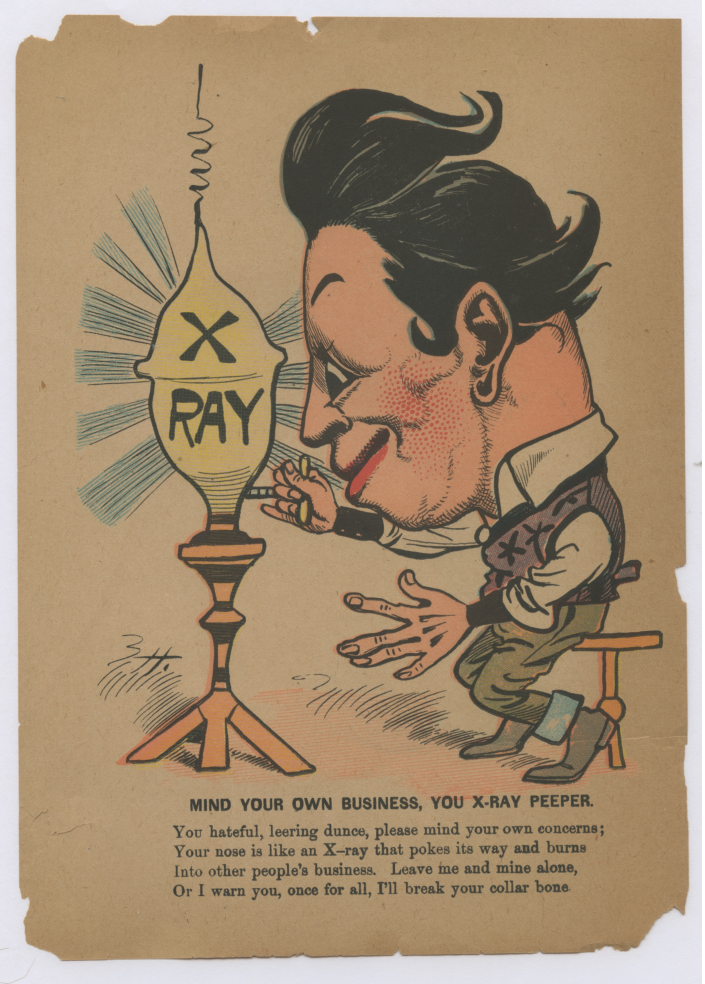
The Invisible Light



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The Invisible Light

Editorial.

The items in this issue of The Invisible Light are all of interest. Even after so many years we can still be aware of the excitement that followed Röntgen's discovery of his new rays, and the craze that resulted. This is reflected in the quotations that Derek Guttery collected. There is still today a public fascination with X-rays as can be seen in their use in advertising and designs. There is still an element of naughtiness about X-rays – a feeling that we are seeing something forbidden. This was best illustrated in the iconic film 'The Man with the X-ray Eyes' starring Ray Milland. In contrast there is something profoundly respectable about MRI and ultrasound. 'The Man with the X-ray Eyes' raised the question about what are the limits of perception and knowledge for humans. Röntgen's discovery transformed physics, medicine and also how we perceive ourselves. Modern developments in biology and computing are producing a similar revolution and the risks are perhaps even greater.

Please contact me if you have any material that can be published here. Book reviews are welcome, as are accounts of talks or of interesting places that have been visited. I have some unpublished material from Jean Guy, Sebastian Gilbert Scott and Derek Guttery, which I will be reproducing in this journal.

Adrian

Dr. Adrian Thomas
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Contents:

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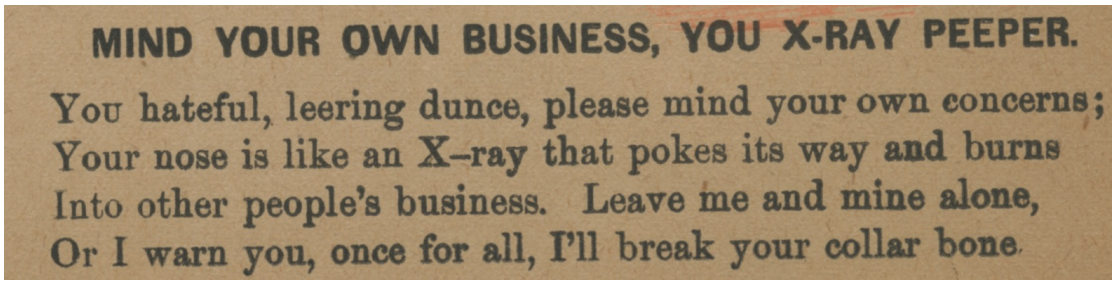
Mind Your Own Business, You X-Ray Peeper.


MIND YOUR OWN BUSINESS, YOU X-RAY PEEPER.

You hateful, leering dunce, please mind your own concerns;
Your nose is like an X–ray that pokes its way and burns
Into other people's business. Leave me and mine alone,
Or I warn you, once for all, I'll break your collar bone.

The image on the front cover is quite charming. It's a recent acquisition, and not an image I have seen before. I would guess that it's from the late 1890s, and at the height of the X-ray craze.
The image of the radiographer is not an attractive one. The X-rays are seen as spying and intrusive. The operator's nose is "like an X-ray that pokes its way and burns its way Into other people's business." The fear is that X-rays will spy into our private lives and intrude. Up to a point these concerns are appropriate. I am writing these words in Heathrow Airport Terminal 4 waiting for my flight. The security was not quite happy when I walked through the security arch. I then had to stand in the X-ray machine. There was a concern about these some years ago, and in particular that this machine will see us beneath our clothing. There were some images in The Sun newspaper with a dramatic headline "You are undie surveillance." We think back to the classic film starring Ray Milland "The Man with the X-ray eyes." The character Dr Xavier invents eye drops that give him X-ray vision. He initially sees under clothing when he goes to a party. However as he keeps on using the drops he sees more and more. Obviously our eyes only see part of reality, and he sees more and more. He finally tears his eyes out because only God can see everything.

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Homage to Derek Guttery.

The 1951 West German stamp commemorating the 50th anniversary of Wilhelm Conrad Röntgen receiving the first Nobel Prize for Physics in 1901.

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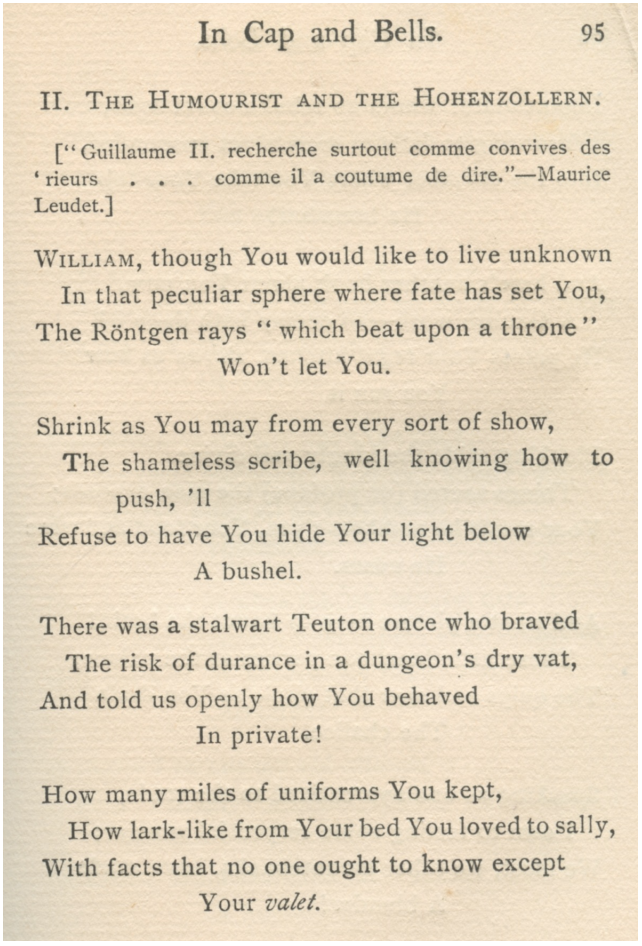
In Cap and Bells.



In Cap and Bells. 95

II. THE HUMOURIST AND THE HOHENZOLLERN.

["Guillaume II. recherche surtout comme convives des 'rieurs . . . comme il a coutume de dire."—Maurice Leudet.]

WILLIAM, though You would like to live unknown
In that peculiar sphere where fate has set You,
The Röntgen rays "which beat upon a throne"
Won't let You.

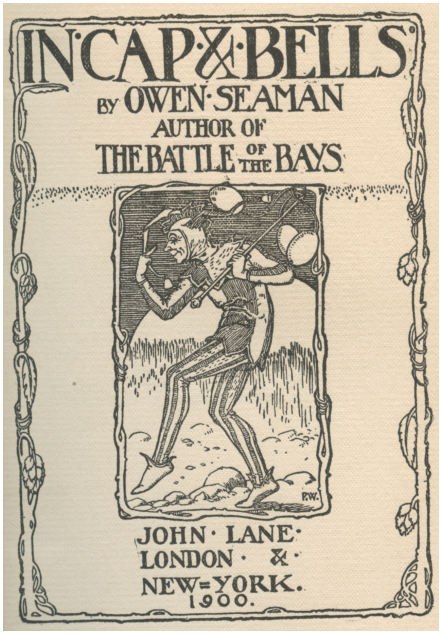
Shrink as You may from every sort of show,
The shameless scribe, well knowing how to push, 'll
Refuse to have You hide Your light below
A bushel.

There was a stalwart Teuton once who braved
The risk of durance in a dungeon's dry vat,
And told us openly how You behaved
In private!

How many miles of uniforms You kept,
How lark-like from Your bed You loved to sally,
With facts that no one ought to know except
Your *valet*.

I have been a fan of old books since I was a youngster. I lived at home in East Finchley and there were four second-hand bookshops within a shortish walk. The one that was furthest away was in Hampstead with a lovely walk across Hampstead Heath. For 10/= (120d = 50np = 50p) I could come home with a bag of books. Sadly so many bookshops, both second-hand and new, are closing. However the printing quality of so many new books is so poor I cannot imagine them surviving for an extended length of time.

I still frequent second-hand and antiquarian bookshops – in fact more so than I visit new bookshops. Most books I buy on line. I was in New Alresford and visited their antiquarian/second hand bookshop Oxleys. This shop has been a feature of the town for years. I have found it useful to look at books published in the late 19th century and early 20th century to see if I can see anything related to Röntgen and the New Photography. I usually find items of interest in old science and photography books, however I was pleasantly surprised to find a poem about the Röntgen rays in a volume of poetry published in 1900 and written by Owen Seaman. Owen Seaman is now obscure, however was popular in his day. The poem is called 'The Humourist and the Hohenzollern. The theme of the poem is similar to that of the X-ray peeper on the cover. The German emperor would like to "live unknown", however the Röntgen rays won't let him and the rays are those "which beat upon a throne." So all that the Kaiser wants to keep hidden is laid bare. The truth is known and cannot be hidden. I remember Alfredo Buzzi telling me that in Argentina the X-ray of a subject is the truth about that subject. So we can speak of the X-ray of a football match, as the truth about what happened.
Happy book hunting!



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Tobacco smoking in World War I.

By Richard F. Mould MSc, PhD
e-mail: manorroadsouthport@yahoo.co.uk

Although this article is not related to X-rays or radium, it is relevant to cancer in that lung cancer and smoking are now known to be inextricably linked: whereas in WWI smoking was not considered to be at all dangerous, but rather advantageous in keep up the morale of the fighting man. This short review concentrates on pipe & cigarette smoking in World War I and relates to the soldiers of many countries. My impetus for the review, was a recent exhibition in Harrogate's Mercer Art Gallery in the United Kingdom, which was entitled *Brangwyn's War: Posters of the First World War*, [1, 2]. Frank Brangwyn who is largely unknown, except to art & photography specialists, was born in Bruges, Belgium in 1867, as Guillaume François Brangwyn, and died in 1956. Tobacco is mentioned in WWI ephemera not only in posters, postcards, lithographs and paintings, but also finds an appearance in a popular marching song, in the gift [Princess Mary's tin box] given to all British soldiers & sailors for Christmas 1914 by Princess Mary, the only daughter of King George V and Queen Mary, and in the story of the clergyman Woodbine Willie. This brief review is also appropriate because of the centenary of WWI.

Frank Brangwyn Lithograph: Ypres

The lithograph by Frank Brangwyn, **Figure 1**, showing British troops at Ypres [1-3] was produced in aid of the *Soldiers & Sailors Tobacco Fund* as a poster print, poster, postcard and stamp. Some copies were printed with the text 'Let us make every effort and see that they are never in want of either pipes or tobacco', and other with 'It is a significant fact that almost every letter from the Front contains a request for 'something to smoke'.' The tower in the background of **Figure 1** is the belfry of the Cloth Hall. On 22 November 1914 German incendiary bombs hit the Hall, and a wooden scaffolding caught fire, with the blaze spreading rapidly. The scaffolding was there because a local stonemason had almost completed his work restoring the belfry tower. As stated by Horner [1] 'During the first battle of Ypres, October and November 1914, the German Kaiser ordered that his troops 'Take Ypres or die' – they died. Over 17,500 Germans in 12 Divisions attacked on a nine mile front against less than 8,000 British and failed to overcome them.'

Figure 1. British troops at Ypres [2].

British, German & American Soldiers

Before the use of the term 'smoking' the habit was known as 'dry drunkenness' and during the war, together with a regular rum ration, it was considered a legitimate means of relieving combat stress and boredom. The Princess Mary gift box for Christmas 1914 contained tobacco for the British, Colonial and Indian soldiers [2]. In the German army the supply of tobacco was both strong and plentiful and Jünger [4] noted 'The image of the soldier that remains with me from those days is that of the sentry with his spiked, grey helmet, fists buried in the pockets of his greatcoat, standing behind the shooting-slit, blowing pipe smoke over his rifle butt.' Also, Erich Maria Remarque's famous book *All Quiet on the Western Front* [5] refers to the importance of 'a double ration of smokes: 10 cigars, 20 cigarettes and two quids of chew per man: now that is decent.'

When the Americans entered the war in 1917 the soldiers automatically received their 'tobacco ration'. Cigarette and pipe smoking became linked to manliness and patriotism and in the USA those opposed to supplying the *doughboys* with cigarettes were considered as traitors. When WWI ended the soldiers in all countries continued smoking and the tobacco industry reaped the benefits [1].

Princess Mary's Gift Box, Christmas 1914

During WWI thousands of appeal funds were set up to aid every conceivable cause. Perhaps the most memorable was the *Christmas Gift Fund* launched on 14 October 1914 by Princess Mary, the only daughter of King George V and Queen Mary. This inspired one of the most enduring mementos of WWI, the Princess Mary's Gift Box, **Figure 2**. The purpose was to provide everyone wearing the King's uniform and serving overseas on Christmas Day 1914 with a 'gift from the nation'.

Figure 2. The head of Princess Mary is in the top centre of the lid of the box, surrounded by a laurel wreath. On the lower edge are the bows of a battleship forging through a heavy sea. The names of the allies are included: Belgium, Japan, Montenegro, Serbia, France and Russia. [Courtesy: Imperial War Museum, London]

The contents of the embossed brass box varied considerably. Officers and men on active service afloat or at the Front received a box containing a combination of pipe, lighter, 1

ounce of tobacco and 20 cigarettes in distinctive yellow monogrammed wrappers. None-smokers and boys receive a silver sterling bullet pencil (contained within a brass 0.303" cartridge case) and a packet of sweets instead. Indian troops often received sweets and spices and nurses were treated to chocolate. The *tin* was approximately 5" long by 3.25" wide and 1.25" depth. A Christmas card with a picture of the Princess was also included in the box. More than 355,000 were delivered by the Christmas deadline. Shortage of brass meant that many others did not receive their box until as late as January 1919. Orders for brass strip had been placed with the USA but the consignment was list with the sinking of the *Lusitania*. When the fund finally closed in 1920, almost £200,000 had been donated for the provision of more than 2.5 million boxes, [6, 7].

Pipe Tobacco Smoking

In 1914 at the start of WWI, pipe smoking was the most common form of tobacco smoking by European soldiers. Indeed, some German soldiers used specially designed pipes with the ceramic bowl of the pipe containing painted images of regimental soldiers and their artillery guns. Pipe smoking was sometimes associated with the officer class of the British army. **Figure 3** is a 1917 painting by Marjory Watherson entitled *The Dispatch* (*The Captain's Dugout*) showing the two officers pipe smoking. Pipe tobacco formed part of Princess Mary's 1914 Christmas gift, and loose tobacco was also issued to Russian and French soldiers. As WWI continued, cigarette smoking became more popular: perhaps because pre-packaged cigarettes were more convenient to keep dry in the trenches than pipe tobacco.

Figure 3. The Captain's dugout. [Courtesy: Imperial War Museum, London]

Pack Up Your Troubles & Smile

One of the most popular marching songs in the British army was *Pack Up Your Troubles & Smile, Smile, Smile*. Another was *Its a Long Long Way to Tipperary*. There was also *Mademoiselle from Armentieres*, which had several versions, some of which were very ribald!! The words included mention of cigarettes (fags) and the matches required to light them (lucifers). It was published in 1915 in London. Such songs were also sung in music halls and aimed at boosting morale. I can also remember in my childhood in the 1940s and early 1950s before any TV was available, that families gathered around the piano and these songs were still belted out even though WWI had ended about 30 years earlier. The song also features in several films and has been translated into languages such as Dutch and Spanish.

Pack up your troubles in your old kitbag
And smile, smile, smile.
While you've a lucifer to light your fag,
Smile boys that's the style.
What's the use of worrying?
It never was worthwhile, so
Pack up your troubles in your old kit bag
And smile, smile, smile.

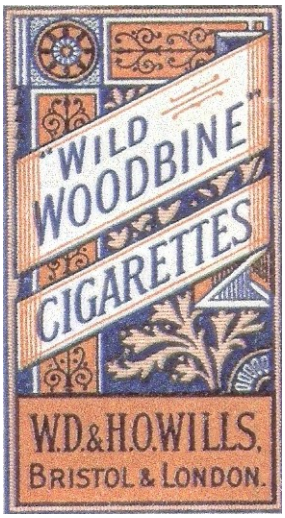
Woodbine Willie

Geoffrey Studdart Kennedy (1883-1929) was an Anglican priest who was nicknamed *Woodbine Willie* during World War I for giving Woodbine cigarettes [8], **Figure 4**, along with spiritual aid to injured and dying soldiers. In 1914 he volunteered as a chaplain to the army on the Western Front and in 1917 was awarded the Military Cross at Messines Ridge after running into no man's land to help the wounded during an attack on the German front line. The citation [9] for the MC reads

'For conspicuous gallantry and devotion to duty.
He showed the greatest courage and disregard
for his own safety in attending the wounded
under heavy fire. He searched shell holes for our
own and enemy wounded, assisting them to the
dressing station, and his cheerfulness and endurance
had a splendid effect upon all ranks in the
front line trenches, which he constantly visited.'

During WWI he supported the war with enthusiasm and was attached to a bayonet-training service where he toured with boxers and wrestlers to give morale-boosting speeches about the usefulness of the bayonet.

Figure 4. Front cover of a packet of Woodbines.



Postcards

The centenary of the 1914-1918 war is commemorated in postcards and rare photographs of the men who marched away, published a century later in the form of a pack of playing cards [11]. These cards feature trench humour, not trenches, the ordinary soldier not generals, and the humour and patriotism of the home front. A selection is shown in **Figures 5-10**. Female models [**Figure 6**] and children [**Figures 8-9**] were sometimes used.

Figure 5. British, with the legend: 'Are we downhearted?' The wooden box, bottom left, is labelled 'From the *Weekly Dispatch*'.

Figure 6. German.

Figure 7. British, with the legend 'First Steps!'

Figure 8. French, note the bottle of wine bottom left.

Figure 9. German.

Figure 10. American.

The picture postcard was invented in Austro-Hungary in 1869 and became a simple way to keep in touch during World War I. The poet Robert Graves serving with the Royal Welch Fusiliers mentions cigarettes in a mock-heroic style message. 'Dear auntie, this leaves me in the pink. We are at present wading in blood up to our necks. Send me fags and a life-belt. This war is a booger. Love and kisses.' The front line soldiers whose leave was only once a year, paid no postage on their cards. By 1917 the British Army Postal Service had 19,000 mailbags crossing the channel each day! [10] To conclude this short review, the two Jokers in the pack of cards [10] are cartoon soldiers from England and France and are reproduced in **Figures 11-12**.

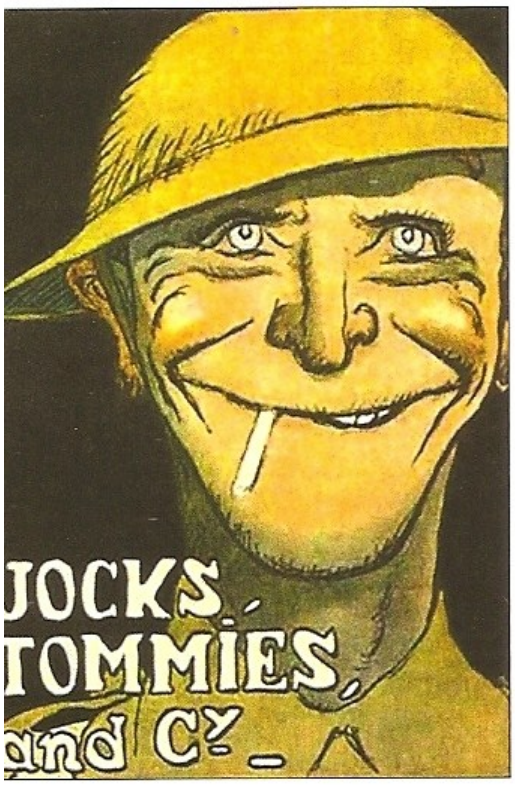


Figure 11. English postcard.

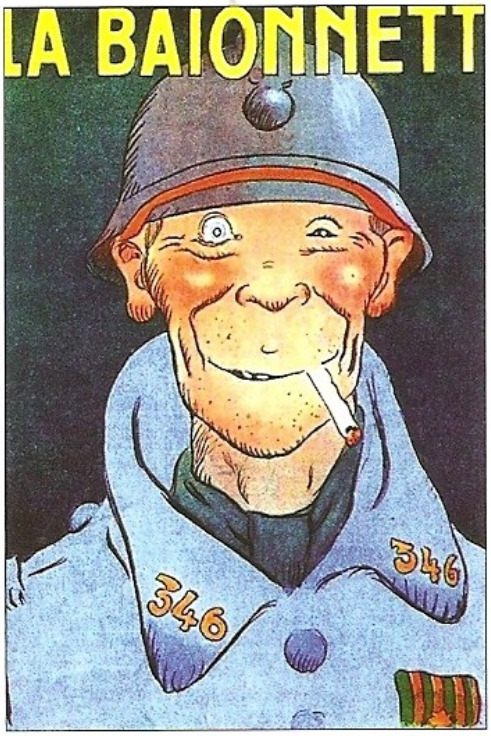


Figure 12. French postcard.

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A Few Quotations on Röntgen's Discovery.

By the late Derek Guttery.

These quotations were found in the papers of the late Derek Guttery. His hard drive was copied for me by his son, and the documents therein are a wealth of information and musings on all things radiological. His death was untimely and he still had so much to contribute. Derek started my interest in ephemera in radiology, and I purchased his collection from his wife Iris. I also purchased his stamp collection, again on the theme of radiology. Here is an interesting collection of quotations and musings. Derek's collection in relation to the UK's X-ray industry is in the John Rylands Library in Manchester, and some of his collection of old X-ray tubes is on display at the Society of Radiographers in London.

A FEW QUOTATIONS ON THE DISCOVERY . . .

" . . . From our Correspondent – Vienna . . . A sensational discovery, which, if the reports are confirmed, is likely to be attended by important consequences for physical and medical science, is spoken of in scientific circles here. A new conductor of light has been discovered by Professor Routgen [sic], the well-known physicist at the Würzburg University. So far his experiments have resulted in the discovery that light penetrates wood and the flesh of men and animals, without, however, penetrating bones and metals. The professor succeed in photographing metal weights placed in a shut-up wooden case. The photograph sent to Vienna shows only the weights, but nothing of the case. Another photograph of a man's hand shows only the bones, while the flesh remains invisible . . . " –
DAILY CHRONICLE, Monday, 6 January, 1896. The first press announcement of Röntgen's discovery of X-rays.

" . . . From our Correspondent – Vienna . . . A very important scientific discovery has recently been made by Professor Routgen [sic], of Würzburg University, the details of which have already reached Vienna, and are now being carefully examined by several scientific authorities here. . . . They show the bones of the hand, together with the rings that were worn on the fingers . . . but they show nothing else. They are ghastly enough in appearance, but, from a scientific point of view, they open up a wild field for speculation. Among the practical uses of the new discovery, it is stated that it will henceforth be possible for surgeons to determine by help of this new branch of photography the exact position of any bullet that may be embedded in the human body, or, again, to render visible any fractures there may be in the bones prior to performing any operation on the respective part of the body . . . The [Vienna] Presse assures its readers that there is no joke or humbug in the matter. It is a serious discovery by a serious German Professor.
THE STANDARD, Wednesday, January 8, 1896.

THE NEW PHOTOGRAPHY

[Professor Röntgen of Würzburg, has discovered how to photograph through a person's body, giving a picture only of the bones.]

O, Röntgen, then the news is true,
And not a trick of idle rumour,
That bids us each beware of you,
And of your grim and graveyard humour.

We do not want, like Dr. Swift,
to take our flesh off and to pose in
Our bones, or show each little rift
And joint for you to poke your nose in.

We only crave to contemplate
Each other's usual full-dress photo;
Your worse than "altogether" state
Of portraiture we bar in toto !

The fondest swain would scarcely prize
A picture of his lady's framework;
To gaze on this with yearning eyes
Would probably be voted tame work !

PUNCH, 25 January, 1896

" . . . The greatest practical importance of these rays is their utility in medicine. So far they seem to serve no useful purpose in any other domain . . . "
Dr (later Sir) James MacKenzie Davidson [the "Father of British Radiology] – British Medical Journal, 1902

LINES ON AN X-RAY PORTRAIT OF A LADY

She is so tall, so slender, and her bones
Those frail phosphates, those carbonates of lime
Are well produced by cathode rays sublime,
By oscillations, amperes and by ohms
Her dorsal vertebrae are not concealed
By epidermis, but are well revealed

Around her ribs, those beauteous twenty-four,
Her flesh a halo makes, misty in line,
Her noseless, eyeless face looks into min,
And I but whisper, "Sweetheart, Je t'adore,"
Her white and gleaming teeth at me do laugh.
Ah ! Lovely, cruel, sweet cathodagraph !

Lawrence K.Russel – LIFE, 27 March, 1896.

X-actly So

The Röntgen Rays, the Röntgen Rays
What is this craze?
The town's ablaze
Of X-ray's ways.

I'm full of daze,
Shock and amaze,
For nowadays
I hear they'll gaze
Thro' cloak and gown
And even stays,
These naughty, naughty Röntgen rays.

Music-hall jingle prompted by press advertisement for "X ray proof underclothing for ladies" – Photography, February, 1896.

The new physics may be said to have begun in 1895 with the discovery of X-rays
Sir William Dampier – The History of Science, 1929.

" . . . HOW DISGUSTING . . . " King Edward VII's response when Lord Crawford showed him the radiograph of A.A.Campbel Swinton's hand taken on 13 January 1896.
A.A.Campbell Swinton: Autobiographical and other Writings 1930

"Röntgen Radiography and its uses"

. . . "Is it too much to hope that before long the Roentgen rays will do for the abdomen what the stethoscope has done for the thorax?" . . .

. . . "It seems likely that the out-patient department of a large hospital will hereafter have a sort of confessional box in one corner, with a dark interior enclosing the skilled

observer, and with a conveniently placed fluorescent screen let into its wall. An operator outside will manipulate the apparatus. and thus one patient after another, by exposing themselves to the stream of rays falling upon the screen, may have their injuries or deformities located and described by aid of the shadow which they cast upon the screen. " . . .

Sir Oliver Lodge – SATURDAY REVIEW OF POLITICS, LITERATURE, SCIENCE AND ART, April 25, 1896.

" . . . Tired as we are of the X-rays, they appear to be doomed, like the poor to be always with us . . . "
The Photographic News, 31 July, 1896.

" . . . while six months ago everybody was excited with the subject [X-rays], it has now become so stale that it was difficult to galvanise it into any sort of interest. The fact thus stated is another illustration of how soon we nowadays cease to wonder at anything . . . "
Middlesborough Gazette, November, 1896, reporting on a lecture on X-rays by A.A.Campbell Swinton.

" . . . WE ARE SICK OF THE RONTGEN RAYS. You can see other people's bones with the naked eye, and can also see through eight inches of solid wood. On the revolting indecency of this there is no need to dwell . . . "
PALL MALL GAZETTE , 1896

. . . AND FINALLY A COMMENT FROM ARTHUR RANSOM, JOINT PROPRIETOR OF THE BEDFORDSHIRE TIMES AND INDEPENDENT, (Saturday, January 18, 1896) . . .

"SEEING THROUGH A BRICK WALL

It has generally been assumed that one cannot see through a brick wall unless there is a hole in it. But it would be rash to prophesy that the time will not come when we shall be able to see through a brick wall in which there is no hole. At any rate we are beginning to photograph objects covered by opaque substances. If bread-winning clairvoyants, who profess to read words enclosed in an opaque envelope of the numbers engraved upon the inner cases of watches, are conjuring tricksters, Prof. Roentgen, of Vienna, is a boná fide scientist, and has discovered that what he calls the x rays of light will produce photographic results through wooden boxes, thick cardboard, and even thin plates of aluminium. If this new photography should happen to be extensively developed and made easily practicable, the impertinent cameras which photographo-maniacs carry about with them will become positive nuisances. How will anyone know, when he is sitting cosily by his fireside, that he and his doings are not being "taken" by some idle photographer outside the house? Really, these scientists are dangerous fellows. Not satisfied with proving that the world is not the centre of the universe, that the history of man is an ascent and not a descent, that there is no man at all in the moon and in other ways upsetting our old comfortable – and uncomfortable – beliefs, these scientists are now threatening our very privacy with the intrusion of a photographic Paul Pry who can dispense with open doors or glass windows. Just imagine John and Mary indulging in a conjugal fracas at the very moment when some irrepressible inquisitor is directing the photographic x rays through the wall upon the happy pair! Or imagine a reverendissimus ascetic indulging in a pipe and – say – "Tit Bits" in his den when a devoted admirer of his

is photographing him through the shutters and curtains! Or imagine a hopeful son, whom his parents believe to be burning the midnight oil in order to get his degree, singing a comic song on a table amid a circle of jolly dogs, just when a candid friend is holding his tell-tale lens against the stout door panel! In truth, if these scientists do not keep their discoveries within decent bounds, life will not be worth living . . ."

The remainder of the article – containing some rather whimsical technical details about the characteristics of X radiation – show that Arthur Ransom must have obtained his information from a report published in the London Conservative newspaper THE STANDARD, January 8, 1896. Ransom's article "Seeing through a brick wall" was almost certainly the earliest detailed speculative notice about the discovery of X-rays to appear in the provincial press. His name will probably be familiar to many members of the Potton History Society for his series of more than 90 articles on the history of the villages and towns of Bedfordshire – including Potton – published in THE BEDFORDSHIRE TIMES above the initials "A.D." during the late 1890's and early 1900's.

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Evening Talk on the Centenary of the Discovery of X-rays delivered to the Potton Historical Society on Thursday, 25 January 1996.

By the late Derek Guttery.

This interesting talk by the late Derek Guttery was given for the Röntgen Centenary in 1996. As far as I am aware it was not published. I do not have Derek's slide collection, however I think that we can imagine what images he used. This talk illustrated the depth of knowledge that Derek possessed, and it was delivered just over three years before his untimely death in May 1999.

SLIDE: PORTRAIT BUST OF RONTGEN by Ernst Kunst
SLIDE: RÖNTGEN RAYS CENTENNIAL, 1895-1995:
PORTRAIT OF RÖNTGEN — THE SUBJECT OF THIS EVENING'S TALK — TAKEN IN 1886 WHEN HE WAS AGED 41.

SLIDE: COVER WRAPPER OF THE FIRST EDITION OFFPRINT OF RÖNTGEN'S "FIRST COMMUNICATION" A NEW KIND OF RAYS — WÜRZBURG ENDE 1895

GOOD EVENING

I think that most of you will have been slightly mystified by the title of this evening's talk and no doubt will have questioned the significance of "radiation" in the context of local history – particularly Potton history. The title "A History of Radiation" – which, incidentally is not mine – also mystified me when I first received the programme because I shall be talking about only one kind of radiation – X-radiation – and then only about one of its many aspects – the events leading up to and immediately following its discovery on 8 November 1895 by Wilhelm Conrad Röntgen, a relatively obscure fifty-year old professor of physics at the Bavarian University of Würzburg. The subject for the talk arose from a chance remark I made last year to a fellow member of the Society that 1995 was the centenary of the discovery. Peter Ibbett heard about this and kindly invited me – a very reluctant speaker – to give a talk on the subject to a society more

usually entertained by such varied subjects as Cockayne Hatley, land enclosures during the 18th. century and railway architecture in the mid-19th. It is with this context in mind, therefore, that I suggest a plausible justification for this evening's talk is that, without exception, every person in this room will have had an X ray examination at some time or other and – if for this reason only – might be assumed to be a little curious about how this type of radiation came about.

PUBLIC PERCEPTION
SLIDE: 2-COMIC POSTCARDS FROM 1950's
SLIDE: 2-POSTCARDS FROM 1901 & 1914

It is obviously impossible to tell the story of a scientific subject without using a certain amount of technical language, but I shall attempt to keep this aspect to a minimum. What could promises to be a dull and tedious evening entirely devoid of humour will be enlivened towards the end – subject, of course, to your still being here – by the playing of an excerpt from the recorded reminiscences of an eminent and long-deceased pioneer worker who had a life-long involvement with X-rays almost from the time of their discovery — Dr. Russell J. Reynolds. My talk will last just over one hour and I shall be happy to take questions when it's finished. Throughout, I shall adopt the convention "quote/unquote" when using reported speech.

By the last quarter of the 19th century, many scientists were confident that they had a reasonably complete understanding of the physical nature of the universe and that while there were still a number of gaps waiting to be filled, the overall picture appeared fairly clear. In fact, many felt that any new advances would, in the main, be limited to taking the measurement of physical entities to a few more decimal places – almost a dotting of I's and crossing of T's on existing knowledge. But, all of a sudden, within a short period of years during the closing decade of the century, three very revolutionary and completely unexpected advances in basic physics occurred that forced a radical re-appraisal of much previous understanding and were soon seen to mark the beginnings of a new and great watershed in the history of scientific thought. These advances were the discovery of X rays in 1895, the discovery of radioactivity in 1896 and the identification and understanding of the electron in 1897.

Two of the advances – the discovery of X-rays and the understanding of the electron – arose from the study of electric discharges in gases at low pressure – studies that had intermittently engaged a succession of scientists in England, France and Germany ever since Michael Faraday's pioneering work on the subject at the Royal Institution in London during the late 1830's.

But to begin at the beginning, how was news of the discovery first received?

During the early part of January 1896, a number of eminent scientists in Germany, France and Great Britain received an unexpected and mysterious package posted by Röntgen on New Year's day containing an offprint of a 10-page technical paper of approximately 3,500 words describing the discovery of "a new kind of rays" which possessed the amazing property of being able to pass through optically opaque bodies and reproduce what was inside or behind them as a shadow on a fluorescent screen or photographic plate. The paper was accompanied by a number of positive photographic prints - not always the same prints for each recipient – taken from X ray plates demonstrating the properties of the rays and their ability to penetrate matter. The

selection of images was made from a collection of at least nine prepared by Röntgen during his experiments and the subjects depicted included a coil of wire on a wooden spool; quartz and other material penetrated by X rays; strips of tinfoil; a small magnetic compass entirely enclosed by metal; part of a wooden door in Röntgen's laboratory showing streaks resulting from differential absorption of the rays in the lead paint; a set of chemical balance weights in a fitted wooden box and a human hand — his wife, Bertha's hand. But it was the ghostly skeletal image of his wife's be-ringed hand made on 22 December and captioned "hand mit ringen" which was unquestionably the most dramatic of all the radiographs sent out by Röntgen and was soon to become world famous through widespread reproduction in contemporary journals. In retrospect, we may consider the caption "hand mit ringen" superfluous — even naive — but it should be remembered that to the first viewers of 1896, the X-ray shadows were a completely new form of imaging and therefore not immediately recognisable or comparable with anything they had seen before. Regrettably, none of Röntgen's original glass plate negatives has survived and the only original images remaining today in various museums and private collections are a few sepia-toned positive prints mounted on card.

SLIDE: Röntgen's radiograph of laboratory balance weights in a fitted wooden box.
SLIDE: Radiograph of Bertha's hand — hand mit ringen — taken on 22 December 1895

The two recipients of Röntgen's package in this country were Lord Kelvin in Glasgow - at that time the doyen of British physicists but at the age of 72 unable to re orient his ideas and adapt to the beginnings of the new scientific revolution - and, secondly, Arthur Schuster, the brilliant German-born and educated Langworthy Professor of Physics at Owen's College, Manchester. Schuster was an ideal recipient for the package as from 1880 onwards he had himself worked on the study of the discharge of electricity through gases and had already made important contributions to the subject.

SLIDE: LORD KELVIN IN 1897 AT THE AGE OF 73

Kelvin was ill at the time but referred the paper to his nephew and private assistant, J.T.Bottomley, who despatched a letter to the pre-eminent scientific journal NATURE containing a few lines on what he referred to as Röntgen's "speculations". Meanwhile, Lord Kelvin tempered his initial scepticism - based on a cursory examination of the prints but not the paper – in a brief but friendly letter of acknowledgement. A few days later, after reading the paper, Kelvin modified his personal feeling that the contents of the package were a mistake or perhaps even a hoax and followed his original non-committal response of 6 January with a second letter to Röntgen on 17 January in which he expressed his warm congratulations "on the great discovery you have made."

SLIDE: LETTER FROM LORD KELVIN, DATED 6 JANUARY, 1896, ACKNOWLEDGING RÖNTGEN'S PACKAGE

SLIDE: LETTER FROM LORD KELVIN, DATED 17 JANUARY, 1896, CONGRATULATING RÖNTGEN "ON THE GREAT DISCOVERY YOU HAVE MADE".

SLIDE: SIR ARTHUR SCHUSTER RECLINING IN HIS STUDY AT HIS HOME IN MANCHESTER IN ABOUT 1897. NOTE PORTRAIT PHOTOGRAPH OF LORD KELVIN ON BOOKCASE

Arthur Schuster's reaction was entirely different. He had just returned to Manchester following a short Christmas vacation. When he called at his laboratory to collect his mail on the way home from the station, he found the package from Röntgen and was so immediately fascinated by its contents that he kept his young wife and a horse-drawn cab waiting outside in the chill January evening while he read the pamphlet twice over. When he finally appeared he excused himself to his wife by explaining that he had received an extraordinary communication "from that man Röntgen who had been so rude in Pontresina." For those of you who are curious, Pontresina was a popular health resort in the Swiss Mountains where Röntgen used to spend his annual autumn holiday.

SLIDE: RONTGEN HOLIDAY POSTCARD FROM PONTRESINA

In fact, Schuster was so impressed by his reading and re-reading of Röntgen's report that he immediately informed his scientific colleagues and at the same time wrote to the Manchester Guardian with a concise account of the discovery which he described as "of very far-reaching consequence" and offered to show the X ray photographs to anyone interested. He also persuaded his assistant Arthur Stanton to translate Röntgen's paper from German into English for publication in the journal NATURE. Schuster's letter to the Manchester Guardian appeared on 8 January - thereby establishing priority as the first authoritative radiological communication in Britain - and Stanton's translation in the journal NATURE on 23 January — the first appearance in English. A different translation appeared in The Electrician the following day and further translations from German into French, Dutch, Polish, Italian and Russian were published within the next few months.

Meanwhile, on 7 January, the Manchester Literary and Philosophical Society held an ordinary meeting at which a Dr C.E.Lees, on behalf of Arthur Schuster, showed members Röntgen's X-ray prints including those of Bertha's hand and the magnetic compass — both of which were also to be reproduced later in the month as illustrations to Stanton's translation in NATURE.

It was thus that the extraordinary news of Röntgen's discovery reached the scientific community in Great Britain prompting an unparalleled frenzy of interest and the generation of a new and enormous literature of technical articles, pamphlets and printed books on the subject amounting in total to more than 1000 titles world-wide before year end. The educated public learned of the discovery even sooner from accounts published in the London press and this aspect of the discovery will be described later. But by the end of 1896, the lay press was entirely bored with the subject and the general feeling was well expressed in an editorial in the journal PHOTOGRAPHIC NEWS – "tired as we are of the X-rays, they appear to be doomed, like the poor, to be always with us".

The rapidity with which Röntgen's communication was transmitted and the speed of response of its recipients demonstrates how effectively and courteously information could be exchanged between scientists in different countries and with different languages at a time when the only available means of transmission of hand-written and printed text were horse-drawn vehicle, steam train, boat and Morse and punch-tape transcriptions sent along a wire via the electric telegraph – no SECURICOR, no FAX, no INTERNET, no BITS, BYTES, RAMS or ROMS.

1896 was the year when Lord Northcliffe founded the DAILY MAIL and the year when young Marconi arrived in London to sell his wireless invention to the Post Office. During the same year the first cinema or bioscope show was presented in the West End, a Mr. Langley successfully flew a steam-driven model aircraft, the "red flag" restriction on motoring was repealed and the maximum permitted speed for vehicles raised to 14 m.p.h. The Nobel prizes were established, the Klondyke gold rush started, Marie Corelli published a novel entitled The Atom and the newspapers were filled with articles about the aftermath of the Jameson raid in South Africa and the part played in it by the much disliked Germans.

There were no airplanes, probably fewer than a dozen cars, virtually no telephones and relatively little electricity. Oceans could be crossed by steamship but even then they were still occasionally equipped with supplementary sails. In physics laboratories, there was often only one professor – who often had his residence on the premises – and the importance of his laboratory might be assessed by the size of battery it possessed: the higher the voltage the higher the status.

5–SLIDES: PARK LANE AT THE MARBLE ARCH END; COUNTRY DOCTOR RUSSIAN BEAR; KODAK PRINT INSPECTION; GAS FIRE, ETC.

The pictures on the screen illustrate a few aspects of this vanished world of 100 years' ago: an almost rural Park Lane at the Marble Arch end; a country doctor in a pony and trap starting on his rounds (Dr Francis Gaman of Caistor, Lincolnshire in pony trap setting of on his rounds, c.1903)
a Russian bear in a London street ; print inspection at Kodak's Harrow factory; and what the fashionable family looked for when selecting a new gas fire, gas iron or washing machine.

In the Western world, Great Britain, France and Germany were the principal leaders in science. France was still recovering from the hurt to its national pride by its defeat in the Franco-Prussian war; in Germany, the Kaiser, Wilhelm II was just starting to throw his weight about while Great Britain had reached the peak of its imperial splendour under the rule of Victoria Regina. Britannia ruled the waves in splendid isolation.

SLIDE: SCHEMATIC OF VARIOUS STAGES OF EVACUATION OF A GAS DISCHARGE TUBE

If two metal electrodes are sealed into either end of a glass vessel or tube containing air at atmospheric pressure and then connected to a source of electricity nothing happens until the voltage is very high; then a spark occurs at about 30,000 volts for every centimetre of separation between the electrodes. If the pressure of the gas in the tube is then reduced by means of a vacuum pump to about 1/100 of atmospheric pressure, a silent discharge passes between the electrodes in the form of a luminous glow in the residual gas such as can be seen in the neon tubes used for street advertising. In simplistic terms, a stream of electrons or cathode rays is flowing between cathode and anode ionising the gas. As the pressure of the gas is still further reduced, the luminous glow begins to retreat away from the electrode connected to the negative – or cathode – pole of the source of electricity and breaks up into a series of striations or alternate transverse bands of light and dark.

At an even lower pressure of about 1/100,000 of an atmosphere, the internal glow disappears altogether – although a current is still flowing through the tube – and it is now the glass envelope of the tube and not the residual gas which begins to fluoresce – blue fluorescence with British lead glass and a bright apple-green with soda glass.

SLIDE: TYPICAL APPEARANCE OF A "HARD" X-RAY TUBE WHEN ENERGISED (ANTERIOR HEMISPHERE)
When this occurs, we have the major essentials of a primitive but workable X ray set although nothing like the X-ray sets of today. X-rays are produced whenever electrons – or cathode rays – are accelerated by a high voltage applied across two electrodes in a suitable evacuated vessel and stopped abruptly by allowing them to impinge upon a target. Irrespective of the target material, X rays are always produced. In the simple arrangement that I have described, we have a vessel evacuated to about 10–4 mm. of mercury, or about 10–7 atmospheres; we have a certain level of residual gas within the tube to provide an abundant source of electrons by ionisation; we have a source of high-voltage electricity such as an induction coil to provide an accelerating voltage above about 30,000 volts and we have a target – the glass wall of the tube envelope. Replace the glass target with material of higher atomic number such as platinum – or, as in a modern tube, tungsten – and we generate much more intense X rays; increase the accelerating voltage and we generate more penetrating X-rays. 40,000 volts for a human hand and 400,000 volts, for 100 mm. of steel.

The property which concerns radiography is the attenuation of X-rays by physical matter – in general terms the reduction in intensity of the X radiation is proportional to the thickness and very roughly proportional to the number of atoms per unit volume of the material traversed. The thicker and denser the material, the greater the attenuation – thus plastic and aluminium for X-ray film cassettes and thick lead for radiation shielding.

The spectacular phenomena associated with electrical discharges through gases in glass vessels at low pressure had intermittently interested scientists ever since they were first reported upon by Francis Hauksbee in 1702 but it was only a number of technical improvements in laboratory apparatus and experimental techniques commencing in the 1850's that enabled physicists to take investigation further. The improvements and techniques which were to lead to the discovery of X rays, the discovery of the electron and numerous applications of the cathode-ray tube were in very broad terms the introduction of a new type of mercury vacuum pump by Geissler; the availability of a powerful source of high voltage following perfection of the induction coil by Daniel Rühmkorff; and a successful method of vacuum sealing platinum wires through soft glasses — by Geissler — followed by significant improvements in technical glasses and scientific glassblowing.

But it was primarily the production of vacuum that dominated physical research during this period and successive advances in investigation of the phenomena associated with the discharge of electricity through gases were usually coupled with advances in vacuum technology. At the beginning of the period so called "vacuum" pumps still employed variations based on the simple plunger and leather valve principle invented by Otto von Guericke of Hamburg in 1650. After improvements by many hands, the mercury pump was applied to the problem and in the form introduced by Geissler in 1858 could achieve pressures of 1/2000 part of an atmosphere and this capability was soon improved by a factor of 10 as a result of further development by Toepler and Sprengel. Invention of

the incandescent electric lamp at about the same time also stimulated progress in vacuum technology.

The names of the principal figures involved in investigation of the discharge of electricity through gases at low pressure following Michael Faraday investigations of 1838 were: Heinrich Geissler, inventor and manufacturer of the famous luminous gas-discharge tubes bearing his name which were to be a source of serious interest to scientists and objects of fascination to the public; Julius Plücker who discovered that the luminous glow in the tube was deflected by a magnet; J.W.Hittorf who observed that an obstacle placed in the gaseous glow from cathode to anode at very low pressure cast a shadow indicating the glow's ray-like nature; [OYGEN] Eugen Goldstein who introduced the term cathode rays for the glow; Sir William Crookes, who developed the gas discharge tubes bearing his name and undertook intensive research on what he called "radiant matter" during more than twenty following his invention of the Radiometer in 1875; Heinrich Hertz who found that cathode rays could pass through gold leaf or very thin foil; and Hertz's pupil, Philipp Lenard who investigated the behaviour of cathode rays outside the discharge tube by cementing an aluminium foil across a vacuum-tight window opening in the tube envelope.

SLIDE: SCHEMATIC CROOKES, LENARD, ETC TUBES.

SLIDE: PHOTOGRAPH OF TWO CROOKES' TUBES

The final names to be included in this chronological list are W.C. Röntgen for his discovery of X-rays in 1895 and J.J.Thomson for his discovery of the electron at the Cavendish Laboratory, Cambridge in 1897. Faraday's investigations at the beginning of the period using an evacuated and electrified glass globe or "electric egg" fitted with brass ball electrodes had been curtailed by the limitations of his piston-type vacuum pump.

During the summer of 1895, Röntgen had collected together equipment in his laboratory in the Technical Institute at Würzburg – including a fairly large induction coil and suitable discharge tubes – for taking up work on
the subject of cathode rays.

SLIDE: The Physical Institute at the University of Würzburg pictured in 1892 — three years before Röntgen's discovery.

SLIDE: INDUCTION COIL WITH TWO CROOKES TUBES

SLIDE: Outline drawing of Crookes (top) pear-shaped and Hittorf (bottom) gas-discharge tubes

SLIDE: 1903 "Spy" cartoon of Sir William Crookes, "FATHER" OF THE CROOKES' TUBE

6-SLIDES: 6 VIEWS OF A RECONSTRUCTION OF RÖNTGEN'S LABORATORY IN THE PHYSICAL INSTITUTE AS VISUALISED IN 1895. MOST OF THE ARTEFACTS DISPLAYED ARE ORIGINAL

From the research already undertaken by Philip Lenard at the University of Bonn, it was known that cathode rays emerging from a Lenard aluminium-foil window in a gas-

discharge tube produce fluorescence in certain crystals and that the rays were completely absorbed in about 8 centimetres of air.

As part of his research programme, Röntgen had decided to find out whether the cathode rays could also pass though the glass of a discharge tube as he felt that their possible presence outside the tube might have been overlooked owing to the fluorescent luminescence produced in the glass envelope. To assist his observations with an experiment conducted during the evening of 8 November, he had darkened the room and purposely shielded a Crookes tube within a cardboard box to exclude the possibility of any light being emitted. To his surprise, he noticed that a barium platino-cyanide screen lying on a table some distance from the tube showed a flash of fluorescence every time the tube was energised by the induction coil. He reasoned that the flash could not be due to cathode rays because they were known to be completely absorbed in 8 centimetres of air. For the next few weeks he hardly left his laboratory while he carried out further tests to convince himself of the reality of his observations which at first he found hard to believe. His tests established that the fluorescence was caused by something, the unknown "X", that travelled in a straight path from the spot where the cathode rays in the tube hit the glass wall of the envelope and that the unknown agent was absorbed by metals and that these cast a shadow in the fluorescent area of the screen thereby establishing its ray-like nature. He then went on to establish that the rays were exponentially absorbed in matter with an exponent roughly proportional to the mass traversed, but very much smaller than the one found by Lenard for the corresponding cathode rays. He also established the action of the rays on photographic plates and took a series of images of the various optically opaque objects that I described earlier including — on 22 December — that of his wife's hand. Further investigation showed that the output of X rays could be increased by letting the cathode rays impinge on a metal "anti-cathode" instead of on the glass wall of the tube and that the rays render air conductive and discharge an electrometer. He also performed various ingenious but entirely negative experiments in which he searched in vain for reflection or refraction or diffraction of the rays, the characteristic features of wave phenomena.

Röntgen was aware that he had discovered something fundamentally new but had to make doubly sure of his facts before submitting them to publication. He did the work single handed and did not discuss it with his assistants or even with his wife. In a letter to his friend Zehnder — probably written in late February 1896 — he wrote "I had not spoken to anyone about my work; to my wife I mentioned merely that I was doing something of which people, when they have found out about it would say 'Röntgen seems to have gone crazy.' "

Finally, on 28 December, 1895 Röntgen submitted the manuscript of his famous "Preliminary Communication" On a New Kind of Rays to the secretary of the Würzburg Physical-Medical Society for publication in the December issue of its transactions. Although the transactions were already at the printers, Röntgen requested that his paper should be included and without prior verbal presentation to the society , evidently to ensure early publication. Its importance must have been realised, since it was forwarded to the printer with an endorsement that it should be placed "at the end before the annual report". The paper was printed as requested in the final issue for the year and although dated "Dec. 1895" was probably not available for distribution until the first week of January 1896. However, an offprint in yellow wrappers – and without a separate title page – was printed from the original type and made available to Röntgen in time for him to post it to a number of his scientific friends and colleagues on New Years Day 1896 as

related earlier – and all at a time when all printed text was set by hand from movable type.

SLIDE: Wrapper of the first edition offprint printing of Röntgen's "First Communication" A NEW KIND OF RAYS — Würzburg ende 1895

SLIDE: First page of holograph manuscript of Röntgen's "First Communication" A NEW KIND OF RAYS (The only page surviving until 1945 when it was destroyed in an air raid)

In the 10 pages and 16 sections of his "Preliminary Communication", Röntgen sets out the facts in a precise narrative but omits any personal or anecdotal elements which he considered unbefitting to a scientific publication.

In March, 1896 the "First Communication" was followed by a second communication of seven printed pages in which Röntgen reported on further aspects of his research on X-rays and a year later, in March 1897, a third and final communication appeared, slightly longer than the first two taken together, containing further observations and measurements. In total, these 31 pages testify to the conciseness of Röntgen's research papers and in spite of the great number of physicists and medical men working in the field following the discovery, only a few new fundamental facts about X-rays were to be discovered during the next fifteen years.

SLIDE: W.A.WELLMER'S 1900 SKELETAL CARTOON OF RÖNTGEN

Röntgen's life up to the time of the discovery of X-rays is easily retold. He was born on 27 March, 1845, in Lennep — now Remscheid-Lennep – about twenty miles north of Cologne, the only child of a prosperous cloth merchant. The family renounced Prussian nationality when he was three and emigrated to Appeldorn in Holland, the home of his maternal grandparents and he was not to return to Germany until 1870 — twenty two years later.

In October 1888, following an academic career involving successive studentships, lectureships and assistant and full professorships in schools, technical colleges and universities in Holland, Switzerland, Alsace-Lorraine and Germany, Röntgen was appointed Professor of Experimental Physics and Director of the Physical Institute at the university of Würzburg and it was there, nearly seven years later, that he made his discovery of X-rays.

Incidentally, it was during his earlier studies in Switzerland that he acquired his love of mountaineering and the countryside, and where he formed many life-long friendships and met his future wife, Anna Bertha Ludwig, the daughter of a German exile.

SLIDE: Röntgen's birthhouse in Lennep with a map showing his academic peregrination

SLIDE: Röntgen as a young student

SLIDE: Röntgen as a young man with his family

SLIDE: Röntgen's wife, Bertha Ludwig

SLIDE: Pontresina, Switzerland, September 10, 1890. Röntgen in a wide-brimmed soft velour hat is seated at the right. The other couple at the table are his friends, Mr & Mrs von Hippel

SLIDE: WATER-COLOUR SKETCH OF WHAT IS ALMOST CERTAINLY A LIGHT-HEARTED PORTRAYAL OF RÖNTGEN DRESSED AS A BRIGAND TAKEN FROM A DECORATED MANUSCRIPT POEM WRITTEN BY THE MRS VON HIPPEL WHO YOU SAW IN THE PREVIOUS SLIDE

In an interview that Röntgen gave to H.J.W.Dam of the American McClure's Magazine shortly after the discovery, he makes a very significant remark. He had described to Dam his first observation of the fluorescence of the barium platino-cyanide screen lying (lying perhaps by accident — for no one really knows) on the table near the tube. "And what did you think?" asked Dam. "I did not think; I investigated," replied Röntgen. A challenge was waiting in the physical world of the 1890's which such a man might accept: Röntgen accepted and it was his characteristically acute observation rather than accident which led to the discovery.

Following a life up to then of relative obscurity, Röntgen now became a scientist of world renown and this was reflected in the more than eighty awards and memberships conferred on him by scientific association in Germany and abroad including the joint award with Lenard of the Rumford Medal by the Royal Society of London and the Barnard Medal by Columbia University. The final accolades for this unassuming scientist were the erection of his statue on the Potsdam Bridge in Berlin, and the award in 1901, of the first Nobel prize for physics. Typically, he gave his Nobel prize money of 50,000 kroner to support scientific studies at the University of Würzburg. However, as a shy and reticent man, Röntgen deeply resented becoming a public personality and always tried to avoid invitations to talk about his discovery.

SLIDE: Illustrating some of Röntgen's awards INCLUDING THE NOBEL PRIZE

SLIDE: Further illustration of some of Röntgen's awards (THE ROYAL SOCIETY'S GOLD RUMFORD MEDAL IS MISSING BECAUSE RÖNTGEN DONATED TO THE WAR EFFORT IN 1914 – AN ACTION HE AFTERWARDS VERY MUCH REGRETTED

SLIDE: Röntgen's LEATHER BOUND ILLUMINATED Nobel Prize CITATION. THE HAND-PAINTED CARTOUCHE AT THE TOP ILLUSTRATES THE APPARATUS USED IN MAKING HIS DISCOVERY

SLIDE: Röntgen iconography — stamps

SLIDE: Röntgen iconography — cigarette cards

SLIDE: Röntgen iconography — emergency banknotes

In 1900, at the invitation of the Bavarian Government, he resigned from his post at Würzburg to take the prestigious chair of physics and directorship of the Physical Institute at Munich.

SLIDE: Röntgen in old age walking in the streets of Munich

Röntgen's final years were shadowed by the distresses and privations of the First World War and the inflation and breakdown of the monetary system that followed. His wife died in 1919 and he retired from his official position at Munich the following year. He spent a good part of his remaining years at his country house near Munich where he had an extensive library. He died on 10 February, 1923.

SLIDE: Death cast of Röntgen's hands, 1923

I would now like to return to 1896. During the same week in January in which Lord Kelvin, Schuster and their favoured compatriots in France and Germany were examining the contents of Röntgen's postal package, the journalist had also been busy and it is fair to say — certainly so far as England is concerned — that the scientific and general public's introduction to the discovery was via the daily press rather than from any technical or scientific journal. The press accounts were generally accurate and contained enough technical detail to enable enthusiastic experimentalists equipped with the readily available apparatus to replicate Röntgen's experiments and produce X-rays.

SLIDE: Announcement of "Routgen's (sic) discovery on front page of Die Presse, Vienna, Sunday, 5 January, 1896.

The news first broke in the public domain on the front page of Vienna's leading daily paper THE PRESS on Sunday, 5 January and contained a short summary of the discovery and referred in romantic and prophetic terms to "rings freely floating around the finger bones", went on to discount the possibility that this was "only a fairy tale or crude April joke" and ended by stating "... if we let our fantasies run freely ... we can imagine that one day these rays will be so perfect that only one layer of the body's soft tissues will be transparent to them, whereas deeper layers will be shown on photographic plates. This could be of immeasurable help for the diagnosis of countless diseases other than those of bone. . . " The reason the first report appeared in an Austrian rather than a German paper is because the editor's son happened to be a young physicist who had attended a scientific meeting the night before at which Franz Exner — Director of the Physical Institute in Vienna and a recipient of one of Röntgen's packages — had described the profound impression made upon him by the contents.

News of the discovery was immediately telegraphed to the London newspapers where it first appeared on Monday, 6 January in a fairly detailed report in the Daily Chronicle in which Röntgen is referred to as "Routgen" — an error copied from Vienna.

SLIDE: Announcement of "Routgen's" discovery in the Standard, Tuesday, 7 January, 1896

In a similarly account in the Standard newspaper of Tuesday 7 January, readers were assured "that there is no joke or humbug in this matter. It is a serious discovery by a serious German professor." The Standard account was read with great interest by A.A.Campbell Swinton, a highly gifted electrical engineer with a life-long interest in photography. He and his assistant J.C.M.Stanton assembled an induction coil and suitable Crookes tube in accordance with the basic information given in the newspaper report and succeeded in producing the very first radiograph taken in this country that evening.

Swinton related "Happening to be possessed of several Crookes' tubes, Mr.J.C.M.Stanton and myself immediately proceeded to test the truth of the alleged discovery, and our first radiogram was developed on the evening of the day in which the Standard article ... appeared. It shows the dim shadow of a coin through a thin sheet of aluminium. The shadow is so faint that one could scarcely notice it unless one is looking for it. None the less, it quite unmistakably proved that the photographic plate had been impressed by some form of radiation which had passed through the sheet of aluminium."

Two further radiograms showing a key, some coins in a leather purse and various thin pieces of wood, ebonite and fibre were taken on 8 January. In each case, the photographic plate was exposed in a camera dark-slide. A letter from Swinton confirming the truth of Röntgen's discovery appeared in the Standard on 10 January and on the 13th, he and Stanton, took a radiograph of Swinton's hand which he publicly exhibited at the Camera Club in Charing Cross Road on the evening of 16 January, showed it again a few days later at the Royal Institution and again at a lecture to the Royal Photographic Society on 11 February. All three presentations caused considerable astonishment and were widely reported in the press. The hand was taken through a sheet of 7½ 'thou. aluminium and exposed for 20 minutes. Swinton obtained a very much better hand on 18 January when he exposed the plate through a thin sheet of vulcanised fibre for 4 minutes at a film-focus distance of 6". The second radiograph was afterwards reproduced for sale in print form and also as a lantern slide and in this form enjoyed a considerable vogue with magic lanternists.

SLIDE: A.A.Campbell Swinton's earliest radiographs reproduced as positive prints on paper.

The two outside images on were taken on 8 January and the centre image on 13 January. In the left-hand picture, the faint rectangles are thin sections of wood and the small superimposed patches pieces of tinfoil. The plates used were almost certainly Wratten & Wainwright's LONDON brand — later to be absorbed by Kodak.

SLIDE: A.A.Campbell Swinton in his laboratory at 66 Queen Victoria Street surrounded by the apparatus used in his lecture "The New Shadow-Photography" delivered to the Royal Photographic Society, at Hanover Square on Tuesday, 11 February 1896.

The two tubes on the bench — both of which are also sketched on the sheet "whiteboard" on the back wall — are standard pear-shaped two-electrode Crookes tubes in which the X-rays originated at the domed glass end-wall making it very obvious why the radiographs produced before the introduction of a metal target and a focused cathode required such extended exposures and produced so poorly defined an image. Both tubes still exist.

SLIDE: Photograph of pear-shaped Crookes tube showing cracking of glass envelope at domed end used by SWINTON.

SLIDE: Schematic and photographic depiction of arrangement of induction coil and Crookes tube for radiography of the hand.

SLIDE: Induction coil and Crookes tube demonstration fluoroscopic and radiographic examination of a heavily be-ringed and gloved female hand

Swinton continued his interest in the technical aspects X-ray equipment – especially X-ray tubes – for a number of years but was also actively involved in many other areas of science and engineering including work on Sir Charles Parson turbine-driven boat the TURBINIA and significant contributions to the development of early radio and television. Of the many honours he received, the one that gave him greatest pleasure was his election to Fellowship of the Royal Society in 1915. He died in 1930 and left his collection of early radiographs on glass plates to the British Institute of Radiology where I re discovered them last year packed in their original wooden box but otherwise completely forgotten. They are now the world's oldest surviving glass-plate radiographs.

SLIDE: A water colour of Campbell Swinton at the age of six working at his woodturning lathe. The artist — his mother Georgiana — was great-aunt to the brother and sister family of writers, Osbert, Sacheveral and Edith Sitwell.

SLIDE: Portrait of Campbell Swinton during his Presidency of the Röntgen Society.

SLIDE: Cartoon drawn by Swinton depicting his joy at election to Fellowship of the Royal Society.

With your agreement, I shall terminate this talk after the break by playing a 10 minute excerpt from a unique 90-minute recording made at a meeting of the British Institute of Radiology on Friday 5 December 1958 – thirty-seven years' ago – in which four distinguished members were invited to reminisce about "The Early Days of Radiology". From the four speakers recorded, I've chosen Dr.Russell J.Reynolds, then aged 78, because of his lifetime's involvement with X rays from the very beginnings in January 1896.

SLIDE: Portrait of Dr.Russell J.Reynolds.

Russell Reynolds was the son of Dr John Reynolds, an amateur scientist and a friend of Sir William Crookes. In 1896, Russell was a fifteen year old pupil at Westminster School who included photography and experimenting with electricity among his hobbies. In the recording, he recounts how he and his father read a report of Röntgen's discovery in the STANDARD morning newspaper on Tuesday, 7 January and immediately decided to replicate the apparatus described so that they could generate X-rays themselves.

SLIDE: X-ray unit constructed by Dr.Russell J.Reynolds and his father Dr.John Reynolds, 1896-97

The X ray unit — pictured on the screen — which Russell and his father assembled and completed by 1897 was described by them in a detailed article in The English Mechanic. It is now deposited at the Science Museum in London and is claimed to be the oldest surviving X-ray unit in the world. Russell Reynolds qualified in medicine at Guy's Hospital in 1907 and went on to have a distinguished career as consultant radiologist at the Charing Cross Hospital and the National Hospital for Nervous Diseases and it was in these two teaching establishments that he performed the life-long work with X-rays that brought him international fame and honour. He died in 1964.

SLIDE: GERMAN REPLICA OF RUSSELL REYNOLD'S X-RAY UNIT IN A SIMULATED 1895 SETTING CREATED FOR THE 1995 RÖNTGEN CENTENARY CELEBRATIONS AT THE WÜRZBURG RESIDENZE

The original recording made in December 1958 is on quarter-inch reel-to-reel tape and now safely deposited in the archives of the British Institute of Radiology where it has remained virtually un-played for the past thirty-eight years. I hope to have this master tape cleaned, digitised and permanently secured on compact disc before the end of this year. Meanwhile, I am obliged to apologise for the indifferent quality of the third-generation excerpt played tonight. Edited versions of the four speakers' reminiscences were subsequently published in the British Journal of Radiology and Clinical Radiology but omit some of the material in the recordings.

Now, Dr.Reynolds .....

TAPE RECORDING: Dr.Russell J.Reynolds.

SLIDE: PORTRAIT BUST OF RÖNTGEN BY ERNST KUNST.

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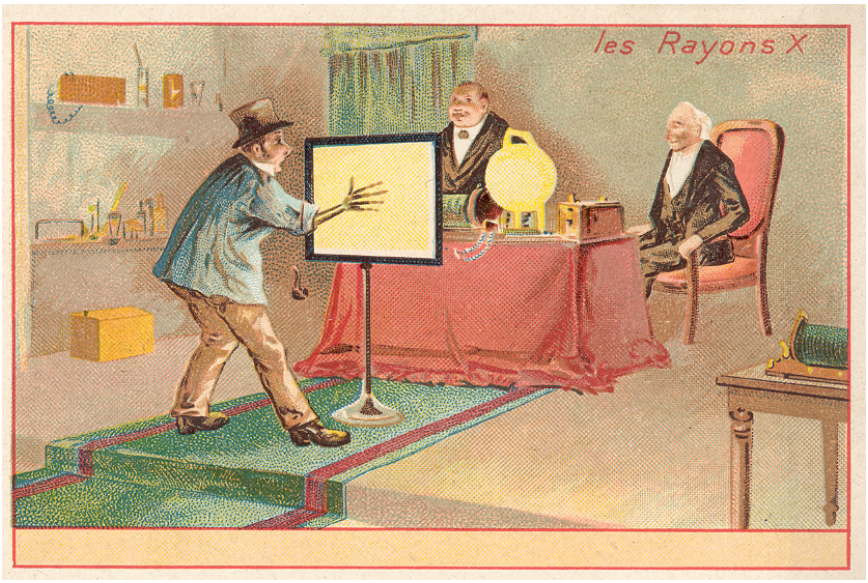
Homage to Derek Guttery.

One of his trade cards with a radiological theme: les Rayons X.
It's a nice image, although the hand seems to be on the wrong side of the screen, and the X-ray Crookes tube is somewhat fanciful. Image from late 1890s I would assume.



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