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BOILER CODE OF PRACTICE (BCOP)

GUIDANCE NOTE

SMOKEBOXES

Purpose

This document describes good practice in relation to its subject to be followed by Heritage Railways, Tramways and similar bodies to whom this document applies.

Development

This document has been developed by boiler experts in consultation with His Majesty's Railway Inspectorate (HMRI) a directorate of the Office of Rail and Road (ORR). The document HGR B9000 sets out the background to setting up the Boiler Code of Practice Committee (BCOP).

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1. Introduction

This Guidance Note is one of a series dealing with locomotive boilers that were produced by the “Steam Locomotive Boiler Codes of Practice” practitioners’ meetings.

Railway locomotive boilers are designed to create, store and distribute steam at high pressure. The working life of such a boiler can be considerably shortened if due care is not taken at all stages of inspection, repair, running maintenance and day-to-day running.

In the past there have been a series of accidents and explosions due to work being undertaken without having due regard to the inherent risks involved. It is with that in mind that HMRI and HRA set up the series of meetings of boiler practitioners to discuss the issues; distil good practice and codify it into this series of Guidance Notes.

This guidance is written for the assistance of people competent to perform these tasks. In places the terminology used may be specific to such practitioners.

This guidance should also be useful to those in a supervisory or more general role. However, no work should be undertaken unless the persons concerned are deemed competent to do so.

Where managements decide to take actions that are not in agreement with these recommendations, following appropriate risk assessments or for other reasons, it is recommended that those decisions are reviewed by the senior management body of the organisation concerned and a formal minute is recorded of both the reasons for and the decision reached.

2. Dimensional Notation

The dimensions in this document are variously described in a mixture of imperial and metric units. Where practical equivalent dimensions have been shown but in some cases the dimensions do not easily equate and so the units in force at the time the original designs were documented have been used.

3. Personal Protective Equipment

Before undertaking any work, a risk assessment must be conducted.

Protective equipment is to be supplied and used at work wherever there are risks to health and safety that cannot be adequately controlled in other ways.

‘Asbestos’ may still be encountered when stripping locomotives. If found it must be disposed of properly, complying with the appropriate Regulations.

The equipment must be:

- Compliant with the latest Personal Protective Equipment (PPE) Regulations;
- Properly assessed before use to ensure it is suitable;
- Maintained and stored properly;
- Provided with instructions on how to use it safely; and
- Used correctly by those undertaking the work

4. Materials

The outer wrapper is usually mild steel, S275 or copper bearing steel.

Hot Rolled Mild Steel BS EN 10025 S275JR Formerly BS4360/43A

For all other items, refer to the original drawings.

5. Smokebox Construction

There are two main types of construction with many variations in the design and construction details.

1. Fully Cylindrical type with a flanged tube plate set into the front of the main boiler barrel. The cylindrical smokebox is riveted to an extension of the main boiler barrel and sits on a saddle which is bolted to the loco main frame. This saddle, in some examples, forms the base or floor of the smokebox, containing passageways for the exhaust steam from the loco cylinders, leading to the

base of the blast pipe. The front opening of the smokebox is closed by a hinged circular door which seals onto a front ring when held closed by a central screwed dart, fixing onto an internal crossbar, or in a few examples by lugs around the periphery of the door.

2. Horseshoe shape type with a flat tube plate riveted to an angle ring attached to the front of the main boiler barrel. The tube plate is extended down to form the back wall of the smokebox, which is bolted along the bottom edge to either a middle cylinder casting or a saddle, thus transferring the weight of the front half of the boiler to the main frames. The outer edges of the tube plate may be flanged to take the smokebox wrapper plate, or an angle ring may be riveted on to carry out this function. The outer wrapper plate sides are extended down to form the lower side walls of the smokebox which can be fastened to the loco main frames or a saddle. The front opening is closed by a hinged circular door, closing onto a sealing ring on the front plate the door being held shut by a central screwed dart, fixing on to an internal crossbar, or, in few examples, by lugs around the periphery of the door. The back of the door is usually provided with a renewable baffle (or wear) plate.

The base of the smokebox may be formed by an inside cylinder casting or by a plain casting or fabrication, through which main steam pipes may pass and exhaust steam passages may be cast integrally leading exhaust steam to the base of the blast pipe. Voids and cavities in the smokebox base are usually loosely filled with refractory material (adding lime can give some protection against corrosion) and finished off with a smooth cement topping to ease the removal of ash and cinders whilst being serviced. These cavities, if allowed to remain damp, can lead to serious corrosion of iron and steel casting structures and fittings such as cylinder blocks.

The refractory material should be removed and thorough checks made for corroded components approximately every 7 to 10 years and the refractory should be removed during a boiler overhaul. ***N.B. Old cement in GW locomotives may contain asbestos and should be dealt with according to standard procedures***. Any leakage of steam through the refractory must be investigated and rectified. This may be due to leaking steam pipe joints, holed steam pipe work, broken small bore lube pipe work or a fractured cylinder casting.

6. Care of smokeboxes

All smokeboxes and their components are subjected to heavy wear and tear due to abrasion from cinders and corrosion due to the inevitable acidic conditions during the lighting up and raising steam from cold, caused by the gas temperatures being below the dew point temperature of the flue gas, until nearly full steam pressure is achieved. The corrosive conditions are aggravated if accumulations of soot, ash and cinders are allowed to build up, as damp ash and soot are very corrosive and should be cleared away each day following operation, while the boiler is still warm.

Slight leakages on the tube plate from tube expansions, washout plugs and tubeplate flange seam and rivets (and longitudinal stays nuts if fitted) should be attended to as soon as practicable. Leakage of boiler water from these components can result in severe corrosion leading to loss of rivet heads and wastage of flanges in a fairly short period of time. Slight leakages from these components are often only present when the boiler is cooling down and can often take up when in steam. However, if the boiler is left to cool down and stay cold for a considerable period of time, considerable corrosion can take place leading to significant loss of rivet heads, thinning of pipe work, castings and steel plate work.

Heavy leakage on the tube plate will result in the locomotive being taken out of service. If this occurs while running in service, symptoms would be loss of steaming power, excess water consumption, difficulty maintaining boiler pressure and boiler water level and the leaks may also be audible. Great care needs to taken when investigating such defects when in steam, to avoid being burnt or scolded.

The smokebox wrapper plates, front ring and door will all suffer in time, wearing thin due to corrosion and erosion, Eventually, holes may develop in localised areas of maximum corrosion. Such holes will result in reduced smoke box vacuum and will adversely affect the steaming of the boiler. Small holes can be repaired by patching but large areas of thinning and holes may require new plate work to be fitted. Severe cases may require a completely new smokebox.

All internal fittings and fastenings such as superheater headers, main steam pipes, blastpipes, blower rings, chimney castings, petticoats, kylchap cowls, and ejector exhaust rings should all be examined at each

washout exam and annual exam. The smokebox dart fastener and crossbar should be examined and a check made to ensure the door will be held tightly closed against the sealing ring.

Internal smaller pipes in steel and copper should also be examined for fractures, thinning, and excessive corrosion. Copper pipes should be annealed every 5 years and whenever they are removed.

Pipes carrying full boiler pressure without means of shutting off, require extra care and attention. E.g, LM and GW steam lance supply, GW oil supply pipe, LNE anti carbonising steam supply.

The main fixing bolts securing the smokebox to the frames via a centre cylinder or a saddle should be examined for loose and broken bolts or any sign of distress due to excessive expansion forces caused by seized expansion bracket slides at the firebox end.

Where fitted, the seals (or glands) around the main steam pipes to outside cylinders should be examined, and also the main door seal. Air in leakage at these locations can lead to destructive internal fires in the unburnt char and this can destroy spark arrestor screens, other internal fittings and lead to badly burnt smokebox doors.

During the steam test following a boiler washout, the smokebox should be inspected internally for leaks on the tubeplate, superheater header and elements, main steam pipe joints, and blower steam pipes. The blower jet should be checked for blocked or ineffective nozzles and the door seal checked when reclosed to ensure air is not being drawn in.

7. Inspection and Examination Regimes

Because certain defects in smokeboxes can lead to safety critical conditions on the footplate, resulting in danger to the staff or public, a regular system of inspection and examination is required.

The most frequent inspections can be carried out by the footplate staff during preparation and disposal duties. Such inspections are only visual by staff trained in the basic requirements of operating. A more thorough inspection should be carried out by a fitter or boilersmith as part of a routine examination schedule (weekly).

A thorough inspection and examination when cold should be carried out following a routine boiler washout by a qualified boilersmith or fitter and a more thorough examination should take place annually. At approximately 7 to 10 yearly intervals, the examination should include removal of refractory lining of the base to expose hidden cylinder castings, steam pipes and joints, exhaust steam duct castings or fabrications and small-bore lubrication pipework to inside cylinders.

It is essential that the examiner understands the construction details as thoroughly as possible by referring to detailed drawings whenever available, so as to understand the possible consequences of any deficiency that may be uncovered i.e. thinning of cylinder casting walls, eroded webs, eroded securing nuts and bolts, wear and thinning of exhaust ducts and methods of fastening. Some ex-LMS and BR locomotives have a blast pipe base which is welded to a smokebox saddle plate by a shallow fillet weld, corrosion of which can lead to complete failure. This can result in the blast pipe shifting and possibly causing a serious blowback into the cab when working hard. These fillet welds require special examination which can be difficult due to their awkward location in a recess in the bottom of the smokebox.

8. Spark Arrestors.

These are now essential fittings for most coal-fired locomotives, there being two basic types.

1. **Basket mesh around the blast pipe and chimney petticoat**. Main line locomotives also have a primary screen, either a mesh screen or a flat plate between the tube plate and the blast pipe. The primary screen is to break up larger pieces of char travelling at high speed exiting the boiler tubes to reduce the chance of them blocking the chimney screen. This type of arrestor usually requires the char to be emptied from the smokebox each day.
2. **Self cleaning system** derived from American practice consisting of internal steel plates arranged to direct the smokebox gasses towards the front door baffle plate, then, on reversal of the gas flow, through a large flat mesh screen into the chimney. The action of the char hitting the front baffle plate breaks up the larger pieces until they are small enough to be ejected through the mesh screen. When correctly proportioned this type of arrestor may operate for a number of days without any need to be cleaned out.

Stainless steel wire mesh with ¼ inch (6.3 mm) maximum opening is recommended. Another mesh in use is a flattened diamond mesh in stainless steel.

All spark arrestor equipment needs to be robustly constructed and secured to withstand the very harsh pulsating conditions that are experienced in smokeboxes. Plates and screens need to be very secure to prevent them working loose in service which could cause a restriction or blockage of the gas flow. This could potentially lead to a serious blowback of the fire into the cab with serious and potentially life-threatening consequences for the footplate crew. Some plates and screens are fitted with safety chains as a backup protection in vulnerable locations.

Routine examination of the screens is essential to ensure the security of the components and the soundness of the mesh screens are maintained.

9. Corroded weld covered in cement

An incident occurred on a Heritage Railway where it transpired that a critical weld failed in a place covered by cement, which increased the likelihood of corrosion.

The locomotives affected are some LMS and BR standard types. The particular locomotive concerned was ex-BR standard 75029

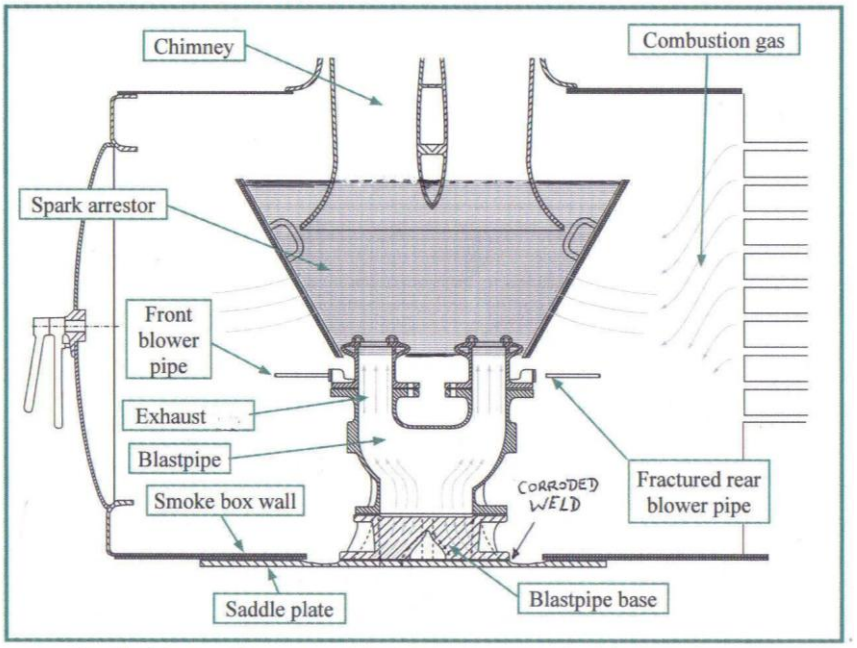

Figure 1 – Simplified drawing of Locomotive 75029 blastpipe and associated smokebox components

Figure 6 – The blast pipe and base (Location of corroded weld)

10. Illustrations

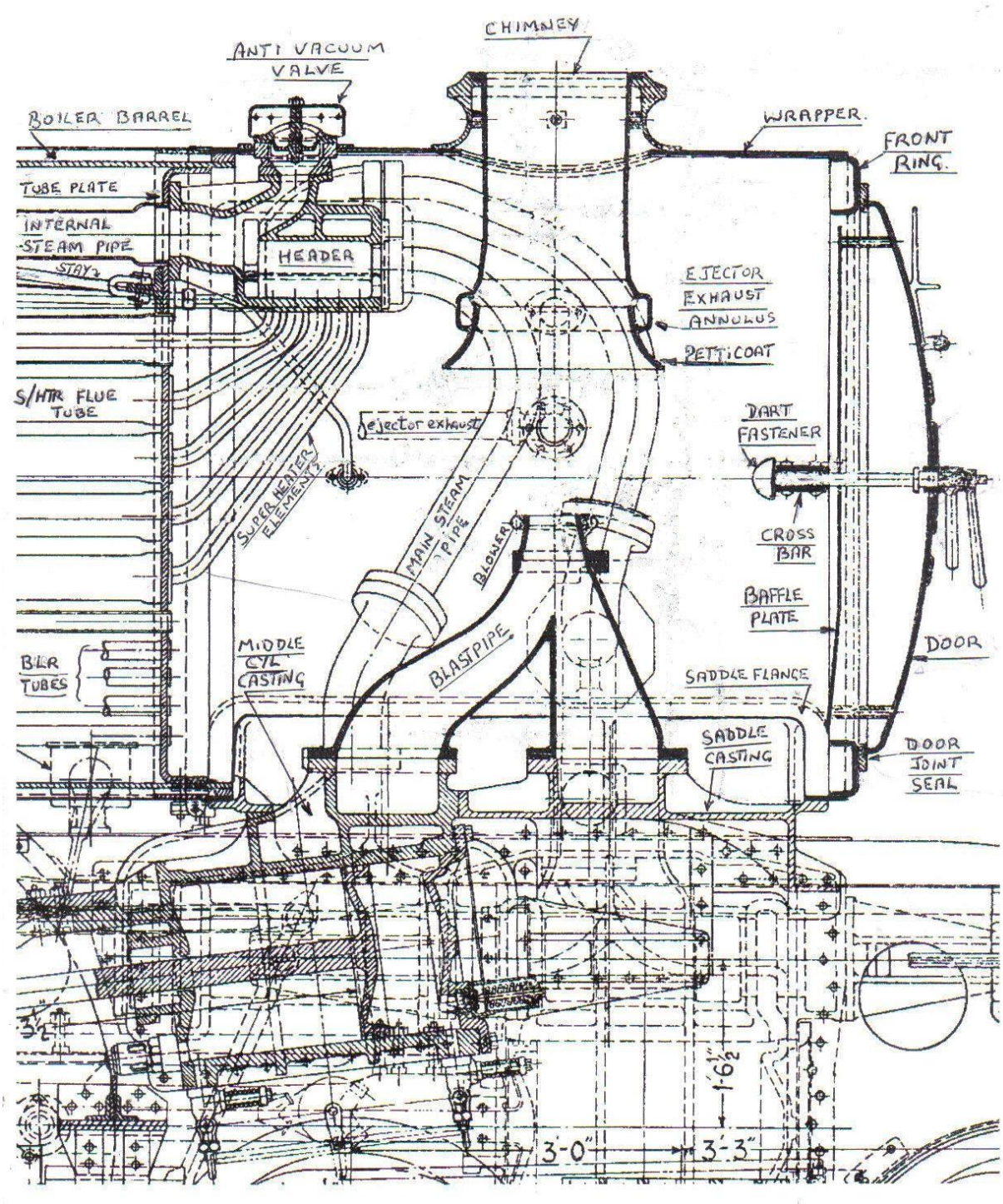

Figure 3 – Side elevation of an LNE A3 type locomotive

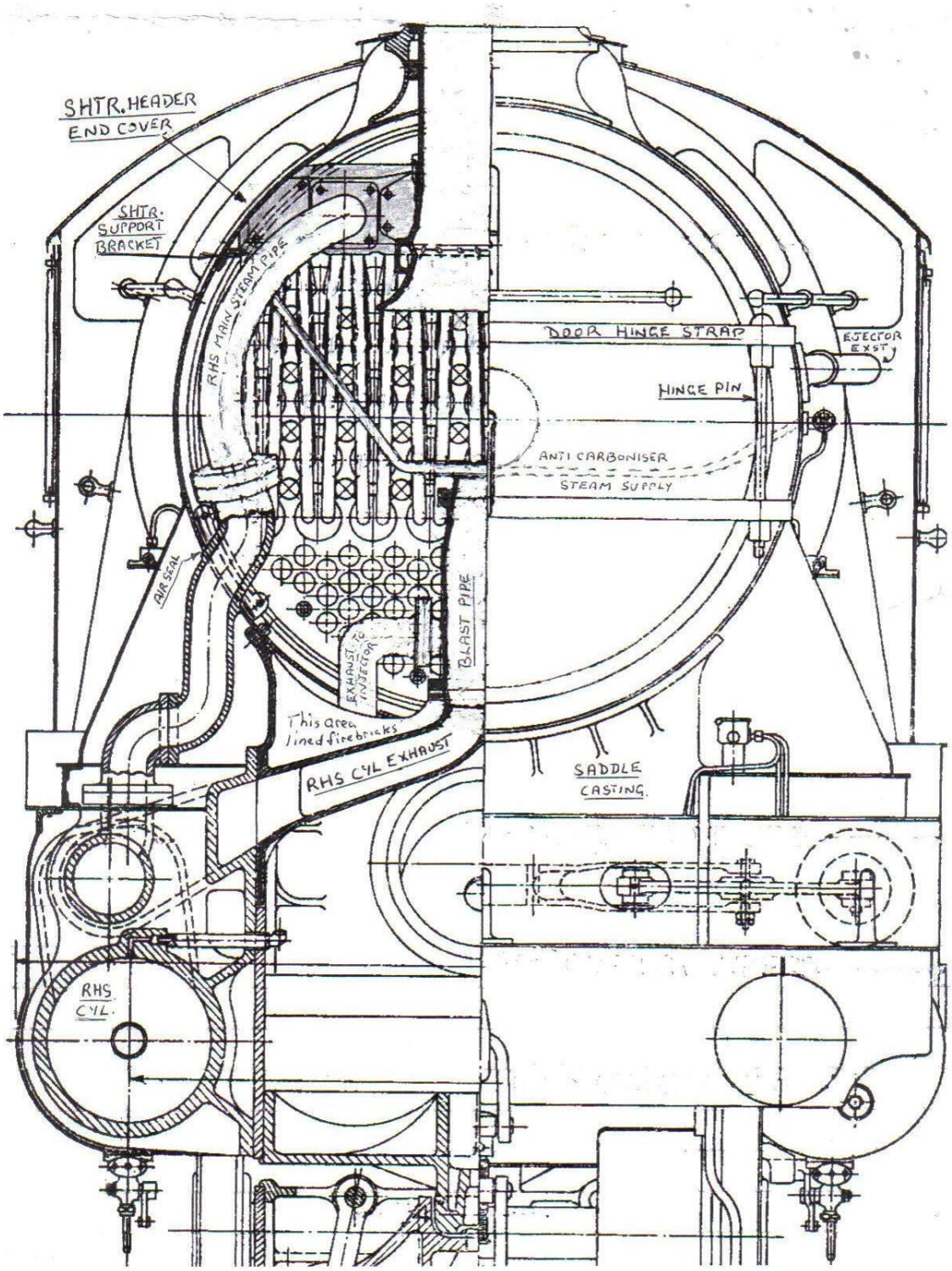

Figure 4 – General View from front of an LNE A3 type locomotive

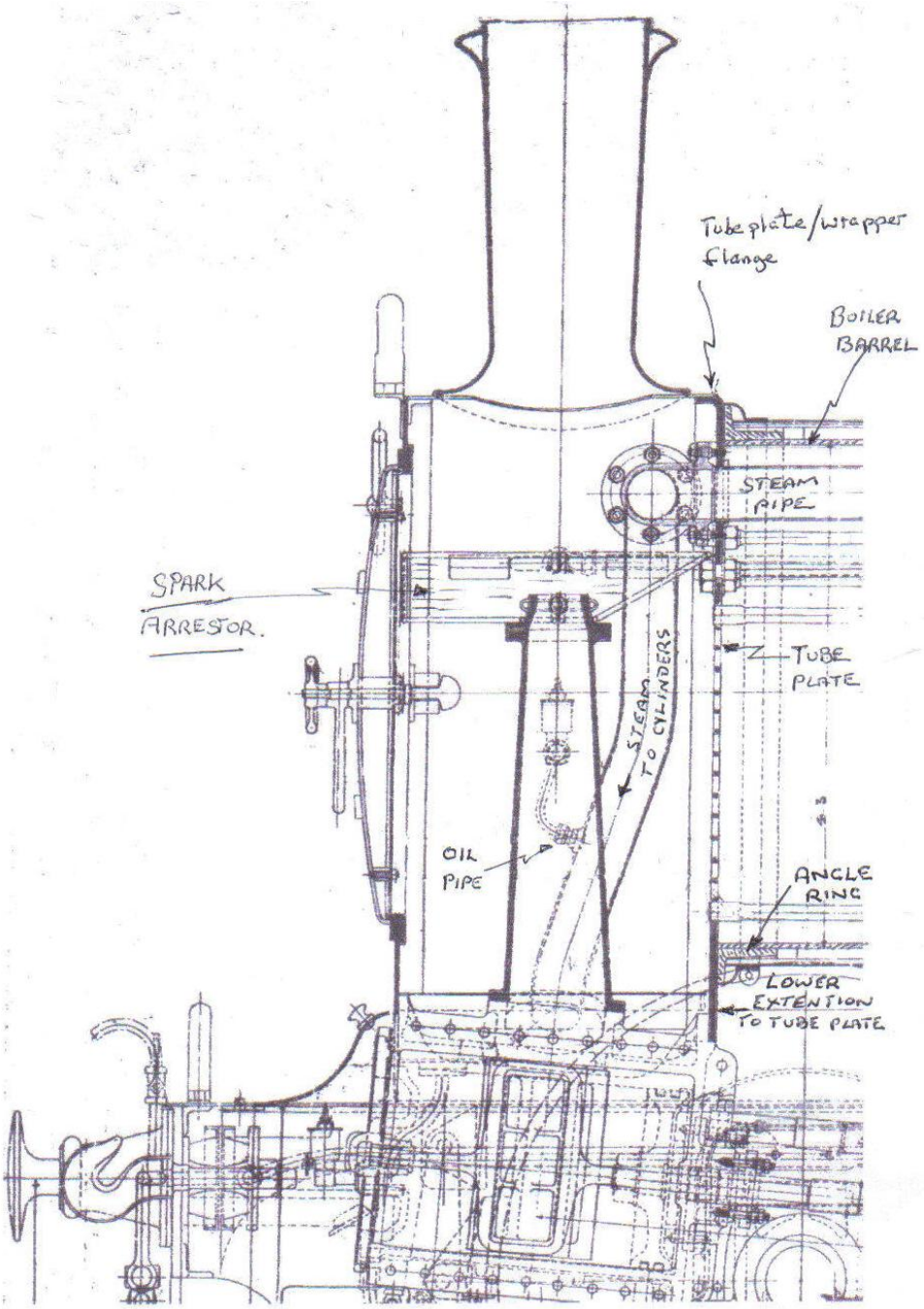

Figure 5 – Old style flat tube plate smokebox

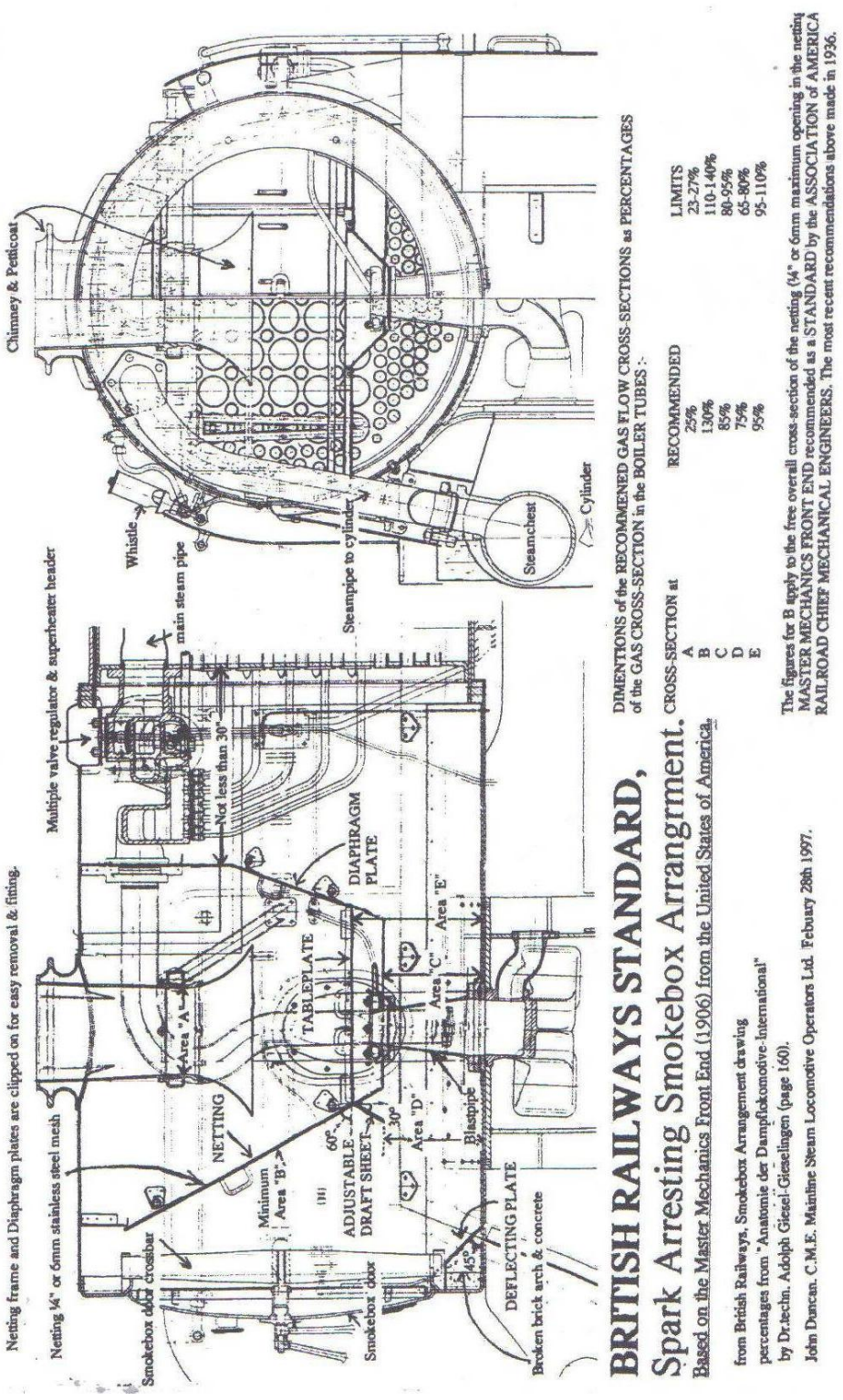

Figure 6 – BR Standard Spark Arresting Smokebox Arrangement