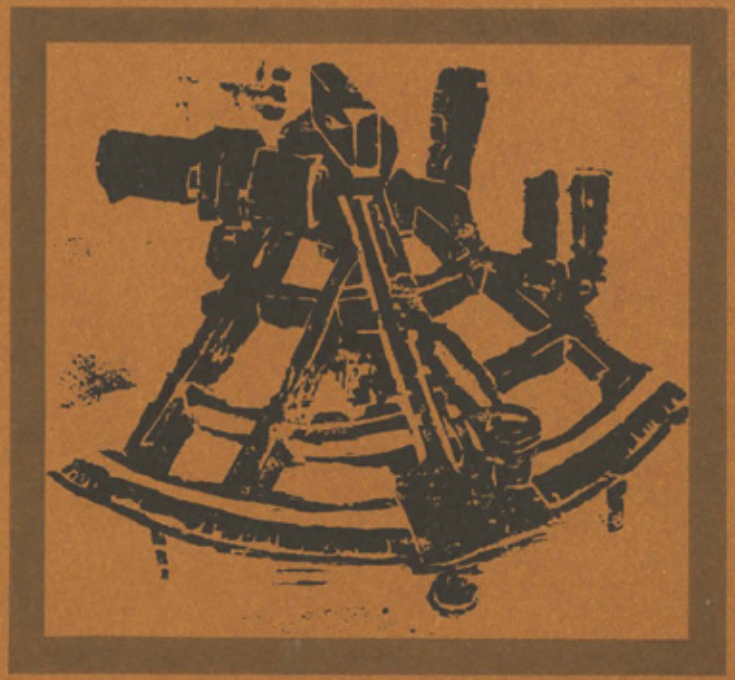
ITT

LORAN-C receiving sets for precision airborne/shipboard navigation



ITT AUTOMATIC LORAN-C RECEIVING SETS for.....

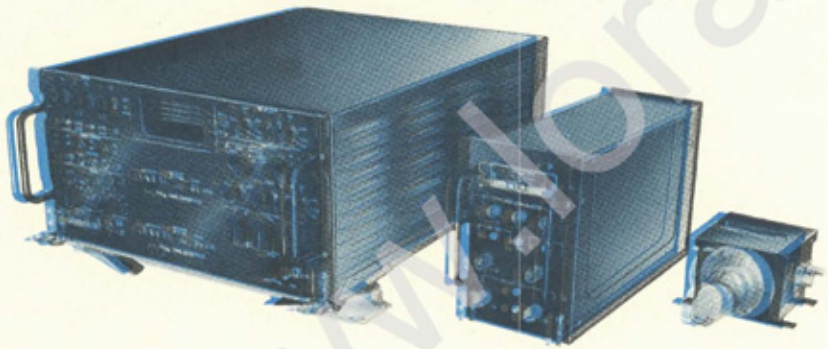
ITTFL's family of automatic Loran-C receiving sets is derived from a single basic design which features high-density modular packaging, fully-transistorized circuitry, electromechanical servo tracking loops and a ready-access construction for rapid trouble-shooting and repair. A product of more than seven years experience in Loran-C, these lightweight receivers develop the reliability, ease of maintenance, and simplicity of operation required of modern electronic navigation gear aboard high performance aircraft and surface vessels. ITTFL's special skills in Loran design insure that these equipments provide the instrumental accuracy and performance required to fully utilize all of the Loran-C system's inherent capabilities.

Each receiving set consists of (1) a Receiver-Indicator unit, (2) a Power Supply unit, and (3) an Antenna Coupler unit. After initial front panel adjustment for transmission lock, the receivers automatically and continually track the Loran transmissions, independent of any maneuver which the ship or aircraft may perform. The output display consists of a pair of time-interval readings which are developed by two sets of electromechanical dial counters, located at the center of the Receiver-Indicator's front panel. These two counters indicate the interval, in microseconds, which exists between the arrival time of the master station transmission, and those of two slave station transmissions, as measured by the Loran receiver.

The employment of narrow-band, servo-driven tracking loops for the achievement of lock upon both the envelope and phase of the received multipulse Loran-C signal permits these receivers to operate successfully in extremely poor signal-to-noise environments.

All models described are in current production. ITTFL further supports these receivers after delivery by maintaining a separate Loran Repair Department stocked with a complete spare parts inventory.

precision airborne/shipboard navigation



IDENTIFICATION

AN/APN-151 and AN/APN-152 • The AN/APN-151 and AN/APN-152 airborne Loran receivers were developed by ITTFL under joint sponsorship (U. S. Coast Guard Contract), of the U. S. Coast Guard (APN-152) and the U. S. Air Force (APN-151). The APN-152 is utilized by various Coast Guard aircraft. The APN-151 is included as standard navigation gear for the C-135 long-range jet transport.

The APN-151 and APN-152 receivers are virtually identical. Their dissimilarities lie in such minor features as type and color of front-panel illumination/dimming and antenna coupler design.

AN/APN-157 • The AN/APN-157 airborne Loran receiver consists of an AN/APN-151 equipment which has been furnished with four analog-to-digital encoders for transmission of Loran-C data to the AN/ASN-24 navigational computer. The encoders fit within the dimensions of the standard APN-151 Receiver-Indicator enclosure.

The APN-157 configuration was developed by ITTFL under the sponsorship of the U. S. Air Force. The receiver is included as standard navigation gear for the Star-Lifter C-141A long-range jet transport.

AN/SPN-36 • The AN/SPN-36 shipboard receiver is an adaptation of the AN/APN-152 airborne unit. The three hardware items are enclosed in ruggedized aluminum cases, rather than the light aluminum dust covers used for the airborne sets. The finish is gray enamel. No shockmounts are furnished, or required.

The relatively slow speed of a surface ship (as compared to that of an airplane) is accommodated in the SPN-36 design: the bandwidths of the phase and envelope tracking loops are narrowed in order to develop an even greater tracking stability and resistance to noise interference than the standard airborne receiver can accommodate.

The SPN-36 receiver was developed by ITTFL, under sponsorship of the U. S. Coast Guard. This equipment is being used aboard Coast Guard vessels, in a variety of operations (air-sea rescue, patrol, survey, etc.).

characteristics common to all receivers

GENERAL

A complete set consists of three units (see illustration) as follows:
Receiver-Indicator Unit • Power Supply Unit • Antenna Coupler Unit
Each set is supplied with one copy of Technical Manual CG-273-90 (three volumes) containing the following sections:

1. General information
2. Installation
3. Operator's section
4. Principles of Operation
5. Trouble-Shooting
6. Service and Repair
7. Parts List

Each set is furnished with all mating connectors required for the RF and power cabling between units. Not supplied are (1) the RF and power interconnecting cables, or (2) the antenna.

OPERATIONAL

Primary Power Requirements:

AN/APN-151, 152 and 157
185 watts @ 115 VAC, 400 cps, single phase
32 watts @ 28 VDC peak
22 watts, maximum @ 0-6.3 VAC (remote panel illumination for the APN-151 and APN-157 sets only)

AN/SPN-36
215 watts @ 115 VAC, 400 cps single phase (a 60 cps to 400 cps rotary converter can be supplied, if desired)

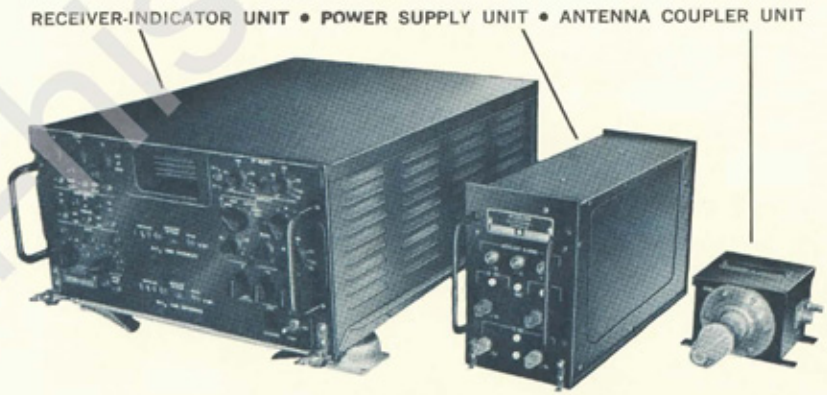
Carrier Frequency: 100 kc

3 db Bandwidth: 23 kc

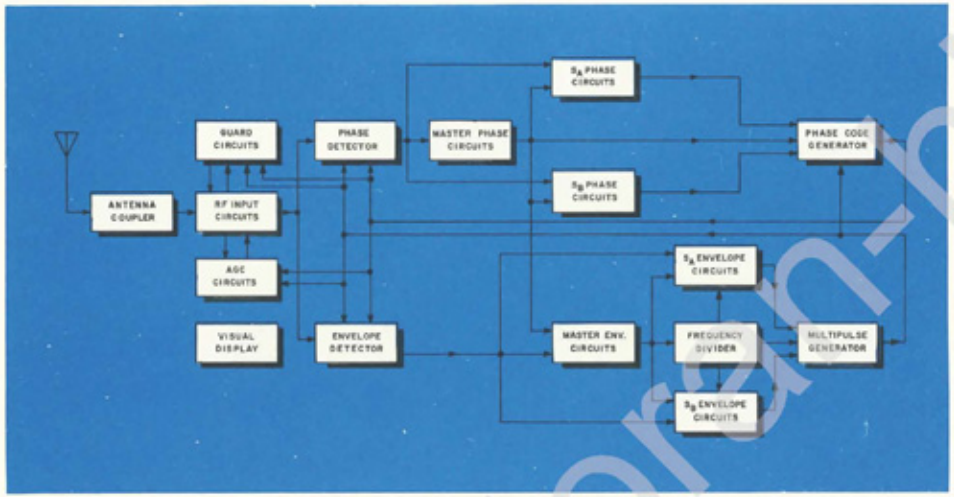
RF Section:

Gain Control: AGC is individually set, automatically or manually, for three signals (master and two slaves). Individual AGC settings can accommodate differences in received signal strengths as large as 68 db.

Interference Rejection: Four separate notch filters, each tunable over a 70-130 kc frequency range, are provided for reduction of near-channel interference. The cathode ray tube display is used as a visual aid, for this adjustment. RF



characteristics common to all receivers



AIRBORNE LORAN-C RECEIVER OVERALL BLOCK DIAGRAM

channel bandwidth can be set for either wide or narrow-band operation, as required by the interference environment.

Sensitivity: The receivers will track normally with input signals as low as 0.3 microvolts.

Antenna requirements: Antenna may be of the long wire, flushmount, trailing wire, or whip type. The minimum vertical electrical height should be at least six feet.

Tracking Section:

Slew and Drift Controls: Drift control aligns the receiver timing with master station signal. Two independent slew controls align the receiver timing with signals from the two slave stations.

Automatic Tracking: The receiver remains locked upon the master and two slave signals when the initial lock has been accomplished. In the case of a three-slave net, the selection of the two specific slave signals to be tracked is optional with the operator.

Tracking Accuracy: Zero velocity error at speeds up to 600 knots (airborne receivers), or 60 knots (shipboard receiver) on baseline. 90-second recovery from acceleration due to any aircraft turns at 600 knots at 30/second on base line. Instrumental accuracy of .05 microseconds.

"Stop Tracking" control: A momentary depress switch at the front panel permits the operator to stop all tracking indicators for a three second interval, in order that readings from the faster-moving indicator dials can be obtained. Automatic tracking resumes upon completion of the "stop" interval.

Signal Noise Accommodation:

The Receivers will track normally under signal/noise ratios as poor as 1/10, and nonsynchronous CW interference as high as 30 times signal strength.

Readout, Control and Alarm Indicators
Time Difference Counters:

The receivers use two sets, each consisting of (1) an envelope counter, (2) a phase counter, and (3) an envelope settling indicator. Each set of counters is associated with one master-slave time difference measurement. The envelope counter indicates time difference measurements up to 99,999 microseconds.

characteristics common to all receivers (cont.)

The envelope settling dial (normally at zero when the readings are taken) indicates the difference, in microseconds, between the "units" dial of the envelope counter and the units dial of the phase counter.

Visual display: A compact 3" x 1½" rectangular-faced cathode ray tube displays RF or video signals for both initial pulse train acquisition and monitor while tracking.

Alarms:

Lost Signal Indicators: Three automatic lost signal indicators warn the operator of the loss of any signal due to system malfunction, synchronization jump, or ground station failure.

Sky-Wave Tracking Alarm: One alarm automatically warns of sky-wave tracking in any combination of master and slave signals. The individual sky-wave being erroneously tracked is identified by means of front panel switches.

Construction:

The receiver is modularized throughout. Plug-in circuit cards permit quick replacement of defective units. Multiple test points, distributed within the receiver, facilitate servicing and trouble-shooting.

The hinged front panel opens downward for ready-access to the mechanical assembly and cathode ray tube circuitry (see illustration).

With the exception of the cathode ray tube and four beam-switching tubes, the receiver is entirely transistorized.

The receivers are equipped with elapsed-time indicators.

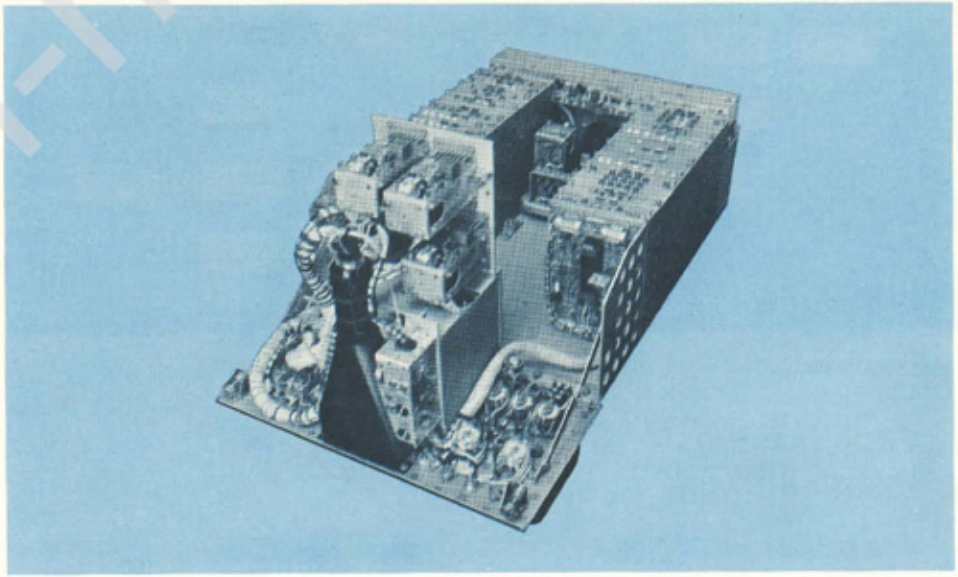
The exterior finish for the airborne sets is black crackle: The exterior finish for the shipboard set is gray enamel.

Environmental:

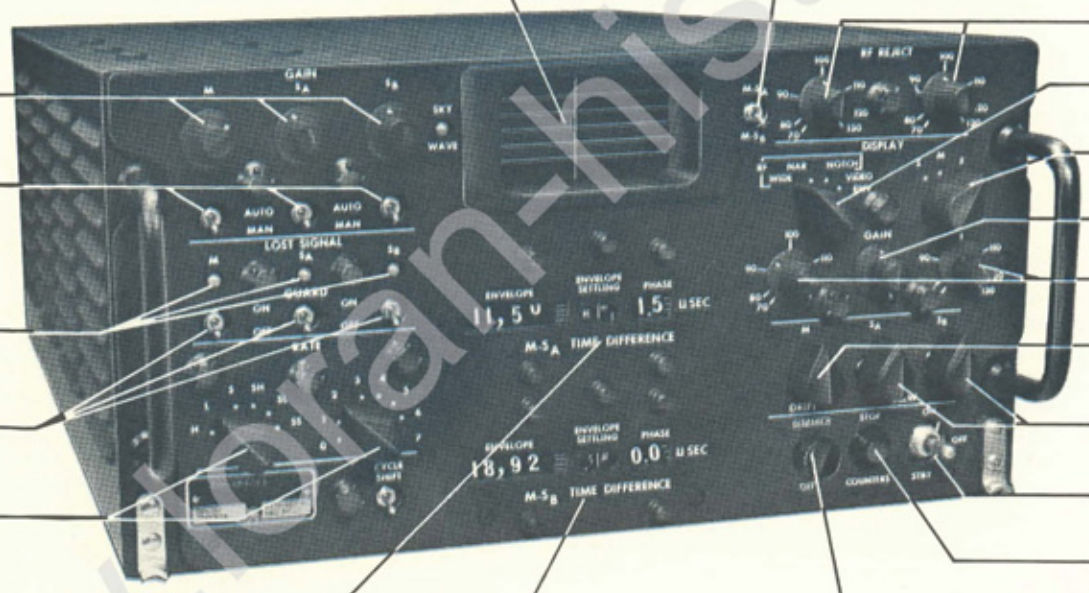
The receiver is designed for operation over an ambient temperature range from −54° C to +55° C.

Quality Control:

These receivers are manufactured and acceptance-tested under rigid quality control conditions. The equipments are subjected to temperature cycling, vibration testing, and a 36-hour burn-in, before acceptance for delivery.



front panel layout – AN/APN-152 AIRBORNE RECEIVER (U.S. Coast Guard)



VISUAL DISPLAY CRT

RF MANUAL GAIN CONTROLS

MANUAL/ AUTOMATIC RF GAIN CONTROL SELECTOR SWITCHES

LOST SIGNAL INDICATORS

SKY WAVE ALARM SELECTOR SWITCHES

SPECIFIC & BASIC PULSE REPETITION RATE SELECTOR SWITCHES

MASTER-SLAVE A TIME DIFFERENCE INDICATORS

MASTER-SLAVE B TIME DIFFERENCE INDICATORS

SLAVE A/SLAVE B DISPLAY SELECTOR

RF NOTCH FILTERS

CRT DISPLAY SELECTOR

CRT SWEEP SPEED CONTROL

CRT GAIN CONTROL

RF NOTCH FILTERS

MASTER PULSE DRIFT SWITCH

SLAVE PULSE SLEW SWITCHES

PRIMARY POWER

MOMENTARY "STOP COUNTERS" BUTTON

PANEL DIMMING CONTROL (APN-152 & SPN-36 ONLY)

individual characteristics

AN/APN-151 AND AN/APN-152 AIRBORNE RECEIVERS

NOMENCLATURE	DIMENSIONS, INCHES	WEIGHT, LB.
Receiver-Indicator R-1117/APN-151 R-1157/APN-152	8″ x 15″ x 23″	55
Power Supply, PP-3256/APN	8″ x 5″ x 15″	9
Antenna Coupler, CU-1013/APN-151	3″ x 5″ x 9″	2½
CU-1103/APN-152	2″ x 4″ x 6″	1
Totals:	2.0 cu. ft. (APN-151) 2.0 cu. ft. (APN-152)	67 lb (APN-151) 65 lb (APN-152)

SHIPPING DATA (either receiver)

	Carton only	Carton plus case
Volume:	8.3 cu. ft.	12 cu. ft.
Weight:	102 lbs.	157 lbs.

Except for the following differences, the AN/APN-151 and AN/APN-152 Loran-C receiving sets are identical.

	AN/APN-151	AN/APN-152
(1) Front Panel dimmer control	Remote (not supplied)	on front panel
(2) Front panel Illumination	White	Red
(3) Front Panel Illumination voltage	6.3 VAC, 400 cps	
(4) Antenna Coupler	Single 50-Ohm Loran C output terminal Receiver disabled when aircraft transmits. Lightning protection, per MIL-A-9094C	Two output terminals (Loran & HF communications)
(5) Resilient mount, MT-2683/APN for Receiver-Indicator	provided	provided
(6) Resilient mount, MT-2823/APN-152, for Power Supply PP-3256/APN-152		provided

individual characteristics

RECEIVER INDICATOR
UNIT AN/SPN-36 SHIPBOARD RECEIVER (U. S. COAST GUARD)

THE AN/APN-157 AIRBORNE RECEIVER

The AN/APN-157 unit consists of an AN/APN-151 which has been equipped with a special analog-to-digital encoder system. This system comprises four A/D shaft encoders which have been attached to the two phase and envelope shafts of the receiver's electromechanical tracking loops. The encoders are wired to a 48-pin output jack, located at the rear of the Receiver-Indicator unit. This jack serves to connect the AN/APN-157 Loran-C receiver to the AN/ASN-24 Navigation Computer.

Upon command from the computer, the encoders transmit, in binary form, the time-difference readings of the two phase and envelope counters. The envelope data is transmitted in 9 bits; the phase data in 7 bits. The AN/ASN-24 computer processes the Loran-C data for direct presentation as (1) latitude-longitude, (2) range-bearing, or (3) along-course/off-course information.

The encoder system is fitted entirely within the Receiver-Indicator chassis. The total weight of the encoder system is less than one pound.

NOMENCLATURE

Receiver-Indicator R-1214/APN-157
Power Supply, PP-3866/APN-157
Antenna Coupler, CU-1013/APN-151

Dimensions and weight are identical to the AN/APN-151 receiver.

THE AN/SPN-36 SHIPBOARD RECEIVER

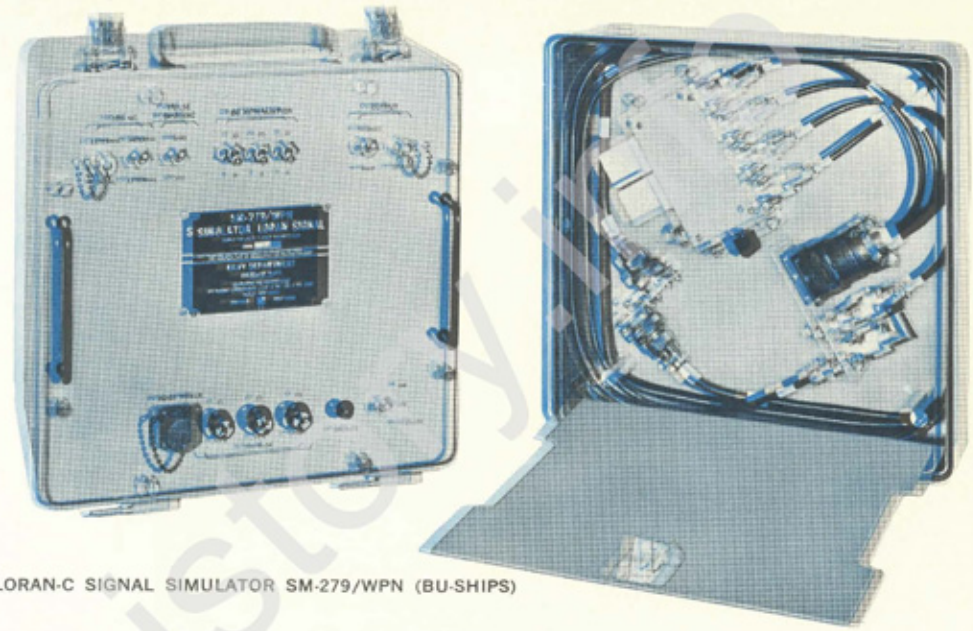
The AN/SPN-36 receiver is a shipboard adaptation of the Coast Guard's AN/APN-152 airborne receiver. The three hardware units are enclosed in ruggedized aluminum cases. The antenna coupler design has two minor electrical changes (with reference to that of the AN/APN-152).

NOMENCLATURE	DIMENSIONS, INCHES	WEIGHT, LB.
Receiver-Indicator, R-1233/APN-36	11″ x 19″ x 23″	87
Power Supply, PP-3952/SPN-36	9″ x 7″ x 16″	16
Antenna Coupler CU-1279/SPN-36	6″ x 4″ x 4″	8
Totals	3.4 cu. ft.	111 lb.

Shipping Data (carton plus case): Volume: 15 cu. ft.
Weight: 210 lbs.

In addition to the standard technical manual (CG-273-90), the AN/SPN-36 receiver is furnished with a complementary technical manual (CG-273-100), which delineates the differences between the SPN-36 and the APN-152 Coast Guard receivers. The SPN-36 set is also furnished with (1) a primary power cable, and (2) an RF attenuator (ITTFL P/N 2391-662G2) which can be adjusted, in 10 db steps, from 0 to 30 db. No shockmounts are required, for this receiver. The recommended antenna (not supplied) is a 35′ vertical whip, or a long wire.

testing and test equipment



LORAN-C SIGNAL SIMULATOR SM-279/WPN (BU-SHIPS)

Under ordinary user conditions, these receivers are checked out by utilizing Loran net generated signals as they are received by a long-wire antenna. A medium-bandwidth oscilloscope with a time-calibrated baseline is also required to check waveforms and signal sequencing at the various test points of the receiver.

ITTFL manufactures the SM-279/WPN Loran-C test set (a BuShips sponsored development). This crystal-controlled test set produces a continuous train of nonphase-coded Loran C pulses which are separated at intervals of 500 or 1000 microseconds. Dimensions of this set are 12″ x 12″ x 12″. Its weight is 25 lbs.

Under current development at ITTFL is a dynamic Loran-C test set which will permit checkout of the receiver's tracking circuitry under simulated aircraft velocity or maneuvers. This test set will be available by 1966.

principals of loran

The Loran (long range navigation) system, developed as a military navigation aid during World War II, is a pulsed-type hyperbolic navigation aid in which time-differences of received radio signals from two or more shore transmitting stations are used to obtain an accurate fix on the earth's surface.

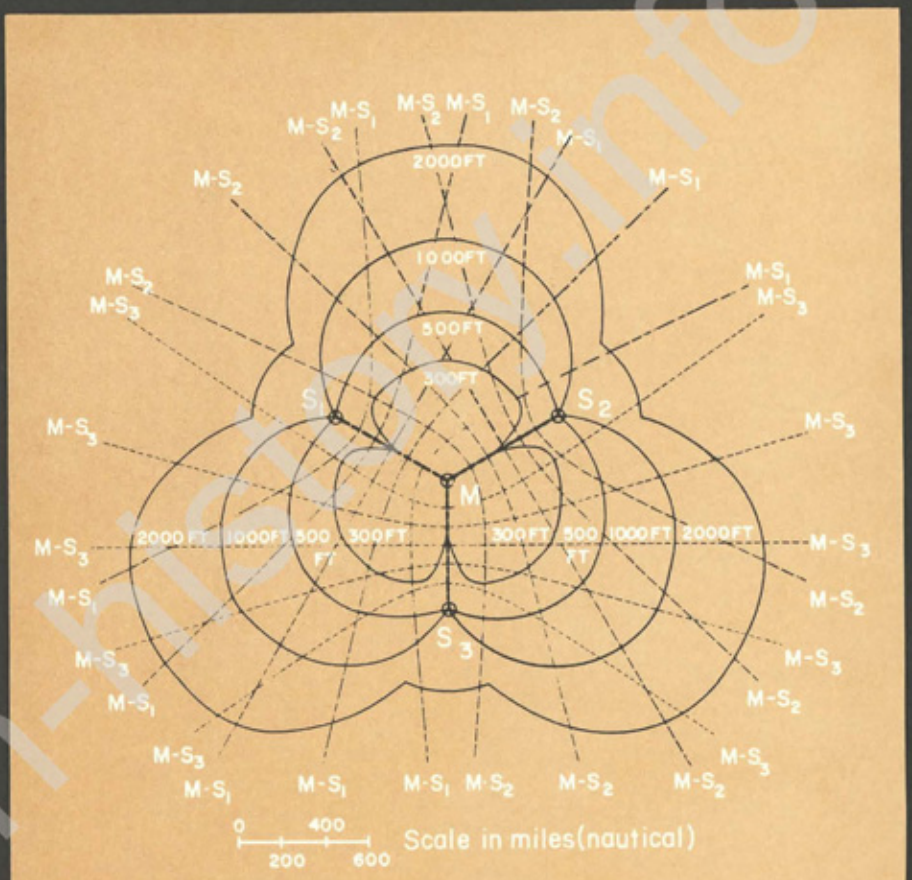
Loran transmitting stations, known as master and slave stations, are synchronized so their signals are transmitted at regular intervals. The time-differences of the signal arrivals relate to the position of the receiver on special Loran navigation charts. These charts show printed hyperbolic lines representing the time-differences of signal arrivals for various geographical points. The intersection of any two lines of time-difference pinpoints the position. For highly accurate navigation as required for surveying, tables and special computers or other translation devices are employed.

While the original Loran system (Loran-A) was a great step forward in the art of radio navigation when introduced in the early 1940's, Loran-C combines improved system concepts and instrumentation with today's knowledge of radio propagation to produce an automatic navigation system capable of much greater range and accuracy.

Substantially increased ranges are achieved by transmitting Loran-C pulses in the 90-110 kc frequency band. Operation in this band permits the synchronization of Loran signals between transmitting stations located much further apart than was heretofore possible. In addition, the lower frequency permits successful propagation of Loran signals over land masses as well as over large bodies of water. This extends radio navigation service to areas not covered by Loran-A.

Greater fixing accuracy is the result of improved system geometry and increased precision in measuring time-difference.

The basic principle of Loran is extended by improved instrumentation techniques to include measurement of the carrier phase of the pulse signals. This technique provides an effective vernier for



Typical Loran-C Star Chain: M = Master Station. S_1, S_2, S_3 = Slave Stations. Dashed lines indicate Hyperbolic lines of position. Solid lines indicate predicted accuracy contours; accuracy within a contour will be better than that indicated for 95% of the observations.

increasing the accuracy of time-difference by over an order of magnitude. Continuous-wave systems operating in this frequency range achieve comparable accuracies at short ranges, but deteriorate at medium and long ranges because the ground-wave signal becomes contaminated by sky-wave propagated energy. Loran-C, as a pulsed-type system, retains ground-wave accuracy and stability, since it is possible, by proper time-sampling, to resolve the ground-wave energy from the delayed sky-wave. Loran-C uses a group-pulsed technique (eight pulses transmitted per repetition interval) instead of single pulsing to achieve a higher radiated average power.

At the present time, Loran-C three-station transmitting chains cover many of the world's busiest air and sea lanes. Installations are operating along the U. S. Atlantic Coast, the Northern European area, the Mediterranean Sea, and the Northern and Central Pacific Ocean regions.

Current World wide LORAN-C coverage diagram (mercator projection)

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TD 66-16
Printed in U.S.A.

ITT Federal LABORATORIES
A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
500 WASHINGTON AVENUE, NUTLEY 10, NEW JERSEY

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