Real Phase—To Preserve All the Complex Sound Field Information Contained in the Music

The Integra Series Sound

The elusive ideal in sound reproduction is to preserve and faithfully recreate all of the feeling of abundant energy and finely detailed presence of a live performance. Over the years, Onkyo has been tackling the myriad problems involved by developing new ways to solve each obstacle in the path to the ideal. As the name "Integra" implies, this new series of audio components makes full use of Onkyo's wealth of innovative technology to give you, the listener, a sound that is as close as possible to the original, a sound that can only be described as uniquely Integra.

Why Phase Accuracy Is So Critical

The relative difference in timing between the peaks and valleys in the left and right stereo channels, a characteristic called "phase," plays a major role in localization of individual sounds on the stereo "sound stage." If, for example, signals of the same frequency, strength and phase are sent to both speaker systems, the sound will seem to originate from a point precisely between the two speakers. If, on the other hand, the phase of the left and right signals does not coincide, the sound source will appear blurred or out of focus. Accurate stereo imaging, therefore, is possible only if the relative phase of the two stereo channels is not altered by the slightest degree during the amplification process.

How Phase Accuracy Is Lost In An Ordinary Amplifier

Because the load presented by a speaker system on an amplifier is not a purely ohmic resistance, there is an inevitable shift in phase between the voltage and current in the amp-to-speaker signal path (see fig. 1). This phase shift is most pronounced around the speaker's bass resonance frequency, where the phase of the voltage and current are reversed (see fig. 2). Naturally, this same phase shift also exists between the voltages

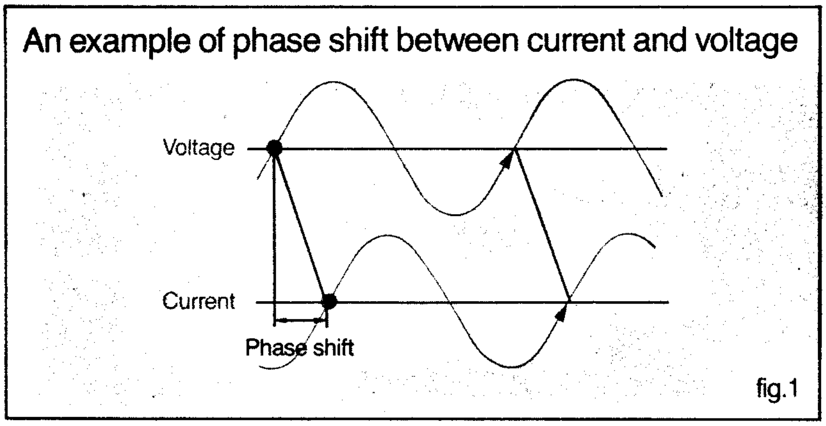

fig.1

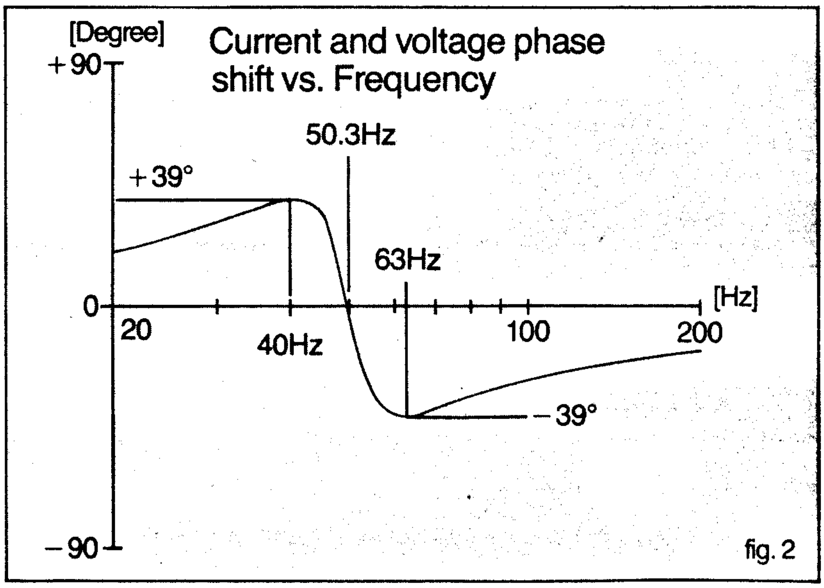

fig. 2

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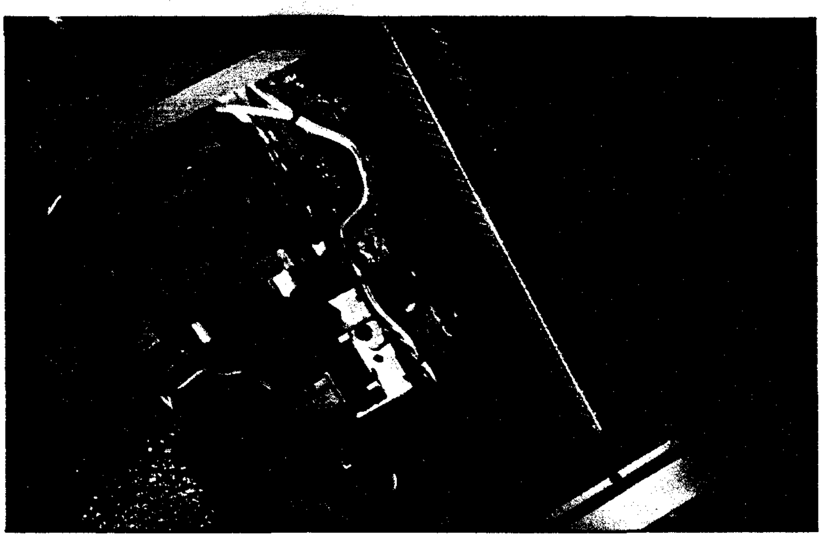
and the charging currents in the amplifier's power supply. These charging currents create a problem when the input signal contains very low frequencies (under about 120 Hz—precisely where voltage and current phase differ by the greatest amount) because the currents are made to fluctuate at the same frequency. Electromagnetic flux generated by these "out of phase" charging currents often induces voltages of the same incorrect phase in the nearby driver stage (see fig. 3) through which the audio signal passes. These spurious, fluctuating voltages are amplified and then go on to the speakers. There they set the speaker diaphragms in a false kind of pulsating motion, which in turn causes phase inaccuracies and a particularly obnoxious kind of intermodulation distortion.

The Onkyo Solution—An In-Phase Transformer

Onkyo dealt with the problem of phase dislocation by going straight to the root: the modulated, "out of phase" charging currents caused by very low frequency signal elements. If this



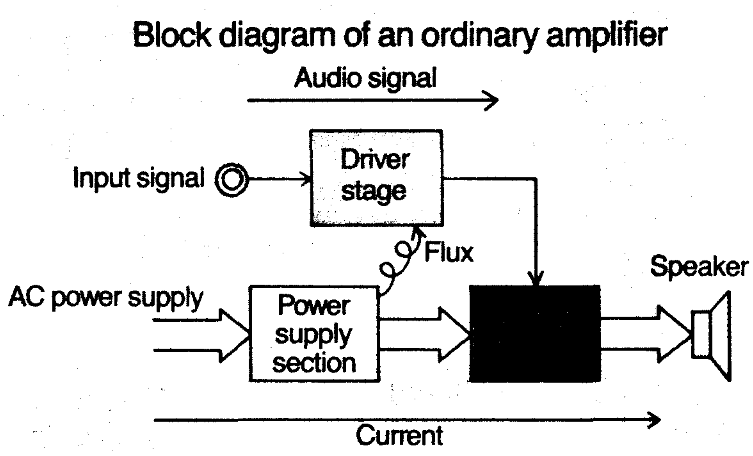
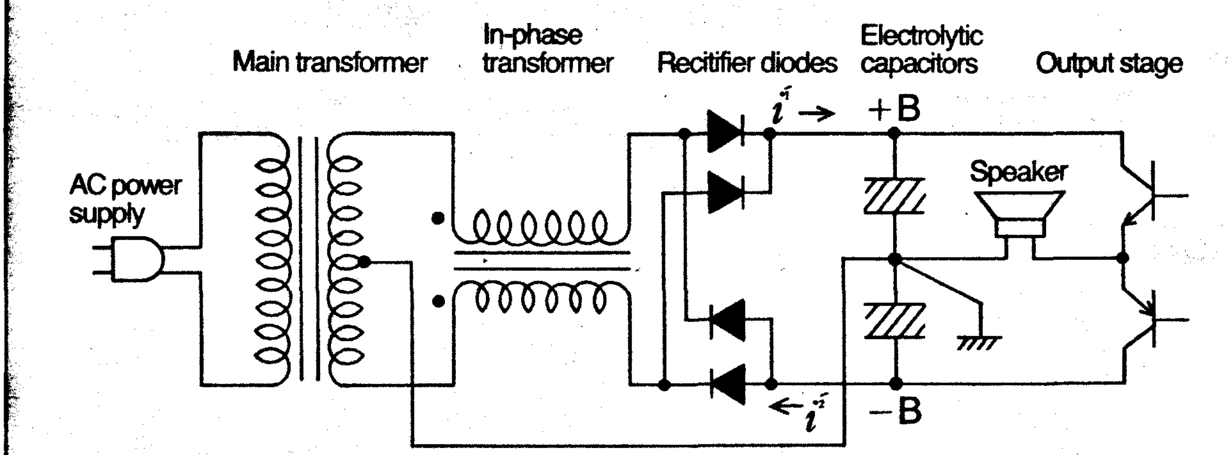


fig. 3



The Real Phase configuration

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undesirable modulation of the charging currents, which occurs every time a very low frequency signal is encountered, could be prevented, the problem would cease to exist. So Onkyo decided to "flatten out" these currents. This is done by taking advantage of the fact that the positive and negative charging currents are mirror images of each other. In the power supply section, an extra transformer (the "In-Phase" transformer) is placed between the power transformer and the capacitors. As the positive and negative charging currents pass through the two windings of this transformer, the unwanted peaks and valleys in the charging currents cancel each other out. The resulting current shapes are perfectly flat (see fig. 4). Another important benefit of having two equal charging currents is that no current flows in the common ground. This prevents another conceivable source of spurious signal fluctuations.

The Benefit—An Unprecedented Degree of Realistic Imaging and Low Range Definition

The audible benefits of Onkyo's Real Phase are striking. First and foremost, these amplifiers create an auditory sensation that faithfully reproduces all the sound staging information in the input signal. Since there is no blurring or smearing, instruments and voices appear precisely focused and rock steady. Another advantage of Onkyo Real Phase is better speaker control in the bass range due to the absence of out-of-phase low frequency signals. You will notice that bass instruments sound much more tightly defined, with no annoying muddiness. It all adds up to unprecedented sound stage realism and image specificity.

A Truly "Digital Ready" Amplifier

With the appearance of compact disc players and other purely digital audio sources, manufacturers are calling all manner of amplifiers "digital ready." However, a closer look often reveals that this so-called "readiness" has been achieved simply by raising output power a few watts. Onkyo, though, builds digital ready amps which incorporate meaningful improvements in the way they operate. Real Phase is an excellent example of this policy. Because Real Phase guarantees that the output sound pressure waveforms precisely reflect the input signals, it also guarantees that the unparalleled purity of digital sources is faithfully preserved all the way to the speakers. Only an amplifier that incorporates such up-to-date technology is worthy of being called "digital ready."

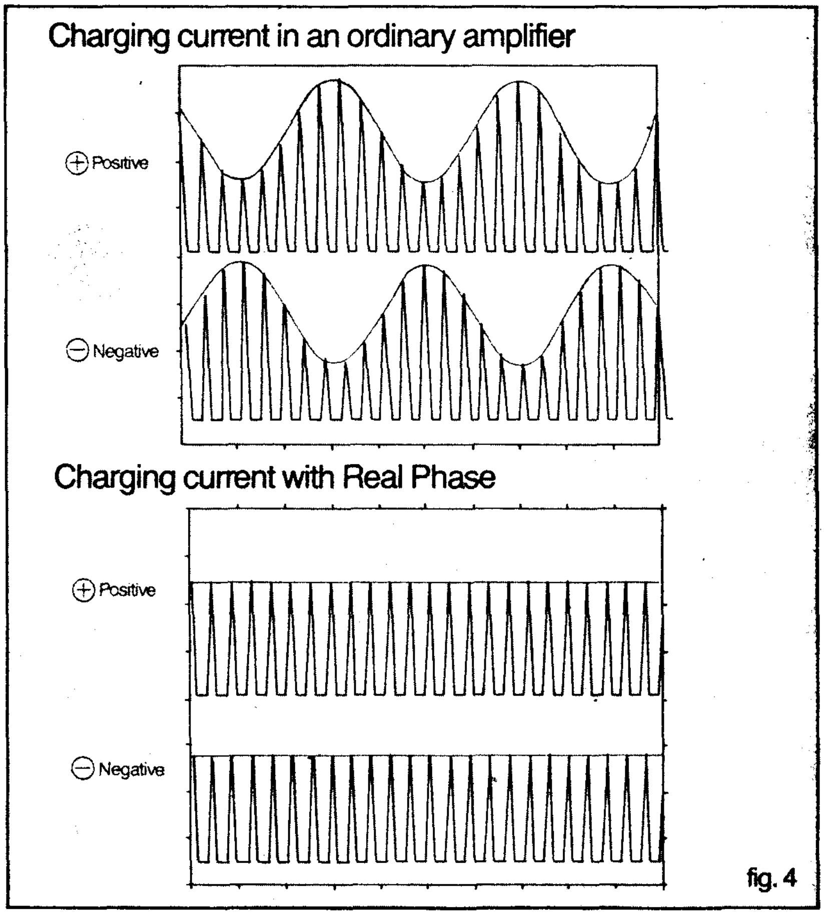

fig. 4

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New Amplifier Enables Clearer Digital Sound Reproduction

Onkyo has two new preamplifier products, Integra A-817RXII and A-815RXII, both based on the real phase amplification concept originating with the preceding RX series. In addition, however, the new products represent a new technology in which the audio effect of units such as the CD players are eliminated completely within the amplifier itself.

Firest there was a jump from the analog to the digital mode, and then a digital source was developed to take over the role once played by the analog sources — the new products appearing in the market represent a fast-changing trend. A case in point is the switchover to compact disks, one of today's premier products: But in audio amplifiers, one does not come across any major shift from analog circuitry. As for the S/N ratio or distortion representing the static characteristics, audio amplifiers, many believe, have reached more or less their limit of attainment. However, the latest developments in amplifiers reflect a more painstaking attention to circuitry and components to improve sound quality.

Apparently, it is this exclusive attention to the amplifier interior that accounts for certain unsloved problems. These have to do with the amplifier connections on the one hand and the program source on the other, that is, instruments actually performing music. In particular, the digital source of the CD players is known to create some kind of interference against which the players, designed with exclusive attention to the interior, are not equipped. As a result, the external noise finding its way to the amplifier interior interferes with the music signals, and affects the sound quality.

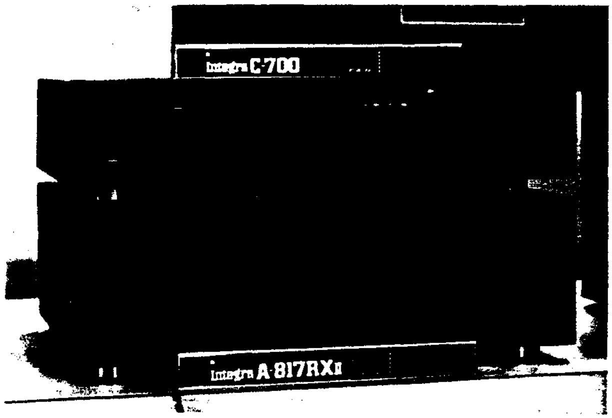
Great consideratiōn was given to this point in the design of the real phase 'digital' amplifiers in order to eliminate external interferences. The result is excellent quality of amplifiers and performances for users.

Figure 1 provides a block diagram of the amplifier and the CD player. The broken lines to the left in the diagram enclose the CD player, the box on top accommodates the digital/analog circuits. The line extending towards the right represents the output terminal. The box at the bottom houses the power transformer, the line going downwards from there being the power cord. The broken line enclosure to the right surrounds the amplifier circuit bow on top right, the line extending to the left from there being the input terminal. The lowermost box in the diagram contains the power transfer. The line running downwards from here is the power cord. Furthermore, the two lines towards the bottom of the diagram represent the ordinary household AC 100V line.

When music is played, the output terminal of the CD player and the input terminal of the amplifier are connected by the audio cable. Also, the respective AC plugs are connected to the AC 100V terminals in the house. This forms a large loop: AC 100V line → CD player power source → CD player circuit → CD player output → audio cable → amplifier input → amplifier circuit → amplifier power source → AC 100V line.

Preventing DSI Generation

Within it the CD player handles a number of signals. These include, besides the digital signals dealt with by the digital signal processor circuit and the control microprocessor, the dynamic lighting signal of the display unit and the servo signals in, respectively, the rotary and optical systems all of which include a high-frequency component. All these signals, important as they are for signal processing and the various controls, tend to affect the quality of sound once they find their way inside the circuitry. This adverse effect of the digital signals on the audio signals is referred to as the digital signal interference (DSI).



A combination of CD player and A-817 RXII amplifier

To return to the amplifier-CD player loop discussed earlier, this loop includes the digital circuit of the CD player. Digital signals from here pass to the inside of the amplifier after a cycle through the loop, where they create the DSI. There are two ways, however, in which this interference may be avoided.

In the first place, the digital source within the CD player – which is also the source of the DSI – may be isolated from the loop. Secondly, the loop may be broken somewhere to prevent the interference current from passing on through it. The first of these methods may be adopted for the CD players.

Indeed, Onkyo's Integra C-700 uses optical fiber between the digital and the analog circuits to isolate the earth of the digital circuit from the loop.

As for the amplifier, it may be connected to the CD player which does not work on the optical transmission pinciple. For this reason, it is only the second of the above methods that is applicable. In the real phase 'digital' amplifiers, two newly developed input in-phase transformers (IIT) are placed as shown in Fig. 1 between the input terminal and the amplifier circuit. This approach has succeeded in completely isolating the loop through which the interference current flows. It must be noted, however, that this very loop constitutes the circuit through which the important music signals from the CD player flow.

The input inphase transformer has no effect on these music signals: it just shuts out the interferene current. This transformer looks as shown in Fig. 2. In it, inductance is equal between the hot and the earth sides and the degree of bond is unity. Also, it offers a reactance against common mode noise which enters both the hot and the earth sides like the interferences signal does. In this way it prevents interference currents.

Figure 3 compares the measured values of noise current in a conven-

Fig. 1: Diagram of real-phase digital amplifier

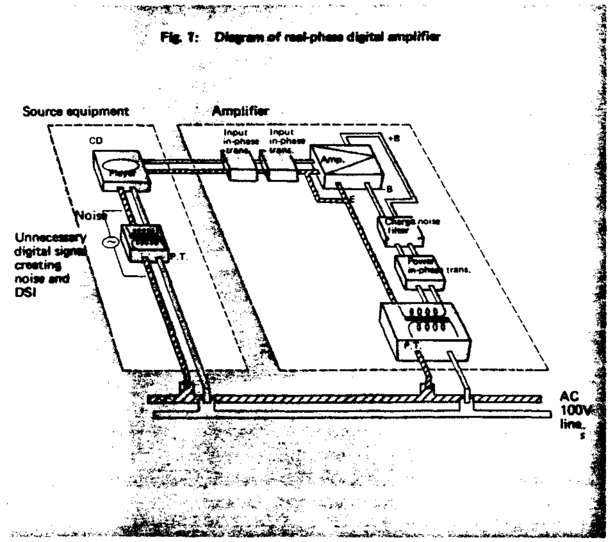
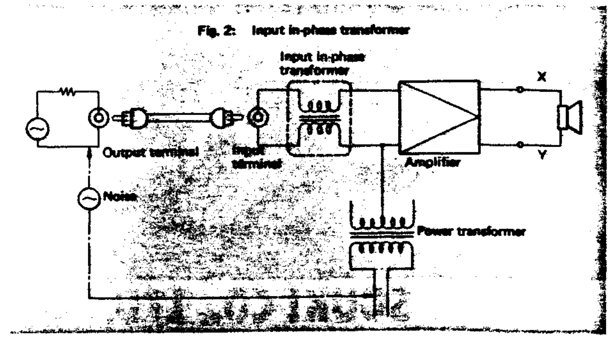
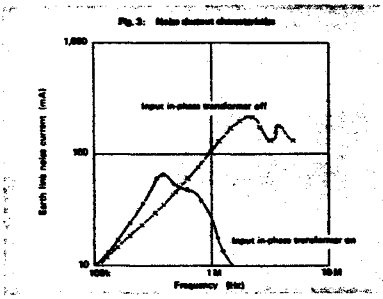
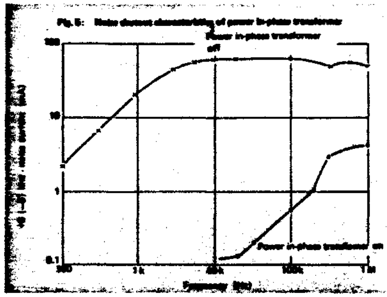
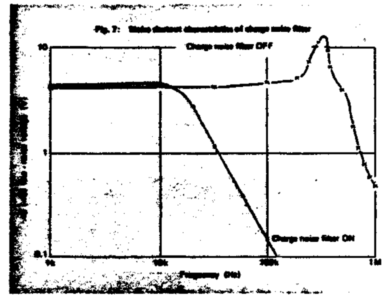


Fig. 2: Input in-phase transformer









tional amplifier and in an amplifier with the transformer. The horizontal axis here represents frequencies.

In an amplifier without the transformer, noise current increases with the rise in frequency. With the amplifier, on the other hand, interference current greatly reduces above a certain frequency range. Photos 1 and 2 show the measurements at the output terminal when a noise corresponding to the interference signal is applied between the earth, at the source side, and the AC 100V line. The amplifier referred to in Photo 1 is a conventional one, not equipped against interferences: in it, therefore, the DSI created reaches the speaker as well. In contrast, the input inphase transformer in the real phase 'digital' amplifier shuts out the interference signals. As a result, Photo 2 shows practically no DSI.

As is shown in Fig. 1, the real phase 'digital' amplifier includes, besides the input inphase transformer, a power inphase transformer (PIT) and a charge noise filter (CNF). Let us now turn to the power inphase transformer.

We have already seen that the input inphase transformer isolates the route (power transformer → earth line inside the amplifier → amplifier input terminal → audio cable → CD player) taken by a part of the interference from the AC 100V line. Even though this route is so isolated, however, part of the interference through it takes the route (AC 100V → power transformer → + B and − B) and tries to enter the amplifier circuit. It is this that the power inphase transformer (Fig. 4) shuts out.

Elimination Using Transformer

Figure 5, with its horizontal axis representing frequency, displays the characteristics of the common mode current finding its way into + B or − B line. As these characteristics show, inclusion of the power inphase transformer greatly reduces the current over a wide frequency range.

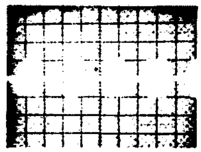


Photo 1

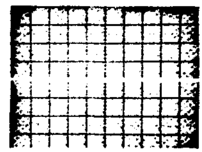
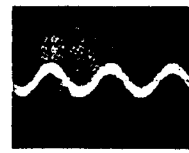


Photo 2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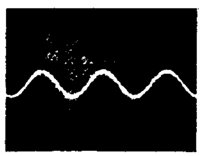


Photo 4


Photo 5

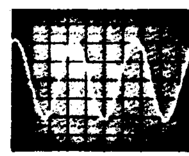
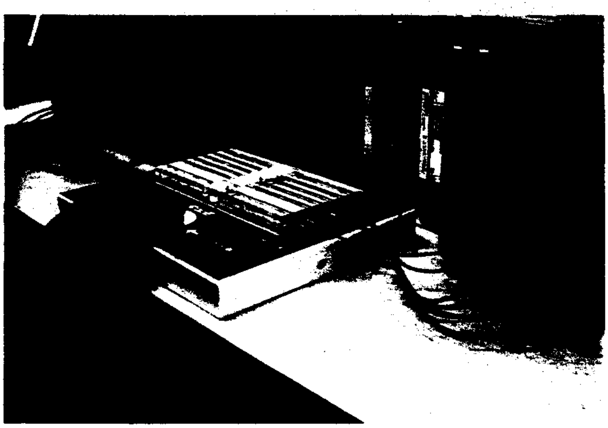


Photo 6


Optical link eliminates DSI

Have a look at Photos 3 and 4 next. Here you see waveforms observed between (B) and (E) when, as shown in Fig. 4, an interference voltage is applied between the AC 100V line, respectively, without waveform in Photo 3 was obtained without using the power inphase transformer and Photo 4 was with it. The transformer eliminates the noise imposed at 50 (or 60) Hz. The power inphase transformer is placed between the power transformer and the charge noise filter. The charge noise filter (Fig. 6) eliminates the normal mode noise, that is, the noise entering through one of a pair of AC lines and leaving from the other (characteristic shown in Fig. 7).

The C. R. of the filter and the inductance component of the power transformer serve to develop the high cut characteristic shown in the figure and also the noise elimination effect at the high frequency region. The waveforms appearing in Photos 5 and 6 were observed for the voltage between (B) and (E) when a normal mode noise was applied to the AC 100V line and the earth line. The and with the charge noise filter. Use of the filter completely removes the spike-shaped noise imposed at 50 (or 60) Hz.

Shutting out External Noise

As we saw, the three technologies represented by the input inphase transformer, power inphase transformer, and charge noise filter, have completely shut out external noise from the real phase 'digital' amplifiers. Also, these guard the amplifier circuit against the distortion due to DSI. The result is a wonderfully clean noise quality with the digital and also the analog source. Indeed the new amplifier features high resolution, sound field reproducibility, and its ability to offer you music without spoiling its inherent verve.

Onkyo Corporation

Fig. 4: Power in-phase transformer

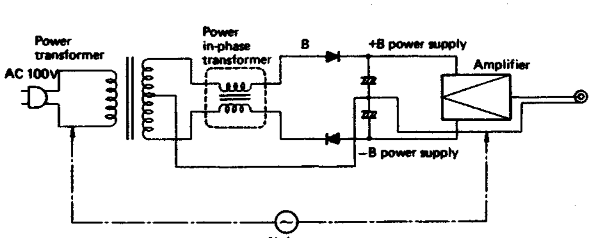


Fig. 6: Charge noise filter (C.N.F.)