

## Reduction of Noise from Pantograph

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Noise from a running train is caused mostly by aerodynamic and mechanical factors.

For a train running at a high speed, the loudness of aerodynamic noise is assumed to be proportional to the sixth to eighth power of the speed. In this case, therefore, aerodynamic noise has a large impact on the surrounding environment.

In the case of the Shinkansen and other trains that collect electricity from overhead wiring, current collecting equipment is installed on the vehicle top, and therefore represents the source of a large aerodynamic noise. Since the sound source is at a high position, it is difficult to achieve a soundproofing effect by using a sound insulating wall.

To prevent current collecting equipment from being directly impacted by wind, such covers have been developed as formerly prevalent bulkhead type covers (for pantographs) and currently prevalent rectifying type ones (for insulators). Also, there have been some cases in which covers are discarded in favor of low-noise designs for pantographs and insulators.

### ○ Conventional method

Crossed lower frame type pantograph + pantograph cover (bulkhead type)

The bulkhead type pantograph cover was introduced for use with the crossed lower frame type (diamond-shaped) pantograph, which had been in use from the inauguration of the Shinkansen.

The crossed lower frame type pantograph has a frame structure composed of supports (insulators and an underframe), peripheral equipment and many other elements. Since this structure significantly contributes to the emission of aerodynamic noise, it requires a cover designed to lessen the velocity of wind that blows over the pantograph and impacts its structure. However, the cover cannot be raised to the height of the vessel-shaped portion, due to the need to secure a certain distance from overhead wiring for insulation. Also, a low cover is desirable in terms of cover downsizing.

The bulkhead type pantograph cover was devised in view of the above circumstances. It is a bulkhead provided to the front of the pantograph, and is designed to re-course air flow upwards, and thereby lessen the velocity of wind impacting the pantograph portion higher than the cover height (Fig. 1,3).

Since the bulkhead type cover needs to effect a sharp upward change of air flow direction, it must be designed as a bulkhead, instead of a gently sloped structure.

Accordingly, the pantograph cover itself becomes a major source of aerodynamic noise. Though

the cover decreases the overall noise level as compared to that produced when it is not used, the level of noise from the cover is higher than that from any other portion of train equipment.

Additionally, the use of this method results in a sharp change in cross section area, which sometimes causes tunnel microbarometric waves\*.

Furthermore, the bulkhead disturbs air flow impacting the vessel-shaped portion, and thereby exerts a negative influence on current collection. Though this disturbance is controlled to a practically allowable level, it certainly does not represent a desirable cover characteristic.

### ○ Present method

Single arm pantograph + insulator cover (rectifying type)

The single arm pantograph, combined with a rectifying type insulator cover, was developed to improve both noise control and current collection compared to the conventional pantograph cover.

The single arm pantograph is designed to subdue noise by minimizing the quantity of members for the frame structure, which represent a source of aerodynamic noise.

The single arm pantograph causes a relatively low level of aerodynamic noise, even if its upper portion (frame structure) is blown by wind. Accordingly, only supports (insulators and an underframe) and peripheral equipment need be covered.

The rectifying type insulator cover was developed as an answer to this need (Fig. 2,4). It features a slope provided at the front of the pantograph. Wind is prevented from impacting the pantograph mount by being re-coursed upwards, but in a gentle manner (no disturbance is caused).

The cover is called an insulator cover, because it is intended to prevent wind impacts only at the height of the insulator.

The cover can be sloped gently, for it does not need to change wind direction sharply. Accordingly, the inclination of the cover can be adjusted so as to subdue aerodynamic noise from the cover itself. In addition, the reduced height of the cover results in a smaller plane of projection, which also contributes to noise control.

Also, the gentle slope and the reduced plane of projection are effective in controlling microbarometric waves.

As the name "rectifying type" indicates, the air flow directed upwards by the slope is not disturbed, and therefore it is unlikely to affect current collection.

Sound insulating walls are provided on both sides of the insulator cover, to control the sliding and arcing sounds from the vessel-shaped portion.

As has been explained, the rectifying type insulator cover has a performance significantly improved from the bulkhead type pantograph cover. The crossed lower frame type pantograph combined with the bulkhead type pantograph cover, the conventional method, has now been replaced by the single arm pantograph combined with the rectifying type insulator cover.

\* When a train running at a high speed enters a tunnel, air inside the tunnel is compressed instantaneously, and emitted from the entrance at the speed of sound. This pressure wave, called tunnel microbarometric wave, may cause an exploding sound, or have the window glass of nearby houses vibrate.