butternut

Instructions

Model CAP-1

Butternut Electronics Co's Instruction Manual for:
Model CAP-1 — 1984 (Revised 1987)

NOTE:
The CAP-1 Vertical antenna previously manufactured by Butternut Electronics Co. was discontinued in 1990. Parts are no longer available for these antennas. This instruction is made available as a reference.

831 N Central Ave Wood Dale IL 60191-1219 Tel: 630.238.1183 Fax: 630.238.1186 e-mail: bencher@bencher.com http://www.bencher.com

00786IZV 032800

BUTTERNUT ELECTRONICS CO.

405 E. Market Street Lockhart, Texas 78644

MODEL CAP-1 VERTICAL ANTENNA FOR CIVIL AIR PATROL FREQUENCIES IN THE 4.6, 7.6 AND 14.9 MHZ RANGES

ASSEMBLY AND INSTALLATION INSTRUCTIONS

PLEASE READ INSTRUCTIONS THOROUGHLY BEFORE PROCEEDING TO ASSEMBLY. DURING ASSEMBLY AND INSTALLATION TAKE EXTREME CARE TO AVOID CONTACTING POWER LINES WITH ANY PART OF THE ANTENNA OR WITH OTHER CONDUCTORS.

DO NOT INSTALL THE ANTENNA IN ANY PLACE WHERE ANY PART OF IT CAN COME INTO CONTACT WITH POWER LINES IN THE EVENT OF STRUCTURAL FAILURE OF ANY PART OF THE INSTALLATION OR IN THE COURSE OF NORMAL FLEXING AFTER INSTALLATION, FOR SUCH CONTACT CAN RESULT IN DAMAGE TO PROPERTY, BODILY INJURY OR EVEN DEATH!

IN NO CASE SHOULD THE ANTENNA BE INSTALLED IN ANY PLACE WHERE STRUCTURAL FAILURE OF ANY PART OF THE ANTENNA OR ITS SUPPORTING SYSTEM CAN ENDANGER PERSONS OR PROPERTY.

Tools required for assembly: standard blade screwdriver, pliers, knife; a set of nutdrivers will be useful but not necessary.

1. Check to be sure that no parts are missing (see parts pictorial page.)

2. If the antenna is to be installed at ground level, plant mounting post A in a hole approximately 21 inches (.55 meters) deep so that the upper end of the fiber rod insulator is approximately 5 inches (12 cm.) above ground level. Pack earth tightly around the mounting post so that it will remain vertical. Concrete may be used in areas of high wind for greater rigidity, in which case the mounting post should be rotated while the concrete is setting so that it may be easily removed later. If the antenna is to be mounted in concrete or in damp, acidic or alkaline soil the mounting post should be given a protective coating of asphalt roofing compound, polyurethane varnish or another suitable covering to protect the metal against corrosion. Do not hammer the mounting post into the ground; hammering can splinter the fiber rod insulator and complicate installation.

3. Prepare the impedance matching/ d.c. grounding coil (Q) as shown in figure 2.

4. Locate section B. This consists of two aluminum tubes, a long one and a short one, joined by a length of insulator rod. The longer tube will later be mounted on the rod insulator at the top of the mounting post (A). In all subsequent steps involving section B assembly should be done indoors or in an area where dropped hardware may easily be recovered.

5. Locate coil assembly (C) for the 4.6 MHz range (refer to fig. 1). Slide either end of this coil over the short end of section B, lowering the coil until the upper clamp of the coil can be positioned approximately an inch from the insulating rod. The lower clamp will have to be pulled open slightly to clear the hardware that fastens the two tubes to the rod insulator. Secure the upper coil clamp firmly in place, using a split-lock washer and a #10 hex nut. Secure the lower coil clamp, using a split-lock washer and a wing nut. Do not tighten too snugly, for the lower clamp will have to be reset later.

6. Take up the assembled 7.6 MHz coil an capacitor unit (D) and slide the end of tube E that has the plastic insulator up through the lower coil clamp and into the upper coil clamp of the assembly. Use a split-lock washer and #10 hex nut to fasten the upper clamp securely around the plastic insulator. The upper edge of the coil clamp should be flush with the edge of the plastic insulator. Use a split-lock washer and a wing nut to secure the lower coil clamp around the metal part of section E--not too tightly, however, for this clamp too may have to be moved during the adjustment procedure.

7. Place the remaining clamp of the completed 7.6 MHz assembly around section B immediately above the upper clamp of the 4.6 MHz coil (C) and secure firmly using a split-lock washer and a #10 hex nut.

8. Locate double clamp F. Place the larger of the two clamps around section B and the smaller clamp around the lower end of tube E of the 7.6 MHz assembly. Secure both ends of F with #10 x 1-inch bolts, split-lock washers and hex nuts after aligning tube E so that it is parallel with section B. This completes the assembly of the 4.6 and 7.6 MHz tuning circuits.

9. Locate tuning rod G for the 14.9 MHz range, clamp H and double clamp and capacitor unit I.

10. Refer to figure 3 and slide tuning rod G through clamp H and double clamp and capacitor unit I as shown. Finger tighten each clamp using the hardware already on the small end of the double clamp and an assembled #8 split-lock washer and hex nut for the large end of the double clamp to position unit I around tube E. Place the hole at the end of clamp H over the #10 bolt coming through the upper coil clamp of the 7.6 MHz unit and secure using a #10 split-lock washer and hex nut.

11. Slide tuning rod G so that the rounded top is 10 inches above the upper edge of clamp H. Tighten clamps H and I firmly around tuning rod G and around the tubing of the 7.6 MHz assembly. Section B and the attached outboard assemblies may be set aside temporarily.

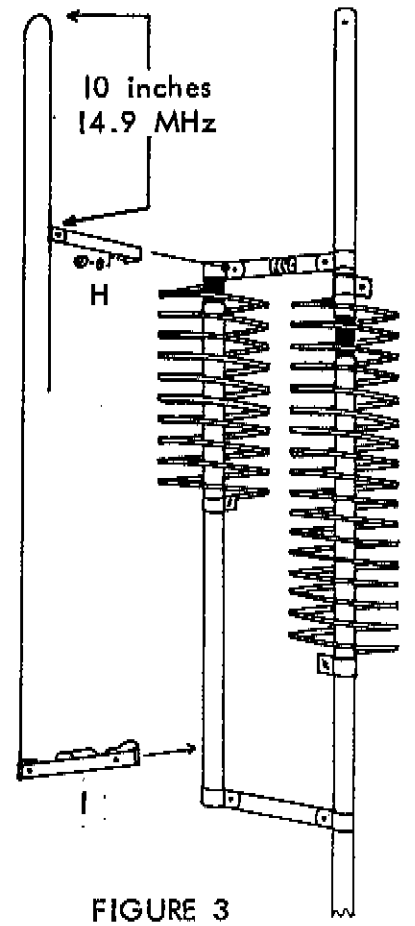


FIGURE 3

IN THE FOLLOWING STEPS TUBING SECTIONS J THROUGH O WILL BE ASSEMBLED AS A UNIT FOR LATER PLACEMENT ATOP SECTION B. AN 11/32-INCH NUTDRIVER WILL BE A USEFUL (BUT NOT NECESSARY) TOOL. IF A FLAT-BLADE SCREWDRIVER IS USED DO NOT HOLD THE WORK OPPOSITE THE BLADE IN ORDER TO AVOID POSSIBLE INJURY IN CASE THE BLADE SLIPS.

12. Insert the unslotted end of tube K into the slotted end of tube J. Align the four holes and pass a #8 x 1-1/4" bolt through the tubes. Pass a split-lock washer and a hex nut over the threaded end of the bolt and tighten securely.

13. Insert the unslotted end of tube L into the slotted end of tube K and proceed as in step 9, using a #8 x 1-1/4" bolt and related hardware.

14. Insert the unslotted end of tube M into the slotted end of tube L and proceed as before, using a #8 x 1" bolt and related hardware.

15. Insert tube N into tube M as in the preceding steps, using a #8 x 1" bolt and hardware. Note that the upper end of tube N has only slots. Place the small gear-driven hose clamp around the slotted end of tube N and tighten only enough to hold the clamp in place.

16. Slide the uncapped end of tube O into the slotted end of tube N until only 37 inches of tube O extends from the end of tube N. Tighten the hose clamp securely.

17. If the mounting post (section A) has been set in the earth for a ground-level installation please proceed to step 18. If a rooftop or other above-ground install-

ation is intended please read the section entitled "Above-Ground Installations" immediately following the checkout and adjustment instructions before proceeding to step 18.

18. Take up the assembled section B and slide its lower end over the rod insulator of section A and align the holes in the tube with the hole through the insulator. Pass a #8 x 2" bolt through the tube and insulator and secure with a #8 split-lock washer and a hex nut.

19. AVOID POWER LINES!! Raise assembly J through O vertically and slide the lower end of tube J into the upper end of section B. Align the holes of tube G with those of section B, pass a #8 x 1-1/2" bolt through the holes and tighten securely with a #8 split-lock washer and hex nut.

20. Install the 75-ohm matching line (P) on sections A and B as shown in figure 4. Simply place the lugs over the ends of the #8 bolts at this time. Be sure that the center conductor of the cable attaches to section B and the braid to section A.

21. Place #8 flat washers over the lugs and install impedance-matching/ d.c. grounding coil Q as shown in figure 4. Point one should go to section B ; point two to section A; and point three to any ground rod or earth connection. Secure the connections to sections A and B with flat washers, lock washers and hex nuts. It should be noted that the function of a ground rod is to place the antenna at d.c. ground potential; it cannot take the place of an effective r.f. ground system such as a number of radial wires, regardless of its depth in the earth. It does, however, serve as a convenient tie-point for such radials, as does the bolt through section A to which radials may be connected by means of the remaining #8 hardware. The exact number of radials required for low-SWR and reasonably efficient operation will depend in large measure on local earth conductivity at radio frequencies, and this will vary from one place to the next and from one frequency range to the next. The best procedure is to assume that most earth is a poor conductor and that some radial wires will be required. Radials may be placed on the surface of the earth or buried slightly below the surface to get them out of the way, and their length is largely a matter of convenience, although it is a good idea to make each radial at least as long as the antenna is tall. In general, a larger number of short radials is preferable to a smaller number of longer radials for a given amount of wire, especially if fewer than a dozen radials are to be used. Unlike resonant radials that must be cut to the proper lengths for use with elevated verticals, ground-level radials need not be cut to any particular length; their sole purpose is to provide less lossy return for currents flowing along the earth than the earth itself can provide. And, since "return" currents will be flowing back to the antenna from all points of the compass, the radial wires should be spaced uniformly over 360°, although physical circumstances will often make this "ideal" distribution impossible. For a discussion of ground systems for elevated verticals see the section entitled "Above-Ground Installations" following the Checkout and Adjustment instructions.

22. Connect the matching line (P) to any length of 50-to 53-ohm coaxial cable. A PL-258 "barrel" connector (R) is provided for this purpose.

CHECKOUT AND ADJUSTMENT

1. Refer to figure 1 and set the lower clamps of the 4.6 and 7.6 MHz coils as shown. These settings should produce antenna resonance and lowest SWR at approximately 4.6 and 7.6 MHz, respectively.

2. For purposes of adjustment a simple SWR indicator at the transmitter will be adequate. More accurate SWR measurements can be obtained at the antenna, but the tuning conditions that exist at the input end of the feedline will normally be of more practical interest to the operator.

3. If the antenna has been assembled and adjusted properly and if a suitable ground system has been installed beneath the antenna SWR should not be much above 2:1 on any of the three frequency ranges. If the transmitter output circuit is capable of operation with this value of SWR there is no practical reason to perform adjustments designed to reduce the SWR to some lower value. Some "solid state" transmitters, however, have no provisions for final amplifier tuning and cannot tolerate SWR much above 1.5:1 or so. In such cases more careful adjustment of the antenna tuning circuits may be necessary.

4. 4.6 MHz adjustment: if the initial SWR reading is above 2:1 loosen the lower clamp of the 4.6 MHz coil and reset it approximately 1/2 inch further down on section B, thus stretching the coil a slight amount. This adjustment will cause the antenna to resonate at a slightly higher frequency in the 4.6 MHz range. If the SWR drops to a lower value as a result of this adjustment but is still higher than 2:1, repeat the adjustment and stretch the coil out another 1/2 inch. If the SWR reading following this adjustment has increased, reset the lower coil clamp for greater compression of the coil by sliding it upward 1/4 inch. It is possible to vary the resonant frequency of the antenna over a range of several hundred KHz by stretching or compressing the coil as described above. Adjustments in either direction should be made in steps of no greater the 1/2 inch, and even smaller steps may be required to arrive at the precise setting that produces lowest SWR.

   If after the first adjustment wherein the coil has been stretched 1/2 inch the SWR has been found to increase, it will be necessary to compress the coil by resetting the lower coil clamp 1/2 inch above its original position. If the SWR decreases as a result of this compression but is still greater than 2:1 compress the coil an

additional 1/2 inch of compression but is still above 2:1, reset for still another 1/2 inch of compression, but be ready to move the clamp in the other direction if the SWR begins to increase. In general, it will not be necessary to move the coil clamp more than a total of one inch in either direction from the original setting to arrive at the adjustment that offers the lowest SWR.

Once this setting for lowest SWR has been found it may be necessary to stretch out impedance-matching/ d.c. grounding coil Q a certain amount to bring the 4.6 MHz SWR below 2:1. The exact amount of stretch required will depend on the quality of the ground system beneath the antenna, and if one is fortunate enough to have a low-loss system consisting of many radial wires, coil Q may have to be stretched to several times its normal compressed length before the SWR will drop to a minimum value. After coil Q has been adjusted it may be necessary to touch up the setting of the 4.6 MHz coil slightly for the sake of lowest possible SWR.

It will not be necessary to perform any adjustments to coil Q during the adjustment of the 7.6 and 14.9 MHz circuits.

5. 7.6 MHz adjustment: adjust the setting of the lower clamp on the on the 7.6 MHz outboard coil and proceed in the same manner as for the 4.6 MHz adjustment. It will be found that the antenna tunes more broadly in this range and that slightly greater movements of the coil will be required to influence the SWR.

6. 14.9 MHz adjustment: it is unlikely that any adjustments for this frequency rage will be required for an initial SWR reading of 2:1 or less once the circuits for the other frequency range have been adjusted, but if adjustments should be needed they can be made by changing the position of the "hairpin" rod that attaches to the 7.6 MHz circuit. Increasing the total length of the rod that is connected across the 7.6 MHz circuit between the two clamps is equivalent to compressing the coils in the other circuits; decreasing the span of rod between the two clamps is equivalent to stretching the coils. To increase the length of rod between the two clamps loosen the large end of the double clamp and capacitor assembly that fastens to the metal tube of the 7.6 MHz circuit as well as the upper clamp that holds the rod in place. Slide the lower double clamp and capacitor upward along the tube and the short end of the rod upward through the upper clamp. To decrease the amount of rod between the two clamps leave the lower double clamp and capacitor in place and slide both ends of the rod downward through the clamps that hold it in place. Adjustments should be made in steps of no more than one inch in either direction.

If adjustments must be made for lower SWR in the 14.9 MHz range it may be necessary to make a slight readjustment for tuning in the the 7.6 MHz range as in step 5.

7. One should keep in mind that the only reason for seeking SWR below 2:1 in any frequency range is to allow the output circuit of the transmitter to deliver full power to the antenna. If the transmitter is capable of delivering full power to the antenna at even higher values of SWR there is little to be gained by extensive adjustments. In the average case there is no measurable difference in communications effectiveness between SWR of, say, 3:1 and 1:1, the latter figure representing a perfect match which is usually unattainable as a practical matter.

ABOVE-GROUND INSTALLATIONS

If the CAP-1 is to be mounted some distance above the earth a system of resonant radials (i.e., radial wires cut to proper length) must be used. The proper length of these wires can be calculated by the formula

$$\text{Length (ft.)} = \frac{240}{\text{Frequency in MHz}}$$

Thus, a radial of the proper length for 14.937 MHz would be 240/14.937 = 16.067 ft., although 16 ft. exactly would be close enough for all practical purposes. At least two such radials for each of the three tuning ranges , although even more distributed more or less uniformly over 360° would be better. If only two radials per tuning range are used these should run opposite each other. Figure 5 shows a possible scheme for arranging a total of six resonant radials for use with the CAP-1.

Resonant radials should be connected to the ground (braid) side of the coaxial feedline at the through bolt on mounting post A and each radial must be insulated from supporting wires at its far end. Resonant radials need not be run parallel to the earth, and an angle of slope up to 45° will not significantly affect SWR or performance. If, however, the far ends of resonant radials are not sufficiently elevated or if any part of the radials comes within several feet of large masses of metal or runs nearly parallel to other conductors the possibility exists that the radial system will become detuned and that the antenna system as a whole will no longer be resonant at one or more of the desired frequencies, in which case it may not be possible to operate with low SWR until the affected radials are "pruned" to restore resonance or rearranged to avoid interfering objects, including the earth itself. This can be a tedious operation if one does not have the proper equipment and has but little experience in antenna adjustment. Similarly, TV antennas along with their masts and feedlines, as well as all other vertical or semi-vertical conductors, should be well away from the vertical portion of the antenna system to avoid interaction that can cause detuning.

In general, there is not much to be gained in performance by elevating the CAP-1 a short distance above the earth (less than about 30 ft.), at least at 4.6 and 7.6 MHz, in preference to a ground-level installation where the length of radials is not very critical and where tuning adjustments are more easily made.

For either ground-level or above-ground resonant radials wire size is unimportant, provided the the wire is strong enough to support itself in a strong wind in the above-ground case. In either case radial wire may be bare copper or aluminum - - insulation along the wire merely adds to weight and expense and serves no electrical purpose.

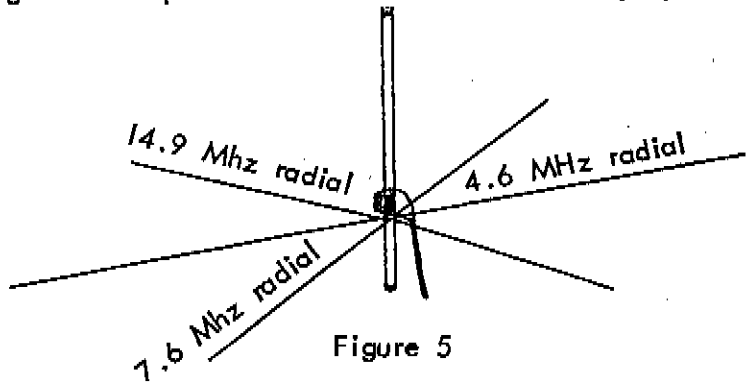


Figure 5

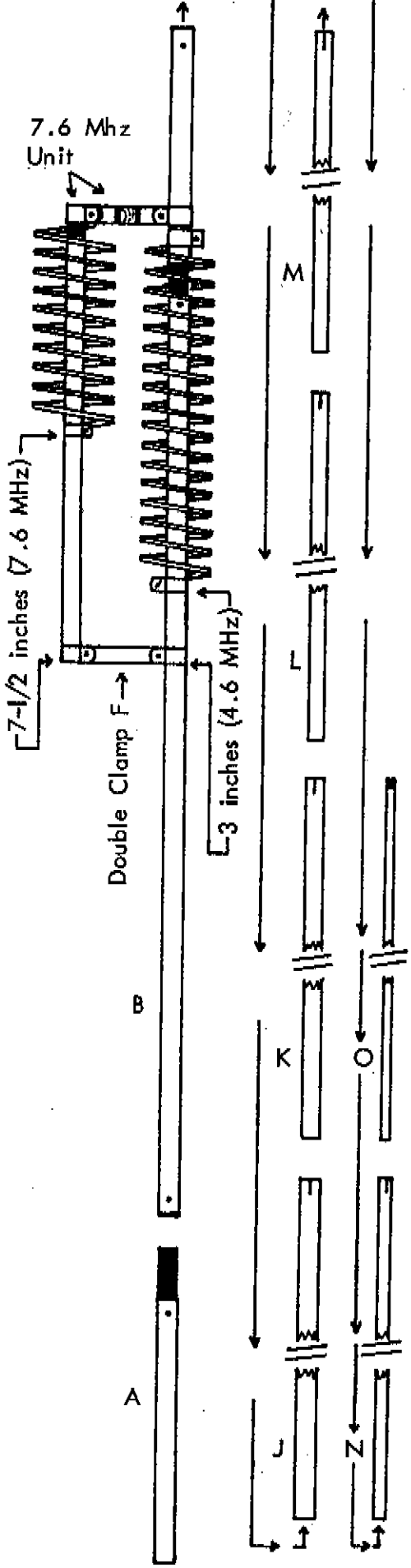
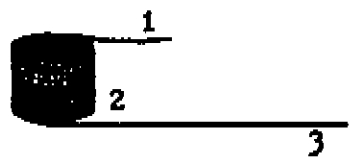
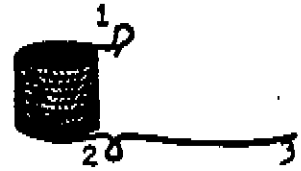


Figure 1

Preparing Coil (Q).



1. Use a knife to scrape 1-1/2" of enamel insulation from points 1, 2, and 3. Be sure that the copper is bright and clean.



2. Bend two of the clean areas (1 and 2) into loops for connection later. The clean areas may be tinned with solder.

Figure 2

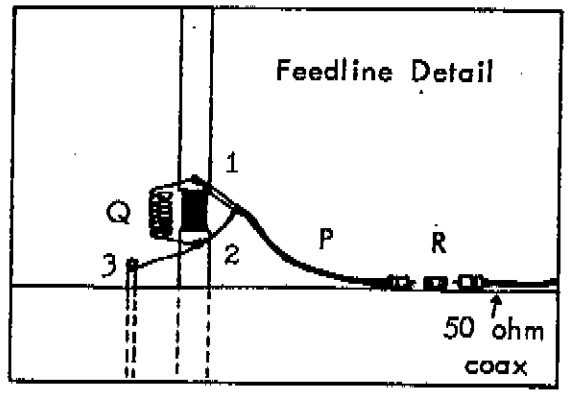
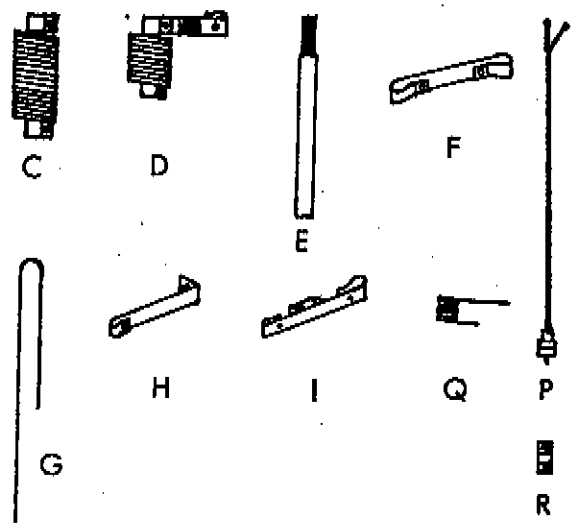


Figure 4



PARTS LIST

A. Mounting Post & Insulator
B. Antenna Base Section & Center Insulator Rod
C. 4.6 MHz Coil
D. 7.6 MHz Coil & Capacitor Unit
E. 7.6 MHz Mounting Tube
F. Double Clamp
G. 14.9 Mhz Tuning Rod
H. Tuning Rod Clamp
I. Double Clamp & Capacitor Unit
J. Tube 1" x 4 ft.
K. " 7/8" x 4 ft.
L. " 3/4" x 4 ft.
M. " 5/8" x 4 ft.
N. " 1/2" x 4 ft.
O. " 3/8" x 4 ft.
P. 75-ohm Matching Line
Q. Base Matching/Grounding Coil
R. PL-258 ("Barrel") Connecto

HARDWARE

#8 (Small)	Qty
3/4" bolt	2
1" bolt	2
1-1/4" bolt	2
1-1/2" bolt	1
2" bolt	1
Flat washers	4
Lock washers	9
Hex nuts	9

#10 (Large)	
1" bolt	2
Lock washers	8
Hex nuts	6
Wing nuts	2

Adjustable Compression Clamp

BUTTERNUT ELECTRONICS CO.

405 E. Market Street Lockhart, Texas 78644

MODEL CAP-1 VERTICAL ANTENNA
FOR CIVIL AIR PATROL FREQUENCIES
IN THE 4.6, 7.6 AND 14.9 MHZ RANGES

ASSEMBLY AND INSTALLATION INSTRUCTIONS

PLEASE READ INSTRUCTIONS THOROUGHLY BEFORE PROCEEDING TO ASSEMBLY. DURING ASSEMBLY AND INSTALLATION TAKE EXTREME CARE TO AVOID CONTACTING POWER LINES WITH ANY PART OF THE ANTENNA OR WITH OTHER CONDUCTORS.

DO NOT INSTALL THE ANTENNA IN ANY PLACE WHERE ANY PART OF IT CAN COME INTO CONTACT WITH POWER LINES IN THE EVENT OF STRUCTURAL FAILURE OF ANY PART OF THE INSTALLATION OR IN THE COURSE OF NORMAL FLEXING AFTER INSTALLATION, FOR SUCH CONTACT CAN RESULT IN DAMAGE TO PROPERTY, BODILY INJURY OR EVEN DEATH!

IN NO CASE SHOULD THE ANTENNA BE INSTALLED IN ANY PLACE WHERE STRUCTURAL FAILURE OF ANY PART OF THE ANTENNA OR ITS SUPPORTING SYSTEM CAN ENDANGER PERSONS OR PROPERTY.

Tools required for assembly: standard blade screwdriver, pliers, knife; a set of nutdrivers will be useful but not necessary.

1. Check to be sure that no parts are missing (see parts pictorial page.)

2. If the antenna is to be installed at ground level, plant mounting post A in a hole approximately 21 inches (.55 meters) deep so that the upper end of the fiber rod insulator is approximately 5 inches (12 cm.) above ground level. Pack earth tightly around the mounting post so that it will remain vertical. Concrete may be used in areas of high wind for greater rigidity, in which case the mounting post should be rotated while the concrete is setting so that it may be easily removed later. If the antenna is to be mounted in concrete or in damp, acidic or alkaline soil the mounting post should be given a protective coating of asphalt roofing compound, polyurethane varnish or another suitable covering to protect the metal against corrosion. Do not hammer the mounting post into the ground; hammering can splinter the fiber rod insulator and complicate installation.

3. Prepare the impedance matching/ d.c. grounding coil (Q) as shown in figure 2.

4. Locate section B. This consists of two aluminum tubes, a long one and a short one, joined by a length of insulator rod. The longer tube will later be mounted on the rod insulator at the top of the mounting post (A). In all subsequent steps involving section B assembly should be done indoors or in an area where dropped hardware may easily be recovered.

5. Locate coil assembly (C) for the 4.6 MHz range (refer to fig. 1). Slide either end of this coil over the short end of section B, lowering the coil until the upper clamp of the coil can be positioned approximately an inch from the insulating rod. The lower clamp will have to be pulled open slightly to clear the hardware that fastens the two tubes to the rod insulator. Secure the upper coil clamp firmly in place, using a split-lock washer and a #10 hex nut. Secure the lower coil clamp, using a split-lock washer and a wing nut. Do not tighten too snugly, for the lower clamp will have to be reset later.

6. Take up the assembled 7.6 MHz coil an capacitor unit (D) and slide the end of tube E that has the plastic insulator up through the lower coil clamp and into the upper coil clamp of the assembly. Use a split-lock washer and #10 hex nut to fasten the upper clamp securely around the plastic insulator. The upper edge of the coil clamp should be flush with the edge of the plastic insulator. Use a split-lock washer and a wing nut to secure the lower coil clamp around the metal part of section E--not too tightly, however, for this clamp too may have to be moved during the adjustment procedure.

7. Place the remaining clamp of the completed 7.6 MHz assembly around section B immediately above the upper clamp of the 4.6 MHz coil (C) and secure firmly using a split-lock washer and a #10 hex nut.

8. Locaté double clamp F. Place the larger of the two clamps around section B and the smaller clamp around the lower end of tube E of the 7.6 MHz assembly. Secure both ends of F with #10 x 1-inch bolts, split-lock washers and hex nuts after aligning tube E so that it is parallel with section B. This completes the assembly of the 4.6 and 7.6 MHz tuning circuits.

9. Locate tuning rod G for the 14.9 MHz range, clamp H and double clamp and capacitor unit I.

10. Refer to figure 3 and slide tuning rod G through clamp H and double clamp and capacitor unit I as shown. Finger tighten each clamp using the hardware already on the small end of the double clamp and an assembled #8 split-lock washer and hex nut for the large end of the double clamp to position unit I around tube E. Place the hole at the end of clamp H over the #10 bolt coming through the upper coil clamp of the 7.6 MHz unit and secure using a #10 split-lock washer and hex nut.

11. Slide tuning rod G so that the rounded top is 6 inches above the upper edge of clamp H. Tighten clamps H and I firmly around tuning rod G and around the tubing of the 7.6 MHz assembly. Section B and the attached outboard assemblies may be set aside temporarily.

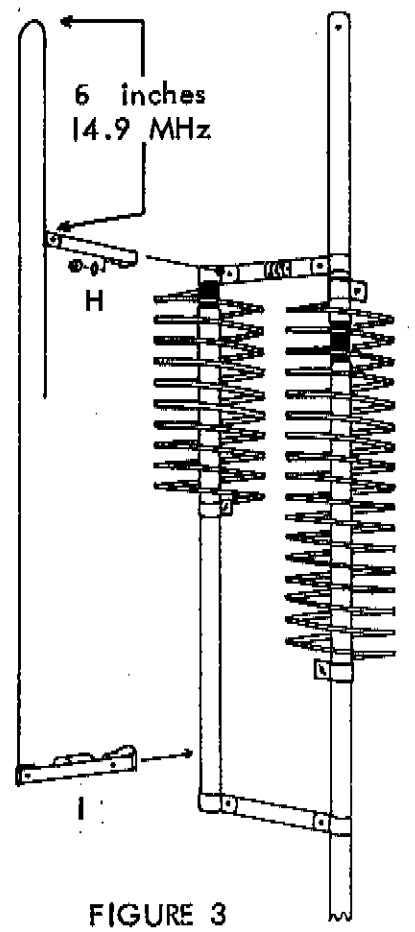


FIGURE 3

IN THE FOLLOWING STEPS TUBING SECTIONS J THROUGH O WILL BE ASSEMBLED AS A UNIT FOR LATER PLACEMENT ATOP SECTION B. AN 11/32-INCH NUTDRIVER WILL BE A USEFUL (BUT NOT NECESSARY) TOOL. IF A FLAT-BLADE SCREWDRIVER IS USED DO NOT HOLD THE WORK OPPOSITE THE BLADE IN ORDER TO AVOID POSSIBLE INJURY IN CASE THE BLADE SLIPS.

12. Insert the unslotted end of tube K into the slotted end of tube J. Align the four holes and pass a #8 x 1-1/4" bolt through the tubes. Pass a split-lock washer and a hex nut over the threaded end of the bolt and tighten securely.

13. Insert the unslotted end of tube L into the slotted end of tube K and proceed as in step 9, using a #8 x 1-1/4" bolt and related hardware.

14. Insert the unslotted end of tube M into the slotted end of tube L and proceed as before, using a #8 x 1" bolt and related hardware.

15. Insert tube N into tube M as in the preceding steps, using a #8 x 1" bolt and hardware. Note that the upper end of tube N has only slots. Place the small gear-driven hose clamp around the slotted end of tube N and tighten only enough to hold the clamp in place.

16. Slide the uncapped end of tube O into the slotted end of tube N until only 37 inches of tube O extends from the end of tube N. Tighten the hose clamp securely.

17. If the mounting post (section A) has been set in the earth for a ground-level installation please proceed to step 18. If a rooftop or other above-ground install-

ation is intended please read the section entitled "Above-Ground Installations" immediately following the checkout and adjustment instructions before proceeding to step 18.

18. Take up the assembled section B and slide its lower end over the rod insulator of section A and align the holes in the tube with the hole through the insulator. Pass a #8 x 2" bolt through the tube and insulator and secure with a #8 split-lock washer and a hex nut.

19. AVOID POWER LINES!! Raise assembly J through O vertically and slide the lower end of tube J into the upper end of section B. Align the holes of tube G with those of section B, pass a #8 x 1-1/2" bolt through the holes and tighten securely with a #8 split-lock washer and hex nut.

20. Install the 75-ohm matching line (P) on sections A and B as shown in figure 4. Simply place the lugs over the ends of the #8 bolts at this time. Be sure that the center conductor of the cable attaches to section B and the braid to section A.

21. Place #8 flat washers over the lugs and install impedance-matching/ d.c. grounding coil Q as shown in figure 4. Point one should go to section B ; point two to section A; and point three to any ground rod or earth connection. Secure the connections to sections A and B with flat washers, lock washers and hex nuts. It should be noted that the function of a ground rod is to place the antenna at d.c. ground potential; it cannot take the place of an effective r.f. ground system such as a number of radial wires, regardless of its depth in the earth. It does, however, serve as a convenient tie-point for such radials, as does the bolt through section A to which radials may be connected by means of the remaining #8 hardware. The exact number of radials required for low-SWR and reasonably efficient operation will depend in large measure on local earth conductivity at radio frequencies, and this will vary from one place to the next and from one frequency range to the next. The best procedure is to assume that most earth is a poor conductor and that some radial wires will be required. Radials may be placed on the surface of the earth or buried slightly below the surface to get them out of the way, and their length is largely a matter of convenience, although it is a good idea to make each radial at least as long as the antenna is tall. In general, a larger number of short radials is preferable to a smaller number of longer radials for a given amount of wire, especially if fewer than a dozen radials are to be used. Unlike resonant radials that must be cut to the proper lengths for use with elevated verticals, ground-level radials need not be cut to any particular length; their sole purpose is to provide less lossy return for currents flowing along the earth than the earth itself can provide. And, since "return" currents will be flowing back to the antenna from all points of the compass, the radial wires should be spaced uniformly over 360°, although physical circumstances will often make this "ideal" distribution impossible. For a discussion of ground systems for elevated verticals see the section entitled "Above-Ground Installations" following the Checkout and Adjustment instructions.

22. Connect the matching line (P) to any length of 50-to 53-ohm coaxial cable. A PL-258 "barrel" connector (R) is provided for this purpose.

CHECKOUT AND ADJUSTMENT

1. Refer to figure 1 and set the lower clamps of the 4.6 and 7.6 MHz coils as shown. These settings should produce antenna resonance and lowest SWR at approximately 4.6 and 7.6 MHz, respectively.

2. For purposes of adjustment a simple SWR indicator at the transmitter will be adequate. More accurate SWR measurements can be obtained at the antenna, but the tuning conditions that exist at the input end of the feedline will normally be of more practical interest to the operator.

3. If the antenna has been assembled and adjusted properly and if a suitable ground system has been installed beneath the antenna SWR should not be much above 2:1 on any of the three frequency ranges. If the transmitter output circuit is capable of operation with this value of SWR there is no practical reason to perform adjustments designed to reduce the SWR to some lower value. Some "solid state" transmitters, however, have no provisions for final amplifier tuning and cannot tolerate SWR much above 1.5:1 or so. In such cases more careful adjustment of the antenna tuning circuits may be necessary.

4. 4.6 MHz adjustment: if the initial SWR reading is above 2:1 loosen the lower clamp of the 4.6 MHz coil and reset it approximately 1/2 inch further down on section B, thus stretching the coil a slight amount. This adjustment will cause the antenna to resonate at a slightly higher frequency in the 4.6 MHz range. If the SWR drops to a lower value as a result of this adjustment but is still higher than 2:1, repeat the adjustment and stretch the coil out another 1/2 inch. If the SWR reading following this adjustment has increased, reset the lower coil clamp for greater compression of the coil by sliding it upward 1/4 inch. It is possible to vary the resonant frequency of the antenna over a range of several hundred KHz by stretching or compressing the coil as described above. Adjustments in either direction should be made in steps of no greater the 1/2 inch, and even smaller steps may be required to arrive at the precise setting that produces lowest SWR.

   If after the first adjustment wherein the coil has been stretched 1/2 inch the SWR has been found to increase, it will be necessary to compress the coil by resetting the lower coil clamp 1/2 inch above its original position. If the SWR decreases as a result of this compression but is still greater than 2:1 compress the coil an-

additional 1/2 inch of compression but is still above 2:1, reset for still another 1/2 inch of compression, but be ready to move the clamp in the other direction if the SWR begins to increase. In general, it will not be necessary to move the coil clamp more than a total of one inch in either direction from the original setting to arrive at the adjustment that offers the lowest SWR.

Once this setting for lowest SWR has been found it may be necessary to stretch out impedance-matching/ d.c. grounding coil Q a certain amount to bring the 4.6 MHz SWR below 2:1. The exact amount of stretch required will depend on the quality of the ground system beneath the antenna, and if one is fortunate enough to have a low-loss system consisting of many radial wires, coil Q may have to be stretched to several times its normal compressed length before the SWR will drop to a minimum value. After coil Q has been adjusted it may be necessary to touch up the setting of the 4.6 MHz coil slightly for the sake of lowest possible SWR.

It will not be necessary to perform any adjustments to coil Q during the adjustment of the 7.6 and 14.9 MHz circuits.

5. 7.6 MHz adjustment: adjust the setting of the lower clamp on the on the 7.6 MHz outboard coil and proceed in the same manner as for the 4.6 MHz adjustment. It will be found that the antenna tunes more broadly in this range and that slightly greater movements of the coil will be required to influence the SWR.

6. 14.9 MHz adjustment: it is unlikely that any adjustments for this frequency range will be required for an initial SWR reading of 2:1 or less once the circuits for the other frequency range have been adjusted, but if adjustments should be needed they can be made by changing the position of the "hairpin" rod that attaches to the 7.6 MHz circuit. Increasing the total length of the rod that is connected across the 7.6 MHz circuit between the two clamps is equivalent to compressing the coils in the other circuits; decreasing the span of rod between the two clamps is equivalent to stretching the coils. To increase the length of rod between the two clamps loosen the large end of the double clamp and capacitor assembly that fastens to the metal tube of the 7.6 MHz circuit as well as the upper clamp that holds the rod in place. Slide the lower double clamp and capacitor upward along the tube and the short end of the rod upward through the upper clamp. To decrease the amount of rod between the two clamps leave the lower double clamp and capacitor in place and slide both ends of the rod downward through the clamps that hold it in place. Adjustments should be made in steps of no more than one inch in either direction.

If adjustments must be made for lower SWR in the 14.9 MHz range it may be necessary to make a slight readjustment for tuning in the the 7.6 MHz range as in step 5.

7. One should keep in mind that the only reason for seeking SWR below 2:1 in any frequency range is to allow the output circuit of the transmitter to deliver full power to the antenna. If the transmitter is capable of delivering full power to the antenna at even higher values of SWR there is little to be gained by extensive adjustments. In the average case there is no measurable difference in communications effectiveness between SWR of, say, 3:1 and 1:1, the latter figure representing a perfect match which is usually unattainable as a practical matter.

ABOVE-GROUND INSTALLATIONS

If the CAP-1 is to be mounted some distance above the earth a system of resonant radials (i.e., radial wires cut to proper length) must be used. The proper length of these wires can be calculated by the formula

$$\text{Length (ft.)} = \frac{240}{\text{Frequency in MHz}}$$

Thus, a radial of the proper length for 14.937 MHz would be 240/14.937 = 16.067 ft., although 16 ft. exactly would be close enough for all practical purposes. At least two such radials for each of the three tuning ranges , although even more distributed more or less uniformly over 360° would be better. If only two radials per tuning range are used these should run opposite each other. Figure 5 shows a possible scheme for arranging a total of six resonant radials for use with the CAP-1.

Resonant radials should be connected to the ground (braid) side of the coaxial feedline at the through bolt on mounting post A and each radial must be insulated from supporting wires at its far end. Resonant radials need not be run parallel to the earth, and an angle of slope up to 45° will not significantly affect SWR or performance. If, however, the far ends of resonant radials are not sufficiently elevated or if any part of the radials comes within several feet of large masses of metal or runs nearly parallel to other conductors the possibility exists that the radial system will become detuned and that the antenna system as a whole will no longer be resonant at one or more of the desired frequencies, in which case it may not be possible to operate with low SWR until the affected radials are "pruned" to restore resonance or rearranged to avoid interfering objects, including the earth itself. This can be a tedious operation if one does not have the proper equipment and has but little experience in antenna adjustment. Similarly, TV antennas along with their masts and feedlines, as well as all other vertical or semi-vertical conductors, should be well away from the vertical portion of the antenna system to avoid interaction that can cause detuning.

In general, there is not much to be gained in performance by elevating the CAP-1 a short distance above the earth (less than about 30 ft.), at least at 4.6 and 7.6 MHz, in preference to a ground-level installation where the length of radials is not very critical and where tuning adjustments are more easily made.

For either ground-level or above-ground resonant radials wire size is unimportant, provided the the wire is strong enough to support itself in a strong wind in the above-ground case. In either case radial wire may be bare copper or aluminum - - insulation along the wire merely adds to weight and expense and serves no electrical purpose.

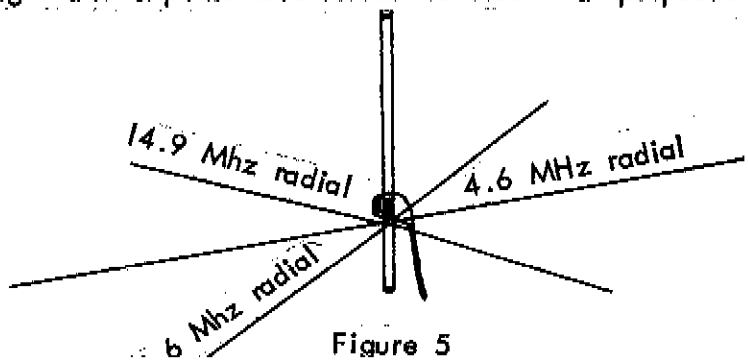


Figure 5

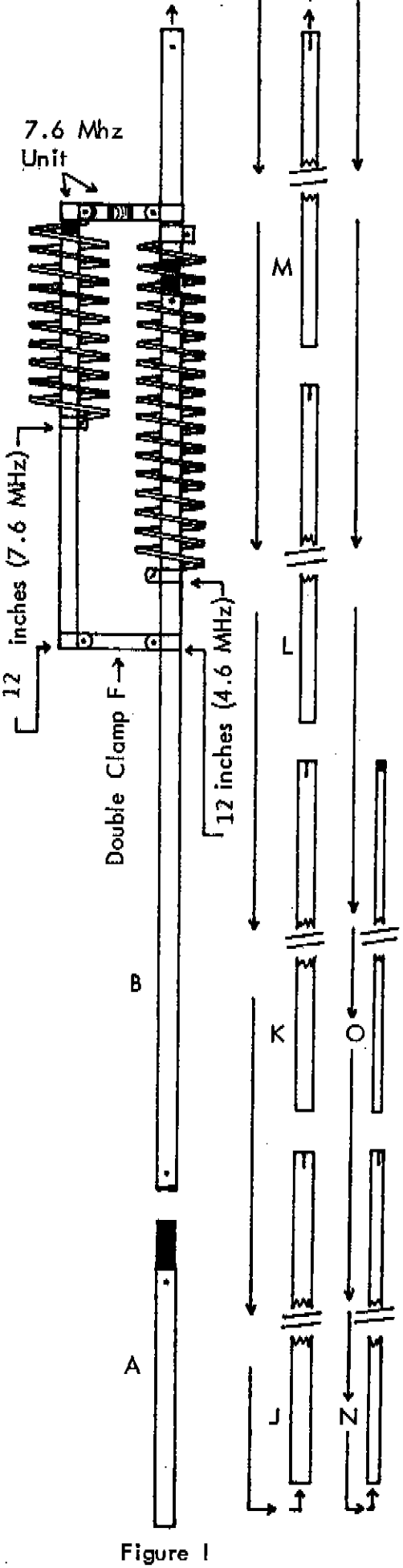
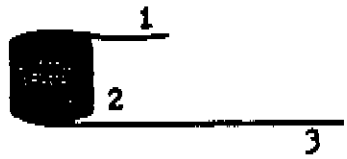
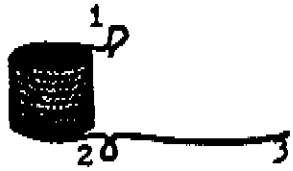


Figure 1

Preparing Coil (Q).



1. Use a knife to scrape 1-1/2" of enamel insulation from points 1, 2, and 3. Be sure that the copper is bright and clean.



2. Bend two of the clean areas (1 and 2) into loops for connection later. The clean areas may be tinned with solder.

Figure 2

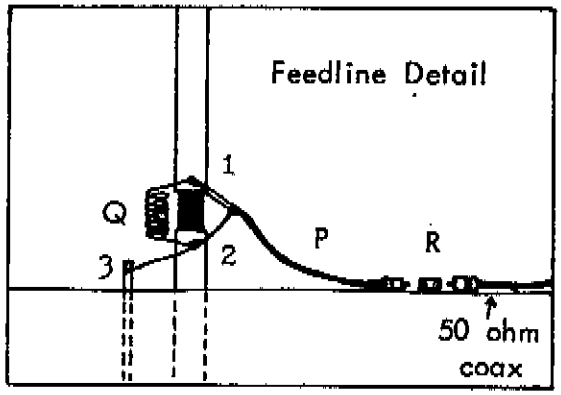
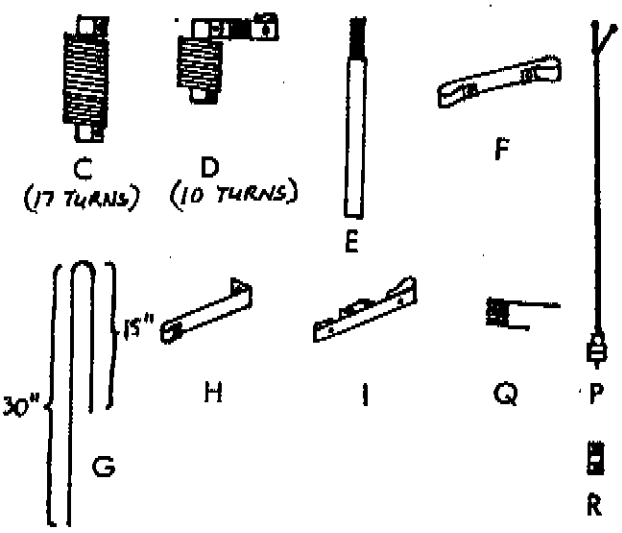


Figure 4



PARTS LIST

A. Mounting Post & Insulator
B. Antenna Base Section & Center Insulator Rod
C. 4.6 MHz Coil
D. 7.6 MHz Coil & Capacitor Unit
E. 7.6 MHz Mounting Tube
F. Double Clamp
G. 14.9 Mhz Tuning Rod
H. Tuning Rod Clamp
I. Double Clamp & Capacitor Unit
J. Tube 1" x 4 ft.
K. " 7/8" x 4 ft.
L. " 3/4" x 4 ft.
M. " 5/8" x 4 ft.
N. " 1/2" x 4 ft.
O. " 3/8" x 4 ft.
P. 75-ohm Matching Line
Q. Base Matching/Grounding Coil
R. PL-258 ("Barrel") Connecto

HARDWARE

#8 (Small)	Qty
3/4" bolt	2
1" bolt	2
1-1/4" bolt	2
1-1/2" bolt	1
2" bolt	1
Flat washers	4
Lock washers	9
Hex nuts	9

#10 (Large)	
1" bolt	2
Lock washers	8
Hex nuts	6
Wing nuts	2

Adjustable Compression Clamp

REV. 1987