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Letters to the Editor

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A 401 MHz RECEIVER FOR TESTING RADIOSONDES

1. The need for a small and compact test equipment to test the carrier and modulation frequencies of audio frequency modulated radiosondes operating on 401 MHz was first felt when these radiosondes were introduced in India some years ago. In the initial stages the Metox radiotheodolite ground equipment itself was used for checking the carrier and modulation frequencies. But this arrangement was unsatisfactory, particularly when used in a calibration laboratory.

The present note describes a transistorised radio receiver designed and constructed in the Instrument Research Laboratories of the India Meteorological Department at New Delhi. The receiver gives a rough estimation of the modulation frequency over the range 0-200 Hertz in the form of an aural output and also indicates the frequency on a meter. The receiver is light and compact and consumes little power compared with the Metox radio-theodolite.

2. 401 MHz oscillator in the receiver heterodyne with the incoming 401 MHz modulated radiosonde signal and the modulation frequency is filtered and taken as output. This output is amplified and fed to a speaker as aural indicator of the modulation frequency. A part of the output is further amplified and converted into pulses of constant amplitude and width. This produces in the final output stage a current directly proportional to the audio frequency which is indicated on a milliammeter.

3. V_1 (R 242 P 10) is used in a butterfly oscillator circuit, which can be tuned to frequencies in the range 390—410 MHz (Fig. 1). The tuning capacitor C_0 is calibrated. The radiosonde transmitter frequency beats with the oscillator freqnency and the modulation frequency is filtered, separated and coupled to the next stage by an audio transformer TR_1. This audio frequency signal is amplified by transistor T_1 and d.c. coupled to T_2, a d.c. amplifier emitter follower. The output of T_2 is connected to a Schmitt's trigger circuit formed by T_3 and T_4 which gives an output of constant pulse width and amplitude. This output is d.c. amplified by T_5, used as emitter follower. The output of T_5 is fed to a driver stage whose output is fed in turn to a push-pull output amplifier. The output of the push-pull stage is fed to a speaker and is monitored as aural indication of the modulation frequency.

A portion of the output is fed to the frequency indicator device. For any given frequency, the meter reading is proportional to the pulse width and pulse amplitude as well as the input frequency. Constant pulse width and amplitude is produced by a circuit using T_9, T_{10} and T_{11}. Since the input to T_{12} is of constant pulse width and amplitude, the output current of T_{12} will be directly proportional to the input frequency, subject only to the circuit parameters discussed in the next paragraph.

4. Silicon transistors are used for T_9 to T_{12}. Silicon transistors in the metering circuit eliminates the effect of changes in ambient temperature normally found in germanium transistors. Further silicon transistors have a low reverse collector current and hence there is virtually no zero set adjustment.

In the choice of the semi conductors for metering, the major limiting factors are low voltage for its operation and its d.c. gain β. The linearity of the collector current to frequency holds good when the ratio of the natural period of the frequency applied, to the recovery period of the switching circuit (T/τ designated as σ), is large. T is the period of input frequency and τ is the time taken for condenser C_T to charge 95 per cent of the voltage which is approximately three times the $C_T R_T$ value of T_{11}. It has been shown by Kotlarski (1961) that for linear amplification of transistors, $\beta_{min} = 4.3\sigma$, where β is the current amplification of the transistor which controls the charging rate of the of C_T through the collector load of T_{11}.

The equation shows that for higher values of σ, higher gain transistors are required. β for CIL 902 is 100 and gives a nearly linear output from 60 Hertz. It is found that with a 5V signal amplitude at B and a 10K Ω variable potentiometer R_v is series for adjustment of sensitivity, a linear output between 110 and 210 pulses per second can be obtained. The meter reading against frequency is shown in the graph at Fig. 2.

Since the amplitude of the standard pulse is proportional to the collector voltage, other parameters remaining constant, the milliammeter reading for any given input frequency will depend upon the collector voltage. But, the emitter and collector loads being of same value for T_{11} and

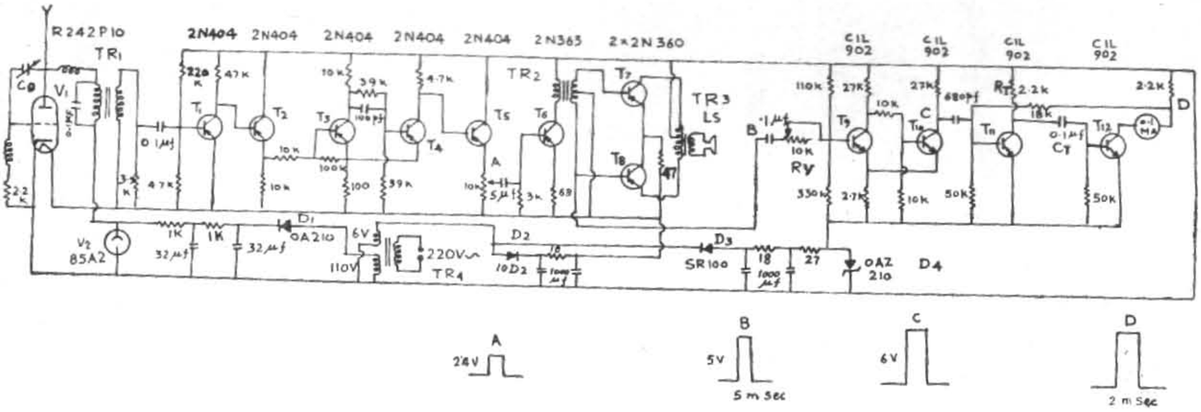

Fig. 1. 401 MHz receiver for testing radiosonde

T_{12}, the supply drain is independent of the pulse width, amplitude and the input frequency. Thus except for transient conditions, power supply regulation is not affected by the input frequency or changes in standard pulse width variation. By having a supply voltage regulation the frequency meter reading is made entirely stable varying only with the input frequency. The sensitivity of the metering circuit is increased when the series base resistance R_y of T_9 is decreased. If this resistance is decreased more than the minimum input impedance, the circuit presents a non linear input impedance to the signal source. By using a series potentiometer of 10K Ω a convenient means of full scale calibration on the meter can be obtained. This method of scale calibration is effective for small changes. For changes of 5 or 10 to 1 or more the single shot-coupling capacitance C_T can be switched to different values. The value shown (0·1 mfd) is for full scale meter reading at 250 Hertz.

The standard pulse width which is fed to T_{11} must be less than half the input signal period so that each input signal cycle is effective in triggering the multi-vibrator with the values used. The standard pulse width is 2 millisec. The meter is normally used for signals upto 200 Hertz, *i.e.*, a pulse repetition period of 5 milliseconds. The standard pulse width is large enough to give a measurable average current flow through the meter at 6 Hertz but the response is non linear at low frequencies.

5. Within a limited range for a certain time constant defined by (R_T C_T), the frequency indicated follows a linear scale. The equipment does

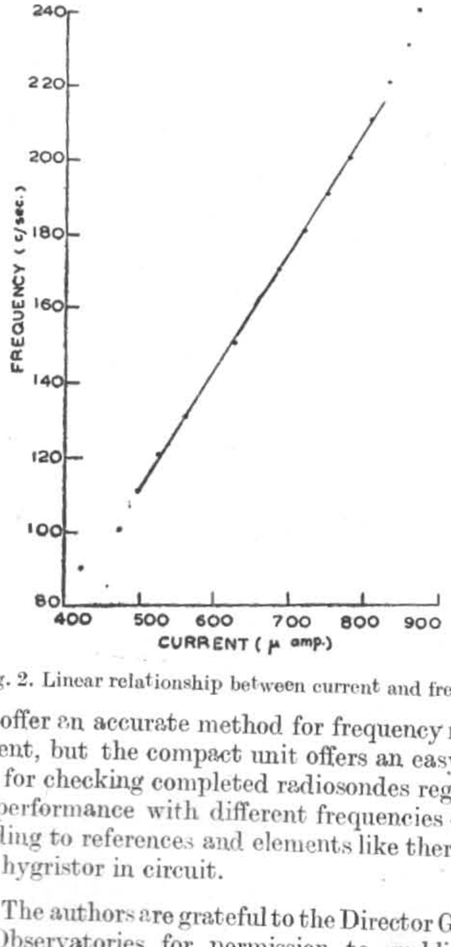

Fig. 2. Linear relationship between current and frequency

not offer an accurate method for frequency measurement, but the compact unit offers an easy method for checking completed radiosondes regarding its performance with different frequencies corresponding to references and elements like thermistor and hygristor in circuit.

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