Controlaire Electronics Division

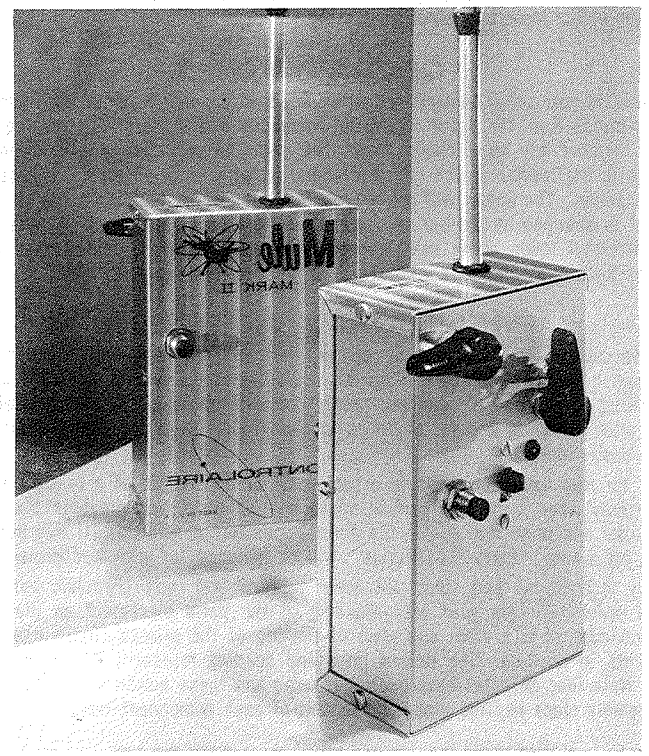
**WORLD ENGINES**

I N C O R P O R A T E D

8206 BLUE ASH ROAD CINCINNATI, OHIO 45236

# CONTROLAIRE

# GALLOPING MULE CONVERSION KIT




# ASSEMBLY INSTRUCTIONS

Made In U.S.A.

# GALLOPING MULE CONVERSION KIT

## INTRODUCTION

The Controlaire Galloping Mule Conversion Kit affords a relatively simple manner in which to convert a Mark II Mule transmitter to pulse operation. While this is not intended to produce a super-deluxe G-G transmitter, it will give the Mule all the capabilities necessary for Galloping Ghost and Rudder-Only flying or model car control.

The circuit utilized is from the latest model of Controlaire's all-silicon, Galloping Ghost transmitter which is voltage and temperature stable. The conversion does not change the basic operation of the Mule for escapement flying.

## OPERATION

The pulser and its associated controls are all mounted on the rear cover of the transmitter and all connections from the pulser are made to readily accessible points, making it unnecessary to remove the Mule chassis from the case. In operation, the existing Mule on/off switch is the master switch with the added on/off switch on the back controlling power to the pulser. The pulser will not operate without the front switch being on. Pulse width control is obtained by the spring centered, vertical lever; pulse rate by the spring centered, horizontal lever, while solid carrier is obtained with the added push button switch on the back and solid tone with the existing Mule push button.

## PRELIMINARY NOTES

After you have studied the pictorials and read the instructions, unpack your kit and check each part against the check list. By doing this you will become familiar with the various parts comprising the complete assembly. After completing the check separate all like components into individual groups, resistors in one group, condensers in another, until all parts are easily identified.

On occasion, we may have to substitute a part to allow completion of a production run. This is done only when a specific part is unavailable. Substitution prevents a delay in filling your order and in no way affects the normal operation of your kit. If this has been done in your kit a note, "Parts Substitution," will be included for your identification.

The assembly instructions and steps are quite detailed and comprehensive, but a few notes are in order. To help your understanding of the parts placement an illustration (Fig. 3) is provided. It is a giant size view of the top of the printed circuit board with the components in position. The dotted lines and shading represent the copper lands underneath. Note that all holes have been numbered and these numbers as listed in the different assembly steps key the proper placement of each component lead.

## ASSEMBLY INSTRUCTIONS

Construction is started by cutting out the full size hole template (Fig. 1) or making an overlay drawing, if you don't care to cut up the instruction booklet. Remove the sub-antenna grommet and place the template on the **inside** of the case back with the top edge even and check to see that the sub-antenna hole aligns pretty closely with the location shown on the template; this will indicate to you whether or not your template is orientated correctly. Tape or hold the template in position and transfer the hole centers and four corners of the slide switch cut out to the case with a scribe or some other sharp pointed tool. You will probably come out better by pilot-drilling all seven holes with a 3/32" drill initially, then open the two switch holes up to 1/8". The three larger holes can be opened up to 3/16" or 1/4" with a drill and then taken up to 3/8" with a tapered hand ream as larger drills don't work too well on thin aluminum. After scribing the outline of the



rectangular opening for the slide switch, a series of 3/32" diameter holes are drilled within the outline to remove the bulk of the metal, and the opening finished with a small file.

After deburring the case holes, refer to (Fig. 2) for a detail of the centering spring arrangement. The two spring detents may now be installed in the 3/32" holes in the case back. Run the 2-56 screws thru the aircraft nuts from the normal direction once to impress threads in the nylon locking insert and then assemble with brass eyelets as shown in Fig. 2.

Now that the hard part is done, the electronic construction may be started; follow the assembly steps below using rosin core solder and a 25 to 40 watt soldering iron. Refer to Fig. 3 for parts placement and hole numbers. Locate all parts as close as possible (within reason) to the board to preclude interference later with transmitter parts. Excess lead material should be removed after soldering with a small pair of diagonal cutters.

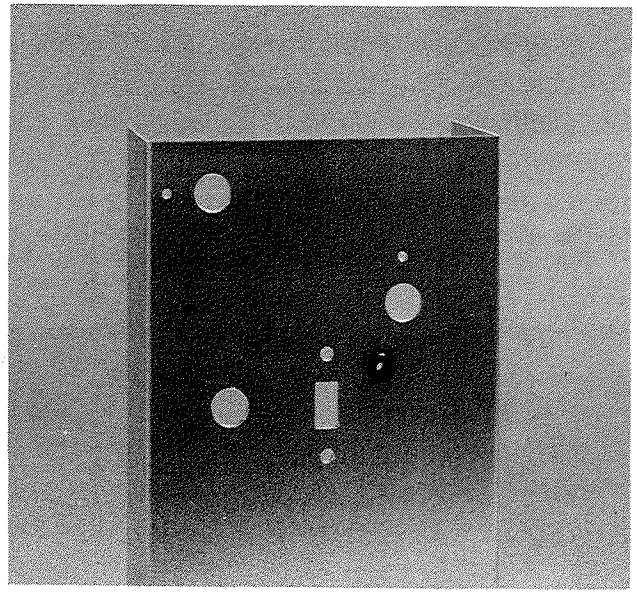


PHOTO 1-Mark II Mule Tx case back. All holes have been drilled for mounting the Galloping Mule Conversion Kit.

( ) 1. Install the 100 mfd electrolytic capacitor in holes 11 and 15, lying flat with the positive lead (the end marked +) in hole 15.

( ) 2. Install the 5 to 15 mfd electrolytic capacitor in holes 9 and 10, lying flat with positive lead in hole 9.

( ) 3. Install a .01 mfd disc capacitor in holes 16 and 17.

( ) 4. Install a .001 mfd disc capacitor in holes 24 and 27.

( ) 5. Install a 330 ohm 1/4 watt resistor (orange, orange, brown) in holes 5 and 6, standing vertically over hole 5.

( ) 6. Install a 4.7K ohm 1/4 watt resistor (yellow, violet, red) in holes 4 and 8, standing vertically over hole 8.

( ) 7. Install a 100 K ohm 1/4 watt resistor (brown, black, yellow) in holes 13 and 14,

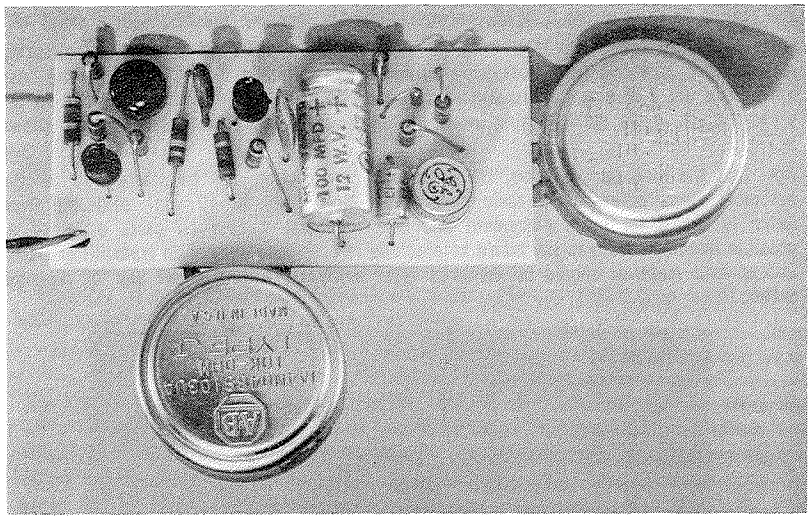


PHOTO 2A-Top view of conversion kit P.C. Board with all components in place; this photo matches Fig. 3.

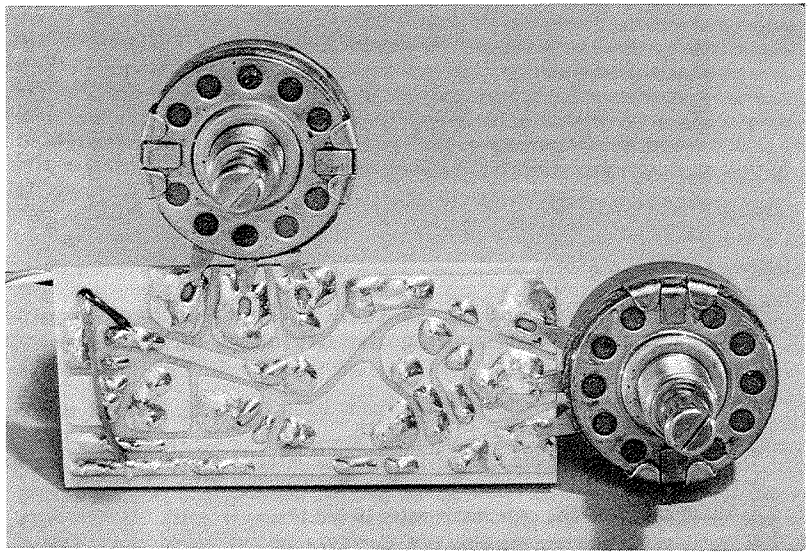


PHOTO 2B-Copper land side of the P.C. Board. This shows the arrangement and mounting of the Pots.



standing vertically over hole 14.

( ) 8. Install a 4.7K ohm ¼ watt resistor (yellow, violet, red) in holes 18 and 20, standing vertically over hole 20.

( ) 9. Install a 1K ohm ¼ watt resistor (brown, black, red) in holes 19 and 26, lying flat.

( ) 10. Install a 10K ohm ¼ watt resistor (brown, black, orange) in holes 25 and 28, lying flat.

( ) 11. Three identical 4.7K ohm ¼ watt resistors (yellow, violet, red) are installed in this step; the first in holes 29 and 30, standing vertically over hole 30; the second in holes 31 and 37, standing vertically over hole 37 and the third in holes 35 and 36, standing vertically over hole 35.

( ) 12. Install a 4.7K ohm ¼ watt resistor (yellow, violet, red) in holes 42 and 43, lying flat.

( ) 13. Note that the small glass DHD 806 diode has an identification band around one end of its body; this denotes the cathode lead end. Install the DHD 806 in holes 7 and 12 with the cathode lead in and standing vertically over hole 7.

( ) 14. Install the 2N1671 unijunction transistor in holes 1, 2, and 3 with the identification tab on the case oriented between holes 2 and 3. Locate this transistor within 1/16" from the circuit board.

( ) 15. Install the 2N3638 transistor in holes 32, 33, and 34. This transistor is epoxy encapsulated and there is no lead identification tab, but inspection of the leads will reveal that there is only one position it can be installed in, fitting down close to the board without mangling the leads.

( ) 16. The two 2N2924 transistors are installed in this step. Notice that the three leads are located in line and equally spaced. Bend the two end leads away from the center lead slightly. Refer to Fig. 3 for correct orientation of the flat portion of the epoxy case and install one 2N2924 in holes 21, 22, and 23 and the other in holes 38, 39, and 40. Stand these transistors about ⅛" above the circuit board.

( ) 17. Cut a 4 inch yellow, a 4 inch black and a 8 inch red length of flexible hookup wire, strip ⅛ inch of insulation from one end and tin the leads. Thread the wires

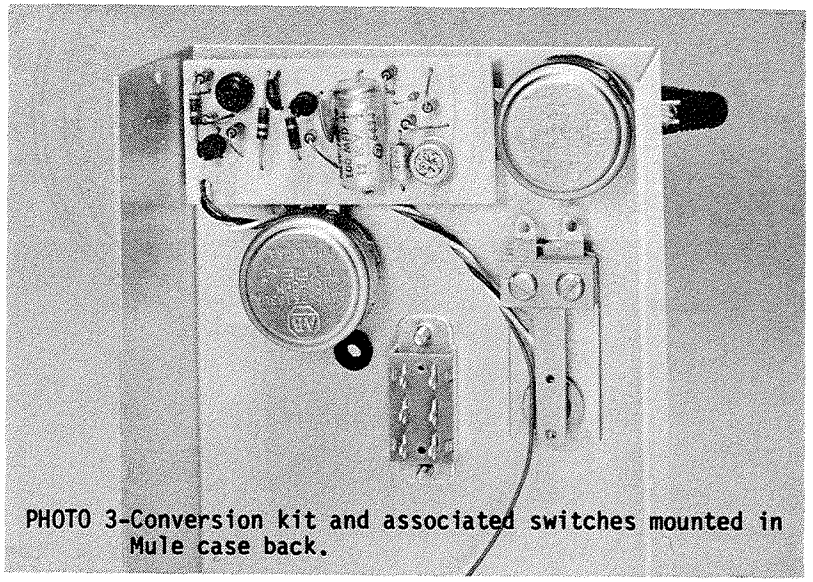


PHOTO 3-Conversion kit and associated switches mounted in Mule case back.

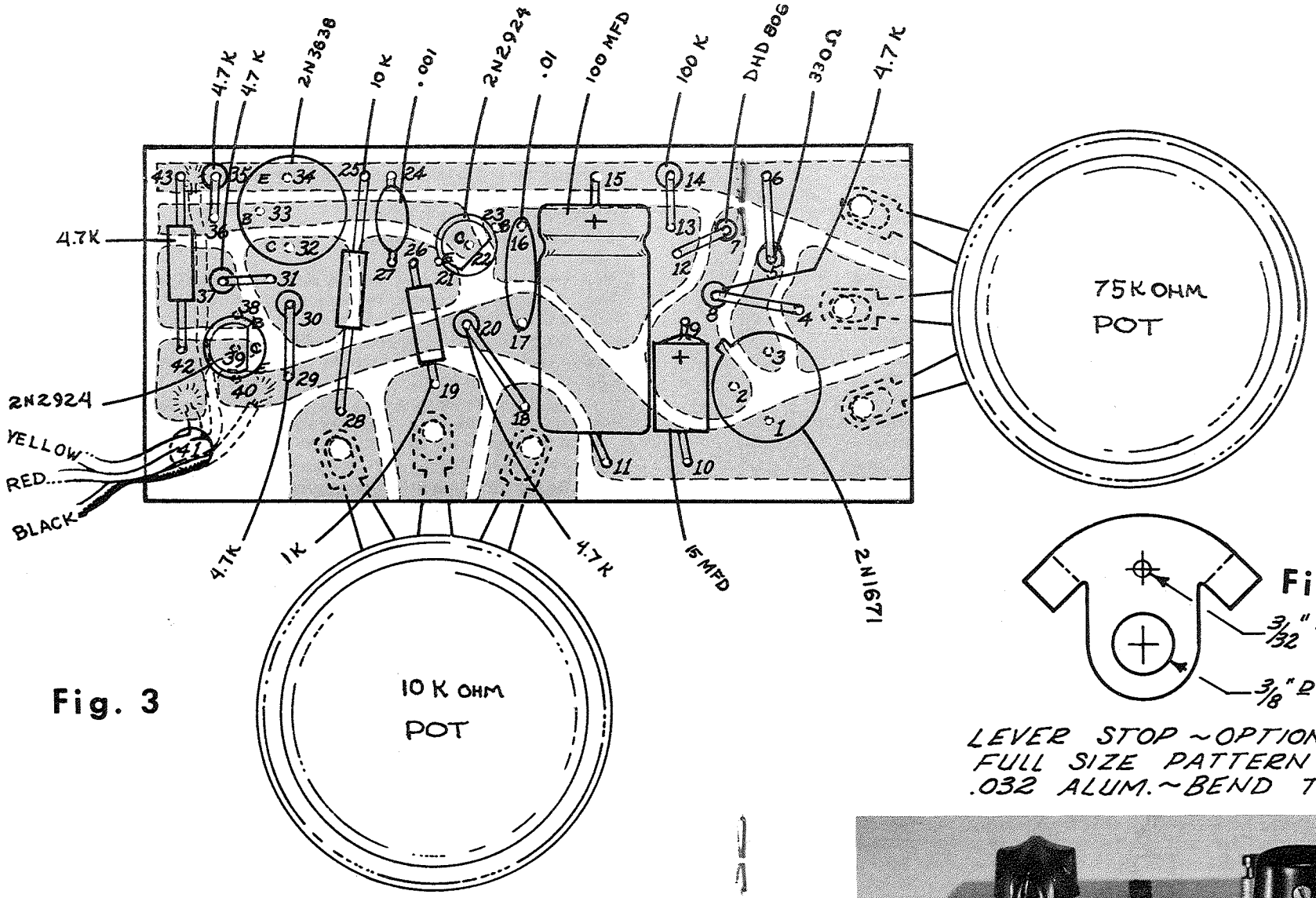



Fig. 3




Fig. 4

LEVER STOP ~OPTIONAL ~
FULL SIZE PATTERN, MAT'L ~
.032 ALUM. ~BEND TABS 90°

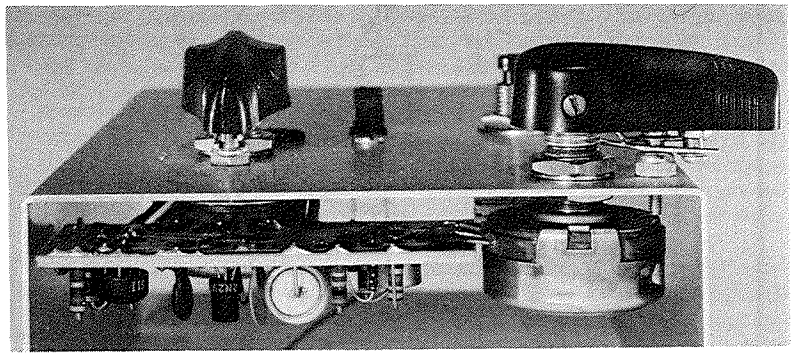


PHOTO 4-Top view of case back. Here you can see centering spring arrangment and proper location of P.C. Board.

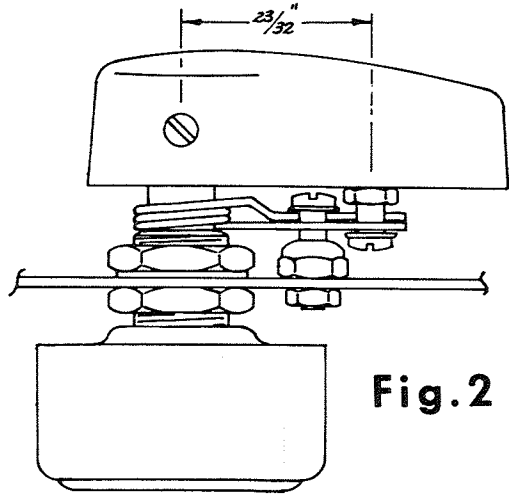



Fig. 2

CENTERING SPRING DETAIL
SPRING MAT'L ~.040 MUSIC WIRE

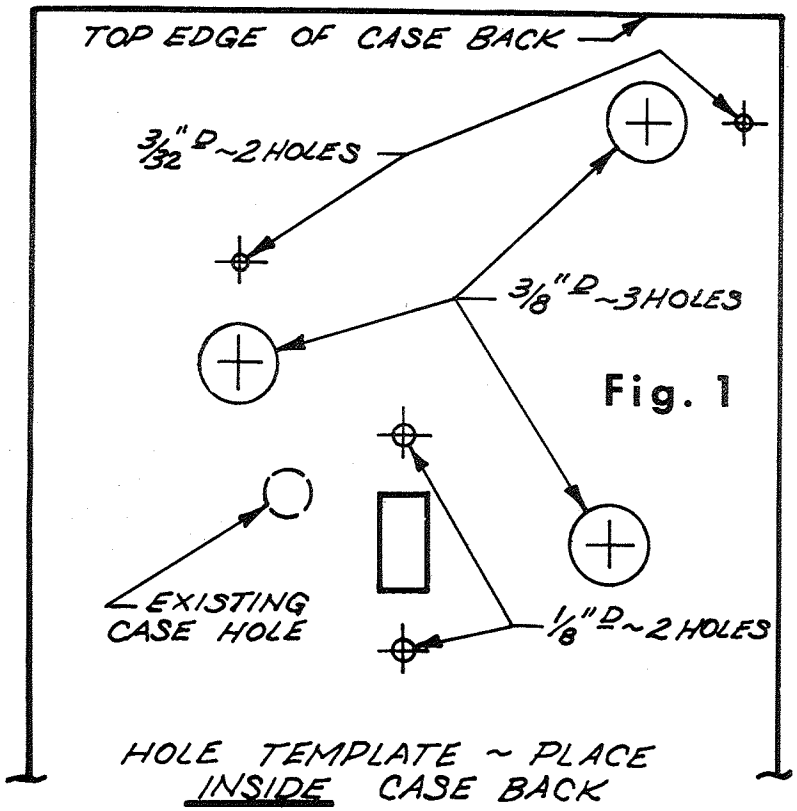



Fig. 1

HOLE TEMPLATE ~ PLACE INSIDE CASE BACK



thru hole 41 and solder the yellow wire to the circuit land adjacent to hole 42, the black wire to the land containing hole 40 and the red wire to the land containing hole 43.

( ) 18. The control pots are added next, with the 75K pulse rate pot (elevator) being located at the end of the board with the lugs soldered to the lands containing holes 1, 4, and 6. The 10K pulse width pot (rudder) lugs are soldered to the lands containing holes 18, 19, and 28. Lay the circuit board with the foil side up and position the pots with the shafts projecting upward and about 1/16" clearance between the pot body and the edge of the board. Utilize the 1/16" diameter spots on the circuit lands to aid in aligning the pots. Initially tack solder only the center lugs of both pots and trial fit the unit in the case; shift the pots as necessary to match the holes and final solder all lugs.

( ) 19. Install the sub-antenna grommet, slide switch and pushbutton to the case back and install the pulser in the case with a 3/8 pot nut on the inside of the case and a 3/8 lock washer and nut on the outside on each pot shank. Slip the lever centering springs on the pot shafts and engage the ends in position on each side of the case mounted spring detent eyelets. Adjust the in and out location of the pots until springs are positioned correctly and final tighten the pot nuts.

( ) 20. Strip 1/8" of insulation from the red, black and yellow wire from the pulser, tin the ends and solder the black wire to the upper lug of the slide switch and the yellow wire to one lug of the pushbutton switch.

( ) 21. Cut a 5" length of yellow and a 5" length of black flexible hookup wire, remove 1/8" of insulation and tin all ends. Solder the black wire to the center terminal of the slide switch and the yellow wire to the remaining lug of the pushbutton switch.

( ) 22. You are now ready to wire the pulser to the Mule, but before doing so, set the pots somewhere near the middle of their rotation range. With this accomplished, solder the red wire to the upper right hand lug of the Mule switch on the component side of the board. Notice that there are two slotted holes in the circuit board located beneath the square shield can with lugs protruding thru them; solder the black wire to the upper lug and the yellow wire to the lower lug. The back cover may now be installed to the transmitter. Route the new wires down below the sub-antenna and make sure the sub-antenna protrudes thru its grommet correctly.

( ) 23. Install the spring detents on the levers as shown in Fig. 2. The 2-56 screws will self tap into the Nylon.

## ALIGNMENT

Pulser adjustment is relatively easy with the aid of a tone monitor. The cut and try method consists of turning the unit on to find out if the pots are set in an operable range. If you can hear the unit pulsing on the monitor, then it's simply a matter of setting the pots for neutral pulse rate and width. If the unit is not pulsing, rotate the pots both ways in turn until the operable range is found. If you were not successful so far, remove the back of the transmitter and take voltage readings between the center lugs of the pots (resistor leads at holes 4 and 19) and the case ground. Remember that the case is grounded to the battery positive and the best place to pick up a ground connection is on the perimeter land of the mule chassis or the positive battery snap. Set the voltage of the rate pot (Hole 4) at —3.5 volts and the width pot (Hole 18) at —4.5 volts, and again see if the unit is operating. If the pulser is not running now, you can be pretty sure of a mistake in the wiring or shorted circuit lands. Pulser output may be checked on a scope by taking a signal from the lugs of the pushbutton.

Final adjustment of the neutral pulse rate and width should be made in conjunction with an operating receiver and actuator. Once this is done, the levers may be installed and you're in business. Stops to limit the lever throw are optional and may be achieved by many methods. A simple bent up sheet metal stop is shown in Fig. 4; this type is held in place with the pot nut and spring detent screw.

# GALLOPING MULE CONVERSION KIT

## PARTS CHECK AND PRICE LIST

| QUANTITY | DESCRIPTION | PRICE EACH |
|---|---|---|
| ( ✓ ) 1 ea. | .001 MFD Disc. Capacitor | .15 |
| ( ✓ ) 1 ea. | .01 MFD Disc. Capacitor | .15 |
| ( ✓ ) 1 ea. | 5 to 15 MFD Tantalytic Capacitor | .70 |
| ( ✓ ) 1 ea. | 100 MFD Electrolytic Capacitor | .90 |
| ( ✓ ) 1 ea. | 330 ohm ¼ watt 10% Resistors | .12 |
| ( ✓ ) 1 ea. | 1K ohm ¼ watt 10% Resistors (brown, black, red) | .12 |
| ( ✓ ) 6 ea. | 4.7 ohm ¼ watt 10% Resistors (yellow, violet, red) | .12 |
| ( ✓ ) 1 ea. | 10K ohm ¼ watt 10% Resistor (brown, black, orange) | .12 |
| ( ✓ ) 1 ea. | 100K ohm ¼ watt 10% Resistor (brown, black, yellow) | .12 |
| ( ✓ ) 1 ea. | DHD 806 Silicon Diode | .35 |
| ( ✓ ) 1 ea. | 2N 1671 Uni-junction Transistor | 3.20 |
| ( ✓ ) 1 ea. | 2N 3638 Transistor | .90 |
| ( ✓ ) 2 ea. | 2N 2924 Transistor | 1.50 |
| ( ) 4 ea. | 2-56 x ⅜" Pan Head Machine Screw | 4 @ .05 |
| ( ) 4 ea. | 2-56 Nuts | 4 @ .05 |
| ( ) 2 ea. | 2-56 Aircraft Nuts | 2 @ .05 |
| ( ) 2 ea. | Centering Springs | .10 |
| ( ) 4 ea. | ⅛" OD x ⅛" Brass Eyelets | 4 @ .05 |
| ( ) 2 ea. | 4-40 x ¼" Pan Head Machine Screws | 2 @ .03 |
| ( ) 4 ea. | ⅜" Pot Nuts | 2 @ .05 |
| ( ) 2 ea. | ⅜" Lock Washers | 2 @ .05 |
| ( ) 1 ea. | 75K Pot | 2.25 |
| ( ) 1 ea. | 10K Pot | 2.25 |
| ( ✓ ) 1 ea. | P. C. Board, Prefabricated | 1.95 |
| ( ) 1 ea. | 8" length #26, 19 Strand Wire (red, yellow, black) | 3 @ .05 |
| ( ) 1 ea. | N. C. Push Button | 1.05 |
| ( ) 1 ea. | DPDT Slide Switch | .45 |
| ( ) 2 ea. | Lever Knob | .35 |



## Circuit Diagram