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Naval Ship Research and Development Center
Washington, D. C. 20007

DEPARTMENT OF THE NAVY
NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER
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A sonar system may incorporate a blanket to cover its transducer system in an attempt to achieve a better signal-to-noise ratio. The blanket is intended to displace the external pressure field away from the baffle— the surface in which the transducer system is flush mounted. In this paper, the propagation of pressure waves in the blanket material is assumed to have fluidlike properties. The analysis of the influence of the baffle–blanket system on the performance of the sonar system is carried out in spectral space and is expressed in terms of the filtering action of the former system. Of particular concern are the effects associated with changes in the speed of sound in the material of which the blanket is cast.

INTRODUCTION

A SONAR system is designed to respond efficiently to specific acoustic signals that are incident on the surfaces of the transducer system that it incorporates. Unfortunately, in addition to the pressure field induced by the useful acoustic signals, there are pressure fields that do not carry useful information; these pressure fields constitute the noise fields. If the sonar system is to perform properly, means must be found to minimize the response of the sonar system to these noise fields so as to increase the signal-to-noise ratio. There are two fundamental approaches to achieve this goal. One is to construct the sonar system and its environment so as to eliminate sources of noise, and the other is to design the transducer system so that its response to the noise fields is substantially inefficient compared to its response to the useful signal.

In assessing the performance of a sonar system, it is convenient to idealize the system so that one does not lose sight of the physical nature of the problem. One may subsequently proceed to tighten the analysis by resorting to more accurate and realistic assessment of the performance of the sonar system. With this approach in mind, it is convenient to consider the pressure field on the surface of the transducer system, due to both the useful signal and the noise, as being stationary, both spatially and temporally. It is further convenient to consider the pressure field due to the useful signal and the noise fields as being uncorrelated. Finally, the sonar system is idealized to admit infinite surfaces without discontinuities in surface impedance; in this approach, the analysis in spectral space becomes algebraic and thus offers considerable mathematical expediency. This general procedure was utilized in a recent paper[1] to assess the performance of a domed sonar system. It was shown in this paper that a properly chosen blanket dome can be employed both to reduce the response of the sonar system to noise fields and to minimize the noise fields in those spectral regions where they may do most damage to the proper performance of the sonar system.[1] The blanket displaces the external pressure field away from the surface of the transducer system by a distance equal to the thickness of the blanket. This displacement forces the external pressure field to propagate through the blanket in order to reach the transducer system. In the process of propagation, the pressure field is modified so that the pressure field on the baffle may be different from that of the external pressure field. The baffle is the surface to which the blanket is attached and in which the transducer system is flush mounted. A suitable blanket should be transparent to the useful signal but largely opaque to the noise fields. It was argued in Ref. 1 that these properties can be expressed in terms of the filtering action of the baffle–blanket system. The filtering action is the spectral measure of the transparency and opaqueness of the system. It is towards the analysis of the nature of the filtering action of the baffle–blanket system that this paper is directed. In particular, the changes in the filtering action due to changes in the sound speed in the material of which the blanket is cast are considered in some detail. It is found that substantial changes in the filtering action of the baffle–blanket system can

[1] G. Maidanik, "A Domed Sonar System," J. Acoust. Soc. Am. 44, 113–124 (1968).

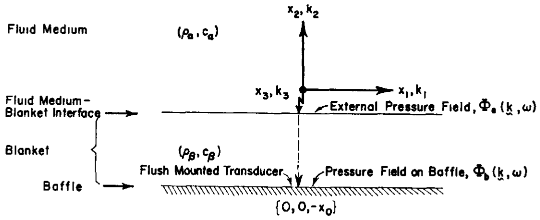

FIG. 1. Baffle–blanket system.

be effected in certain spectral regions by changes in the sound speed in the material of the blanket.

I. DESCRIPTION OF THE BAFFLE–BLANKET SYSTEM

The baffle constitutes a flat infinite surface—the surface possessing a spectral reflection coefficient denoted by R_b. The baffle is covered by a uniform blanket of thickness x_0. The properties of the blanket material are such that the acoustic propagation in it is fluidlike and is, therefore, completely specified by the density ρ_β and the speed of sound c_β. The semi-infinite space above the blanket is occupied by a fluid medium of density ρ_α. The speed of sound in the fluid medium is denoted by c_α. Figure 1 illustrates the baffle–blanket system together with the coordinate system employed in this paper.

It is assumed that a test external pressure field acts directly on the fluid at the plane of the interface between the blanket and the fluid medium. (The external pressure field is that pressure field that would be generated by an external source, if the plane constituted a rigid surface!) The external pressure is assumed to be stationary, both spatially and temporally, and unaffected by the characteristics of the system. The spectral density of the external pressure field is denoted by $\Phi_e(\mathbf{k},\omega)$, where $\mathbf{k}=\{k_1,k_3\}$ is the wavevector variable in the plane of the interface between the blanket and the fluid medium and ω is the frequency variable. The test external pressure field induces a pressure field on the baffle. In general, the spectral density $\Phi_b(\mathbf{k},\omega)$ of the pressure field on the baffle is different from that of the external pressure field, because the baffle–blanket system acts to modify the external pressure field as it propagates to the baffle. The functional form of this modification is termed the filtering action of the baffle–blanket system, and the expression for it is designated by $W_{\alpha\beta}(\mathbf{k},\omega)$,[1]

$$\Phi_b(\mathbf{k},\omega)=W_{\alpha\beta}(\mathbf{k},\omega)\Phi_e(\mathbf{k},\omega). \tag{1}$$

It is towards the study of the nature of $W_{\alpha\beta}(k,\omega)$ that this paper is chiefly directed.

II. FILTERING ACTION OF THE BAFFLE–BLANKET SYSTEM

The expression for $W_{\alpha\beta}(\mathbf{k},\omega)$ for the system under consideration here was derived in a recent paper.[1] This expression is

$$W_{\alpha\beta}(\mathbf{k},\omega)=|Z_{\beta b}/Z_{\alpha\beta}|^2, \tag{2}$$

where

$$Z_{\beta b}(\mathbf{k},\omega)=(1+R_b)Z_\beta \exp(-ik_{2\beta}x_0) \times[1-R_b \exp(-2ik_{2\beta}x_0)]^{-1}, \tag{3}$$

$$Z_{\alpha\beta}=(Z_\alpha-Z_\beta)+2Z_\beta[1-R_b \exp(-2ik_{2\beta}x_0)]^{-1}, \tag{4}$$

$$Z_\alpha=\rho_\alpha c_\alpha[1-(k/k_\alpha)^2]^{-\frac{1}{2}}, \tag{5}$$

$$Z_\beta=\rho_\beta c_\beta[1-(k/k_\beta)^2]^{-\frac{1}{2}}, \tag{6}$$

$$k_{2\beta}=[k_\beta^2-k^2]^{\frac{1}{2}}; \quad |\mathbf{k}|=k, \tag{7}$$

$$k_\alpha=\omega/c_\alpha; \quad k_\beta=\omega/c_\beta. \tag{8}$$

Previous discussions were limited primarily to situations where $\rho_\alpha=\rho_\beta$ and $c_\alpha=c_\beta$.[1] The discussions are extended in this paper to situations where $c_\alpha\neq c_\beta$. The extension to include situations where $\rho_\alpha\neq\rho_\beta$ is straightforward once those situations where $c_\alpha\neq c_\beta$ are considered; therefore, they are not considered in detail in the present text.

To facilitate the computations and discussions, the spectral reflection coefficient R_b is set equal to unity. This condition is commensurate with a baffle of infinite impedance; this condition can rarely be met in practice, although, with the exclusion of spectral components incident at grazing angles to the plane of the baffle, many surfaces can be constructed to approximate this condition. With $R_b=1$, Eq. 2 can be written in the simpler form

$$W_{\alpha\beta}{}^0(\mathbf{k},\omega)=4|(1+\gamma)\exp(i\psi)+(1-\gamma)\exp(-i\psi)|^{-2}, \tag{9}$$

where

$$\gamma=Z_\alpha/Z_\beta; \quad \psi=k_{2\beta}x_0, \tag{10}$$

and the superscript 0 on $W_{\alpha\beta}$ is chosen to indicate the value of this function under condition of $R_b=1$.

The class of problems considered previously in Ref. 1 concerned situations where $k_\alpha=k_\beta[c_\beta=c_\alpha]$. In this paper, two additional classes are considered, one where $k_\alpha<k_\beta[c_\beta<c_\alpha]$ and the other where $k_\alpha>k_\beta[c_\beta>c_\alpha]$.

III. CLASS A; $k_\alpha=k_\beta[c_\alpha=c_\beta]$; $\rho_\alpha=\rho_\beta$

In this class of problems, the function of the blanket is to remove the external pressure field away from the baffle without introducing a surface-impedance discontinuity at the plane defined by the interface between the blanket and the fluid. The absence of a surface-impedance discontinuity eliminates the establishment of multiple reflections in the space occupied by the blanket.[1] It is convenient to subdivide Class A into two regimes, one pertaining to the supersonic region of spectral space defined by $k<k_\alpha=k_\beta$ and the other to the subsonic region defined by $k>k_\alpha=k_\beta$. The convenience stems from the difference in the modes of propagation of supersonic and subsonic spectral components.[1]

1. $k<k_\alpha=k_\beta$

In this spectral region, both γ and ψ are real quantities. Indeed, γ is equal to unity. The expression for the filtering action is

$$W_{\alpha\beta}{}^0(\mathbf{k},\omega)=1. \qquad (11)$$

Equation 11 states that for those spectral components of the external pressure field for which $k<k_\alpha=k_\beta$—the supersonic spectral components of the pressure field—the blanket is transparent.

2. $k>k_\alpha=k_\beta$

In this spectral region, γ is a real quantity and its value is unity; however, ψ is a purely imaginary quantity. The expression for the filtering action is

$$W_{\alpha\beta}{}^0(\mathbf{k},\omega)=\exp(-2|\psi|); \quad |\psi|=|k_{2\beta}|x_0. \qquad (12)$$

Equation 12 states that for those spectral components of the external pressure field for which $k>k_\alpha=k_\beta$—the subsonic spectral components of the pressure field—the blanket acts to inhibit them from inducing corresponding spectral components in the pressure field on the baffle. The greater the value of $|\psi|$, the stronger the inhibition. The parameter $|\psi|$ increases with increase in k.

The form of $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$ as a function of the normalized wavenumber ka for Class A (Eqs. 11 and 12) and for three distinct values of (x_0/a) is given in graphical form in Fig. 2. The parameter (a) is here defined as an arbitrary constant length and is used for normalization purposes. In a practical situation, the parameter (a) may represent a typical transducer spatial dimension with the transducer flush mounted in the baffle to measure the pressure on the baffle.

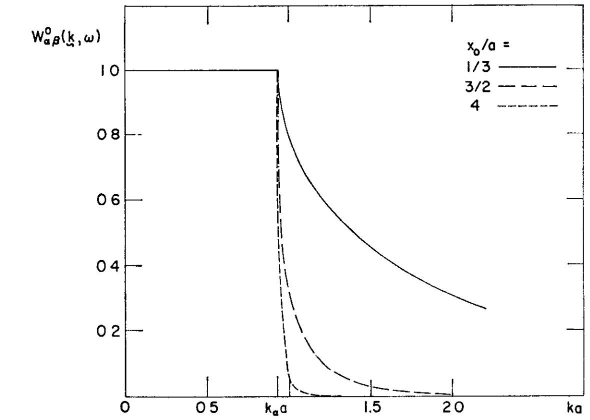

FIG. 2. Filtering action $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$ of baffle–blanket system as function of normalized wavenumber ka. The ratio of speeds of sound in fluid medium and blanket material equal unity, $c_\alpha/c_\beta=1$.

IV. CLASS B; $k_\alpha<k_\beta[c_\alpha>c_\beta]$; $\rho_\alpha=\rho_\beta$

This class—Class B— differs significantly from Class A in that a term describing multiple reflection is present in the expression for $W_{\alpha\beta}(\mathbf{k},\omega)$.[1] The discontinuity in the surface impedance that now exists at the interface between the fluid medium and the blanket can maintain multiple reflections in the space occupied by the blanket. The surface impedance discontinuity is measured by the term $(1-\gamma)$ in Eq. 9.

Another significant difference is that in Class B, γ is no longer equal to unity throughout the spectral region but rather is a function of k, k_β, and k_α; e.g., when $k=k_\alpha$, γ becomes infinite. Thus, in Class B, one must deal with variation in the value of γ as well as with variation in the value of ψ.

In dealing with Class B, it is convenient to subdivide the class into three regimes. The first regime pertains to the spectral region where the spectral components of the pressure field are supersonic in both the fluid medium and the blanket, $k<k_\alpha$. The second regime pertains to the spectral region where the spectral components of the pressure field are subsonic with respect to the fluid medium but remain supersonic with respect to the blanket, $k_\alpha<k<k_\beta$. The third regime pertains to the spectral region, where the spectral components of the pressure field are subsonic with respect to both the fluid medium and the blanket, $k>k_\beta$.

1. $k<k_\alpha$

In this spectral region, both γ and ψ are real quantities, and, therefore,

$$W_{\alpha\beta}{}^0(\mathbf{k},\omega)=[1+(\gamma^2-1)\sin^2\psi]^{-1}. \qquad (13)$$

It is readily deduced from Eqs. 5–8 and 10 that γ exceeds unity in the supersonic spectral region defined by $k<k_\alpha$. Therefore, in this spectral region, $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$ is less than unity except at those values of k for which $\psi=n\pi$, where n is an integer [when $\psi=n\pi$, $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$ is unity]. For the near-sonic and sonic spectral regions, with respect to the fluid medium, $k\rightarrow k_\alpha$,the value of γ is substantially in excess of unity and $W_{\alpha\beta}(\mathbf{k},\omega)$ is substantially zero (unless simultaneously, ψ is equal to $n\pi$). Thus, a blanket of the type that falls in Class B inhibits, to some degree, the supersonic spectral components in the external pressure field from reaching the baffle. The supersonic designation of the spectral components in the external pressure field are made with reference to the fluid medium in which they reside. Indeed, the near-sonic supersonic spectral components are by and large prevented from reaching the baffle altogether (provided $\psi\neq n\pi$ in this spectral region). Physically, these near-sonic supersonic spectral components see substantial impedance in the plane formed by the interface between the fluid medium and the blanket and consequently suffer substantially a total reflection at this plane.

2. $k_\alpha<k<k_\beta$

In this spectral region, γ is a pure imaginary quantity and ψ is a real quantity. The expression for the filtering action in this spectral region is

$$W_{\alpha\beta}{}^{0}(\mathbf{k},\omega)=(\cos\psi-|\gamma|\sin\psi)^{-2}. \tag{14}$$

In this spectral region, $|\gamma|$ decreases monotonically with increasing k from infinity (when $k=k_\alpha$) to zero (when $k=k_\beta$), and ψ decreases monotonically with increasing k from $(k_\beta{}^2-k_\alpha{}^2)^{\frac{1}{2}}x_0$ (when $k=k_\alpha$) to zero (when $k=k_\beta$). These conditions make it possible for the filtering action of the baffle–blanket to undergo a resonance phenomenon. The resonances occur whenever the condition

$$\tan\psi=(|\gamma|)^{-1} \tag{15}$$

is satisfied. It is straightforward to show that at least one resonance occurs within the spectral region $k_\alpha<k<k_\beta$ whatever the thickness of the blanket, provided, of course, that it is finite. The resonances arise when conditions are such that a spectral component enters into the space occupied by the blanket and is trapped in this space. The spectral components then undergo multiple reflections. (With respect to the blanket material, these spectral components are supersonic.) Since the blanket material is considered nondissipative and the spectral reflection coefficient is considered unity, the spectral pressure field associated with this component becomes infinite. In practice, of course, such a singularity in pressure can never be attained either because the conditions imposed on the system cannot be met or because nonlinear effects come into play.

The filtering action when $k=k_\beta$ is unity because both $|\gamma|$ and ψ are zero (see Eq. 14).

3. $k>k_\beta$

In this spectral region, γ is a real quantity and ψ is a pure imaginary quantity. The expression for the filtering action in this spectral region is

$$W_{\alpha\beta}{}^{0}(\mathbf{k},\omega)=(\cosh|\psi|+\gamma\sinh|\psi|)^{-2}. \tag{16}$$

In this spectral region, $W_{\alpha\beta}{}^{0}(\mathbf{k},\omega)$ is unity at $k=k_\beta$ and decreases monotonically and approximately exponentially with increasing $|\psi|$ ($|\psi|$ increases as k increases). In this spectral region, the behavior of $W_{\alpha\beta}{}^{0}(\mathbf{k},\omega)$ is approximately equivalent to that of Class A; the higher the value of k, the closer the equivalence.

Figure 3 is a graphical presentation of $W_{\alpha\beta}{}^{0}(\mathbf{k},\omega)$ as a function of the normalized wavenumber ka for Class B (Eqs. 13, 14, and 16) and for three distinct values of (x_0/a).

V. CLASS C; $k_\alpha>k_\beta[c_\alpha<c_\beta]$; $\rho_\alpha=\rho_\beta$

This class—Class C—is similar to Class B in the sense that multiple reflections can be established in the space occupied by the blanket because of the surface impedance discontinuity in the plane of the interface between the fluid medium and the blanket. However, the discontinuity has the reverse sign and its magnitude is different from that of Class B. These differences and

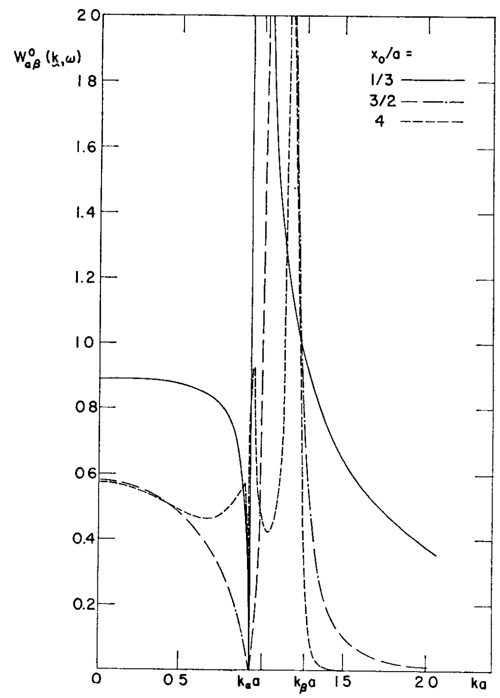

FIG. 3. Filtering action $W_{\alpha\beta}{}^{0}(\mathbf{k},\omega)$ of baffle–blanket system as function of normalized wavenumber ka. The ratio of speeds of sound in fluid medium and blanket material equal $\frac{4}{3}$, $c_\alpha/c_\beta=\frac{4}{3}$.

the fact that supersonic pressure components in the fluid may induce subsonic pressure components in the blanket are sufficient to make the filtering action of the baffle–blanket for Class C significantly different from that of Class B.

1. $k<k_\beta$

In this spectral region, both γ and ψ are real quantities and, therefore, the expression for the filtering action is the same as that for Class B-1, Eq. 13:

$$W_{\alpha\beta}{}^{0}(\mathbf{k},\omega)=[1-(1-\gamma^2)\sin^2\psi]^{-1}. \tag{17}$$

The difference between the behavior of $W_{\alpha\beta}{}^{0}(\mathbf{k},\omega)$ in Eq. 13 and Eq. 17 is that in the former case, γ exceeds unity and in the latter case, γ is less than unity. It is then apparent that $W_{\alpha\beta}{}^{0}(\mathbf{k},\omega)$ for Class C-1 exceeds unity in this spectral region except where $\psi=n\pi$ or zero, in which case $W_{\alpha\beta}{}^{0}(\mathbf{k},\omega)$ is unity. (The parameter ψ is zero when $k=k_\beta$). Thus, the amplitude of a spectral component in the pressure field on the baffle, in this spectral region, exceeds the amplitude of the corresponding spectral component in the external pressure field; the increase arises as a result of multiple reflections.

2. $k_\beta<k<k_\alpha$

In this spectral region, both γ and ψ are pure imaginary quantities. The expression for the filtering action is

$$W_{\alpha\beta}{}^{0}(\mathbf{k},\omega)=(\cosh^2|\psi|+|\gamma|^2\sinh^2|\psi|)^{-1}. \tag{18}$$

Since $|\psi|$ is zero at $k=k_\beta$, $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$ at this spectral point is unity. As k increases, $|\psi|$ and $|\gamma|$ increase and, therefore, $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$ decreases monotonically. At $k=k_\alpha$, $|\gamma|$ becomes infinite and $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$ is zero (see Sec. IV). In this spectral region, both the surface impedance discontinuity and the fact that the components become subsonic with respect to the blanket material conspire to inhibit some of the external-pressure supersonic spectral components from reaching the baffle. The surface impedance discontinuity in this spectral region introduces reflection of the spectral components of the external pressure field; the reflection becomes total at $k=k_\alpha$.

3. $k>k_\alpha$

In this spectral region, γ is a real quantity and ψ is pure imaginary. The expression for the filtering action is essentially the same as Eq. 16:

$$W_{\alpha\beta}{}^0(\mathbf{k},\omega)=(\cosh|\psi|+\gamma\sinh|\psi|)^{-2}. \tag{19}$$

The parameters at the initial value of the spectral region, $k=k_\alpha$, are different from those pertaining to Eq. 16. The parameter γ is infinite at $k=k_\alpha$ and, therefore $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$ is zero at this spectral point. As k is increased, γ decreases monotonically towards the value of unity. On the other hand, the value of $|\psi|$ increases monotonically with increasing k. The filtering action $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$, therefore, increases first with increasing k, reaches a maximum value, and then decreases approximately exponentially with further increase in k. The increase in the filtering action as k is increased initially from k_α is a consequence of the departure from total reflection at the plane of the interface between the fluid medium and the blanket so that components in the external pressure field begin to penetrate into the blanket. As k is increased further, the usual exponential decay of the subsonic components takes over to control the situation.

Figure 4 is a graphical presentation of $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$ as a function of the normalized wavenumber ka for Class C (Eqs. 17–19) and for three distinct values of x_0/a.

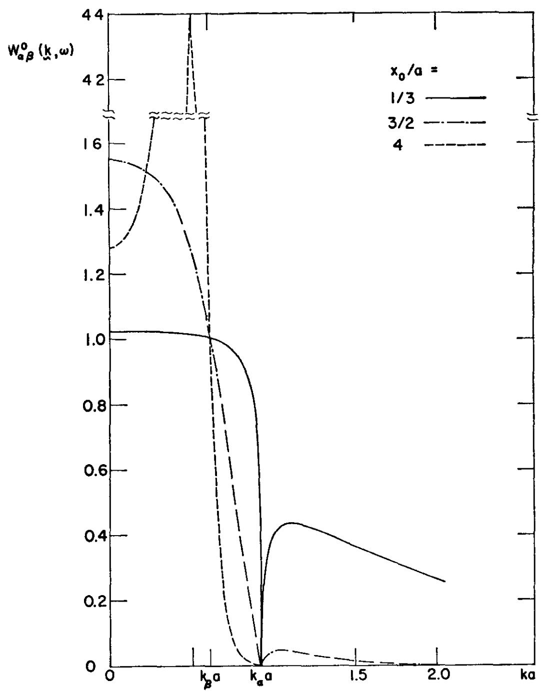

FIG. 4. Filtering action $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$ of baffle–blanket system as function of normalized wavenumber ka. The ratio of speeds of sound in fluid medium and blanket material equal $\frac{2}{3}$, $c_\alpha/c_\beta=\frac{2}{3}$.

VI. ADDITIONAL COMMENTS

The intent in presenting the analysis and the computations in this paper is to generate interest in this field and to solicit further research, both theoretical and experimental. A glance at Figs. 2–4 would convince the reader that even a disparity of 30% between c_α and c_β is sufficient to cause significant changes in the filtering action of the baffle–blanket system. These changes are particularly significant in the low-wavenumber spectral region, $k<2k_\alpha$; $2k_\beta$. Of couse, the computations were performed for ideal situations that can hardly be matched by a practical system. However, it can be argued that introduction of more realistic conditions would affect the filtering action only slightly in the greater part of spectral space and would "round off" the singularities and diminish the peaks in $W_{\alpha\beta}{}^0(\mathbf{k},\omega)$. These effects can be estimated in the present analysis by relaxing the condition that the spectral reflection coefficient be equal to unity and by inserting a more realistic value for this parameter. Also, one may attempt to introduce a parameter to account for the dissipation in the blanket material; this can be accomplished by introducing an appropriate complex speed of sound instead of the real parameter c_β. Nevertheless, the present analysis is deficient in that it does not account for the shear motion that is most probably present in motion of the blanket; the blanket material does not have purely fluidlike properties with respect to its vibratory motion.

Since the significant changes in the filtering action of the baffle–blanket system, resulting from changes in the speed of sound in the blanket material, occur in the spectral region $k<2k_\alpha$; $2k_\beta$, one may design experiments (when studying these changes) that are commensurate with this spectral region only. Design has it, then, that relatively large transducers can be used to examine the baffle–blanket system filtering action without loss in range. The combined filtering action, that of the baffle–blanket system and that of a suitable circular transducer, is illustrated in Fig. 5. In Fig. 5, the change in the combined filtering action that can be expected as a result of a change in the speed of sound in the blanket material is depicted for a blanket of thickness x_0, equal to half the radius (a) of the trans-

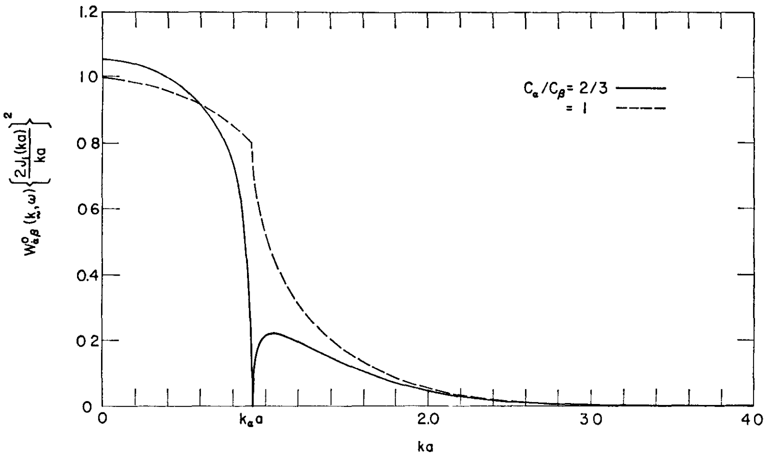

FIG. 5. Filtering actions of flush-mounted circular transducer covered by blankets as function of wavenumber k normalized by transducer radius a. The ratios of the speed of sound in fluid medium and blanket material are equal to $\frac{2}{3}$ and unity, respectively. In both cases, thickness of blanket is half radius of transducer.

ducer. (It would be important to demonstrate that the properties of the propagation of waves in the material of the blanket are independent of the wavenumber, especially in the higher wavenumber region.)

Finally, it is suggested that the proposition that a transducer system incorporating a properly designed blanket be employed as a device for measuring the supersonic spectral distribution of the pressure field in a turbulent boundary layer be given serious consideration by experimentalists engaged in this field of endeavor. The proposition stems from the results of the present analysis and the analyses presented in a number of recent papers.[2,3] Basically, it is proposed that a transducer system in the form of a line array and consisting of reasonably sized transducers flush mounted in a baffle be used in conjunction with a blanket to measure the supersonic spectral distribution of the pressure field in a turbulent boundary layer. The turbulent boundary layer is to be generated on the top surface of the blanket. It is proposed that the separation between adjacent transducers be chosen about or less than $2\pi/3k_\alpha$, a third of an acoustic wavelength in the frequency range of interest. The most suitable separation can be estimated from knowledge of the frequency range of interest, the number of transducers, the thickness of the blanket, and the resolution desired. Initially, the number of transducers need not exceed a dozen. The transducer system is to be covered by a blanket of an appropriate thickness and of the type having, by and large, the properties described under Class A in the text. The thickness is to be chosen so as to substantially reduce the response of the transducer–baffle–blanket system to the pressure field components in the spectral region defined by $k > 2k_\alpha$. The simultaneous output of the transducers can be recorded. With the aid of a computer, the appropriate steering of the array can be implemented to examine the relative spectral distribution of the pressure field of a turbulent boundary layer in the spectral region of concern.[4]

ACKNOWLEDGMENT

The authors are indebted to J. M. McKee of the Applied Mathematics Laboratory of the Naval Ship Research and Development Center for programming and assisting with the numerical computations.

[2] D. W. Jorgensen and G. Maidanik, "Response of a System of Point Transducers to Turbulent Boundary Layer Pressure Field," J. Acoust. Soc. Am. **41**, 1616 (A) (1967); **43**, 1390 (1968).

[3] G. Maidanik and D. W. Jorgensen, "Boundary Wave-Vector Filters for the Study of the Pressure Field in a Turbulent Boundary Layer," J. Acoust. Soc. Am. **42**, 494–501 (1967).

[4] G. Maidanik, "Flush-Mounted Pressure Transducer Systems as Spatial and Spectral Filters," J. Acoust. Soc. Am. **42**, 1017–1024 (1967).

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13 ABSTRACT

A sonar system may incorporate a blanket to cover its transducer system in an attempt to achieve a better signal-to-noise ratio. The blanket is intended to displace the external pressure field away from the baffle–the surface in which the transducer system is flush mounted. In this paper, the propagation of pressure waves in the blanket material is assumed to have fluidlike properties. The analysis of the influence of the baffle-blanket system on the performance of the sonar system is carried out in spectral space and is expressed in terms of the filtering action of the former system. Of particular concern are the effects associated with changes in the speed of sound in the material of which the blanket is cast.

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