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MODIFICATION OF COLLINS 51R NAVIGATION RECEIVER FOR IMPROVED PHASE LOCALIZER FLAG ALARM PERFORMANCE

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By
Henry C. Hurley
and
David S. Crippen

Radio Development Division
Technical Development
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CIVIL AERONAUTICS ADMINISTRATION
TECHNICAL DEVELOPMENT
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At present, the operation of the course line deviation indicator flag alarm is unsatisfactory when the navigation receiver is operated as a phase comparison localizer receiver The flag position is determined primarily by the output of the reference phase channel so that an operational failure in the variable phase channel causes an on-course indication without noticeable change in the flag position.

Several methods have been suggested for obtaining satisfactory flag indications in case of operational failure in the variable phase channel or loss of reference phase signal at the transmitter or in the receiver. It was suggested that a portion of the 30-cps output of the reference phase channel be fed into the variable phase channel after the phase was shifted 90° to prevent deviation indicator deflection. The flag position would then be controlled by the outputs of both the reference and variable phase channels. This method is not satisfactory because phase shift in either channel, even though very small, causes a large course error.

Other methods involve the introduction of a signal having a frequency of approximately 24-cps in the variable phase channel by means of an oscillator in the receiver or by modulation of the carrier at the transmitter. The flag position depends upon the output of both channels and indicates loss of signal in either channel. The circuit that controls the flag must be modified in either case to obtain satisfactory differential action. Mixture of the 24-cps signal and reference channel signal before rectification does not provide satisfactory differential action. By modifying the input circuit so that the signals are combined after rectification, it is possible to obtain a flag-down indication from the combined 24-cps and reference channel rectifier outputs, and a visible flag when either signal is lost. If the reversible phase 30-cps signal is equal to or less than the 24-cps signal, the flag position is practically unchanged since these signals are added before instead of after rectification

Several disadvantages occur when the 24-cps signal is added by modulation at the transmitter In order to obtain adequate changes in flag position for loss of signal in either channel, the 24-cps modulation must be approximately 30 per cent. This means that the voice modulation percentage must be reduced. The 24-cps modulation percentage can be reduced to 10 or 15 per cent if a filter is added in the variable phase channel flag input circuit to attenuate the 30-cps reversible phase signal approximately 9 db with respect to the 24-cps signal level. The filter must be added to prevent the 30-cps signal from holding the flag down when the reference channel fails and the 30-cps modulation is 30 per cent. It is believed that a simple filter having small components and the desired attenuation of the 30-cps signal without serious 24-cps insertion loss is difficult to obtain. Propeller modulation effects may be increased when the 24-cps signal is added at the transmitter since a larger combination of intermodulation products is possible. A flight test of a transmitter having the 24-cps modulation has not been made.

Introduction of the 24-cps signal by means of an oscillator eliminates or reduces the disadvantages noted regarding the addition of modulation at the transmitter However, the receiver modification is more complex since a 24-cps signal source must be obtained. The flag alarm input circuit modification is the same except that the 30-cps attenuation filter is not required since the 24-cps signal level can be made the equivalent of that obtained from 30 per cent modulation at the transmitter

Fig. 1 shows the modification made to a Collins 51R navigation receiver. The connections and components that were added are shown by heavier lines. This receiver has been flight tested to determine the detrimental effects, if any, from the standpoint of clearance, propeller modulation, and character of course. The switches were not added in this receiver, but the connections were made as shown. The changes are listed as follows:

- (a) Disconnected C233 from R265 and C234 from R266
- (b) Connected C233 through 750,000-ohm resistor to bottom control grid and C234 through 750,000-ohm resistor to upper control grid of V207.
- (c) Added .004 mfd capacitor in parallel with C231.
- (d) Broke connection from top of R257 to junction of C226 and R276
- (e) Broke connection from R253 to terminal 19 of plug at rear of the receiver
- (f) Connected terminal No. 2 of T203 to junction of R132, R133, and C131 through a 220,000-ohm resistor.
- (g) Disconnected terminal 9 of T204 from terminal 9 of T205.
- (h) Disconnected junction of R237 and C223 from junction of R228 and R229.

(i) Disconnected terminal 8 of T204 from rectifier E206 and connected terminals 8 and 10 to the new rectifier with 54,000-ohm resistor in series with the lead from terminal 8.
(j) Connected terminals 8 and 10 of T205 to new rectifier with 24,000-ohm resistor in series with the lead from terminal 8
(k) Connected output of new rectifier to flag alarm movement.
(l) Added 17,000-ohm resistor in parallel with R205.

Six resistors, one rectifier and one capacitor are the only additional components required besides the switches. Tube V207 is already a part of the receiver. Normally, this tube is used only when the receiver is operated as an omnirange receiver. The switching problem is complex but would be accomplished automatically by the frequency selector system and the relay that is now used to select either tone or phase localizer mode of operation. Further study might make it possible to simplify the switching problem considerably. For example, the addition of another winding on transformers T204 and T205 to operate the flag would eliminate the need for the switches in the leads to terminals 8 and 9 of T204 and in the lead from the junction of R237 and C223 to R228 and R229. The windings between terminals 8 and 10 are normally used to operate the TO-FROM meter during operation as an omnirange receiver

The flight tests showed that the modification did not cause detrimental effects. Fig 2 shows clearances obtained with the 24-cps oscillator on and off. The clearances are marginal in each case since the antenna spacings at the transmitter do not conform to newer standards. For the newer spacing, the minimum reversible phase modulation percentage existing at low clearance points is approximately 16 per cent as compared to 13 per cent for the older spacing. Fig. 3 indicates flag alarm performance during the flight. Addition of the 24-cps signal does cause a reduction of approximately 25 per cent in course sensitivity. The 17,000-ohm resistor was added in parallel with R205 to compensate for this reduction.

The modified flag alarm circuit could also be used when the receiver is operated as an omnirange receiver if the additional winding was added in transformers T204 and T205. The change in flag alarm indication obtained from the modified circuit when either channel becomes inoperative is greater than the change obtained from the present omnirange flag alarm circuit. The 24-cps oscillator is not required for this mode of operation. The following table shows flag alarm currents and deflections from the vertical axis under various conditions for a modified and normal receiver as measured in the laboratory. The reference and variable phase modulations were 30 per cent. The rf input signal level was 1000 microvolts at 114.9 Mc and the battery voltage was 26.5 v. All measurements were made with a two flag alarm load.

Normal Receiver

Variable Phase Channel Condition	Reference Phase Channel Condition	Single Flag Current Microamps	Flag Deflection
On	On	250	Not Visible
Off	On	165	30°
On	Off	190	45°

Modified Receiver

Variable Phase Channel Condition	Reference Phase Channel Condition	Single Flag Current Microamps	Flag Deflection
On	On	270	Not Visible
Off	On	150	18°
On	Off	150	18°

To obtain the operation shown in the above table for the modified receiver, it was necessary to connect a 13,000-ohm resistor in parallel with the 54,000-ohm resistor and a 11,000-ohm resistor in parallel with the 24,000-ohm resistor shown in Fig. 1.

The following table shows flag alarm currents and deflections from vertical axis when the modified receiver is operated as a phase localizer receiver as measured in the laboratory. The rf input signal level was 1000 microvolts at 110.1 Mc and the battery voltage was 26.5 v. All measurements were made with a two flag alarm load.

Modulation Reference Phase 30%, Reversible Phase 0% (On-Course)

Reversible Phase Channel Condition	Reference Phase Channel Condition	24-Cycle Oscillator Condition	Single Flag Current Microamps	Flag Deflection
On	On	On	260	Not visible
On	On	Off	150	18°
Off	On	On or Off	150	18°
On	Off	On	130	5°

Modulation Reference Phase 30%, Reversible Phase 30% (10° Off-Course)

Reversible Phase Channel Condition	Reference Phase Channel Condition	24-Cycle Oscillator Condition	Single Flag Current Microamps	Flag Deflection
On	On	On	270	Not visible
On	On	Off	260	Not visible
Off	On	On or Off	150	18°
On	Off	On	140	11°
On	Off	Off	125	0°

The method of improving phase localizer receiver flag alarm performance described in this memorandum is the best method known at present. No transmitter modification is required. The receiver modification is somewhat complex. However, no method of obtaining satisfactory phase localizer flag alarm performance through transmitter modification without receiver modification is known or has been suggested at this date. It is believed that further study may make it possible to simplify the receiver modification somewhat should this method of energizing the flag alarm be adopted.

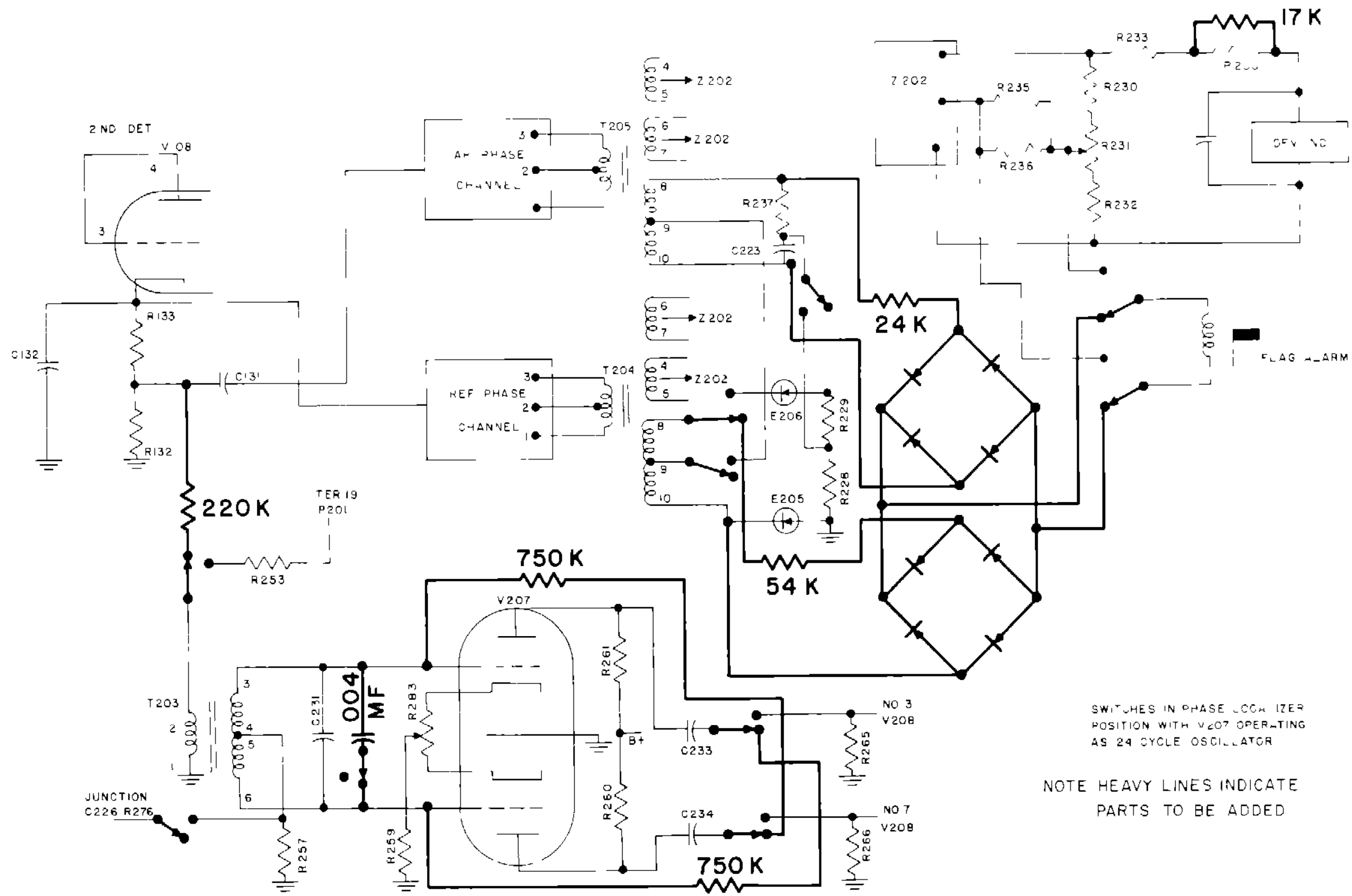

FIG I MODIFICATION COLLINS 51R RECEIVER FOR IMPROVED PHASE LOCALIZER FLAG ALARM PERFORMAN

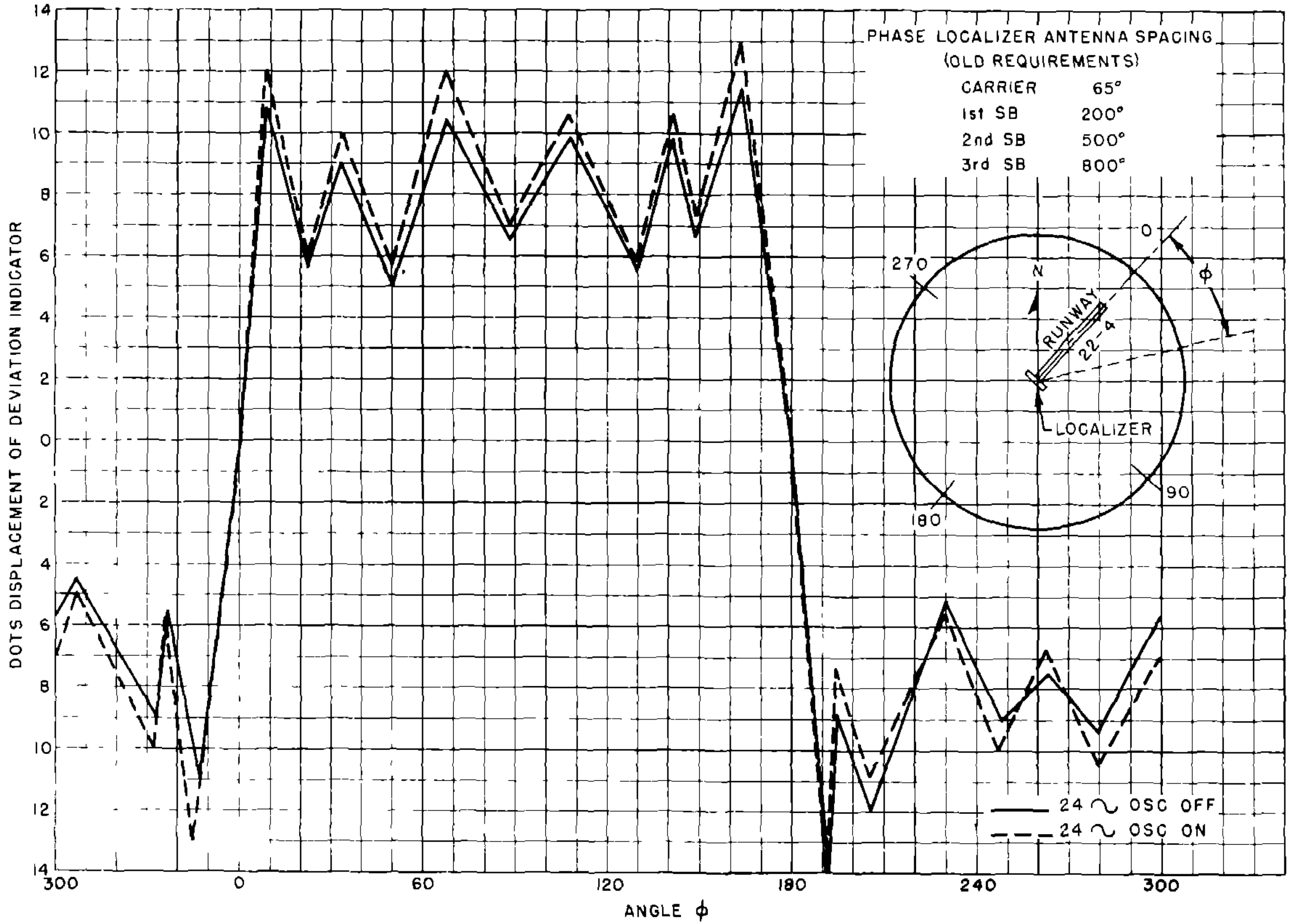

FIGURE 2 FLAG ALARM CURRENT MEASURED ON CLEARANCE FLIGHT CHECK

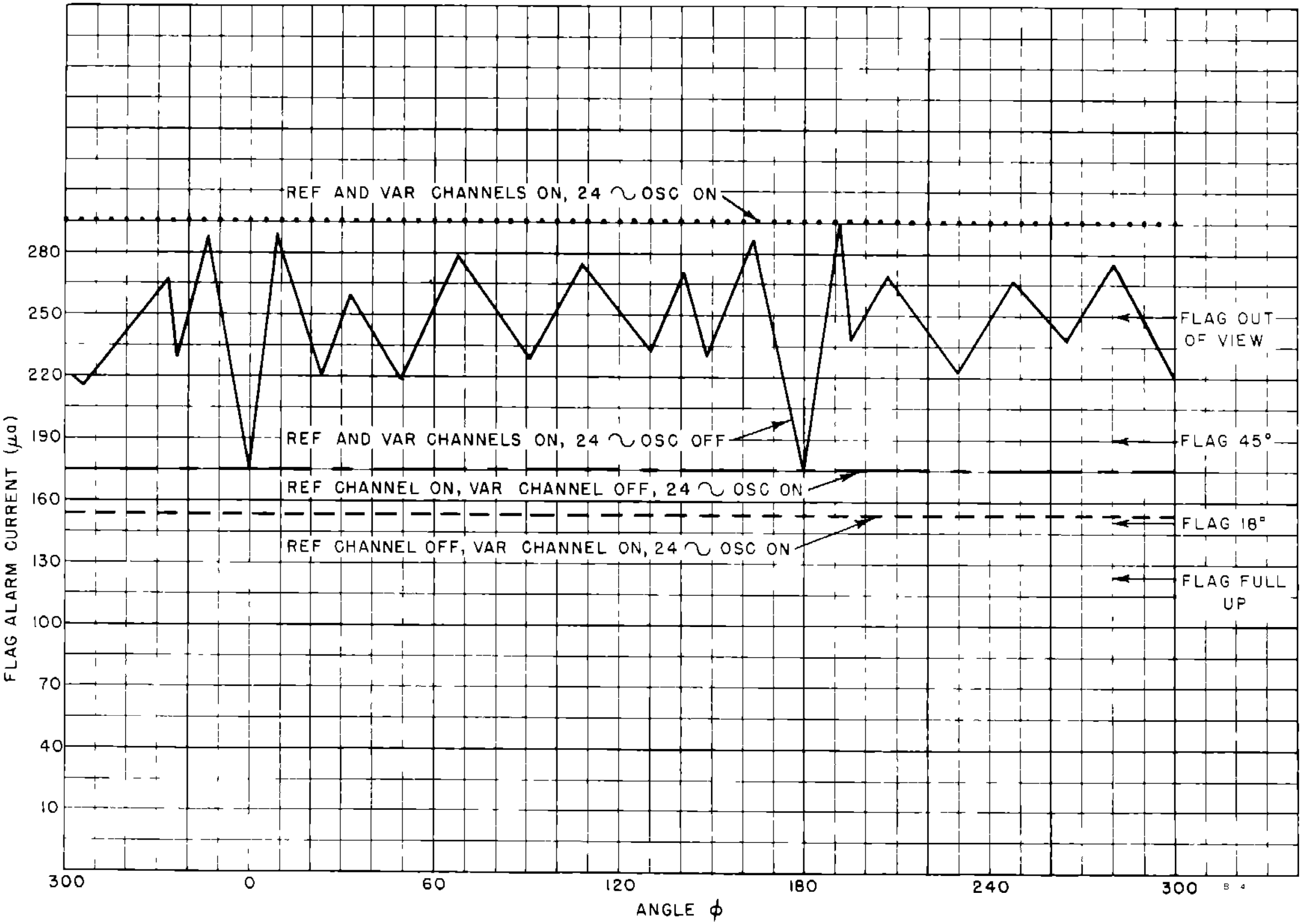

FIGURE 3 PHASE LOCALIZER CLEARANCE MEASURED WITH 24 ∿ OSCILLATOR ON AND OFF (6 MILE RADIUS)