HOT BOX ACTUATED THERMO PNEUMATIC AIR BRAKE APPLICATION ON TRAINS (UPADHYAY SENSOR)

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The problem of hot axle box due to bearing failure is a well-known problem in all railways. It can lead to not merely derailments but also collision on double line. In India in one such collision, many people died when GT Express collided with a CRT wagon, which had derailed due to hot axle breakage and had infringed the opposite track in a double line section in Jhansi division. This problem was very acute when rolling stock used plain bearings, which were lubricated by cotton rolls immersed in oil. Advent of roller bearings, particularly cartridge bearings, has reduced the problem substantially.

But due to high speeds and absence of tell tale signs before catastrophic failure of roller bearings, the consequences of are much more severe now than those in plain bearing days. This was amply demonstrated in the G.T. Express derailment and collision case described above.

To prevent such accidents hot box detectors are in use in some railways. The present hot box detectors in use are track based which can not prevent such accidents as they can not stop train and may not be available at all spots where a bearing becomes hot. SKF in Europe has come out with a special bearing for this purpose. It has a sensor, which stops train through electrical/electronic signals in case of not only hot box but also derailment. Americans have developed a system where one of the of the bearing cap screw has a thermal sensor. But these systems are electrical/electronic and applicable in electrical/electronic brake systems. Most of the goods trains, world over, use only pneumatic brakes using Westing House or similar pneumatic brake system in locomotive. These trains can not use these European or American hot box detectors without extensive and costly modification in rolling stock and locomotive control circuits. Ideally a hot box detector should not require any modification in locomotive brake system and should have universal application on all types of rolling stock.

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Author has developed a thermo pneumatic hot box detector which Indian Railway has very kindly named after him (UPADHYAY SENSOR).

This device overcomes the difficulties of track based hot box detectors and does not require any change in brakes system of locomotives or wagons. Though designed initially for three piece freight bogie design (similar to American wagon bogies) using air brakes but it can be adopted in coaches and even vacuum brake systems.

Like old steam loco boiler lead plugs, it has a fusible metal plug which remains in contact with wheel bearing constantly due to spring pressure. The fusible plug melts at 85°C. This temperature could be reached when bearing touches about 100°C outside and may be about 120°C inside. The device has to be shielded from cold air in run, which is done by the adaptor. The melting of fusible plug opens a vent hole through which the brake pipe air leaks thus reducing the brake pipe pressure, which initiates brake application in the train. The train can thus hopefully stop before derailment or axle breakage due to hot bearings.

Initially an audible warning was also kept to warn the train passing staff. Ordinary whistles were placed near the vent holes but their alignment was critical. An electronic device with heat sensing device and buzzer was also developed. But audible warnings became redundant when a foolproof train stoppage in case of hot box was ensured by adequate drop in brake pipe pressure through vent hole.

To bring the brake pipe air near all bogie wheels, the brake pipe is tapped before distributor valve and a steel pipe make the brake pipe air available near every bogie. A flexible armoured rubber hose connects each plug from brake pipe. This system therefore does not in any way disturb the normal brake system of locomotives or rolling stock and is merely a modular add on.

The choice of metal composition of fusible plug is important. Inorganic material like wax etc. are bad conductor of heat and were not found suitable in trials. Similarly the bearing greases generally lose their lubricating properties at higher temperatures. Ideally the fusible plug should have a melting temperature of 85ºC so that considering the temperature rise in bearing before the plug melts, we should be able to stop the train before actual catastrophic bearing failure. Lead based soldering alloys have

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melting point of around 130ºC and are not suitable for this application. Special metal compositions had to be developed for this application and contours were developed to suit Indian bearings by trial and error method.

The amount of leakage permitted also has to be carefully regulated. If the vent hole is too small, it will not permit brake application in the whole train as in absence of drivers application of brakes the loco brakes (A-9 valve) will remain in 'self lapping' position thus treating the additional leakage thus induced as extra train pipe leakage. It will try to rush more air from air reservoirs to maintain the brake pipe pressure thus preventing brake application. In worst case it may lead to partial brake application in one wagon and may cause severe brake binding and flat wheel, which can cause even serious rail fractures. This self-lapping action is essential in loco brakes and cannot be removed because train brakes should not get applied merely due to normal leakage in brake pipe and rubber hoses. On the other hand, large vent opening may cause very sudden brake application and may result in train parting. This is important in coaching trains with screw coupling. In India 24 coach trains have taken screw coupling to brink. The choke size thus has to be carefully chosen. It was selected by simulating the most adverse condition by putting a disc with hole on the last wagon and keeping the locomotive compressor at highest speed on eighth notch. The minimum size, which permits brake application on whole train even when the train is running in eighth notch, was chosen.

Also during trials it was found that the compressed brake pipe air has to be isolated from fusible plug till it melts, which is done by a special valve inside. It can be seen in the photograph enclosed. Compressed air, if it remains in contact with the fusible metal, carries the heat away and does not allow the fusible plug to melt unless bearing becomes very hot. It was confirmed during trials in development stage.

Another problem is to keep the hot box detector constantly in touch with the axle box/roller bearing. It is a problem because due to vibrations any permanent fitment can become loose. This was achieved by putting the device through a spring, which remains in tension thus constantly pressing the hot box detector against the bearing even during severe vertical vibrations. This arrangement can be seen in the film (CD) of the device, which is enclosed with this paper.

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Another problem was introduced different horn size of bogies used in India as well as in Europe and America. The standard American three-piece bogie has both wide as well as narrow horns. To overcome this problem, the detector is housed in a universal adaptor, which can work in both wide horn and narrow horn bogies. The compressed air is supplied by tapping brake pipe near the distributor value. The air pipe is connected below the adaptor as can be seen in the film (CD). To enable train operation in case of defective or leaking detector, an isolation lock is provided for isolating defective wagons. Each bearing is fitted with one detector, as it is a very low cost device having no moving parts.

During development stage the device was first tested on a special rig where a round piece, simulating bearing was heated by electrical resistances from inside. It was essential to choose proper fusible alloy.

The device was tested subsequently in dynamic condition on a wagon with one wheel fitted with sand filled seized cartridge bearing. The rollers in this bearing were immobilised. The bearing was fully jammed. The brakes got applied within three hundred meter run as the fusible plug melted very quickly. After successful testing the device was fitted in several wagons, which are working in South Eastern Railway in India for last several months. Indian Railway is fitting this device on one rake to gain field experience before considering its adoption. Two photo of the device are enclosed which gives the construction details. The CD which has a film, gives all details in a much more appreciable visual manner.

The device is superior and much more effective than presently available track based hot box detectors as it can catch a hot box in incipient stage. It requires no change in loco or train brake systems unlike its electronic counterparts developed in Europe and America. It is simple, cheap and has no moving parts. It can become part of wagon and can get condemned with wagon in case no hot box ever takes in its entire life. It makes sound economic sense as it has a potential of eliminating not only hot box and consequential accidents but can also eliminate unnecessary expenditure on overhauling of cartridge bearings before ten years service necessitating removal of wheels.

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