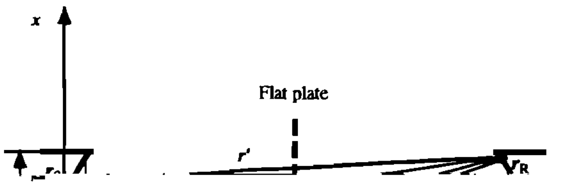
Acoustic coupling from a focused transducer to a flat plate

Xucai Chen and Karl Q. Schwarz
Rochester Center for Biomedical Ultrasound and Department of Medicine, University of Rochester, Rochester, New York 14627

Kevin J. Parker
Rochester Center for Biomedical Ultrasound and Department of Electrical Engineering, University of Rochester, Rochester, New York 14627

(Received 12 May 1993; accepted for publication 5 March 1994)

An approximate solution for the acoustic coupling factor (the diffraction correction function)



$$r' = \{z^2 - 2r_0^2[(z/r_0 - 2)(2 - \cos\theta_2 - \cos\theta_0) + 1 - \cos\theta_2\cos\theta_0 + \sin\theta_2\sin\theta_0\cos\varphi_0]\}^{1/2}. \quad (11)$$

Letting $U_0 = \sin\theta_0/\sin\alpha$, and $U_2 = \sin\theta_2/\sin\alpha$, Eq. (11) becomes are the zeroth and first-order Lommel functions of the second kind. Substituting Eqs. (18) and (19) into Eq. (17), we have

$$D_F(z;f) = -\frac{Z}{Y}\left(\frac{\exp[\,j(Y/2 - Z^2/2Y)\,]-1}{j(Y/2-Z^2/2Y)} - \exp(jY)I_2(Y,Z)\right), \tag{20}$$

where

$$I_2(Y,Z) = 2\int_{U_2=0}^{1} \exp\left(-j\frac{Y}{2}(1-U_2^2)\right)[\nu_0(Y,ZU_2) - j\nu_1(Y,ZU_2)]\,U_2\,dU_2. \tag{21}$$

The details for the reduction of Eq. (21) will not be given here. It is sufficient to state that by substituting Eq. (19) into Eq. (21), a summation of complex integrals in the form of $\int_{U_2=0}^{1} U_2^{n+1} J_n(ZU_2)\exp[-j(Y/2)(1-U_2^2)]dU_2$ for $n \geqslant 0$ results and their solutions can be derived from similar expressions given in the text by Gray and Mathews.[10] After some lengthy manipulation, Eq.

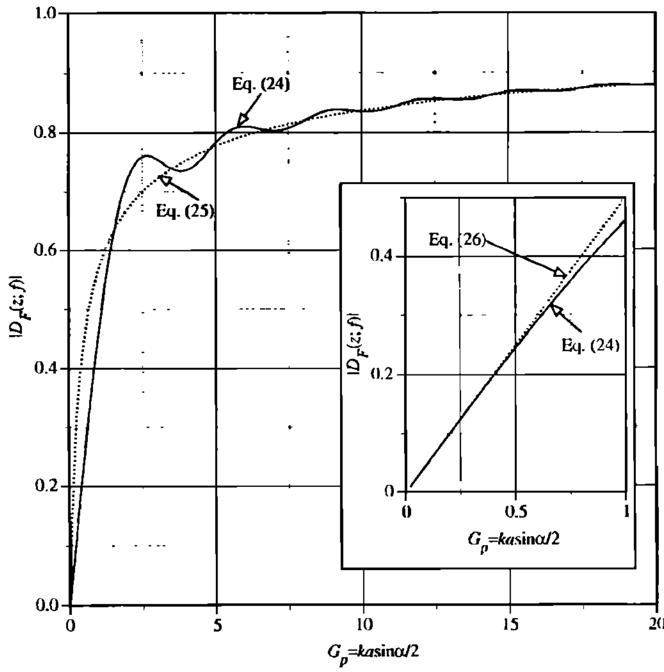
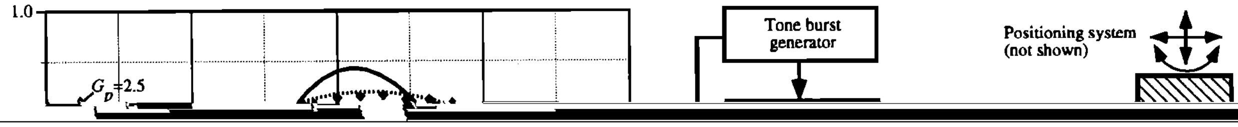


FIG. 2. Amplitude of the acoustic coupling factor $|D_F(z;f)|$ as a func-

[illegible]

$$1 \;/\exp[\,j(Z/2)(X-1/X)\,]-1$$

Eqs. (25) and (26).


1.0
G_D=2.5
Tone burst generator
Positioning system (not shown)

nected directly to a digitizing oscilloscope (model 9430,

frequency (rf) signal was digitized at a 100-MHz sampling

metrical focus. For the transducer used in this experiment,

the transducer surface at 3.73 MHz, corresponding to a includes the solution for a flat disk transducer as a limiting [redacted]

the theoretical solution. [redacted]

of this work. Financial support in part by the National [redacted]

National Science Foundation through Grant No. [redacted]