工程技术英语注释读物

RADIO

无线电

上海交通大学科技外语系
课外读物注释组 注释

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〔英〕H. Henderson 著

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商 务 印 书 馆

1981 年 · 北京

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商 务 印 书 馆 出 版
（北京王府井大街36号）
新华书店北京发行所发行
北京第二新华印刷厂印刷
统一书号：9017・1127

1981年10月第1版
1981年10月北京第1次印刷
印数 1—7,600 册
开本 787×1092 1/32
字数 78 千
印张 3 1/4

定价：0.38 元

目　录

1 INTRODUCTION

1.1 Radio

This is a very general term which covers a very wide field of communications. Whether we are thinking of radio telephones, radio navigation or radio broadcasting①, we are basically concerned with② the transmission of information by means of electro-magnetic waves.

When a pressure wave passes through air we have a sound wave and we can demonstrate the vibration of the particles of the medium, air, through which it travels. Similarly a sea wave is accompanied by the transfer of energy over large distances by the circular movement of water particles.③

It is therefore difficult to think of a wave which requires no medium — one that can pass through a perfect vacuum. People who could not accept such a situation postulated a mythical medium — the 'aether'. But it had to④ be given fantastic properties, and we are better without it⑤.

Let us start then by showing how an electric oscillation in a circuit can give rise to⑥ electro-magnetic waves and then how these waves can be made to carry information.

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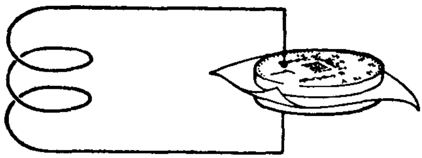
① **Whether we are thinking of radio telephones ...: whether** 引导的是让步状语从句，可译成："无论我们想到无线电话，…"。 ② **be concerned with:** 涉及到。 ③ **Similarly a sea wave ... particles.** 可译为："同样由于水的粒子的环流运动， 海浪就伴随着能量的转移而扩散得很远。" ④ **had to** (+ 原形动词)：必须；不得不。 ⑤ **and we are better without it:** 因此，我们觉得不要它为好。 ⑥ **give rise to:** 引起；产生。

1.2 Electromagnetic waves

It was shown that a circuit containing inductance (L) and capacitance (C) can resonate. When it does so① energy transfers itself rhythmically from being magnetic, when a large current is surging round the circuit, to electrostatic, when the current has momentarily ceased and the capacitor is fully charged. The frequency of resonance of such a circuit is given by the expression

$$f=\frac{1}{2\pi\sqrt{(LC)}}\text{ cycles per second (hertz).}$$

Thus a circuit consisting of two or three turns of wire round the thumb connected across two new pence separated by an insulating piece of paper would② resonate at about 100 million cycles per second (100 MHz) — see Fig. 1.



1. A simple tuned circuit

By applying the known laws of electricity and magnetism, Maxwell③ in 1864 showed mathematically that such a circuit should radiate electromagnetic waves with a speed of 3×10^8 metres per second (7 times round the world in one second). That this speed was also the speed of light led him to④ believe that light itself was an electromagnetic radiation.

It was some time later in 1872 that Hertz was able to⑤ detect

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① **When it does so:** does 代替前句中的主要的词 resonate。这个从句可译为:"当这种电路谐振时"。 ② **would:** 表示按照某种判断,应当会…的意思,但语气要婉转些。 ③ **Maxwell:** 马克斯韦尔,英国物理学家(1831—1879)。 ④ **led … to:** 使…有可能…。 ⑤ **was able to** (+原形动词):能够。

the existence of such waves in the neighbourhood of① an oscillating circuit. Marconi② realised the great potential of electromagnetic transmissions and so strikingly demonstrated their power in the transmission of a signal across the Atlantic③ in 1901.

Since those days the transmission and reception of e.m. waves④ has found many important applications; from navigation of ships and aircraft to the control of lunar buggies from the earth. The range of frequencies employed now extends from 16 kHz to many gigahertz (1 GHz = 10^9 Hz) — even higher if the frequency of the laser is to be included (500 000 GHz).

In this chapter we will deal with⑤ three major categories of radio transmissions:

Radio communication: where we desire a person to person (or person to lunar buggy) relationship, the simplest here being a radio telephone conversation.

Radio navigation: where, for example, a pattern of radio transmission from fixed stations allows accurate position-finding on the sea and in the sky.

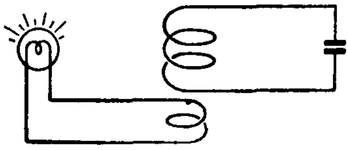
Radio broadcasting: where a widely radiated transmission intended for⑥ reception by possibly millions of people, provides 'information, education and entertainment'.

2 BASIC IDEAS

First, however, we must look more closely at the basic aspects of the transmission and reception of electromagnetic waves. At its simplest this could mean a torch directing a beam of light

① **in the neighbo(u)rhood of:** 在…的附近；大约。 ② **Marconi:** 马可尼，意大利电气学家(1874—1937)。 ③ **the Atlantic:** 大西洋。 ④ **e.m. waves:** electric magnetic waves 电磁波。 ⑤ **deal with:** 谈论；研究。 ⑥ **intend for:** 供…用的。

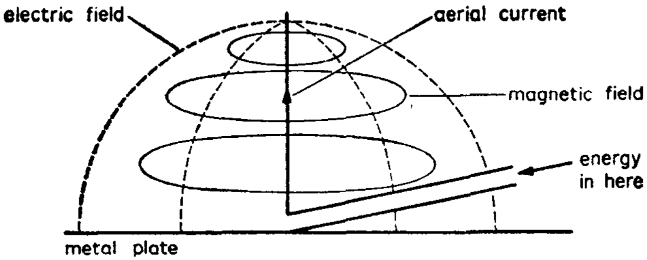
(e.m. waves) into someone's eye (the receiver). If we take a circuit consisting of a coil and a capacitor (Fig 2), and produce large electrical oscillations within it (we will deal with how this happens later), then we can sense the presence of the magnetic field by putting a torch bulb, in series with① a loop of wire, into the coil. The bulb lights up②!



2. The oscillations in a tuned circuit may cause a nearby lamp to glow

The presence of the large oscillating electric field can be sensed with a neon bulb③. Just bring it up to④ one terminal of the capacitor and it glows pink. Even a short distance from this circuit almost no effect can be observed. The reason is that the electric and magnetic fields are too closely related to⑤ the coil and capacitor; we need to open things out⑥ to let e.m. waves escape.

A very open form of oscillatory circuit consists of a vertical rod of metal above the centre of a large metal plate (Fig. 3).

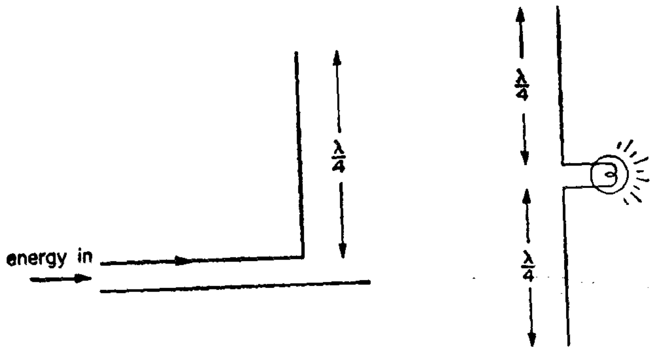


3. A tuned circuit which radiates electromagnetic waves

① in series with: 与…串联地。 ② lights up: 发光。 ③ a neon bulb: 氖灯(管)。 ④ bring … up to: 把…引到。 ⑤ related to (使)和…相联系。 ⑥ need to open things out: 需要打开某些元件。

In the rod, the current is surging up and down and this produces a circular magnetic field; this is the inductive part of the 'circuit'. The voltage between the rod and the metal plate produces the electric lines of force as in a capacitor, and it can be seen that the magnetic lines and electric lines are at right angles①.

Electromagnetic waves radiate very easily from this circuit and can be detected with a bulb at a fair distance — a few feet at any rate②, depending on the power of the transmitter (Fig. 4). We have of course③ constructed an aerial. In practice we use the earth itself instead of④ a metal plate.



4. The quarter wave-length aerial

The detector bulb is also connected in the centre of a metal rod — the receiving aerial, because it is a fact that the aerial which radiates best also receives best⑤. This aerial picks up⑥ the electric component of the e.m. wave when it is parallel to the transmitting aerial. If we rotate the receiving aerial to be right

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① **at right angles:** 成直角。 ② **at any rate:** 无论如何；至少。 ③ **of course:** 当然。 ④ **instead of:** 而不是。 ⑤ **because it is a fact ... receives best:** 这是一个原因状语从句。在该从句中包含有"that"引导的同位语从句，而在该同位语从句中又包含有"which"引导的定语从句。可译为："因为事实是，发射得最好的天线，接收得也最好"。 ⑥ **picks up:** 接收到。

angles to the transmitting aerial the bulb goes out①. We say the transmitted wave is vertically polarized, i.e.② the electrical vibrations are in a vertical plane.

For good radiation the transmitting aerial should be about 1/4 of a wavelength long, ($\lambda/4$).

Let us see what this means for wavelengths employed in the medium frequency band. If an e.m. wave has a frequency of one megahertz it takes one microsecond to go through one cycle. In this time, how far has the wave gone? It travels 3×10^8 metres per second so that in 1 μs it must have travelled 3×10^2 m or 300 m. This is said to be the wavelength, i.e. the distance an e.m. wave travels through space in the time of one cycle③.

The wavelength of a 1 MHz transmission is thus 300 metres. A good aerial for this frequency would need to be 75 metres (about 225 ft) high.

The 'magic' relation between frequency and wavelength which we have in effect④ derived is frequency (f) × wavelength (λ) $= 3 \times 10^8$ or if frequency is in megahertz

$$f.\lambda = 300.$$

3 RECEPTION

By the time⑤ the e.m. wave has travelled some miles from the aerial, spreading out into almost a hemisphere as it goes, it becomes very weak and will no longer⑥ light a bulb! It needs amplification before it can be detected.

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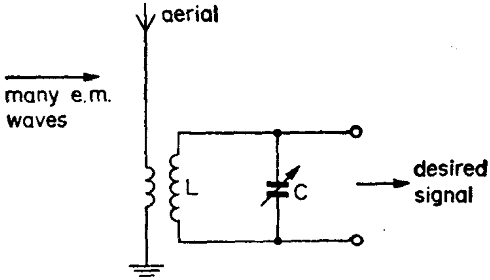
① **goes out:** 熄灭。 ② **i. e.** (id est〔拉丁语〕): 也就是；换言之。 ③ **an e.m. wave travels through space in the time of one cycle:** 这是一个定语从句，其关系代词 that 或 which 因为在从句中作宾语，所以被省略。可以译成："电磁波在一周波的时间内通过空间的距离"。 ④ **in effect:** 实际。 ⑤ **by the time:** 到这时。在这个短语之后引出时间状语从句。 ⑥ **no longer:** 不再；已不。

Furthermore there are normally e.m. waves of many frequencies from transmitters all over the world① falling on our receiving aerial and usually we want to receive only one at a time②. This can be done by using a tuned circuit to discriminate between the wanted signal and all the unwanted ones. We do this by using a circuit like the one in Fig. 5.



5. A tuned circuit can select one frequency from the many falling in the aerial (Note the symbol for a variable capacitor)

All the weak oscillations set up in the aerial due to③ the different transmissions falling on it are injected into the tuned circuit. But only the frequency which has the same frequency as the LC circuit produces any appreciable voltage across C④.

By varying C we can 'tune in'⑤ any desired frequency. Once we have got a good amplitude signal from the e.m. wave we wish to receive, we can easily detect it. Of course if two transmitters are operating on the same frequency we shall receive them both together unless we can discriminate between them by using a directional aerial.

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① **all over the world:** 世界各地；全世界。 ② **one at a time:** 一次一(个)。 ③ **due to:** 由于。 ④ **across C:** 在 C 的两端。 ⑤ **tune in:** 调准；调谐。

4 MODULATING

If a transmitting aerial radiates a constant amplitude e.m. wave it conveys little information to the receiver except that① it, the transmitter, is on!

The simplest way of sending information is to switch the transmitter on and off② so that a series of 'dots and dashes' are transmitted — the morse code③ for example. This is a very common method of communicating between ships at sea, but it does require the operator to 'read' the code.

Any process of superimposing some pattern on the continuous e.m. wave which allows information to be carried is called modulation. We say the carrier wave is modulated. To modulate a carrier wave all we need to do is to vary a property of the wave in a controlled way④. Thus, if we vary its amplitude we produce amplitude modulation (a.m.), if we vary its frequency we produce frequency modulation (f.m.), and if we vary its phase we have phase modulation (p.m.).

5 TRANSDUCERS

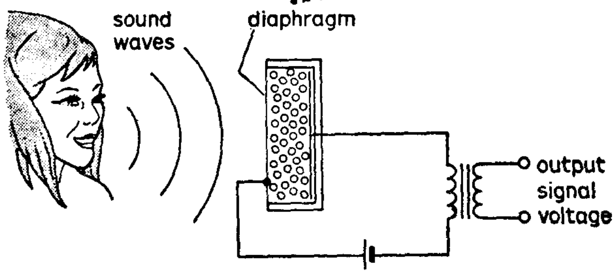
Before we look at the processes of modulation we need to pause and see how sound (speech for example) can be transformed into an electrical signal and how this signal can be converted back into sound. Devices which convert one form of energy (acoustic in this case) into another (electrical) or vice versa⑤ are

---

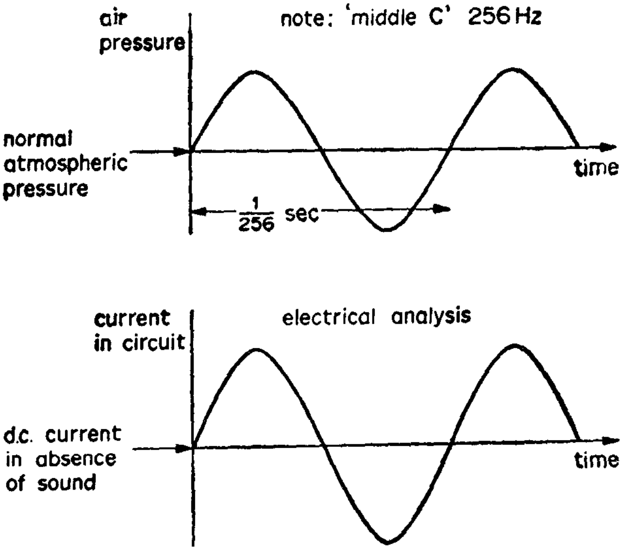
① **except that:** 除…以外。 ② **switch … on and off:** 使…接通和关掉 ③ **the morse code:** 莫尔斯电码。 ④ **in a controlled way:** 有控制地。 ⑤ **or vice versa:** 反之亦然。

called transducers. Here the appropriate transducers are microphones and loud-speakers or earphones.

The simplest microphone consists of a thin metal diaphragm pressing against carbon granules. A current (from a battery)



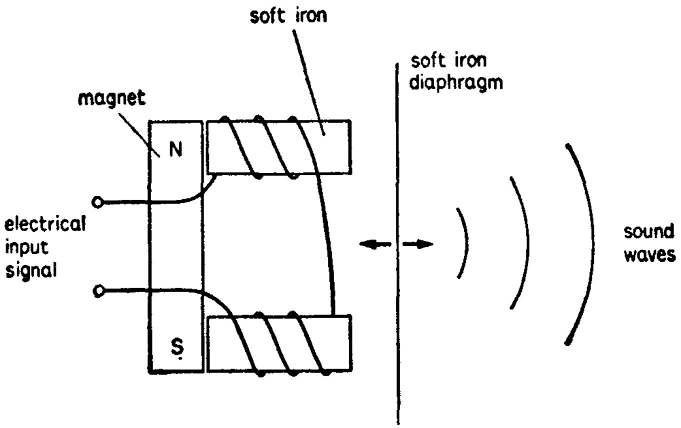
6. A simple carbon microphone



7. A microphone converts fluctuating air pressure into a fluctuating voltage of the same waveform

flows through the granules (Fig.6). When sound waves fall on the diaphragm it moves in and out at the frequency of the sound waves, alternatively compressing and releasing the granules. This varies the resistance of the circuit and so the current in the circuit varies in step with① the sound wave (Fig.7). The transformer used in Fig. 6 is used to pass on② the a.c. part of the current without the d.c.

The simplest 'reverse transducer' is the headphone, where the alternating current from the microphone flows in coils with soft iron cores attached to a permanent magnet, NS (Fig. 8). The magnetism of the cores, varied by the signal, adds to③ and subtracts from the permanent magnetism, and this causes the soft iron diaphragm to move in and out.



8. The principle of the earphone, which converts a fluctuating current into sound waves

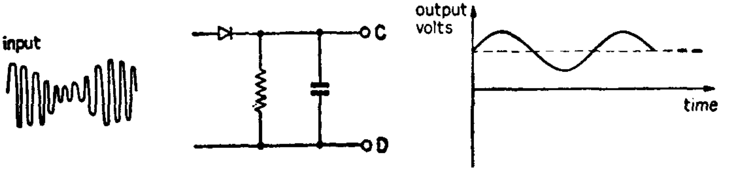
Returning now to modulation — the problem is to modulate a carrier wave with the microphone output (the electrical analogue

① in step with: 与…(步调)一致。 ② pass on: 通过。 ③ adds to: 增加。

of the original sound) and to recover the analogue at the distance receiver; and then to reproduce the original sound with an earphone or loudspeaker.

6 AMPLITUDE MODULATION (A.M)

Here all we do is to vary the amplitude of the carrier wave according to the amplitude of the sound signal. To detect this at the receiver, after it has been amplified a little, we use a circuit like Fig. 9.

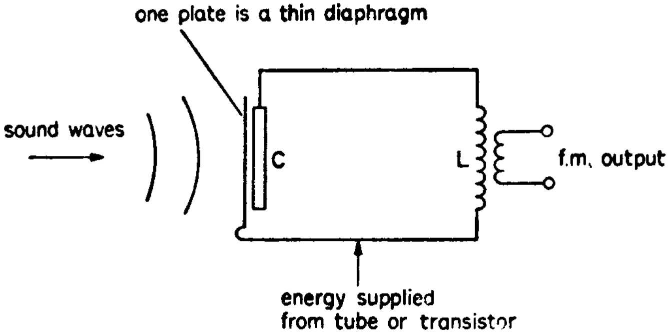


9. A diode detector circuit for demodulating an amplitude modulated signal

If a steady signal is applied to this circuit a d.c. voltage appears across CD. If however the signal amplitude is changing because the signal amplitude is modulated then a 'changing d.c.' is obtained across CD which follows the amplitude of the signal. The voltage across CD is as shown in Fig. 9, i.e. the original signal with a d.c. component. And so to the earphone.

7 FREQUENCY MODULATION (F.M.)

Here we vary the frequency of the carrier according to the amplitude of the sound signal. The simplest way of doing this is to use a special capacitor as a microphone. It is not usually done like that, but it gives us the basic idea.



10. Frequency modulation can be simply achieved by using a capacitor microphone as a variable capacitor in a tuned circuit

In Fig. 10 we have a tuned circuit maintained in oscillation by some active device (tube or transistor). The frequency of the oscillation is as usual① determined by the LC circuit values, but in this case the capacitance *C* fluctuates as one of its plates (which is a thin microphone diaphragm) vibrates under the influence of sound waves. Thus the frequency of the oscillations fluctuates to an extent② determined by the amplitude of the sound waves. The unmodulated frequency of this oscillation is of course the resonant frequency of the tuned circuit when no sound waves are falling on the microphone-cum-variable-capacitor. In the presence of sound waves this frequency swings above and below its unmodulated value.

Here then is our frequency modulated (f.m.) carrier which can then be amplified and radiated from an aerial.

Detection is a bit more complicated than for a.m., and in

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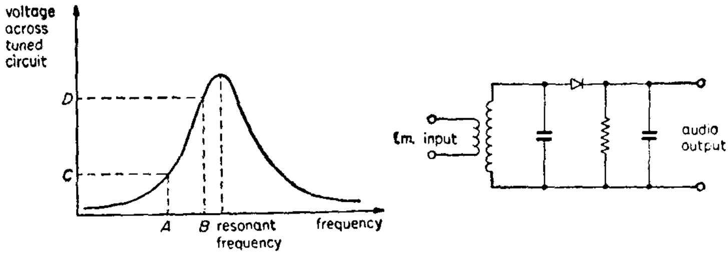
① **as usual:** 照例,照常。　② **to an extent:** 在一定程度上。



11. A tuned circuit may be used as a frequency to amplitude convertor; but it is not really satisfactory

practice rather more so①. The simplest way is to employ a tuned circuit which is slightly 'off tune'② to the incoming f.m. carrier (Fig. 11). As the carrier frequency swings between *A* and *B* the output from the circuit swings between *C* and *D*. Thus the variations in frequency of the incoming f.m. carrier have resulted in corresponding variations in amplitude of this carrier, and these amplitude variations can be detected as in the a.m. case above.

Phase modulation has a very close affinity with③ f.m. and will not be dealt with here.

8 A.M. AND F.M.

Generally, interference — from lighting or electrical machines — produces amplitude disturbances on an e.m. wave passing by④. Because the amplitude of an f.m. carrier is not carrying information, such interference has very little effect on the received signal. This is not the case with an a.m. carrier, where all such

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① **and in practice rather more so:** 这是一个并列子句，句中省略了 de-*tection is*。so 代替 complicated。可译为："而实际中更为如此（复杂）"。
② **off tune:** 失谐；脱调。 ③ **has a very close affinity with:** 和…很相近。 ④ **pass by:** 从…旁边过去。