1.2: Nuclear Magnetic Resonance Spectrometers

A block diagram of an NMR spectrometer utilizing an electromagnet is shown in Fig. 1-2. For high-resolution spectra, the magnet will have pole faces up to 12 in. in diameter, a pole gap of about 1.75 in., and a field of up to 14,000 gauss. The magnet is energized by a highly stable d-c power supply. If a fixed-frequency rf oscillator is employed, one "sweeps" through the resonance by varying the total magnetic field through injection of the linearly varying output from a "sweep generator" into coils either wound around the magnet pole faces or located within the pole gap. The output of the generator is synchronized with the trace along the X axis of an oscilloscope or suitable graphic recorder.

The sample is placed within the pole gap and subjected to the rf alternating magnetic field produced by passing a high-frequency a-c current through the oscillator coil. The detector serves to pick up changes in the magnetization of the nuclei induced by the rf oscillator, and the detector signal is fed to the Y axis of the oscilIoscope or graphic recorder. A nuclear resonance spectrogram is thus a plot of detector signal against magnetic field at constant oscillator frequency.

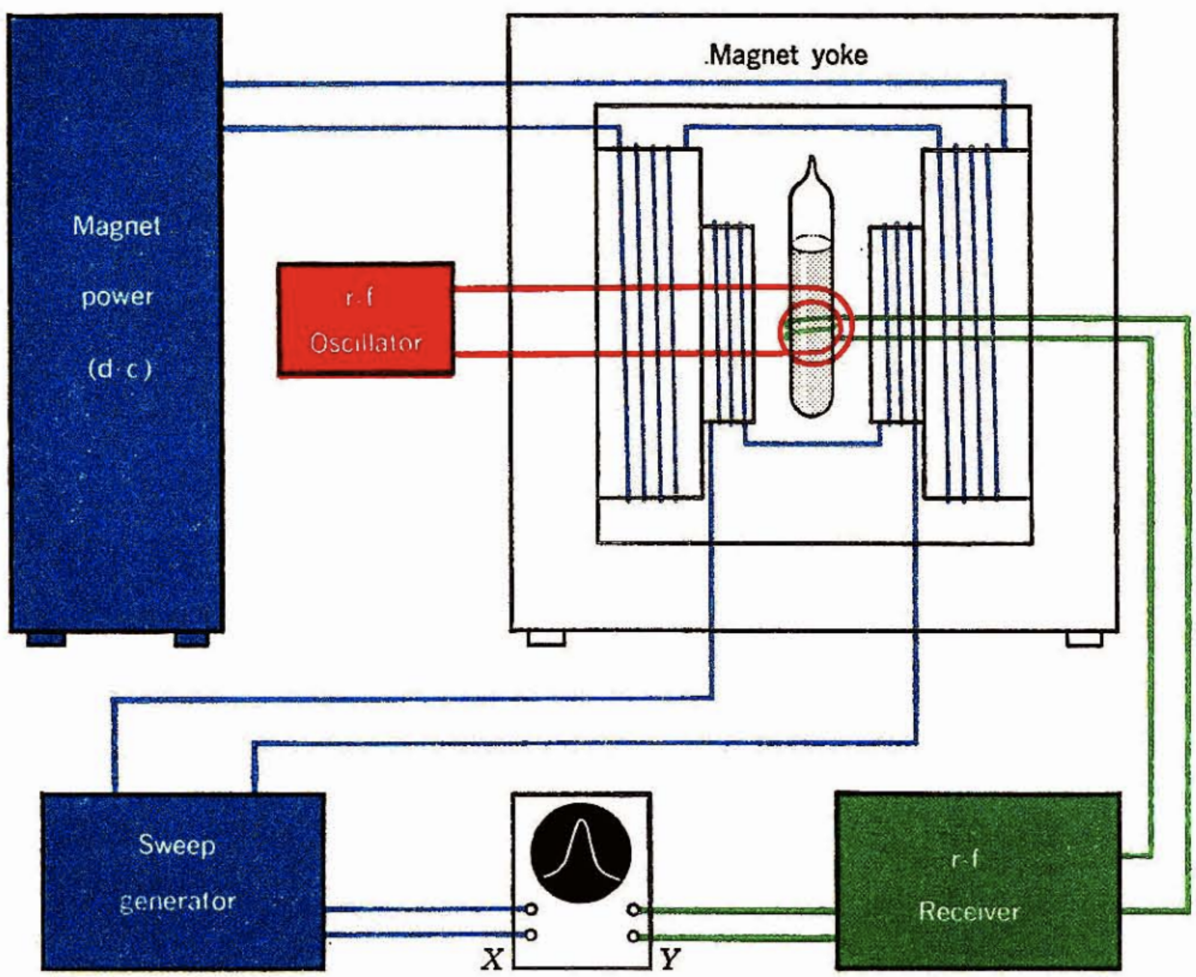

Fig. 1-2. A block diagram showing NMR spectrometer equipped with an electromagnet.

The state of affairs in the immediate vicinity of the sample is shown in Fig. 1-3. It will be seen that the oscillator coil is oriented with its axis perpendicular to the principal magnetic field. The receiver coil is tuned to the oscillator frequency but is oriented with its axis perpendicular to both the direction of the principal magnetic field and the axis of the oscillator coil. This arrangement is used to minimize the overloading of the necessarily sensitive receiver which would result from direct coupling between the oscillator and receiver coils. Therefore, a nuclear resonance signal arises from an indirect coupling between the oscillator and receiver coils produced by the sample itself. The requirements for such coupling can be described more precisely as follows. The magnetic field of the oscillator alternates through the sample along one direction. The receiver coil responds to a magnetic field which alternates perpendicularly to the field produced by the oscillator coil. The signal results from an alternating magnetization which is induced in the sample by the oscillator field in a direction perpendicular to the axis of the oscillator coil.

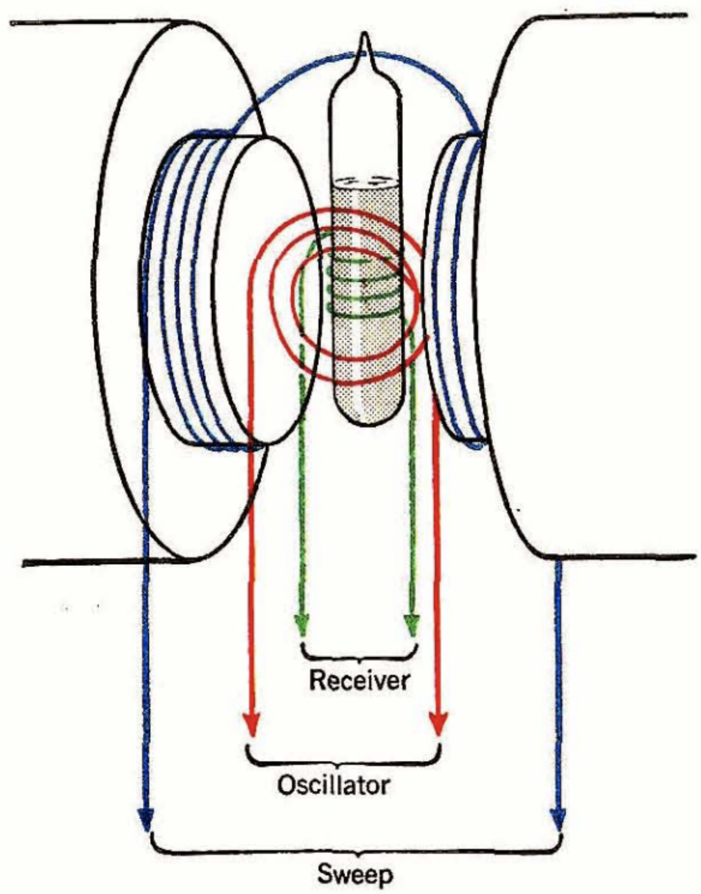

Fig. 1-3. Arrangement of sample and coils in nuclear induction apparatus.
