A Microwave "Optical Bench"

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(Received 15 October 1968)

A sequence of experiments in the sophomore physics laboratory at the University of California at Santa Barbara deals with microwave analogies of conventional experiments in optics. Two of the experiments in this sequence are similar to Berkeley Physics Laboratory experiments B-10: "Microwave Propagation" and B-11: "Microwave Polarization,"[1–3] and have been performed with commercial apparatus produced by Hickok teaching systems.[4] This equipment includes microwave transmitting and receiving horns, slotted plates for Fabry–Perot interferometry, and aluminum baffles for the study of microwave propagation in the presence of metallic boundaries. The experimental geometry is indicated in Fig. 11 (p. B-10-94) of Ref. 1. The microwave horns and Fabry–Perot plates are mounted on a meter stick, while the baffles are placed on either side of the stick. Measurements of baffle separation (a) and separation of Fabry–Perot plates (d) yield such relevant parameters as the wavelength of radiation in the baffle region, the free space wavelength, and the group velocity of the waves.

Experience has indicated that further refinement of the apparatus is necessary for the proper performance of the experiment. As received, three major difficulties are encountered with the Hickok apparatus. First, there are stringent requirements on the alignment of the components. The Fabry–Perot plates must remain perpendicular to the direction of microwave propagation and parallel to each other at all times, especially when their separation is being varied. Similarly the baffles must remain parallel to the direction of propagation and to each other while being moved. This is crucial since the experiments involve the observation of the transmitted microwave power as the parameters a and d are varied and a slight misalignment of either plates or baffles profoundly affects the amplitude of transmitted microwaves. Experimentally, it is found that this alignment must be maintained to within one or two degrees of arc for good results to be obtained. Second, it is necessary to preserve a certain symmetry in the experiment. When the baffle spacing (a) is varied, it is essential that both baffles remain symmetrically positioned with respect to the center line of the Fabry–Perot plates for the correct transmission pattern to be observed. Third, it is necessary to be able to measure a and d at least to the nearest millimeter without disturbing the experimental arrangement.

The "optical bench" and components illustrated in Fig. 1 are capable of eliminating these difficulties. The bench itself [Fig. 1(a)] consists of a plywood base with a smooth masonite top surface. A meter stick is secured to the base and two split pieces of meter stick are mounted at right angles to the main stick to form a "cross" in the center of the bench. They are secured in such a way that the graduations on the stick allow direct measurements of the distance of the baffles and plates from the center of the "cross" [indicated as point "A" in Fig. 1(a)]. This arrangement facilitates measurements of a and d and greatly simplifies symmetrical placement of the baffles. The baffles and plates are mounted on special bases shown in Fig. 1(b) and 1(c). The bases are made with sufficient precision to insure that the plates and baffles are perpendicular to the top of the bench and the length of the supports is sufficiently long to achieve an alignment of less than $\frac{1}{2}°$ when a nearly snug fit is maintained between the tracks of the optical bench and the slots of the support.

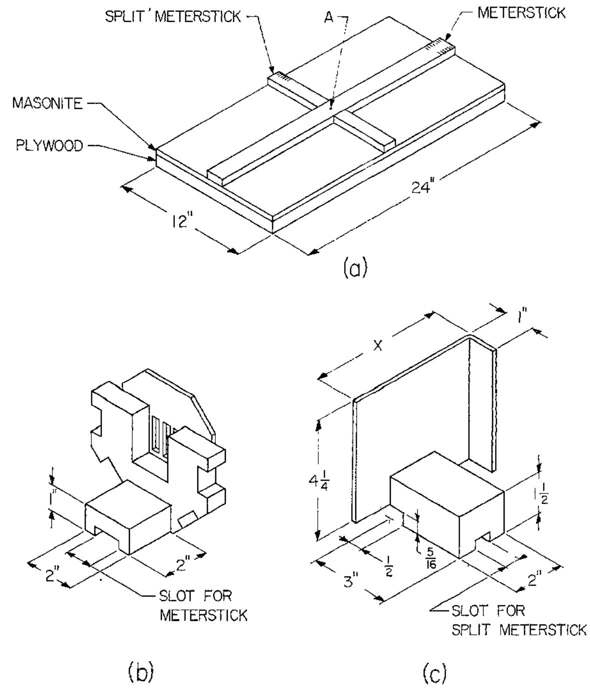

Fig. 1. The microwave optical bench. The base is shown in (a) where the metersticks are arranged so that the distance from point A can be measured directly. Figures (b) and (c) illustrate the supports attached to the Hickok Fabry–Perot plates and baffles to adapt them to the bench. The length of the support is chosen to maintain alignment to within $\frac{1}{2}°$ when a snug fit is maintained between the tracks of the optical bench and the slots of the support.

This modification has been used in the past year with approximately 200 students and the results have been found to be extremely reproducible—in distinct contrast to previous experience with this apparatus. The bench is inexpensively and simply constructed and easily stored. It has proved to be a great asset to the laboratory curriculum.

[1] A. M. Portis, *Laboratory Physics, Part B, Berkeley Physics Laboratory* (McGraw–Hill Book Co., New York, 1965), pp. 87–102.

[2] A. M. Portis, Amer. J. Phys. **34**, 1087 (1966).

[3] A. M. Portis, Amer. J. Phys. **32**, 458 (1964).

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