IMPORTANCE OF THE THERMIONIC VALVE TO THE ENGINEER.

By J. Richter.

Known to most as the radio valve, the thermionic valve embodies a principle which is being recognised more and more in recent years as being of great importance to the factory and production engineer. Almost limitless in application, the valve assists engineers to obtain a standard of perfection in production once deemed beyond the capacity of the mere mortal.

To cite a few applications where equipment using the thermionic valve principle can be used with distinct advantage, I suggest the most familiar, the public address system or, as is most usually termed in factories, the call or paging system.

This device is simply a speech and sound amplifier similar to that incorporated in a radio receiver. The set is wired to convenient speaker points from a central amplifier; as a matter of fact, recently several installations have been effected where microphones are installed at several of the more important sections of the plant. By this more comprehensive installation, it is possible for various members of the staff to sound their requirements throughout the entire plant without contacting the central station. For instance, if a maintenance fitter is required in a particular department, the use of a paging system obviates the necessity of contacting the foreman, who, in turn, would in all probability search for the fitter with, of course, a consequent loss of time. With the use of the public address system, the individual required may be immediately contacted, although he may be in the farthest corner of the plant. However, the many and varied advantages of the public address system in factories is probably familiar to all, and needs no further elaboration.

More important and complex than the speech amplifier is the X-ray equipment now rapidly gaining favour among production engineers who are often called upon to provide a means of checking the finished product without interference to labels or other coverings.

The applications of the X-ray plant are many and varied, and in all probability during the presentation of this paper, many other instances where the X-ray can be used to distinct advantage will indicate themselves to members. The most important use of the X-ray, with the exception of therapeutics, is for the inspection of castings. Aeroplane and motor-car factories in America, England, and other countries have long since dis-
covered the advantage of the X-ray plant for the checking of important castings. Blow holes, internal cracks, and clinker, etc., are readily distinguishable.

Rubber manufacturers found the use of X-ray an advantage in checking tyres and other fabricated rubber goods for uniformity of texture. However, the demonstration which will be given to-night should show the Ray’s ability to visually penetrate the substances of an opaque nature. This particular ray equipment is not in the form used normally in industry, but is the most suitable for demonstration purposes in this particular instance. The equipment shown here to-night is usually known as the portable medical apparatus. The industrial ray equipment is not complicated, and can be operated by any factory worker who has received a short course of instruction, probably less tuition than would be necessary to enable him or her to operate the average modern factory production-machine.

One point which should be mentioned at this juncture is that there is no danger in operating the modern X-ray plant. In the past, radiologists suffered through X-ray burns, but modern protective measures make this an impossibility.

Now, I propose to give a short general technical explanation of the method by which X-rays are produced. The slides shown are not intended to be accurate, and in many cases do not illustrate the actual form which the various components take, but are shown in this manner for the explanatory purposes:

**Thermionic Principle**: The first diagram shows in a broad fashion the components of a full wave rectifier valve for the conversion of alternating to direct current. You will note the twin anodes and the cathode, also the connection of high tension direct current taken from one leg of the filament. To refresh your minds on the operation of this tube, I propose to embark on a short technical explanation.

What is usually termed the Edison effect takes place when a heated mass is placed in close proximity to another mass in a partial or full vacuum; there is an emission of electrons from the heated mass. In this case the cathode, being heated by a low tension alternating potential, emits a stream of electrons which are attracted to the positively charged anode; and as the twin anodes are connected individually to both conductors of the alternating high tension source, they are, individually and alternately, positively and negatively charged. Therefore, the streams of electrons from the negative charged filament alternatively are attracted to each anode as they become positive.

Used in conjunction with a suitable tapped transformer, the operation of the thermionic rectifier valve is entirely automatic.
IMPORTANCE OF THE THERMIONIC VALVE

1. Full Wave Rectifier

2. X-Ray Tube

Anodes

High Tension "D.C.

High Tension "A.C.

Supply

Cathode Leads

Cathode

Anode

Opaque Object

Photo Plate on Viewing Screen

X-Ray Tube
There is a certain pressure fluctuation due to the cycle reverses; but this is easily smoothed out by chokes and capacities installed on the direct current line. The rectifier tube incorporated in the X-ray plant is called upon to meet higher loading than a similar type of tube in a radio receiver; for this reason a heavier type of valve is used, and in some cases a bank of several valves are in service.

Figure 2 illustrates the cathode and anode of an X-ray valve, and shows the path of electrons from the cathode to the anode and the focussed X-rays. The principle of X-ray production is as follows: A heated cathode is placed in close proximity to a positively charged anode fed from a high voltage direct current supply. The electrons are attracted to the anode at a very high velocity—the higher the anode voltage, the greater electron velocity. This bombardment of electrons result in the emission of X-rays which are in the form of invisible light, and have the power to penetrate opaque substances. The degree of penetration is governed principally by the voltage fed to the anode.

The focussing effect of the X-ray tube has been greatly improved recently by alterations to the target surface of the anode, and by more efficient design of shielding. Inspection of the parts of an X-ray tube here to-night will show these improvements. Improvements recently to the cooling system of the anode have resulted also in greater efficiency. The fin type air-cooled radiator has superseded the water chamber which required considerable attention and supervision.

The fluorescent screen is placed in the path of the rays with the object to be examined between it and the tube. The fluorescent screen is visible to the operator, who stands directly in front of it, and is able to easily view the objects being X-rayed which are caused to pass behind the screen. The fluorescent screen also partly reduces the dangerous X-ray effect on the human tissue.

Radio photography, where a photographic plate is used in place of a fluorescent screen, is not so valuable to the engineer. The fluorescent screen type of plant is quicker and more economical in operation. The X-ray plant in engineering is not entirely unknown in Melbourne, for there is one firm of metal casters who have had a plant in operation for some time, and have used it with decided advantage. Practically every motor-car factory in the States has an X-ray plant for the inspection of the more important castings. The X-ray is not confined to vertical or horizontal operation, nor do the rays necessarily need to be focussed downwards. During the construction of the Boulder Dam, in America, X-ray was used for inspection of huge
importance of the thermionic valve

cast-steel pipes after installation. To effect this work the tube was sometimes set at most unusual angles. The application of X-ray in the shoe shops is familiar to all as an indication of the simplicity of the modern X-ray machine. The industrial X-ray is similar in operation, and just as simple.

The Photo-Electric Cell.

This is another form of thermionic valve, and it will assist the engineer who is continually called upon to provide the seemingly impossible. Absolutely automatic in operation, the photo-electric cell will perform an amazingly comprehensive set of duties. In wire drawing plants it will detect the smallest difference in diameter of the wire as it runs past the inspection point. As the fault occurs, the photo-electric cell can either be used to stop the winding machine while adjustments are being made, or it may be operated in such a fashion that the necessary adjustments will be automatically controlled by a device coupled to the photo-electric cell apparatus. A familiar instance of photo-electric cell application is that used on some country roads to automatically illuminate an electric sign when needed. A notable case is at the entrance to Geelong. A beam of light is projected across the roadway on to a photo-electric cell on the opposite side, a passing vehicle breaks this beam, and the temporary loss of light on the sensitive element of the photo-electric cell causes an electric relay to come into operation, and closing a switch, supplies electric power for lighting purposes to the sign.

Water purification can be greatly assisted by use of the photo-electric cell in regard to colour control. The slightest difference in colour is detected by the cell when scanning a thin stream, and the necessary adjustments can be automatically made. For the purpose of counting objects along a conveyer belt the photo-electric cell obviates the necessity of using trip counters or other mechanical methods of indicating total quantities.

Textile manufacturers can use the photo-electric cell with distinct advantage for the purpose of checking thread uniformity and thread position.

Railways use it frequently for automatic signal control in conjunction with time cycle controllers. The photo-electric cell is the basic principle of sound picture operation, where "sound-on-film" is used. This type of picture projection is the most widely used to-day. There are literally thousands of uses for the photo-electric cell—too many in fact to allow a complete treatment of this device in this paper.

The X-ray apparatus demonstrated was kindly loaned by Messrs. Philips Lamps Pty. Ltd., and was demonstrated by Mr. H. H. Davidson of that company.