

South Africa

We hear from many sources that the X rays have been extensively used at the war in South Africa. Many of the wounded soldiers who have been sent to their homes to convalesce, or to the great military hospitals for treatment, have been allowed to bring with them prints of the radiographs taken of their injuries, which they exhibit to all comers with much pleasure and pride.

(*Archives of the Roentgen Ray*, 4: 83, May 1900.)

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Experiences of X-Ray Work During the Siege of Ladysmith

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(*Archiv. Roentg. Ray*, 5:69-74 (March) 1901.)

As a preface to my experiences in Ladysmith during the siege, I wish to impress on members present that this paper will be confined to a simple account of how I was able to overcome difficulties in the management of the X-ray apparatus entrusted to my charge. It will, therefore, be outside my province to touch other than in a general way on the scientific principles of radiography. The surgical details will be carefully avoided, as, not being a surgeon, it is not my business to discuss them.

The siege of Ladysmith furnished the first occasion in which radiography was attempted under such a condition. It was here also that actual work was done under shell-fire for any lengthened period. I do not mean to positively state that in such circumstances insuperable barriers to practical radiography will always be present, but difficulties must necessarily be many, and each has to be overcome by some

improvised method. Under ordinary conditions radiography is easily practised; when given a good instrument and a knowledge of procedure and electricity, our primary objective is within reach. In a siege you may expect to find things not so easy, and especially is this the case, when, in a town such as Ladysmith, electric light has not been thought of, as it is generally the case that operators have to depend on town installations for having their batteries charged.

I was stationed in Cairo when I received my orders to proceed to Natal and to take a set of apparatus. The apparatus was forthcoming without any trouble, but to arrange for a supply of electricity was not so easy. From experience up Nile I knew that it would be useless to take the specially fitted-up bicycle which had been tried as a motor for a dynamo. I confess I have no faith in manual aid for driving a dynamo, and I

think you will agree with me when I tell you that it would be well-nigh impossible to get men to drive with their feet such a contrivance for more than half an hour. Those gentlemen who are cyclists will more fully understand my point when I tell them that the power and endurance necessary to ascend a very steep hill on an ordinary cycle is like that which is experienced in charging six cells with the bicycle arrangement. It is climbing a never-ending hill, as it were; in fact, it may be likened to a treadmill. I have ridden a good deal on an ordinary bicycle, and I have tried to keep a set of batteries charged by the bicycle arrangement, thus, I think I am entitled to speak from experience. When up Nile and the temperature in the hut over 100°, much of this style of charging batteries left an impression on me that my relationship with a dynamo was extremely small. It was a good thing we had the batteries charged before proceeding; otherwise we should have been grinding away yet, with the result that they would not have been properly charged. This question of obtaining a supply of electricity, I must own, looked like a stumbling-block, and under the circumstances I had to trust to luck, having no motor to drive my dynamo. I was entirely ignorant of the electrical resources of the country I was proceeding to, and was also led to believe that, if fighting did take place, the scene of action would be amongst hills far removed from enterprising towns. However, I took the dynamo with me, trusting that some means might become available to drive it. My apparatus consisted of the following: An Apps 10-inch portable coil with separate break; two four-cell batteries and six single cells; Mackenzie Davidson's localizing apparatus; a supply of Deane's tubes, three of which were specially made for me and two which had been used up Nile; a specially made screen; developing dishes; a small set of repairing tools, consisting of pliers, files and soldering materials; red lamps for developing-room; plate rockers; sulphuric acid

for batteries; Lumière plates; hyposulphite of soda and alum; and Burroughs and Wellcome's compressed tabloids of soda developer—Ilford formula.

My destination was Pietermaritzburg, which I reached without any mishap occurring to any of the articles. Having unpacked my batteries, I made arrangements to have them charged without delay. I had this done at the Royal Hotel, as the town installation had no shunt-wound dynamos, and I was therefore not able to charge batteries from the dynamos generating electricity there. On travelling by rail from Durban to Pietermaritzburg, my attention was drawn to the fact that the train was lighted by electricity, and from inquiries made at the railway-station I learned that batteries were used for the lamps. This information gave me a clue, and I acted upon it. Accordingly I submitted an application for two large railway batteries, which was approved, and these, being provided, were sent on to Ladysmith. Later on I received instructions to proceed thither on October 16, taking all my apparatus with me. A set of apparatus under charge of Lieutenant Weld, R.A.M.C., had preceded me, so that two sets of apparatus were now available. The sets were much alike, with this exception, that Lieutenant Weld had lithanode cells. These, I am sorry to say, broke down entirely; whether from faulty charging or from damage received during the journey from Pietermaritzburg I cannot say, as I did not examine them. The cells brought from Cairo were the E.P.S. type, and had been used up Nile. For general efficiency I don't think that better cells than these can be obtained. Those procured from the railway authorities were of very large capacity, but, unfortunately, a large amount of leakage very soon became apparent, the voltage falling considerably, for which no reason could be assigned. Possibly the warm weather prevailing at the time had something to do with it, or perhaps, being the first charge, the voltage was not stable.

Two small dressing-rooms in the Town Hall were handed over for X-ray work, one of which had the water laid on.

The apparatus was unpacked, and, fortunately, was found to have suffered no damage in transit.

The dark-room was our first consideration, a very serviceable one being fitted up in the small room where the water was laid on. The fixed hand-basin made an admirable sink, as the plates could be washed face downwards. The window was darkened by covering it with the table-cover from the council chamber and a blanket; and, to make everything secure, a blanket was hung up on each side of the door. For convenience in developing, I fitted up two small electric lamps to be worked from one of the batteries. One was red, and the other white. These minimized the discomfort when developing in hot weather, as the best oil-lamps give off heat.

Our next consideration was the fitting up of an X-ray room. The one at our disposal, although small, was convenient to the main hall, which was used as a ward, and patients could be brought from thence to be examined with little or no discomfort. Few fittings were required for this room and were easily obtainable. Again we had recourse to the council chamber where we obtained a cover for our dark-room window. In this instance we commandeered the table, as the pattern of the Mackenzie Davidson apparatus in our charge did not include an operating-table. The council table was 7 feet in length, of a convenient height, and, being firmly built, answered all necessary requirements. To provide for the fluorescent screen being used during the day, blankets were nailed to the framework of the window, thus effectively blocking out the light.

The apparatus was fitted up, tubes tried, and all was now in readiness. The battle of Elandslaagte very soon furnished the first series of cases.

Comparatively speaking, the number of cases from this battle which required exam-

ination was not very large. Few patients had to be examined for bullets, the majority of the wounded having bone injuries, the extent of which had to be ascertained. This absence of imbedded bullets may be accounted for by the fact that the firing was at short range, and those bullets which did not pass through the parts caused severe injuries to the bones when these obstructed their course. All the bullets were successfully localized, and subsequently extracted. Fortunately, in this our first work in the war none were lodged in the pelvic region, as the Mauser bullet, being so small, proves very awkward to find in deep tissues.

All the instruments worked well, but, unfortunately, about this time the enemy had cut off the main water-supply from the town, and nothing but a small and dirty service remained for use. This supply was in addition very uncertain, and many plates suffered through want of water for washing purposes. For a supply of clean water for making developers I was obliged to use a Berkefeld filter. The water was so dirty that only half a pint could be passed through the filter at a time, so soon was the candle blocked by the heavy layers of mud. For washing the negatives after fixing, a plentiful application of a cotton-wool swab was the only means at command under the circumstances. Negatives obtained in this way cannot be good for reproduction; however, the surgeons were satisfied, showing that, after all, the main object had been attained.

From the battle on October 30, commonly known as Black Monday, we had a good many cases having bullets to locate. A few of them were lodged in deep tissue, to discover which required that the instruments were in good working order. It is in these that good tubes become invaluable. When I say good tubes, I mean those having a maximum of penetration with a minimum of liability to heat the anodes. Without these attributes a tube is of little use when examining deep tissues with the object

of discovering a small foreign body, such as a Mauser bullet. The search often occupies a lengthened period, and it is certainly of great advantage to do so uninterruptedly when once the eye gets accustomed to the screen. All Mr. Deane's tubes answered these expectations—the tubes which had been used on the Nile, and subsequently in the Citadel Hospital at Cairo. Altogether these tubes did duty in hundreds of cases, and are, I believe, in use in the Transvaal at the present day. For search work a good screen is indispensable. I was fortunate in having such. Its chief characteristics were very clear definition and a total absence of woolliness. The cryptoscope was the exact focal length, enabling one to see the whole screen at once; thus impacted fractures, so difficult to discern by longer cryptoscopes, were more easily detected.

On November 1 rumours were afloat that the town was fast being surrounded by the enemy, and that we might expect to be beleaguered at any moment. This actually took place on the following day, proving the rumour to have been correct.

Unhappily, our supply of electricity was giving out, for a large amount of work had been done. The lithanode batteries were useless, and the railway batteries were low down. On the E.P.S. batteries we had therefore to depend, but they could not be expected to stand up forever.

I ought to mention here that during the period from October 30 to November 3 shells were continually dropping in the neighbourhood of the hospital. Nevertheless, the work in the X-ray room was carried on as usual. Great caution had to be used in photographing the patients when shells were heard in the immediate vicinity, as they were sure to start, thinking the building would be hit. Exposures under these condition had to be of the shortest, necessitating long developments. We eventually arranged for a look-out to announce the firing of the gun, which did much to facilitate our work.

As a certain amount of work had yet to be gone through, it became absolutely necessary to do something in the way of getting our batteries charged. This is how I managed. Close to the Town Hall is situated a flour-mill, which kept going day and night. To this mill I went to interview the manager, with the object of asking his assistance to get driving power for the dynamo which I had brought with me from Cairo. This gentleman was most obliging, and anxious to help me to the best of his ability. As he had no suitable engine to offer me, I asked his permission to have the dynamo driven from the mill shafting. To this request he readily agreed and a particular shaft was chosen. The number of revolutions per minute of this shaft having been ascertained, also the diameter of the pulley on the dynamo, it remained as a matter of calculation to find out what the diameter of the pulley should be in order to obtain a speed of 2,000 revolutions per minute on the dynamo. I am glad to say that this installation worked remarkably well, and charged the batteries most efficiently. Not only was I now able to supply my own wants by this means, but I was able to give effect to the wishes of Major Bruce, the chief operating surgeon, by supplying an electric light to the operating-room for use at night. It was a great disappointment to us all when we were ordered to pack up our instruments and proceed to Intombi Neutral Camp on November 5. It seemed like breaking up our plant. However, we had to accommodate ourselves to circumstances to show that we could be mobile when necessary. The apparatus was duly packed, and placed on a waggon drawn by six old horses. The dynamo was left in the mill in charge of the manager, so that it could be used at any future time for charging batteries. This sudden move to Intombi was rendered imperative by the fact that the immediate vicinity of the hospital was receiving too much attention from the Boer shells. The wisdom of this move

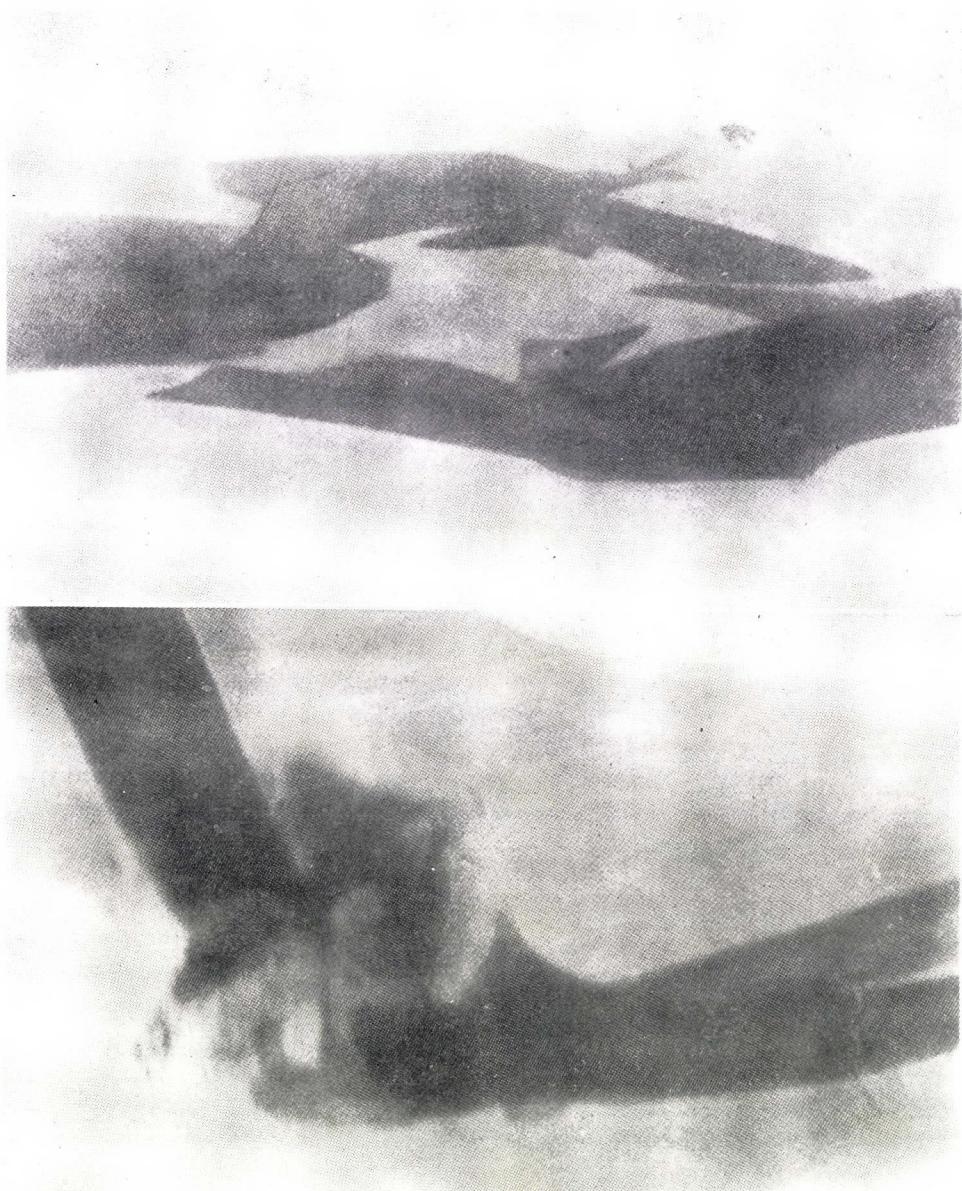


Plate CVIII (a):907. Gunshot wound, right thigh; upper third of femur shattered. Officer in Imperial Light Horse; no amputation; returned to duty. Elandslaagte.

Plate CVIII (b):908. Gunshot wound near head of radius; fracture of head of radius and lower end of humerus. Waggon Hill, January 6, 1900.

was afterwards proved when several shells struck the building.

During the journey to Intombi Spruit the Klip River had to be forded, as it was too far out of the way to go round by the only bridge available. When half-way

through the river the waggon stuck fast in the mud. Another waggon was procured from the town, and half the contents of the stuck waggon transferred to it in mid-river. In this transfer a few of the plates were spoiled, and cases containing apparatus

damaged. However, by using great care, nothing suffered damage from water. A fresh start was made, and Intombi was reached without any further event. All the tents there were appropriated for the sick arriving from Ladysmith, and until others became available for our use the baggage had to remain unprotected on the veldt where it had been unloaded. If the weather had kept fine there would have been no hardship in this, but the rain began to fall. Something, therefore, had to be done to protect the instruments, seeing that we could not get them housed; a railway-wagon was commandeered, which by propping up protected everything from damage, the rain meanwhile coming down in torrents. Two days after a tent suitable for our use arrived from Ladysmith, and the instruments were safely housed. During the time we remained at Intombi no work was done during the day, for three important reasons: First, we could not darken the tent sufficiently for general work; second, the heat

was too great for development; third I had to superintend the working of the Pasteur filters for supplying the sick and wounded with water, an employment occupying the greater part of the daylight. When the batteries required charging, they were taken to Ladysmith by rail and charged during the night, as the people in the mill would not work during the day on account of the shell-fire.

Little of importance occurred, except the two sorties, until December 15, when I was ordered to take a set of apparatus to the town, so as to be handy for cases should the relieving column arrive, it being expected about this time. I asked the principal medical officer's permission to occupy the old rooms in the Town Hall. The permission was fortunately refused, for within a few days both the rooms were gutted by shells. I was ordered to find some place at the back of the hill, immediately in rear of the General's quarters. Two Indian hospitals were located there, the situation being

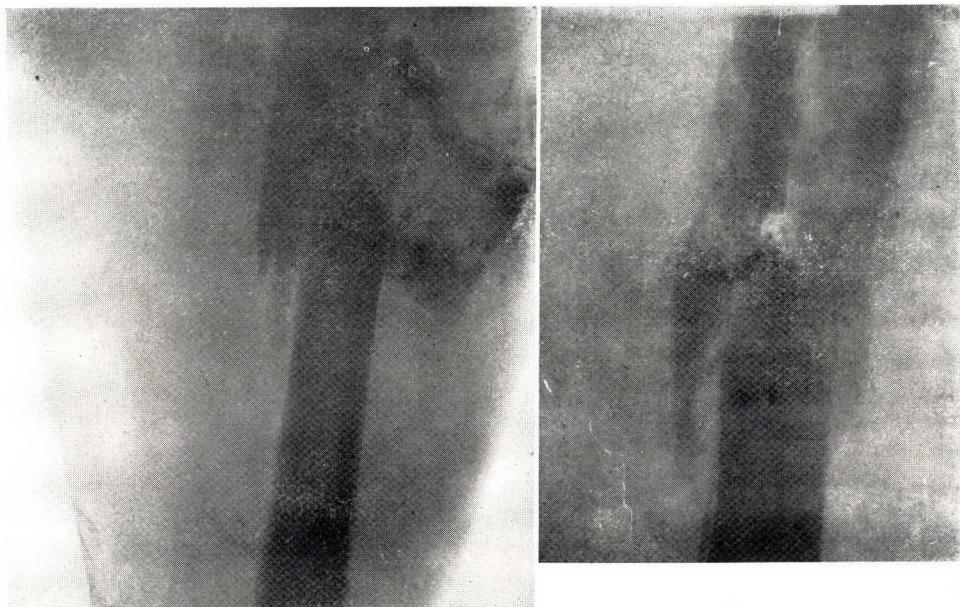


Plate CIX (a):909. Gunshot wound, right thigh; comminuted fracture, junction of upper and middle thirds of femur. Boer, wounded at Elandslaagte.

Plate CIX (b):910. Gunshot wound, anterior aspect, right thigh; comminuted fracture, junction of middle and upper third of femur. Sortie, Surprise Hill.

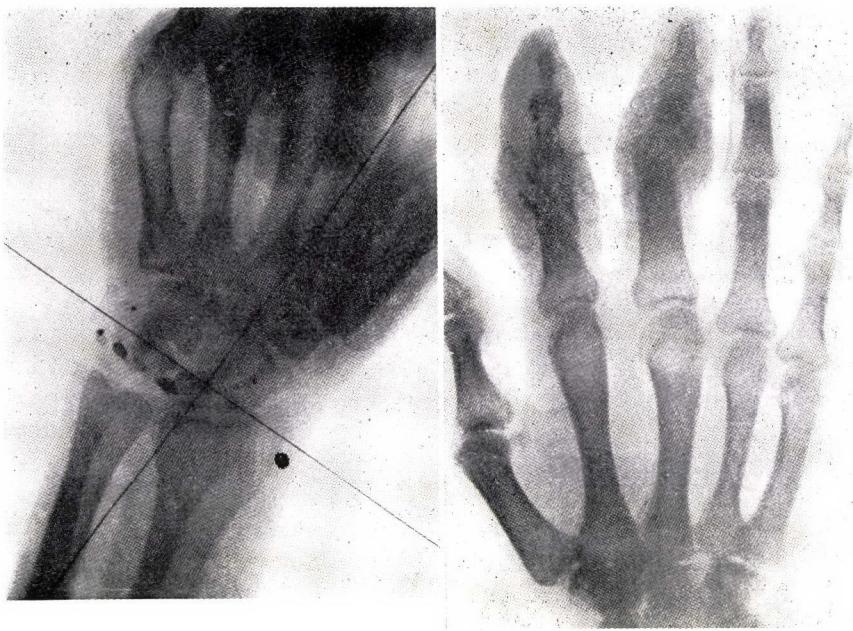


Plate CIX (c):911. Gunshot wound, right wrist; fracture of unciform bone; three small fragments of lead located and extracted. Wound supposed to have been caused by splashes of lead from bullet which had struck a stone. Waggon Hill.

Plate CIX (d):912. Gunshot wound, left hand, first and second fingers; fracture of first phalanges of both fingers. Waggon Hill.

really a nullah. No tent was available, also no house. There were two culverts near the place, under the roadway, which would have answered well; but, as they were really occupied by families taking shelter from the shells, we were not justified in suggesting that they should be handed over to us and the poor people evicted. Hence, by the help of Indian labour, we had to start and build a house. This house was not only to provide protection from the weather, but also to be proof against shells. To answer these requirements, the walls on two sides would need to be at least 12 feet thick. A commencement was made, and a height of 3 feet reached. Suddenly a storm burst overhead, and in less than half an hour the entire bottom of the nullah was under water. The operating-tent, hospital, and other tents were soon completely washed out, everyone taking shelter as best he could. You need not wonder that this site was abandoned and a search made for

another. The Congregational Church was chosen as a hospital, the vestry being utilized as an operating-room, and for X-ray work a room in the house of an inspector of police was requisitioned. We were stationed here for nearly a week, doing little or no work. During this brief time a large number of shells fell in our immediate vicinity, cutting up the street in front of the house, besides doing damage to the houses. The relief column not arriving, I was ordered to return to Intombi, leaving the set of apparatus for use when necessary. Two sets of apparatus were now available at two different places, the one at Intombi having the most important work to do, as the wounded still were being sent there. Only on one occasion were the services of the set left in Ladysmith required, an Indian native follower being so badly wounded that he could not be removed to Intombi.

The battle on January 6 following fur-

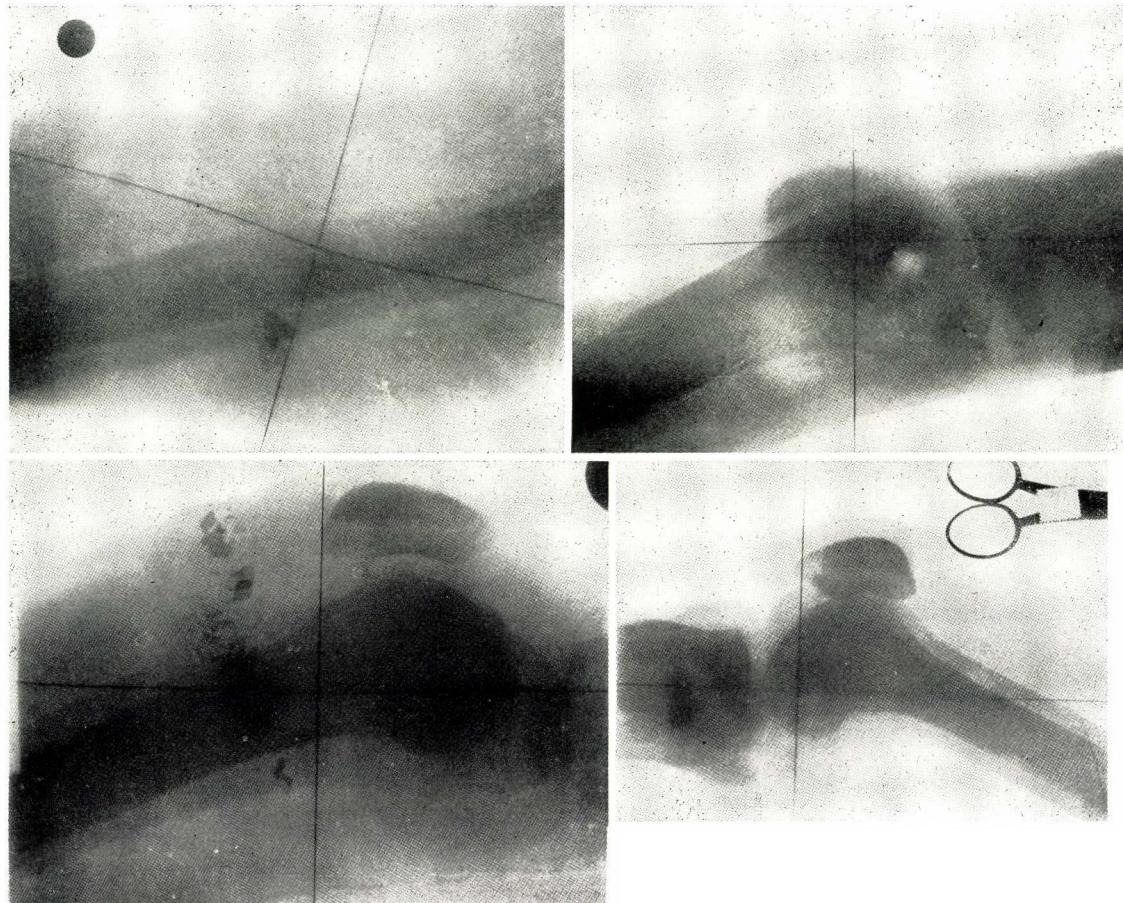


Plate CX (a):913. Gunshot wound. (No description given..)

Plate CX (b):914. Gunshot wound, left leg, near top of tibia; bullet extracted. Waggon Hill.

Plate CX (c):915. Gunshot wound above right patella; one large piece of lead and several splashes located and extracted (probably expanding bullet). Waggon Hill.

Plate CX (d):916. Gunshot wound. (No details.)

nished the next batch of cases. Some interesting cases were photographed, showing the behaviour of the expanding bullet now used by the Boers. They showed the lead scattered about the injuries in all directions, the mantle remaining nearly intact.

From this time to the end of the siege only desultory cases were brought, hence our work was light. All cases of injury to bones were, however, periodically examined with the screen to note progress. The E.P.S. batteries remained to the last in excellent

working order. As a rule, they were recharged once weekly, the voltage being kept up to 2 per cell. When the mills ceased working, I had, with the assistance of a Kaffir, to start the engine and keep it running all night when required for the purpose of charging.

Nothing further remains for me to relate but to state the number of cases X rayed and the lessons to be learned for future guidance.

The number actually recorded is 200, of

which nearly one-half were radiographed. In addition, a vast number of cases under treatment were examined by the surgeons through the medium of the screen. As regards the general results by the apparatus, all were unanimous in saying that it was of the greatest assistance, not only in locating bullets, etc., but also as an aid in the treatment of fractures generally.

As regards improvements necessary to make it more complete, only a few came under my notice. A properly-constructed operating-table is a necessity. It should be constructed so that the tube can be worked below or above the patient. By having the tube underneath, the thorax and pelvis can be more easily examined without discomfort to the patient. Such tables are, I believe, on the market, and will, if generally adopted, prove invaluable.

The generation of electricity is the chief point I should like to touch upon. I maintain that for field use a set of X-ray apparatus cannot be considered complete unless it includes its own means for working the coil direct, or, if desired, for charging batteries. Suppose that the present war was being carried on in Abyssinia, or, in fact, in Central Africa, much of the services of this important adjunct to surgery would be minimized, simply because we have to depend on outside aid for our motive power. And, again, satisfactory work cannot be accomplished unless full power is available, and we can only hope for this consummation when we become complete in ourselves, that is to say, when we may have a motor to drive the dynamo. From an electrician of note, I learn that my idea of a motor driving a dynamo in direct circuit with the coil is feasible. One of the motors for driving tricycles now so common, in addition to a small dynamo, would obviate the necessity of batteries, for these are troublesome articles to keep in working order during active operations. In general hospitals, which are stationary, and, as a rule, situated far forward on the lines of communications,

the charging of batteries is only effected at great risk during transport to and from the base. I am at present engaged in an attempt to arrange an apparatus which I hope will answer the requirements as regards weight, bulk, and general effectiveness, and I shall have much pleasure in communicating the results of my endeavours, provided I am successful.

I have now nothing more to add. I trust you will be so generous as to condone all my



Plate CXI (a):917. Gunshot wound, right side of neck; bullet located under left lower jaw, and extracted; jaw fractured. Armoured train disaster, Chieveley.

literary defects, and if my humble efforts to interest you have succeeded, I shall be amply compensated for the trouble I have taken in preparing this paper.

Lieutenant Bruce's paper was illustrated by a number of lantern slides made from

radiographs taken in Ladysmith. A selection of these is reproduced in the plates.

DISCUSSION

The CHAIRMAN: Lieutenant Bruce's paper is very interesting, and especially so in the circumstances in which it is written and under which the radiographs were taken. The author is not here to answer any questions, but if there are any to make we might send them on to him, and perhaps Dr. Low may be able to furnish some information. If anyone present wishes to ask any questions or has any observations to make, therefore, it will be interesting. I am sure all practical radiographers will be glad that they do not have to carry on their work under such conditions as Lieutenant Bruce had to. It is difficult sometimes to take radiographs under any conditions, but particularly so if the building is threatened by shot and shell, and I thought it quite a touch of nature when Lieutenant Bruce said that in one case a patient got very excited.

Mr. E. PAYNE: The question as to the source of current is one that Lieutenant Bruce brings out very strongly. It is the chief difficulty one would have to contend with in field hospitals and places where there is no means of getting at any public supply. I am surprised to hear that they find so much difficulty in using the "bicycle-dynamo." I should have thought that in a town where men are besieged, and can sometimes find nothing to do, quite a number would be willing to take a turn at the charging for a few minutes, and thus they soon do half an hour's charging. It is astonishing what a long way a charge does go if you do not waste any over experiments. We have not yet been told whether any experiments have been made during the war with influence machines. Ebonite plates, I believe have been tried. On the whole, one might think that influence machines under these conditions would perhaps be more

satisfactory than batteries and coils. Even glass plates, if carefully packed, could be carried on the backs of animals without breakage.

MR. GARDINER: It is difficult to discuss this most interesting paper in the absence of the author, but I cannot help feeling surprised that there has been so much trouble in driving the dynamo. From what we heard from the other military gentleman who read a paper on this subject on a previous occasion, he seemed to have no difficulty with his bicycle arrangement.* I should rather suspect that Lieutenant Bruce's dynamo was a larger one, and that perhaps would account for it. I should like to endorse what Mr. Payne has said about the possible use of influence machines under such circumstances. I am exceedingly sorry that Mr. Wimshurst was not here, because I am sure he would have taken the subject up warmly. There seems no reason why vulcanite plates should not be used with influence machines. There is certainly no question that good results can be got from a Wimshurst machine working under ordinary conditions, and it would seem that this would remove a great deal of the difficulty that Lieutenant Bruce has had to deal with in charging his batteries. As regards the photographs, I am surprised that the negatives shown to-night are as good as they are. Considering the difficulties in taking them, and the absence of water, and the fact that it is now some months since they were taken, we must congratulate ourselves on having seen such a fine set of negatives. I only wish that Lieutenant Bruce were here that we might express to him our gratification.

MR. BOWRON: With reference to charging accumulators by means of a small

* See Archives, Vol. III, No. 3. p.89.

dynamo driven by hand or foot, I have always found that the difficulty is to keep the speed constant, and the best way to get over this is to use a pendulum or metronome, which can be watched by the person or persons working the machine. So long as they keep time with the pendulum the charging goes on all right, but if you take the pendulum away in a little while they begin to drop, and instead of charging you are discharging. Another thing I find is, that a large proportion of the electricity generated goes to excite the field-magnets; but if you use a magneto-machine you do away with almost half the driving power at once. Not only that, you might use a magneto to supply the coil direct, and so do away with the accumulators altogether. I know it is practicable, because I have tried it on a small scale.

The CHAIRMAN: Is it sufficiently practicable on a large scale?

MR. BOWRON: I cannot say; I have not tried it.

MR. DEANE: In reply to Mr. Bowron's remarks, I may say that I fitted up a magneto-machine for the Cairo Hospital to supply the induction coil direct. We had many trials with it, and it worked perfectly. The officer in charge took it away, but the dynamo Lieutenant Bruce had was the same one that Major Battersby used with

his dynamo bicycle. Some modifications have since been employed. The operating coil is worked direct from a shunt machine and an electro-magnetic interrupter, taking very little current. We obtained any radiographs we wanted, and I have several letters saying that it is working satisfactorily in Bloemfontein at the present time.

MR. SHENTON: I think Lieutenant Bruce's suggestion about using petroleum motors is practical. I believe also that a petroleum motor can be driven by gas, and this can be obtained in almost any town. Again, a can of paraffin would go a long way in making electricity. It has been mentioned that a coil can be driven direct from a dynamo. I more often work in this way than with accumulators. You will find it very satisfactory indeed. Considering how small the petroleum motors are, the suggestion of Lieutenant Bruce is a very good one.

The CHAIRMAN: I have no doubt it will be your pleasure and wish to signify our heartiest thanks to Lieutenant Bruce for the interesting paper he has sent to us. Our Honorary Secretary will no doubt convey to him the expression of opinion that we think, under the circumstances in which he worked, the results he has shown us have been highly praiseworthy, and, in addition, thank him very much for his paper.