FIG. 3. These sectional roentgenograms of the chest were taken in the anteroposterior position, 9 cm from the table surface and centered at a 36-in. target to film distance. The tuberculous cavitations shown in the left upper lung offer an opportunity for clinical comparison of the planigraphic movements described. These pictures were obtained by the corresponding x-ray tube motions illustrated in Fig. 1.

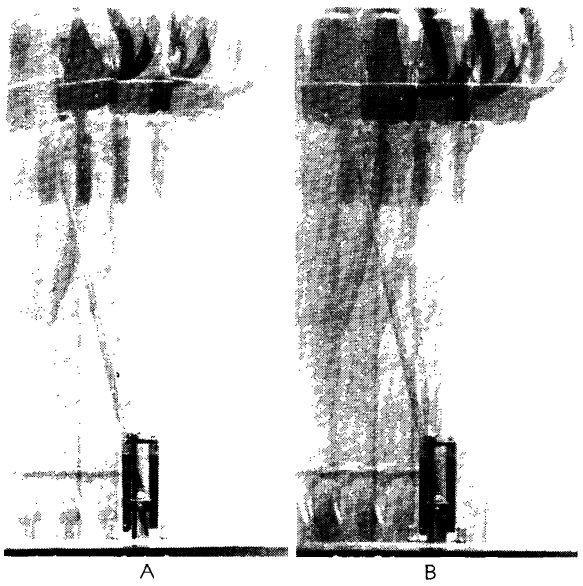

FIG. 4. Serial photographs show the slight degree of angulation in x-ray tube portal which occurs during 15 in. of planigraphic movement. *A*, customary type of rectilinear tube movement used in sectional radiography (corresponds to Fig. 1 *A*); *B*, simplified nonangulating x-ray tube motion illustrated for comparison (corresponds to Fig. 1 *B*).

tests with a 14-in. length of "hardware cloth" (½-in. wire mesh). In fact, the arcing tube motion conforms to the contour of many organs such as thorax, lungs, heart, and skull. Since sectional roentgenograms obtained by the simplified tomographic motion (Fig. 1 *C*) have been proved satisfactory, this type of x-ray tube movement can be recommended as a means of extending planigraphy to the Trendelenburg and semiupright positions and as a means of adding stability to some types of x-ray equipment when used for planigraphy in the upright position.

It may be concluded from the above studies that planigraphic movement can be simplified by utilizing short amplitudes of x-ray tube motion and by eliminating x-ray tube angulation, and that this can be accomplished without sacrificing diagnostic quality or the ability to obtain sharp, thin radiographic sections. As a result, many x-ray machines previously considered unsuitable can now be adapted to sectional radiography.

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Observations on the Cobalt Enhancement of Penicillin Activity Against *Salmonella pullorum*[1, 2]

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In vitro experiments were conducted to evaluate the effectiveness of several antibiotics against *Salmonella pullorum*[4] (the causative agent of pullorum disease in chicks). During the course of routine sensitivity determinations, penicillin at moderately low concentrations was found to exert a slow bactericidal action against this organism. Preliminary *in vivo* studies revealed, however, that penicillin preparations[5] had to be in-

[1] Journal Article No. 1405 of the Michigan Agricultural Experiment Station.

[2] In part, excerpts from thesis of the senior author presented June 1952 to the School of Graduate Studies of Michigan State College, in partial fulfillment of the requirements for the Ph.D. degree.

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[4] Strain #89817 (Poultry Pathology Laboratory, Michigan State College) was used in all experiments.

[5] Penicillin G (buffered potassium salt). Supplied through the courtesy of the Upjohn Company, Kalamazoo, Mich.

corporated in feed at relatively high levels in order to be therapeutically effective.

Practical application of these findings appeared to depend on some method that would allow for reduction in penicillin levels without loss of therapeutic efficiency. Previous work by Pratt, Dufrenoy, and Strait (*1–3*) had demonstrated that appropriate concentrations of cobalt definitely enhanced the antibacterial action of penicillin against selected gram-negative and gram-positive organisms.

interest to note that inhibition of respiration by cobalt has been reported by Burk *et al.* (*5*) in *Streptococci, Micrococci,* colon bacteria, yeasts, and in spontaneous mammary adenocarcinomas of mice.

Preliminary *in vivo* experiments have revealed a similar enhancing phenomenon with cobalt and penicillin. Cobalt was administered in the drinking water to day-old chicks (White Leghorn) for 24 hr prior to artificial infection. Ordinary drinking water and a feed containing penicillin were used following infection. An

TABLE 1

THE COBALT ENHANCEMENT (*in vitro*) OF PENICILLIN ACTIVITY AGAINST *S. Pullorum*

Penicillin (100 u/ml)						Cobalt control—no penicillin (0.2 mg/ml)
Series 1		Series 2		Series 3		
2 ml cobalt solution (0.2 mg/ml)	No cobalt	3 ml cobalt solution (0.2 mg/ml)	No cobalt	3 ml cobalt solution (0.2 mg/ml)	No cobalt	
Zones of inhibition (mm)*						
29.2	22.0	29.1	22.4	29.1	22.8	0

* Each zone reading represents the average value of 8 plate determinations.

The cobalt concentrations employed by the above investigators did not produce any detectable enhancement of penicillin activity against *S. pullorum.* However, with certain modifications of experimental procedure, a pronounced enhancing effect was ultimately demonstrated. Results from these tests are presented in Table 1; they were obtained by utilizing the paper disk technique of Vincent and Vincent (*4*).

No observable inhibitory effects on the test organism were evident at the end of a 24-hr incubation period with the particular concentration of cobalt used. Respiration studies, however, conducted with a Barcroft-Warburg apparatus indicated that cobalt, in a concentration of 0.2 mg/ml, did produce a marked inhibition of oxygen uptake by *S. pullorum.*

It may be postulated that a similar early action of cobalt (applied without penicillin) might have taken place when the organism was grown on plates or in broth, but that its effect was overcome during the later part of a 24-hr incubation period. At the end of this period the organism presented abundant growth. If, however, cobalt was employed together with penicillin, the initial inhibitory effect appeared to be of sufficient magnitude to induce a synergistic phenomenon, as shown in Table 1. Trace amounts of cobalt (0.001 mg/ml) were neither stimulatory nor inhibitory when used alone or in conjunction with penicillin. It is of approximately threefold enhancement of the protective action of penicillin was recorded in those groups receiving cobalt. Chicks serving as cobalt toxicity controls exhibited no ill effects from prolonged drinking of cobalt water.

Pratt *et al.* (*2*) have claimed that incubation of the test organism in the presence of cobalt prior to its exposure to penicillin increased the antibacterial action of the latter. This was confirmed *in vitro* and *in vivo* by the present study.

A detailed account of this work will be published elsewhere. Tests are now in progress to determine whether the concentration of cobalt employed in this study possesses therapeutic value when administered without penicillin. Previous work has indicated that enhanced concentrations of cobalt were in no way protective (*2*). The role of cobalt in a practical program of penicillin therapy is receiving further attention.

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