fraction of the bias voltage during the first revolution it makes, so that the radius of its instantaneous orbit is reduced correspondingly. On subsequent revolutions, it receives an impulse radially outwards each time it passes the injector. The oscillations set up by this impulse are, however, thought to be relatively small, because of the large gradient of the field near the injector. If the contraction is large enough, electrons will not enter the high potential region in the vicinity of the gun.

The results obtained in tests carried out at injector voltages of 8 and 11 kev respectively, are illustrated in Fig. 1. To obtain points on these curves, the filament current and injector phasing were in each case adjusted for maximum output. It was noticed that the optimum emission was reduced considerably as the bias voltage was increased, as is illustrated in Fig. 2. This seems to indicate that, as the bias is increased,

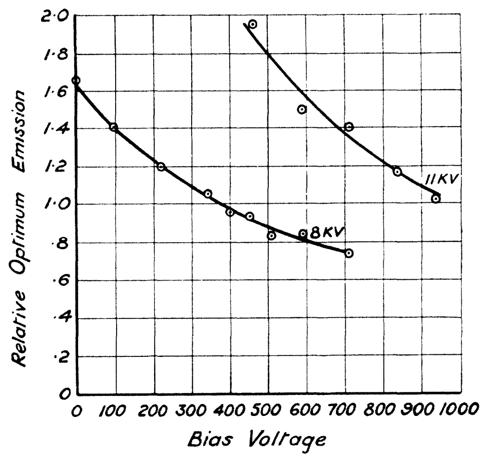

FIG. 2.

less of the contraction due to the Kerst mechanism is needed in order to miss the injector. With 11 kev applied to the injector, it was impossible to obtain a measurable output at zero bias, without increasing the filament current to a dangerously high value.

It is difficult to estimate the fraction of the bias voltage which is effective in producing orbit contraction. An upper limit to the contraction may be found by assuming that the whole of the bias voltage is effective. In this case, the maxima of the curves in Fig. 1 correspond to 2.1 cm and 2.7 cm contraction for 8 and 11 kev respectively. ($r\simeq 20$ cm.)

It was thought that the increase in output might be due to improved focusing of the beam produced by the field in the vacuum chamber, but this seems to be ruled out by the following considerations: The silver coating in the betatron under discussion is split into two isolated sections with the injector placed in the middle of the first section. The currents collected at the two segments were observed separately. The ratio between these currents did not vary by more than 20 percent when the bias was varied. Thus, since the bias does not appreciably improve the fraction of the total emission which manages to reach the further section of the vacuum chamber, it seems probable that the angular spread of the beam emerging from the injector is not appreciably improved by the bias.

With the optimum bias required for 11 kev injector voltage, the x-ray output of the betatron was 9 roentgens/min. at 1 meter, measured in a Victoreen thimble chamber shielded by a $\frac{1}{4}''$ lead sheath with $\frac{2}{3}$ full excitation on the magnet.

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Evidence for a Change in the Nature of Work-Hardening at Small Strains*

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A THEORY of work-hardening using a type of crystalline imperfection known as a dislocation has been given by G. I. Taylor.[1] Taylor supposed that dislocations originate at the surface of the mosaic blocks and that they move through the material until they are stopped at some high internal stress such as a mosaic block boundary or near another dislocation. As the deformation of an initially unstrained crystal proceeds the density of dislocations increases since in Taylor's theory each dislocation on the average contributes a small but finite plastic strain. Simultaneously the stress required for further deformation increases because of the increasing stress field resulting from the large numbers of dislocations present. Taylor supposes that the dislocation density is uniform throughout the material and that most of the dislocations are trapped in the specimen.

There is now considerable evidence that deformation on slip bands is of importance particularly in the initial deformation of a well annealed single crystal. Since slip bands are easily resolved in an ordinary microscope the units responsible for this deformation are therefore more widely spaced than the dislocations used by Taylor. Heidenreich and Shockley[2] obtained electron microscope and electron diffraction pictures of pure aluminum single crystals. After 5 percent extension they observed slip bands separated by about 4μ. At small strains they indicate that the slip bands consist of a single step whereas at larger strains the bands consist of fine parallle laminae about 200A thick. The maximum relative shearing displacement of two neighboring laminae was about 2000A. Heidenreich and Shockley found that the material in the slip bands was sufficiently distorted so that it gave no Kikuchi lines whereas the material between the slip bands gave Kikuchi lines. After 6 percent extension the slip bands were from 1 to 2μ apart and no Kikuchi lines were observed. Blewitt[3] has measured the increase in the electrical resistance of ordered single crystals of $AuCu_3$ during tensile tests in which only single slip occurred. In agreement with Sachs and Weerts[4] he finds that the resolved stress-strain curve consists essentially of two intersecting straight lines; the resolved shearing stress increases slightly in going from a resolved shearing strain of 0 percent to 10 percent whereas when the strain is larger than 10 percent the stress increases rapidly with increasing strain. Blewitt's preliminary data indicates a similar change in the resistance increase produced by coldwork. The increase in the electrical resistance was small for resolved shearing strains less than 10 percent. For larger strains an increase in the residual resistance was found. For a resolved shearing strain of 22 percent the increase amounted to about 2 percent of the initial residual resistance. Miller and Milligan[5] have obtained stress-strain curves for pure aluminum and silver single crystals at small strains. Their data shows changes in the sign of the curvature at extensions of less than 1 percent. Sachs and Weerts[6] have also observed a similar change using single crystals of copper, silver, and gold. Dehlinger and Kochendörfer[7] measured x-ray line widths on polycrystalline rolled copper specimens; after correcting for changes in particle size they found that the average internal stress is negligible until a 5 percent reduction is achieved; the internal stress increases rapidly for larger strains. In other words, there is considerable evidence that the mechanism of flow and hardening alters when the strain exceeds a few percent.

In summary one finds that for small strains the deformation seems to occur by a shearing displacement at the slip bands. The rate of work-hardening seems to be low for this case and according to Heidenreich and Shockley the distortion seems to be confined to the immediate vicinity of the slip bands. Somewhere in the range of strain from 1 percent to 20 percent the behavior changes, the strains become more homogeneously distributed, the rate of work-hardening increases, and the average of the internal strains over the volume increases rapidly. It may be that at large strains the deformation is sufficiently homogeneous that Taylor's theory can be applied. It seems that the limiting amount of deformation at the slip bands before severe work-hardening begins can be increased by increasing the temperature, by decreasing drastically the rate of strain, and by the use of solid solutions.[8]

There are a number of leading questions which we would like to ask: Does the stress-strain curve remain relatively flat as long as the slip bands consist of a single step; does the stress begin to rise when the slip bands change from a single step to one or more laminae? Does slip continue to occur at a slip band throughout the entire course of deformation? Do new slip bands appear throughout the course of deformation? At large strains is all of the strain accounted for by the relative shearing displacement of neighboring laminae or should one suppose that a portion of the strain is associated with a Taylor dislocation lattice? For deformations at low temperatures does the maximum shearing displacement at a step depend on the size of the specimen?

We would like to thank Professor F. Seitz for several helpful discussions.

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** AEC Fellow in the Physical Sciences.

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The Positron Decay of F^{18}

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The positron spectrum of F^{18} has been investigated by different authors with rather contradictory results. Snell[1] and Yasaki and Watanabe[2] found a simple spectrum with upper limit between 500 and 700 kev using absorption and cloud-chamber methods. Knox[3] could not find any evidence for nuclear γ-rays. A detailed investigation by means of a cloud chamber has been carried out recently by Zah-Wei Ho,[4] who described a twofold complex β^+-spectrum with upper limits at 950 ± 50 kev (20 percent) and 600 ± 100 kev (80 percent). In addition this author found a 1.4 Mev γ-ray together with some low energy γ-radiation.

A study of this problem with a magnetic β-spectrometer seems desirable. Thin sources of high specific activity are required herefor. A well suited F^{18}-source has been obtained by irradiation of a thin mica foil (muscovite: $KAl_3Si_3H_2O_{12}$) with protons from the cyclotron. A few minutes after bombardment all short periods arising from Al, Si and O have practically disappeared and only two periods of respectively 112 ± 1 minutes and 8 days remain. The negligibly weak 8 days activity can be assigned to Ca^{41} produced in the reaction $K(p, n)Ca$. The 112 minutes period showing β^+-activity arises from F^{18} formed by (p, n)-reaction of O^{18}. In spite of the low isotopic abundance of O^{18} the resulting activity is sufficient for spectrometer measurements. The source used for the magnetic lens spectrometer was a 1.6 mg/cm² mica foil activated directly with a 5.5 Mev proton beam of 1 μA and 6 mm in diameter.

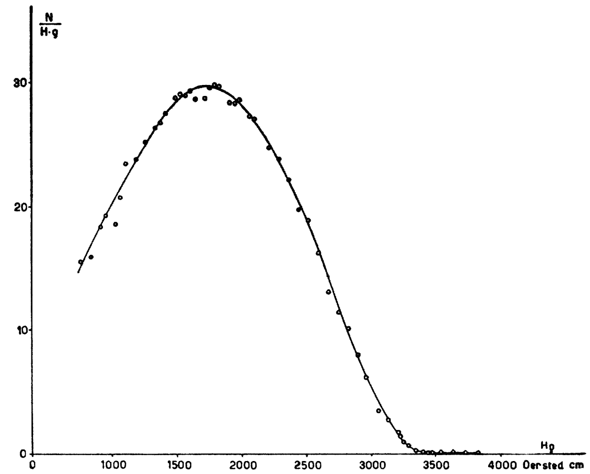

FIG. 1. Positron momentum distribution of F^{18}.

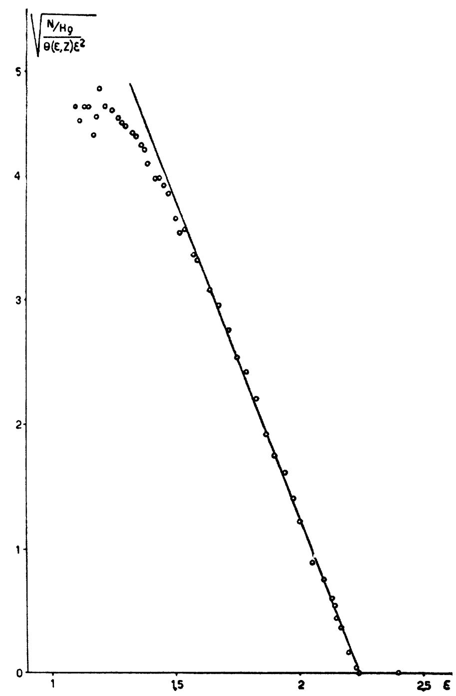

FIG. 2. Kurie plot of the positron spectrum of F^{18}.

Figure 1 shows the momentum distribution of the positrons. The Kurie plot (Fig. 2) indicates an upper limit of 635 ± 15 kev and brings to evidence that the β-spectrum is simple. With $W_0=2.24$ mc² the *ft*-value is found to be $ft=4100$ characterizing an allowed transition. The mass difference of F^{18} minus O^{18} becomes 0.001781 ± 0.000016 atomic mass units.

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