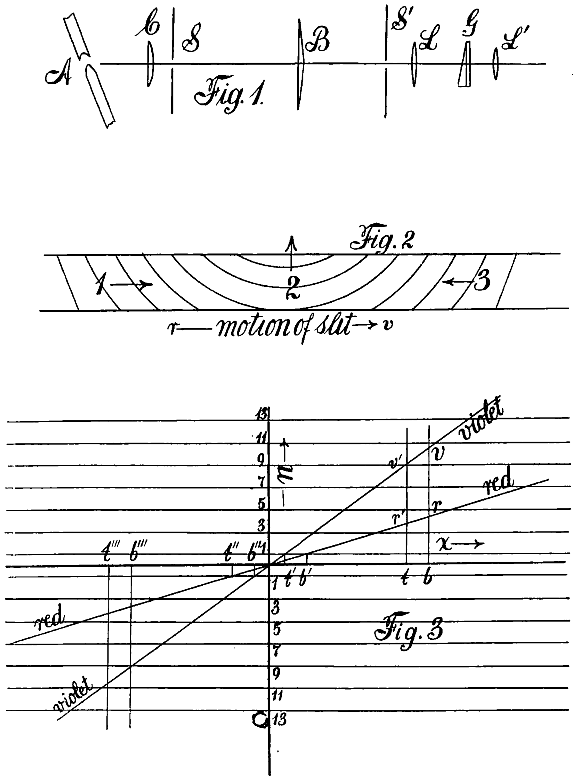
ART. XXVII.—*The Resolution of Interference Fringes;* by C. BARUS.

1. *Experiment.*—The following remarks apply to interference fringes produced preferably by the bi-prism, though Young's slits and the other methods of course show the same results. The experiment is straightforward, as is given in fig. 1, but the effect obtained is at first quite unexpected.

FIGS. 1, 2, 3.



In fig. 1 the arc light A passing the condenser C and the slit S, falls on the bi-prism B and then upon the direct vision spectroscope S' G (preferably of the grating form like that of Mr. Ives), where S' is the slit, G the grating with attached prism, L and L' the collimator and eyepiece, respectively. Both slits S and S' must be as fine as possible, the spectrum seen being just short of darkness to obtain the sharpest effects, though the results are perfectly distinct, if more washed, for wider slits.

What one would expect to see as the spectroscope $S'G$ is moved across the field from left to right is the usual form of channeled spectrum, with the fringes moving horizontally from end to end of it. What actually appears, however, is a succession of intercepts between an upper and a lower horizontal, of broad concentrically circular or oval absorption bands, all of a very large radius, the displacement being on the plan shown in fig. 2, or the reverse. In other words, the spectroscope reveals the similarly intercepted arcs of large absorption bands. The arcs if essentially horizontal move up and down, if essentially vertical right and left. They are never quite vertical, and they become thinner and more crowded toward the ends of the spectrum. The groups 1, 2, 3, appear in succession.

The phenomenon is exceptionally sensitive to changes in the approximate verticality of the slit, so that if the spectroscope is slightly rotated on its axis, all the groups may reappear in turn.

2. *Explanation.*—To interpret this phenomenon it is convenient to plot the order n of a given fringe in terms of its distance x from the center of fringes, where $n = (c / r(\lambda / 2))x$, r being the virtual distance of the fringes on the screen, here the slit of the spectroscope, from the virtual position of the two slit images for the wave length λ. There will be dark bands for a given color λ, as fig. 3 shows, whenever $n = 1, 3, 5$, etc. The two lines drawn show the limits of the spectrum for any distance of fringe x and the heavy horizontal lines the number of dark bands to be expected. Thus for the value of x corresponding to vr, there will be three black bands in the spectrum, their color distribution depending upon their position between v and r. As the slit moves from right to left from the positive to the negative values of x, bands will enter the red end and leave the violet end, for a positive value of x and do just the reverse for a negative value of x.

The question now arises as to what will happen if the fine slit is not quite parallel to the fine interference fringes, crowded together as they are in a vertical band about half an inch in breadth. The oblique but fine slit in such a case corresponds to a succession of values of x depending upon the obliquity and length of the slit, and the diagram, fig. 3, therefore, shows the case for only one point in the length of the slit. It is thus necessary to introduce the third dimension corresponding to the breadth of spectrum, at right angles to the plane of fig. 3, which plane may be supposed to correspond to the bottom point of the slit. If the horizontal projection of the oblique line of the effective slit is *tb*, the spectrum corresponding to the top point of the slit will be $v'r'$, so that all the bands have been displaced toward the violet. Since the internal points of the slit correspond to the intermediate spectra between *vr* and $v'r'$, the spectrum will thus contain curved black bands with the tops toward the violet and their bottom toward the red. Precisely the opposite will be the case at $t''' b'''$ for a negative value of x, *i. e.*, on the other side of the center of interference fringes. If the slit moves, the general motion of bands will remain as already explained, only there must now be successive changes of form.

Thus if the slit takes the position $t'b'$ (some distance apart from top to bottom of spectrum) there can be but one black band in the spectrum, running from the red at the bottom to the violet at the top and being, therefore, nearly horizontal. At $t''b''$ a single band must run from the violet at the bottom to the red at the top, *i. e.*, with reversed slope, so that clearly with the projected slit symmetrical to $x = 0$ the bands if appearing (as they do in multiple in a proper position of the bi-prism B, fig. 1, close to the spectroscope $S'G$), must be quite horizontal in the middle and curved upwards, or the reverse, at both ends.

Following fig. 3 for a given obliquity and length of slit, all conditions may be easily computed. It is clear, moreover, that the bands can never be closed curves, but are limited to arcs cut off by the band of spectrum from a series of concentric closed curves. In this respect they differ from the elliptic interferences, which they in many respects recall; but the elliptics are essentially closed curves moving as a whole in the same direction.

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