1938

Fundamentals of X-Ray

L. E. Pinney
Iowa State College

Follow this and additional works at: https://lib.dr.iastate.edu/iowastate_veterinarian
Part of the Radiology Commons, and the Veterinary Medicine Commons

Recommended Citation
Available at: https://lib.dr.iastate.edu/iowastate_veterinarian/vol1/iss1/8

This Article is brought to you for free and open access by the Journals at Iowa State University Digital Repository. It has been accepted for inclusion in Iowa State University Veterinarian by an authorized editor of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.
Fundamentals of X-Ray

L. E. PINNEY
Instructor in Physics
Iowa State College

X-rays were first detected in the year of
1895 by the German physicist, William
Conrad Roentgen. The discovery occurred
during a systematic search for radiation
able to penetrate materials opaque to
ordinary light.

Roentgen's original source of X-rays
was an exhausted bulb of the type already
known as a Crookes tube. Such tubes
were at that time relatively common and
were used for demonstrating cathode rays,
a radiation later identified as a projected
beam of electrons. Under ordinary cir-
cumstances these cathode ray electrons
are completely stopped by the glass walls
of the tube, but the spot upon which they
fall gives out a faint visible illumination
known as fluorescence. The fact that this
fluorescence is accompanied by an invis­
able radiation very different in penetrating
properties from ordinary light was left
for Roentgen to discover.

X-rays may be defined as an invisible
radiation produced by the stopping of
rapidly moving electrons. The nature of
this radiation is greatly affected by both
the velocity of the electrons and by the
composition of the target, which is also
called the anode, is made of a metallic
element of high melting point and high
atomic weight. High melting point is nec­
essary to prevent fusion by the heating
effect of the cathode ray stream while high
atomic weight favors efficient production
of X-rays. Tungsten meets both these re­
quirements and is commonly used as an
anode material.

The source of electrons in modern X-ray
tubes is ordinarily a hot tungsten filament
incorporated in a second electrode called
a cathode. The space surrounding both
cathode and anode is enclosed in a glass
bulb from which the air has been very
effectively exhausted. A source of high
electrical potential such as a transformer
is connected across the electrodes of the
tube for the purpose of imparting the nec­
essary velocity to the electrons as they
traverse the path through the vacuum
from cathode to anode.

By nature, X-radiation falls in the same
category as light, but by definition the
name applies to radiation produced by
electron bombardment of a solid target.
Although it is true that radiation produced
in this manner occupies a more or less
definite region in the spectrum, the fact
should not be overlooked that there is no
essential difference between X-rays of
very long wave length and ultra violet
light of very short wave length. In other
words, X-rays may be regarded as ultra
ultra violet light.

In both light and X-rays the usual unit
of wave length is the angstrom. (1 ang­
strom = .00000001 cm.) When measured
in terms of this unit, the approximate
regions of wave length with which certain
significant names are associated are as
follows:

<table>
<thead>
<tr>
<th>Region</th>
<th>Wave Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible light</td>
<td>7,000 to 4,000</td>
</tr>
<tr>
<td>Ultra violet</td>
<td>4,000 to 100</td>
</tr>
<tr>
<td>X-rays</td>
<td>100 to .01</td>
</tr>
<tr>
<td>Gamma-rays</td>
<td>.1 to .001</td>
</tr>
</tbody>
</table>

The fact should be recognized, however,
that the electromagnetic spectrum exists
as a continuity through an enormous range
of wave lengths and that any division into
regions as given in the preceding para-
graph is largely arbitrary. Radiation of
any particular wave length and intensity
produces physical, chemical, or biological
effects dependent only upon wave length
and intensity and in no sense upon the
manner in which the radiation is pro­
duced.

The effect of velocity of the electrons
has already been mentioned. More speci-
fically it may be stated that the kinetic
energy, which depends upon the square of the velocity is directly proportional to the voltage and inversely proportional to the minimum wave length of the X-rays. This fact gives the equation:

$$\text{minimum wave length} = \frac{12336}{\text{voltage}}.$$ 

From this relation it will be seen that 100 kilovolts (100,000 volts) will give a minimum wave length of 0.123 angstroms. The wave length of maximum intensity is about 1.3 times the minimum value or, in this case, about 0.18 angstroms. It will also be observed that very high voltages are capable of producing X-rays comparable in wave length with the gamma-rays of radium.

The unique penetrating properties of X-rays afforded an immediate practical application as a means of investigating the interior of objects opaque to ordinary light. It is not true, however, that all X-rays are highly penetrating. This property increases rapidly with decreasing wave length or with increasing voltage. Very long wave lengths (several angstroms) are strongly absorbed by air, even to the extent of fifty per cent in a distance of a few millimeters. The much shorter wavelengths (a few hundredths of an angstrom) are, on the other hand, able to penetrate several centimeters of steel.

For X-rays of a given wave length, absorption increases rapidly with increasing atomic number of the absorbing material. This property is in many cases a distinct advantage because in most substances to be examined composition varies more than density. In the case of animal tissues, for example, bone owes its comparative opacity for the most part to its calcium content and not to its greater density.

An understanding of the physiological effects of X-rays developed much more slowly and is yet far from complete. It is well known that in some case, as in the treatment of cancer for example, beneficial effects are obtained, but in general any unnecessary exposure to X-rays should be avoided. Lack of knowledge of the adverse physiological effects resulted in serious injury to many of the early X-ray investigators.

**MIXER INITIATES FROSH**

A greased pole—a flag—and two scrap ing classes. Thus the annual "Vet Mixer" ushered in this year’s student A.V.M.A. calendar.

At the word from President Sid Bjorn son, the freshman and sophomore classes, lined up at each end of the Meat Lab rushed for the pole and for a full 15 minutes battled to see which class would retrieve the flag at the top. The pole, however, broke loose from its mooring and the fray was then declared officially ended. But class spirit over-rode the official halt, and free-for-alls continued for awhile.

Approximately 100 per cent of the student members were in attendance. Drs. Foust and Benbrook addressed the group for a short time at the beginning of the meeting.

“"We have been criticized for sticking too closely together—but such criticism is in reality a compliment," Dr. Benbrook stated. "However," he went on, "we have been inclined to think too little of our profession in the light of its true function—that of protecting the livestock industry.”

**Prepubic Tendon . . . .**

(Continued from page 17)

3. Vary rarely there is a definite history of violence.

Usually the prognosis of complete rupture of the prepubian tendon is very grave, since most mares, along with their foals, perish before the conclusion of the pregnancy during which the rupture occurs.

If the pregnancy existing at the time of the accident is safely determined, the animal may thereafter breed without danger or difficulty, but is so unsightly that her value for this purpose is seriously diminished. She may do ordinary slow work, but here the unsightliness becomes even more serious and few persons are willing to use such an animal.