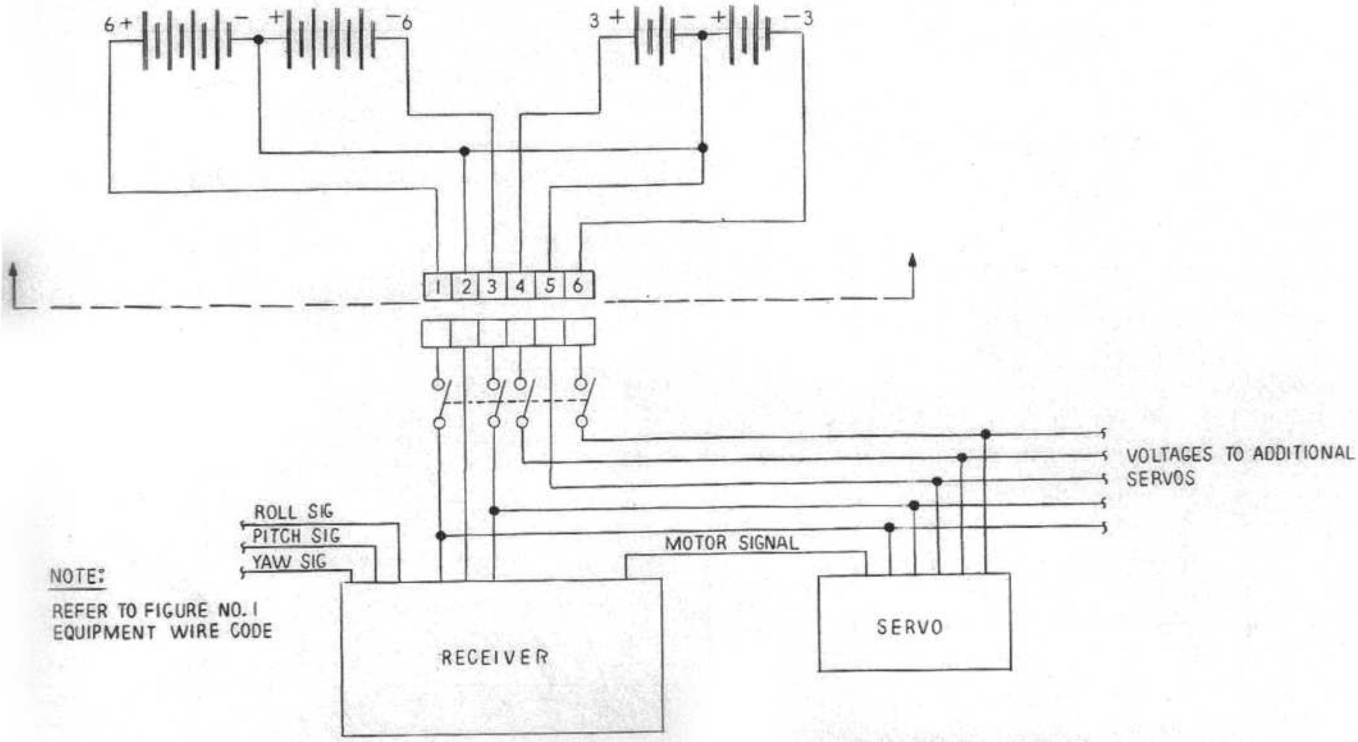


FIGURE NO. 3

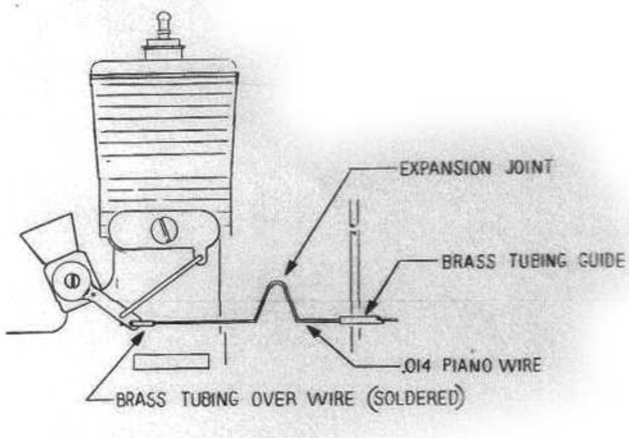


FIGURE NO. 4

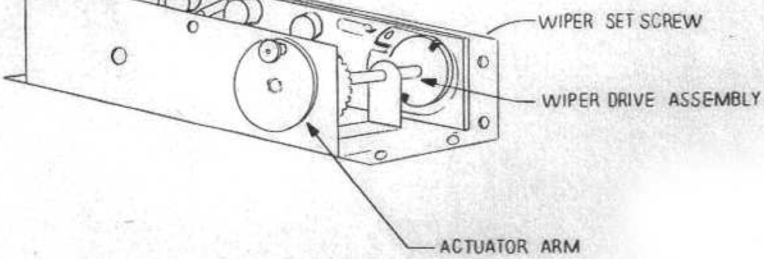


FIGURE NO. 5