United States Patent

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[54] SHIP'S WARNING SYSTEM
7 Claims, 2 Drawing Figs.

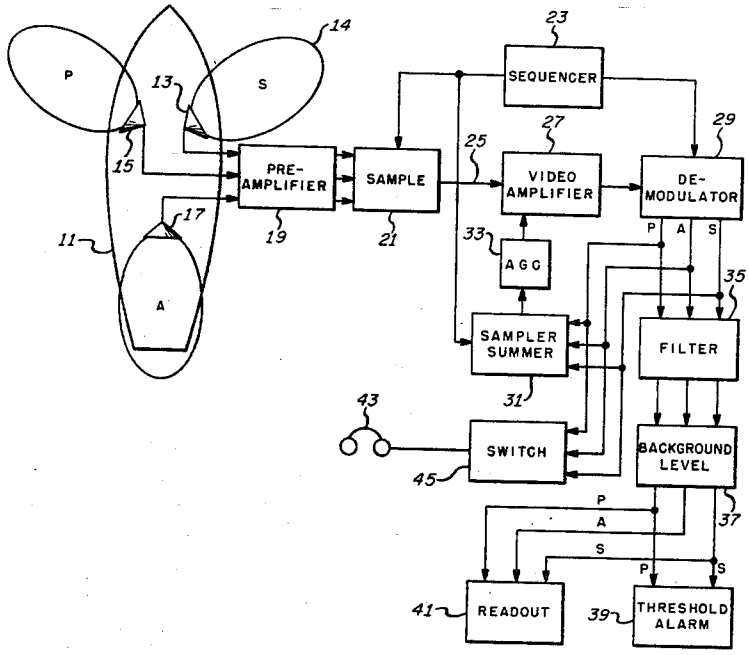
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[51] Int. Cl. G01s 3/00
[50] Field of Search 340/6, 16, 261

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ABSTRACT: A ship's warning system for detecting vessels approaching in the forward sector by analyzing sounds received by a plurality of forward-looking microphones. Sounds arriving from astern are detected by an auxiliary microphone. The signals from the various microphones are sequentially sampled and amplified in an automatic gain controlled amplifier in which the gain is limited by the amplitude of the largest received signal. Relatively intense sounds from the forward sector are amplified and actuate an alarm. Relatively intense sounds from astern affect the auxiliary microphone most strongly and reduce the gain of the amplifier so that the corresponding signals from the forward-looking microphones cannot actuate the alarm.



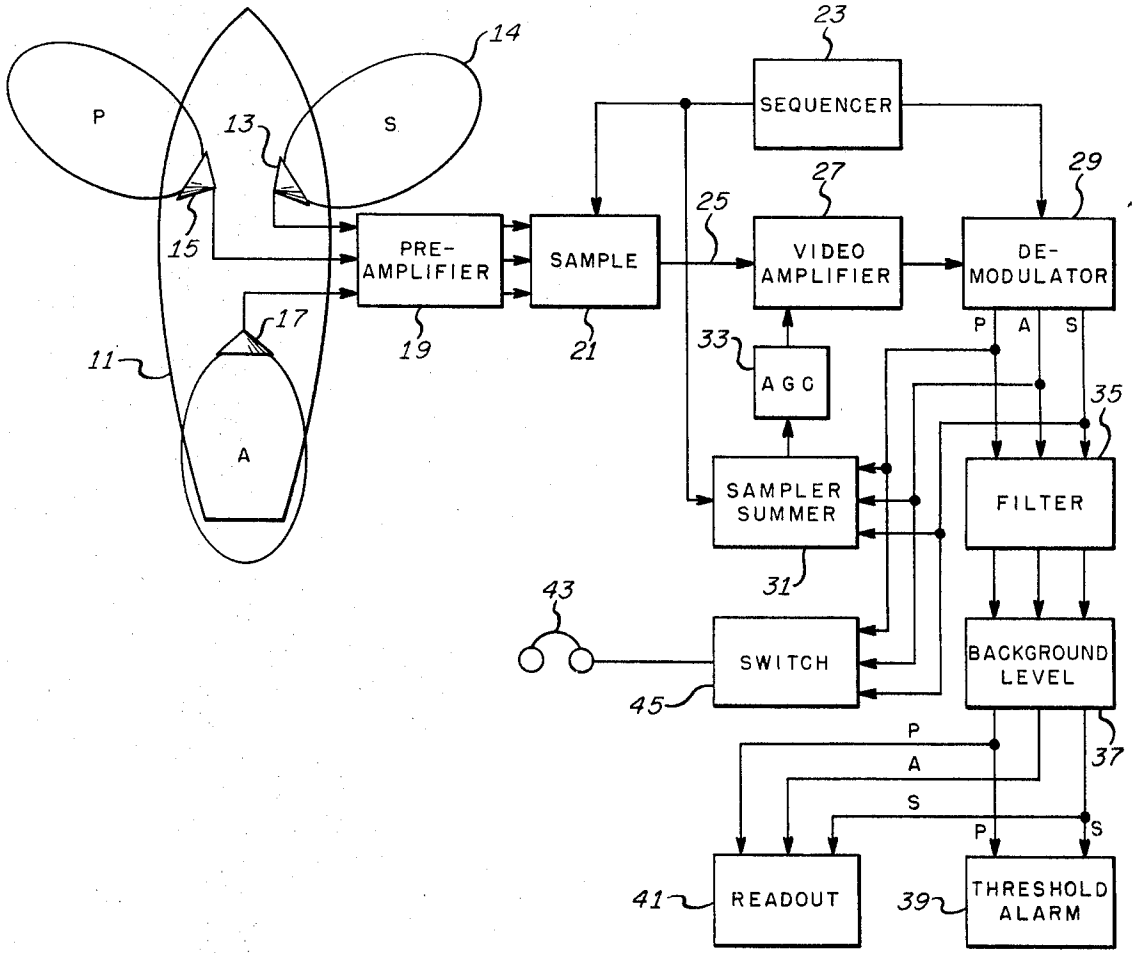


FIG. 1.

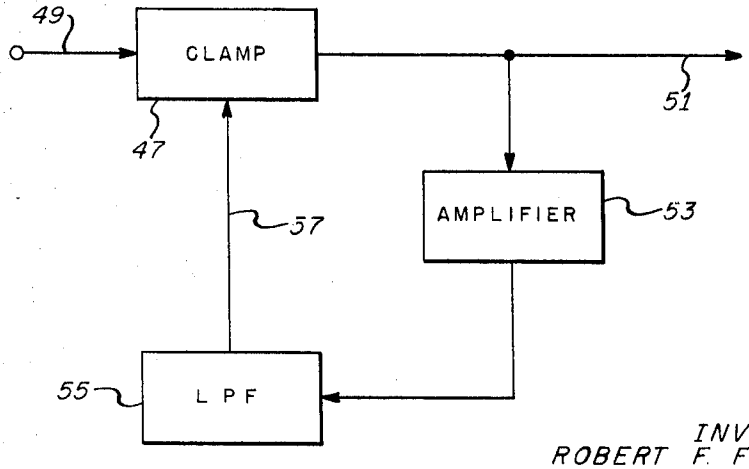


FIG. 2.

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SHIP'S WARNING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to conning equipment for ships and more specifically to conning equipment utilizing passive, in-air sound detection means.

2. Description of the Prior Art

Increasing ship traffic has complicated the lookout officer's task so that means for extending the lookout's range have become imperative. Radar, for instance, is commonly used as an all-weather conning aid.

Despite the obvious merits of radar detection, however, great reliance is still placed on the audio and visual observation of the lookout.

Since the hearing range may be relatively short, electronic aids have been used to provide additional sensitivity. Frequently, these devices suffer from poor directivity. In collision avoidance operations, for example, the lookout is principally interested in vessels approaching in the forward sector. Because of the poor directivity of the microphones used in such systems, sounds originating astern may be detected by the microphones and confused with the sounds originating in the ship's forward path.

Since it is important to know the direction of sounds reaching the lookout station in order to plan evasive maneuvers, this confusion frequently presents a dangerous hardship.

It is an object of the present invention to provide an audio lookout aid that indicates the direction of a sound source.

It is another object of the present invention to provide an audio lookout aid that is relatively insensitive to sounds originating in regions not of primary interest to the lookout officer.

SUMMARY OF THE INVENTION

The present invention employs a primary microphone means arranged to respond principally to sounds originating in specified regions of interest. Auxiliary microphone means are arranged to respond to sounds originating outside these regions of interest. The signals from all microphone means are passed through an automatic gain controlled amplifier and the signals from the primary microphone means are then applied to an alarm system. Sounds originating outside the region of interest provide a large signal in the auxiliary channel but only small signals in the primary channels. The larger auxiliary signal in this case reduces the gain of the amplifier so that the corresponding primary signals cannot actuate an alarm.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating the presently preferred form of the invention; and

FIG. 2 is a block diagram illustrating a background learner used in practicing the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, a ship 11 is fitted with a pair of primary microphones 13 and 15. The microphone 13 is oriented so as to respond to signals originating off the starboard bow, as indicated by the polar sensitivity diagram 14. The microphone 15 is oriented so as to respond to signals originating off the port bow. An auxiliary microphone 17 is arranged to respond to signals originating aft of the ship.

Each of these microphones has been pictured as having a simplified ovate polar sensitivity diagram for purposes of illustration. It will be understood that in most instances the actual sensitivity diagrams also include side lobes which complicate the directivity characteristics of the device.

In a typical two-channel system such as that pictured in FIG. 1, the port and starboard microphones would be arranged to cover a forward sector of about 120°.

Although only two primary channels have been shown for illustration, more channels may be employed so as to cover a wider sector or to increase the directional sensitivity of the system.

Signals from each of the microphones are applied to a preamplifier 19 and then to a sequential amplifier 21.

The sequential sampler is actuated by a sequencer 23. The sequencer 23 typically actuates the sampler at a frequency of 44 kHz. The sampler sequentially samples the three signals applied from the preamplifier 19 in a cyclical fashion. Electronic samplers for this purpose are well known in the art. Basically, however, they serve the same purpose as a continuously rotating rotary switch having the switch arm connected to a common output line 25. A complete sampling cycle corresponds to a full revolution of the switch arm.

In a preferred form, the sampler may be of a conventional type in which video pulses are applied to the output line 25. A video amplifier 27 is connected to receive the output of the sampler 21. The output of the video amplifier is demodulated in a demodulator 29 which is also actuated from the sequencer 23. Thus, the demodulator 29 is operated in synchronism with the sampler 21.

The demodulator 29 produces output voltages on three output lines, each supplying a signal which is an amplifier version of the signal from one of the three microphones.

The output signals from the demodulator are applied to a sampler/summer 31 which is also actuated by the sequencer 23.

The sampler/summer is a straightforward circuit including conventional summing means to combine the three signals from the demodulator and chopping means to sample the combined signal at the sequencer rate. The output of the sampler/summer is applied to an automatic gain control circuit 33 which controls the gain of the video amplifier 27.

The automatic gain control circuit 33 is a straightforward AGC circuit that is constructed to serve a dual purpose: it provides a steady gain control voltage that adjusts the amplifier to a linear operating range in response to relatively steady ambient sounds, yet reduces the amplifier gain momentarily to prevent the amplifier from saturating in response to bursts of sound received from a probable target. The circuit may contain, for instance, a simple storage circuit in the feedback loop to provide an average gain control voltage, and a high frequency bypass to provide momentary gain reduction. The circuit constants are also adjusted so that a momentary gain reduction persists for at least one sampling cycle.

Thus, a burst of sound actuating any microphone establishes a signal in the associated channel that passes through the amplifier without significant distortion, but effectively attenuates corresponding signals in the remaining channels.

The three signals of the demodulator 29 are also applied to a band-pass filter 35. This filter typically has a passband in the region from 100—1500 Hz. so as to pass only the signals corresponding to sounds ordinarily expected from intruding vessels. The signals from the filter 35 are passed to a background level circuit 37. This is essentially a storage circuit and will be discussed in detail. Its purpose is to provide a reference signal in each channel that represents an average of the ambient noise over a long period of time. Thus, the background level circuit does not pass ambient signals, but an unusually large sound in any one of the channels is passed on to succeeding circuits.

The port and starboard signals from the background level circuit 37 are passed to an alarm circuit 39.

Signals from all three channels of the circuit 37 may also be passed to a suitable readout circuit 41.

The alarm circuit 39 contains a conventional threshold circuit which actuates an alarm if the port or starboard signal exceeds the background level by a predetermined amount. Separate alarms are ordinarily provided for each of the port and starboard channels.

The readout 41 may be any desired type of readout instrument. In many instances, a conventional cathode-ray tube

readout is used. In a typical cathode-ray tube readout, the three channels are fed to circuits which provide a Y pattern, corresponding to the port, starboard or aft microphones.

In more elaborate systems, the readout may include recording means in which the signals may be recorded on a magnetic drum or tape and played back in response to the officer's command.

The signals from the demodulator **29** may also be audibly detected by a loudspeaker or headset **43**. Such detection means may be operated in any one of several modes as selected by a straightforward switching means **45**. Thus, the officer can listen to sounds originating in the full forward sector, or off either the port or starboard bow individually.

A close estimate of the bearing of a sound source can be made by using the switching means to insert calibrated delay means in series with the individual receivers of the headset and applying the port signals to one receiver and the starboard signals to the other receiver. By adjusting the delays until the sound seems to emanate from a point dead ahead, the setting of the delay means can be used to determine the bearing of the sound source.

More accuracy can be obtained with this scheme by employing a reversing switch for alternately reversing the signals fed to the individual receivers as to provide a "wobbling" effect.

Returning to the background level circuit **37**, one of the three identical channels in this circuit is shown in more detail in FIG. **2**. Each channel may contain a conventional clamp circuit **47**. The signal from the filter **35** is applied to a line **49** and appears on a line **51** which is connected to the alarm and readout circuits. The output of the clamp circuit **47** is amplified in an amplifier **53** and passes through a lowpass filter **55**. The lowpass filter has a long time constant which provides a bias for the clamp **47** by means of the line **57**.

Thus, the bias of the clamp is adjusted by the output of the filter **55** which can provide only a slowly changing bias to the clamp. A rapidly changing signal, such as that experienced when a vessel intrudes from the port or starboard bow of the ship, can pass through the clamp and the line **51** to actuate the alarm **39** or provide a signal to the readout **41**.

When a sound originates aft of the ship **11**, this sound actuates the aft microphone **17** with full intensity. The same signal may also actuate the port or starboard microphones. However, since the sound originates from astern, the port or starboard microphones respond only weakly to such sounds.

Since the aft microphone provides a large signal in the automatic gain control circuit associated with the amplifier **27**, this signal reduces the gain of this amplifier so that the corresponding port and starboard channels pass only a small signal to the background level circuit **37**. The port and starboard signals from the background level circuit **37** are thus reduced to a low level with respect to the reference signal being stored in this circuit so that the alarm circuit **39** is not actuated.

The readout circuit, however, receives this aft signal to indicate that a signal from astern has been received.

While the invention has been described in its preferred embodiment, it is to be understood that the words which have been used are words of description rather than limitation and that changes within the purview of the appended claims may be made without departing from the true scope and spirit of the invention in its broader aspects.

We claim:

1. A warning system for installation aboard a ship comprising primary receiving means responsive to sounds received from specified regions of interest; auxiliary receiving means responsive to sounds received from a region other than said regions of interest; amplifying means for amplifying signals from all of said receiving means, said amplifying means being arranged to subject the signals from all receiving means to essentially the same gain; automatic gain control means for regulating the gain of said amplifier, said automatic gain control means being adjusted to maintain the amplifier below saturation upon the receipt of a large signal from any receiving means; a plurality of signal channels coupled to said amplifying means; said plurality including a channel corresponding to each of said regions from which sounds may be received; individual averaging means coupled to each of said channels for obtaining a reference signal representative of the long term average of the signal amplitude in that channel; threshold means coupled to those channels that correspond to said regions of interest, said threshold means including means to pass signals that momentarily exceed the reference signal from said averaging means by a predetermined amount; and alarm means to indicate the passage of a signal through said threshold means.

2. The warning system of claim **1** in which said amplifying means is a single channel amplifier; said warning system further including a cyclical sampling means for sequentially sampling signals from each of said regions; and means to apply signals serially from said sampling means to said amplifying means.

3. The apparatus of claim **1** in which the primary receiving means are constructed to respond principally to sounds originating in the forward sector of said ship and in which the auxiliary receiving means are constructed to respond principally to sounds originating astern of said ship.

4. The apparatus of claim **3** in which the primary receiving means include first microphone means for receiving signals originating off the port bow of said ship, and second microphone means for receiving signals originating off the starboard bow of said ship, and in which said plurality of signal channels includes a channel for signals from said first microphone means and another channel for signals from said second microphone means.

5. The apparatus of claim **4** in which said alarm means includes individual alarms responsive to signals from said first and second microphone means respectively.

6. The apparatus of claim **5** further including a demodulator means actuated in synchronism with said cyclical sampling means, said demodulator means being connected to receive signals serially from said amplifying means and constructed to distribute signals to appropriate channels in said plurality of channels.

7. The apparatus of claim **6** in which the automatic gain control means is responsive to the instantaneous sum of all signals in said plurality of channels.