Automatic Direction Finder

SCR-269G

Hands-on Demonstration Exhibit

Progress Report as of March, 2022

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The SCR-269-G Automatic Direction Finder

This project is intended as a gift to the Museum for use as a Docent-assisted, hands-on, working display of World War 2-era aviation direction-finding technology.

Putting this system in the hands of Museum visitors will transport them inside the aircraft, sit them down in the navigator's seat, and require them to plot their position.

More important, it will challenge them to appreciate the sophisticated training and judgement needed by pilots and navigators of the day as they executed their mission… all performed in a cold, noisy, Garmin-free environment.

I hope the Museum will find a place for this display in its current exhibit space. If not, then stored for future use.

This is a report on the progress of the Exhibit to date. I expect to complete it by Spring 2022. Grant Schwartz and I have discussed some options in transporting the project to the Museum.

This project began years ago when I acquired several components of the SCR-269-G system: an LP-21 Loop Antenna, a partially cannibalized BC-433G Receiver, and one of the directional indicators.

I became interested in learning about the SCR-269 system and discovered that it was quite sophisticated for its day.

But my LP-21 loop and the associated mechanism in the pylon turned out to be badly weather-damaged and totally beyond repair. And the familiar aerodynamically shaped housing was badly cracked from improper storage.

Rather than abandoning the project I began searching for the other components. Over the years I accumulated everything except for the LP-21 Loop. While these loops are sometimes available, the prices are always very high.

Grant Schwartz mentioned that the Museum owned an LP-21/pylon assembly and would be willing to lend it, minus the housing in exchange for my damaged unit. We agreed that once I completed it, I would donate the entire system to the Museum as a Docent-assisted working Exhibit.

Special recognition goes to Mike Hanz (aafradio.org), and to Don Reaves for invaluable technical counsel and for help in sourcing hard-to-find components. More on their help later.

The exhibit includes:

- BC-433G Receiver
- BC-434A Control Box
- BK-22 Junction Box
- LP-21 Loop Antenna
- IN-81A and IN-82A Direction Indicators, one for the Pilot and one for Navigator
- Vertical Sense Antenna
- Power supply delivering 28 Volts DC, and 115 Volts AC at 400 Cycles
- All Cables and Connectors
- FAA VFR maps for the Detroit area showing the location of AM Radio Stations and beacons to be used in the demonstration
- A 15 inch parallel rule for plotting, plus explanatory stand-up placards

It requires a table-top mounting space, preferably L-shaped: a center space to hold the all the components of the system, and a left wing to hold a Plotting Board with map and parallel ruler. Power requirement: 120 volts AC at 4 amps.

In constructing the system, no modifications were made to any of the components. Thus, all components can be substituted, plug compatible, for any other of the same type.

Here is where we are to date, and what still needs to be done…

The BC-433G Receiver

The receiver covers Low Frequency Non-Directional Beacon Stations plus Standard AM Broadcast Frequencies in three bands. A temporary crank is shown where the tuning cable normally connects.

The unit in this Exhibit was the cleanest and most complete of three available receivers and was the designated “survivor”. The other two served as parts donors and were scrapped after being stripped for spares, which have been set aside.

The outside case, not shown in these photos, is in good condition. Size of the Receiver is 12 x 19.

Don Reaves generously provided a donor receiver, parts, and moral support. He gave his contributions as a swap, but it must be remembered that shipping these things is very costly, and he was more than generous in this regard.

In reconstructing this unit, I replaced 80-year-old components known to be failure-prone. But In spite of these precautions, the Receiver remains the weakest link in the system, and can ultimately fail. Some components can only be replaced by pullouts from other receivers. The R-5/ ARN-7 Receiver can be a source of parts or can be modified to work in this Exhibit.

A BC-433F Receiver can be substituted directly for the BC-433G.

The tuning cable, a flexible “speedometer” type, runs from the Control Box to the Receiver. The original cable is 10 feet long and originally ran with minimum curves or sharp bends within the aircraft. This installation requires a shorter cable to reduce friction.

To do this, new fittings needed to be machined.

Mike Hanz, (aafradio.org) generously contributed his advice and his skill with a lathe, and created these special parts for the project…

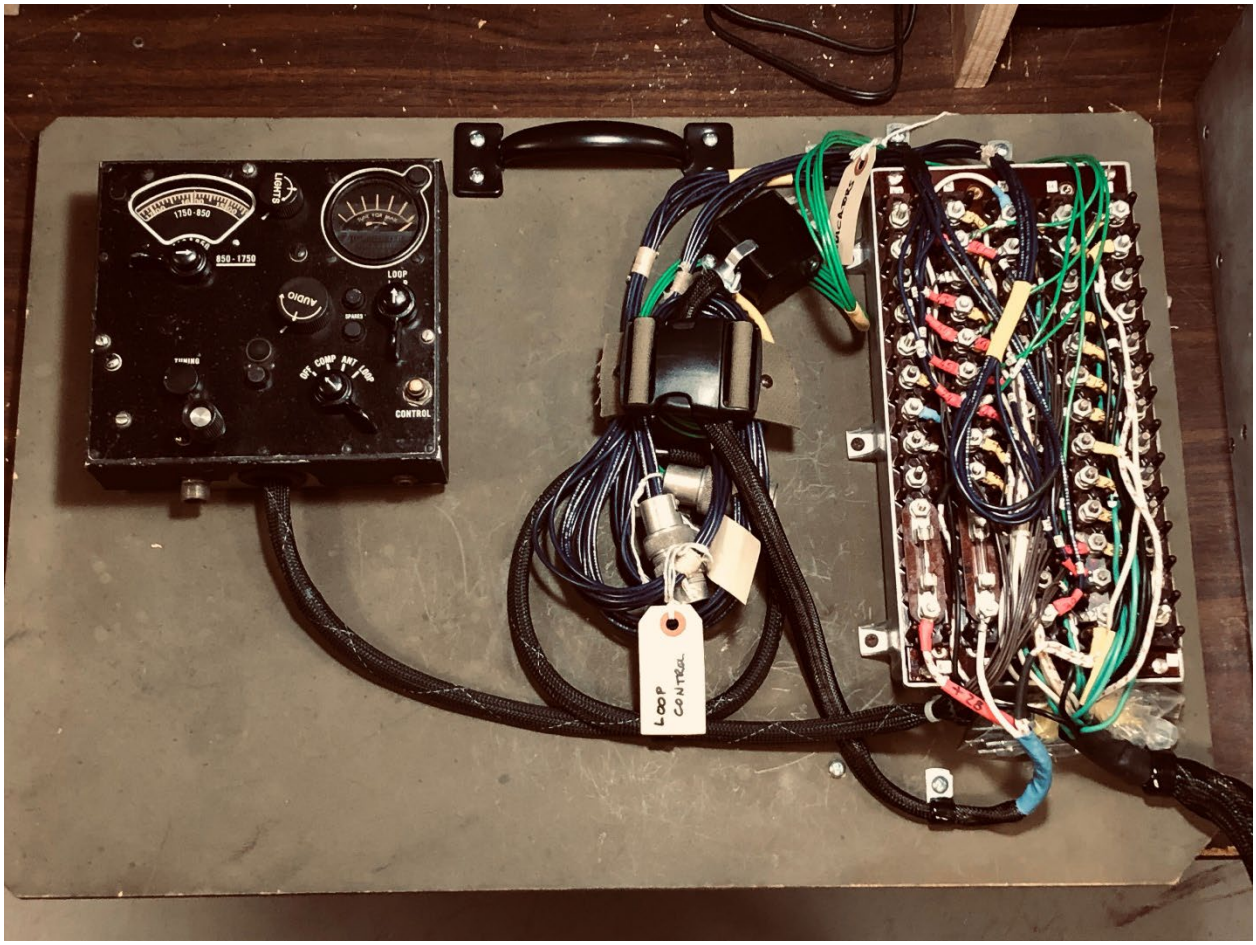
Still to do…

- Shorten the tuning cable

The Control Box and Junction Box.

Both are mounted on a single board, 18 x 25, to be placed at the center of the Exhibit, accessible to visitors, in front of the LP-21 and the Indicators.

Cables from the Junction Box run to the LP-21, the Indicators, the Receiver, and the Power Supply.



Still to do:

- Fabricate a transparent safety cover to keep prying fingers off the Junction Box

The LP-21 Loop

The loop is on its own board, 24 x 36, along with the I-81 Pilot's Indicator and the I-82 Navigator's Indicator. The board will sit at center rear of the Exhibit.

The loop is mounted on a raised box and is removable to give access to cable connections at the bottom of the pylon.

This box in turn is mounted on a platform that sits on a turntable, thus allowing the "Direction of Flight" to be changed up to 45 degrees in either direction.

I am relying on the Museum to supply a compass (vertical card or fluid filled) attached to the loop box, visible to the observer, to establish the magnetic bearing of the center line of the Loop. Alternately, the board can be secured to the table in a fixed position with no compass, the bearings can be marked, and care taken not to move the board.

As mentioned above, my LP-21 housing was badly damaged. But this was a blessing in disguise because it justified cutting a large observation port in the side to see the loop in action. The port is covered on the outside of the housing with a window of flexible polycarbonate sheet for protection. A slightly better appearance can be obtained by attaching the window to the inside of the housing. However, it would require thinner, more flexible sheet because the loop clearance inside the housing is very tight. A thinner sheet may not provide the protection needed.

The Indicators

The larger indicator (I-82A) is the Navigator's. The smaller one (I-81A) is the Pilot's. Both currently need some work to loosen them up. They stick in an arc of about 45 degrees, but I have been able to free them to some extent by exercising them back and forth using the "Left-Right" switch on the Control Box. I expect be successful with some further work. I have a spare I-81A which has not yet been tested.

The indictors will sit on the LP-21 board, left and right. The Navigator's will be easily accessible so that corrections can be made for aircraft heading when bearings are taken.

Still to do:

Fabricate two sloping-panel mounting boxes for the I-82A Navigator's Indicator on the left, and the I-81A Pilot's Indicator on the right.

Continue working to loosen the rotation. If necessary, consider opening them up to repair.

The Sense Antenna

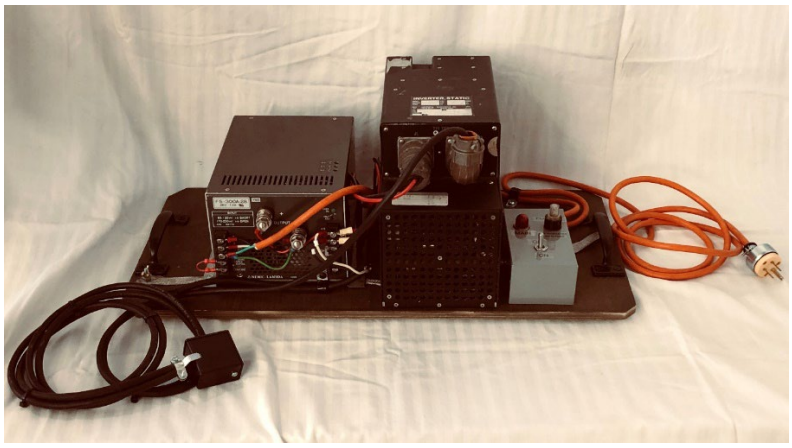
The Sense Antenna feeds into the receiver to eliminate the 180 degree ambiguity in the bearing. This antenna was normally positioned on the bottom of the aircraft, pointing downward. It should be mounted several feet away from the LP-21 Loop.

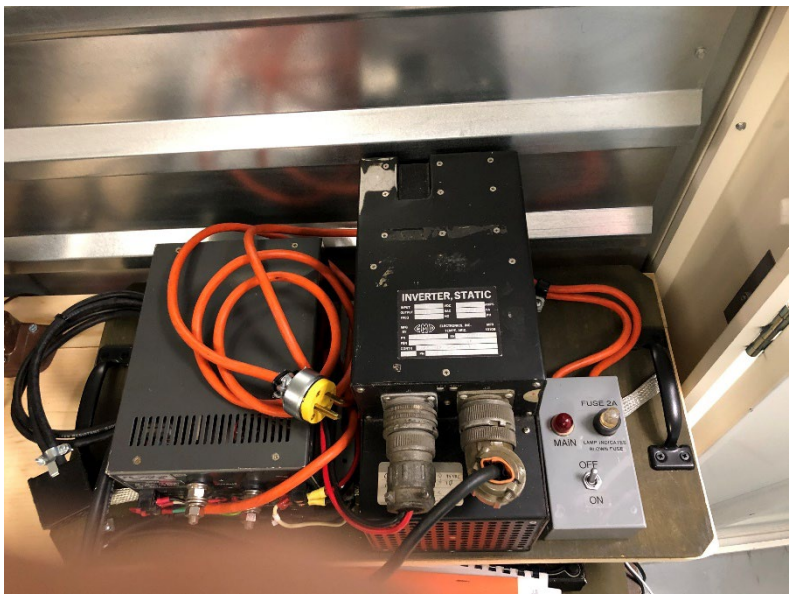
The Power Supply

The Power Supply consists of two units: a 28 Volt DC supply to power the Receiver Relays and Band-Switching Motor, plus a static inverter delivering 110 Volts AC at 400 cycles to power the three Selsyn motors that synchronize the Indicators with the LP-21 Loop. The static inverter also supplies operating voltage to the BC-433G Receiver.

Here again, Mike Hanz was instrumental in sourcing various inverters (and hard-to-find connectors) before we finally decided on this one. Mike's recommendations and his advice were essential.

Size of the Power Supply mounting board is 12 x 24.





Still to do:

Fabricate a transparent shield to cover the exposed terminals on the 28 Volt DC Supply

Plotting and Visual Aids

A 15-inch parallel rule is supplied along with FAA VFR section charts of the Detroit and Chicago areas.

Still to be determined is the method of plotting on the map… choices include laminating the map with a durable surface to permit drawing lines with erasable markers, or by printing maps that visitors can mark on directly, then take along as a souvenir of their Museum visit. Ideas, anyone?

One, possibly two, placards (18x24?) still need to be designed to give visitors basic information about the system, and historical context.

A laminated enlargement of a page from the C-47 instruction manual will show the plotting technique:

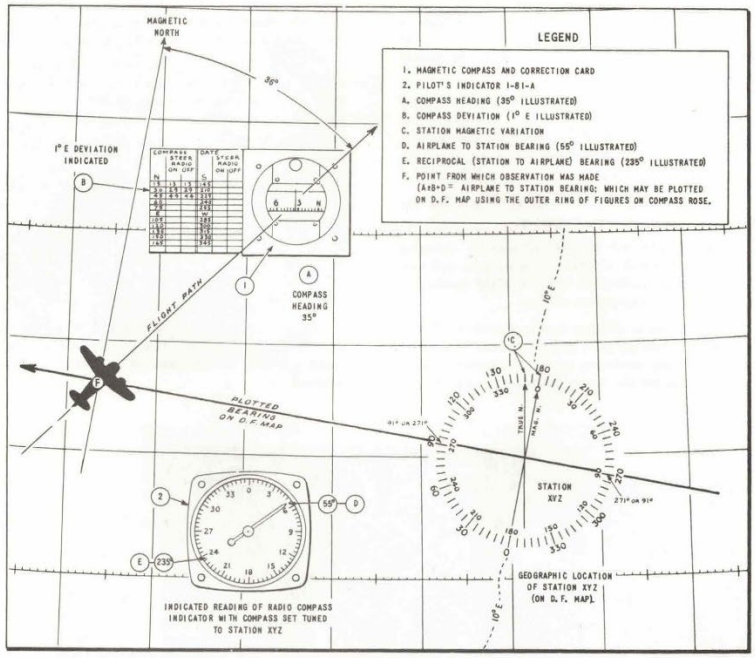


FIG. 52. PLOTTING A GEOGRAPHIC BEARING WITH SCR-269-G RADIO COMPASS

OPERATIONS NECESSARY TO PLOT A BEARING.

I. Add the magnetic compass heading (A) plus 1°E deviation (B) to the indicated station-to-airplane bearing shown by reciprocal reading (E) of Radio Compass Indicator pointer when radio compass is properly tuned to frequency of radio station XYZ.

II. The result (36° + 55° = 91°).

III. When using maps (other than D.F. maps) that do not have offset compass roses, the magnetic variation for locality of radio station (D) must be used in the calculation of I, above. The variation must be added to sum of (A) and (B) if variation is indicated on map as Easterly. (Subtract if variation is Westerly.)

IV. The result of step III above will then be plotted on the map using a standard compass rose that is calibrated on a basis of True North and *not* offset for magnetic variation compensation.

NOTE: The plotted bearing for only one station (Station XYZ) is shown for sake of simplicity. To complete an actual observation, two additional stations (located at equal intervals throughout 360° for best accuracy) would be plotted on the same map, following the procedure outlined above. The three plotted bearings should then intersect at point (E) indicating the approximate position of the airplane at the time of observation.

Summary

All the components have been tested individually. The real test comes when they are set up and required to work together.

I expect to begin testing in the next several weeks.

When complete, the Exhibit will require a tabletop approximately 6 feet wide by 5 feet deep, with a 3 foot by 2 foot side table on the left for plotting.

The technology and methods demonstrated in this Exhibit are obsolete or becoming so.

Non-Directional Beacons (NDB's) are being allowed to disappear, replaced by more sophisticated VHF and satellite-based DF systems.

But it is my hope that this Exhibit will fire the imagination of young visitors to future accomplishment by allowing them to pull aside the curtain of today's easy results, revealing the skill, intelligence and judgement demanded of flyers in an earlier era.