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NOTES.

(*a*) TESTING OF MATERIALS FOR HAIR CRACKS.

Concurrently with the progress in design of machinery, fresh methods have been employed for testing the materials to be used both for their quality and suitability for the intended service. For ordinary machine parts not subjected to undue stresses, the normal method of specification, combined with standard tests of the mechanical properties of the material, is sufficient to ensure satisfactory service, but in the case of important high speed machinery, generally subject to high stresses, further special tests have to be evolved to ensure complete suitability of the machine part for the service required.

Many large machine parts are in the form of steel forgings made from ingots which may suffer from a number of faults such as segregation of impurities, cavities and slag inclusions, and to eliminate as far as possible the possibility of objectionable features in the forging, the head of the ingot is always discarded and, further, the centre of the forging is bored out. A complete visual inspection of the forging is then made, the surface of the bore being closely inspected throughout its entire length by means of special instruments.

This inspection is supplemented by sulphur prints, which show whether the distribution of the remaining segregates is satisfactory. For ordinary steel forgings this inspection, together with satisfactory mechanical tests on test pieces, is sufficient, but in the case of certain alloy steels other defects may be present which are not revealed by these methods. The most serious fault found in alloy steels, especially those containing, say, more than 0·5 per cent. of carbon, is the presence of minute hair cracks in the material. These, while usually numerous, are not visible to the naked eye and, normally, are only visible under a microscope.

In order to test for this fault two methods of test have been tried :—

(*a*) Tarnishing.
(*b*) Magnetic.

Tarnishing Test.—The part to be tested is smooth machined with an oil cut and its surface wiped clean with a rag. Fumes of cold strong nitric acid are passed evenly over the surface for about 20 minutes and the steel left for 24 hours. The steel is then covered with a light brown film of tarnish all over, and should hair cracks exist they will show up bright and clearly visible, presumably owing to the oil in the crack from the final machining preventing the fumes attacking the steel at the edges of the crack. After examination the steel must be thoroughly cleaned to prevent rust setting in. The tarnish film is thin and will scratch off, so that during examination great care is necessary to prevent any touching of the surface, otherwise misleading results will be obtained.

Magnetic Test.—By means of a suitable electro magnet a powerful magnetic flux is caused to pass across the part under test. Very finely divided iron or magnetic oxide of iron suspended in paraffin is then allowed to flow gently across the surface under examination. Any small crack will involve a magnetic discontinuity on the surface of the material and the iron filings will adhere and bridge the crack, outlining the crack.

This method of test has proved particularly useful for testing stainless steel turbine blades. Stainless steel is peculiarly liable to this trouble of hair cracks and its use for this purpose has therefore been viewed with some suspicion. Certain firms, however, in order to take advantage of the special properties of stainless steel for turbine blades, have developed a routine whereby all stainless steel blades are tested for cracks. In this case, the blades are placed in batches inside an electric coil which magnetizes them and are then placed in a bath containing paraffin to which iron dust has been added, the mixture being kept in a state of agitation. The residual magnetism is sufficient to cause the iron to mark out any cracks present, such blades being then rejected. After examination, the blades are placed in an alternating current coil which demagnetizes them.

Other methods of magnetic and electric testing have been tried but the above is that generally employed at present.

(*b*) LOSS OF HEAT IN FUNNEL GAS.

In ships provided with CO_2 recorders and thermometers for measuring the temperature of the Gases at the base of the funnel where no preheaters are fitted, an estimate of the loss of heat in the funnel gas, and thence of the boiler efficiency, can readily be obtained.

The curve given in Fig. 1 represents the excess air over that theoretically required for complete combustion present in the gases for various CO_2 contents.

Fig. 2 gives the heat lost up the funnel expressed as a percentage of the total heat supplied for various funnel gas temperatures and percentages of excess air.

Using Fig. 1 and 2 together, the actual per cent. heat lost can be obtained from the readings of the CO_2 indicator and thermometer.

A small amount (2 to 3 per cent.) must be added for radiation losses, and the boiler efficiency is thus 100 per cent. minus (Funnel gas loss per cent. + 2 or 3 per cent.).

Two conditions are necessary before reliable results can be obtained, using this method :—

(1) The thermometer should be situated as low down in the uptake as possible, as there is a considerable fall in temperature of the funnel gas along the length of the uptake and funnel.

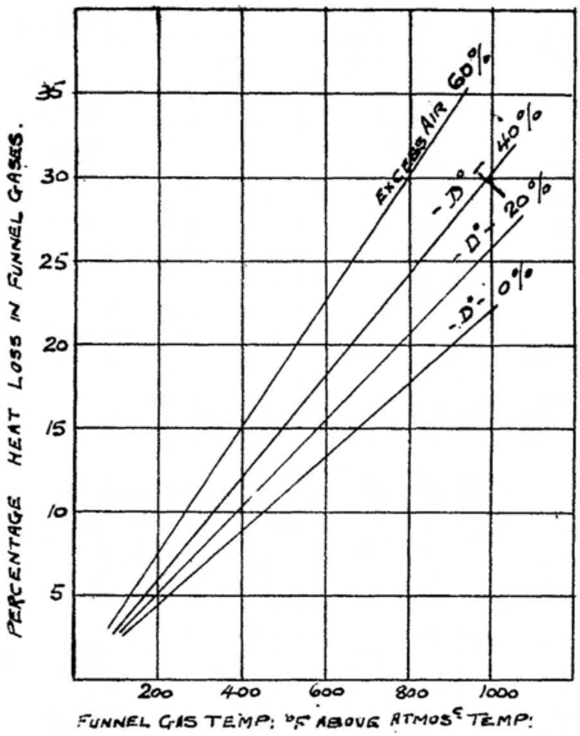

FIGURE. 2.

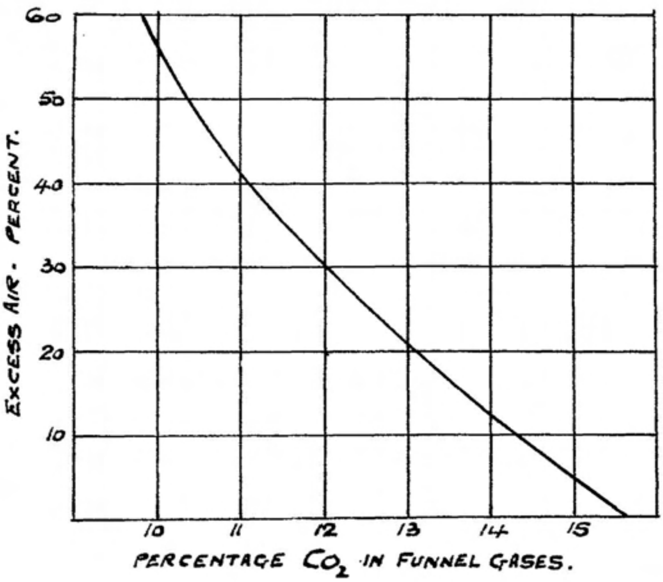

FIGURE .1.

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(2) The combustion must be complete, and in general it may be assumed that this is the case if no trace of carbon monoxide is present in the gases.

As regards the second condition it is not very easy in a ship to obtain the ideal conditions of the highest percentage of CO_2 possible with complete combustion. It may be taken, however, that with moderate and light smoke at the funnel the combustion will be complete provided the oil burning arrangements are functioning efficiently.

(*c*) WASHING PARAFFIN AND PETROL.

Paraffin and petrol as supplied for service use frequently contain particles of foreign matter. Some of the particles are so fine that it is impossible to separate them out by normal straining processes even when using the finest available straining materials. In spite of the fineness of the particles they are liable to choke certain types of carburettor jets.

In order to ensure complete removal of these foreign substances, a washing process may be resorted to, and the following method has been tried successfully.

A tank or drum is procured and fitted in a suitable position on deck, and arrangements made to provide a cover at the top fitted with a locking device.

The tank should be fitted with a drain cock at the bottom and another cock about 6 in. up the side. Water is poured into the tank to a level of 1 in. below the upper cock, after which the tank is filled with petrol or paraffin and is well stirred.

The mixture is then allowed to settle for at least an hour and the " washed " fuel may now be drawn off from the upper cock as required.

It will be found that the whole of the foreign matter settles in a film between the water and the fuel.

(*d*) MANUFACTURE OF SPRINGS.

The following method of making coil springs for use in tension has been found to be of service on board where the means available are restricted. The tempering process described can be used for any type of spring with equal success.

One end of the spring steel wire to be used is passed through a hole drilled in a mandril, the diameter of which is that of the inside of the finished spring. The mandril is then placed in a lathe or horizontal boring machine and the wire led through a block or over a pulley at some convenient height. A weight, sufficient to cause a stress in the wire slightly below its elastic limit, should be hung upon it, with sufficient scope between the weight and the block to allow the whole spring to be wound in one operation.

The lead to the block should be so arranged that the wire, in feeding on to the mandril, keeps each successive coil tight against the last.

The machine is now started and the wire slowly wound on. During this process it should be well brightened with fine emery cloth, to enable a high finish to be put on it later. When the winding is complete the coils should be removed from the mandril and placed on a bolt of the same diameter and the nut screwed up to keep the coils tight.

The spring and bolt should then be placed in a tube in the fire and slowly and evenly heated to a bright cherry red (1650° F.) and immediately quenched in water, taking care to immerse the bolt with its axis vertical. An alloy of one part of tin to twelve parts of lead (melting point 650° F.) is suitable for tempering. This alloy should be heated in a convenient vessel until it is not quite all molten and the spring and bolt plunged in. Immersion for one minute is sufficient for light springs of about ¾-in. mean diameter. The spring should then be requenched in water, taking the same precautions as before.

The spring is now ready for use, but a fine blue finish may be given by coating with the following mixture : cod liver oil, 1 pint ; beef suet, 2 ounces ; neatsfoot oil, ⅛ gill ; resin, ½ ounce ; reheating in a tube until the mixture flashes and then quenching in water. As this mixture flashes at a temperature approximating to the tempering temperature, care must be taken that the spring is not overheated during this process.

It will be found that once this method has been successfully employed the number of failures will be negligible if reasonable care is taken.

A similar means of tempering lathe tools, etc., using an alloy of 65 per cent. lead and 35 per cent. tin (melting point 430° F.) has also been used with success.

Springs made by the method described above must have end caps with suitable hooks made separately and screwed into the spring ends. If it is desired to form the end hooks from the spring material, the end coils must be bent up before tempering and the bolt cannot therefore be used to hold the coils tight. Springs made in the latter manner are quite satisfactory but they will not be quite "close coiled" after tempering.

(*e*) **MAINTENANCE OF CENTRIFUGAL PUMPS.**

The efficiency of Centrifugal pumps is to a certain extent dependent on the maintenance of a suitably small clearance between the casing and the periphery of the eye of the impeller, and as wear from erosion, etc., usually takes place at these surfaces, they require periodical attention.

In the larger types of pump renewable rings are usually fitted to the pump casings, but in the smaller types no provision is made.

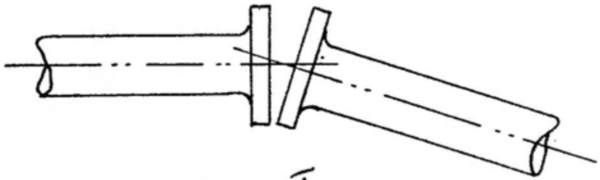

FIGURE I

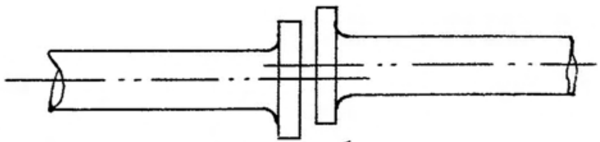

FIGURE II

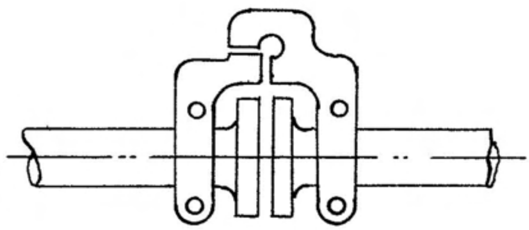

FIGURE III

FIGURE IV

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The following method of repair has been applied with success to such pumps on board :—

The casing is carefully rebored and the wearing faces of the eyes of the impeller turned up in the lathe. The impeller fans are then carefully tinned and built up to the required diameter with the same metal. Although not necessary, it is desirable, when in the lathe, to form an undercut recess round the periphery of each eye to assist the adhesion of the tin. The impeller is then replaced on its shaft and the eyes carefully trued in the lathe, leaving a running clearance of some two or three thousandths of an inch in the case of small impellers.

In the case of pumps handling sea water the repair should last a year before it becomes necessary to renew the tin. There should, of course, be no necessity to rebore the casings.

(*f*) **ALIGNMENT OF SHAFTING.**

Excessive wear in the bearings of auxiliary machinery generally accompanied by considerable vibration is often traceable to lack of alignment between the shafts of the driving and driven members.

Flexible couplings are useful as a means of allowing for any expansion of the members or distortion of seatings, but are not a satisfactory substitute for lack of alignment. If two shafts out of line are joined by a flexible coupling, rapid wear of the coupling usually results, and a harmonic force of period two cycles per revolution is generated, which may be the cause of serious vibration troubles.

Shafts may be out of line in three general ways :—

(1) Their axes may make an angle one with the other (Fig. I).
(2) Their axes may be parallel but not coincident (Fig. II).
(3) A combination of (I) and (II).

A simple way of checking the alignment of two shafts which involves no trial and error methods and little skill on the part of the user is as follows :—

A male gauge is fitted on to one shaft which has two faces, one parallel to the axis of the shaft, the other at right angles to it.

A female gauge is fitted to the other shaft with two similar faces and is set up so that the faces of the male and female gauge are a few thousandths of an inch apart (*see* Fig. III).

The two shafts are now rotated, keeping the gauges together, and the distances between the faces of the male and female gauges may be measured at various points with feelers.

The shafts are in line when the distance between both faces of the male and female gauges are constant throughout a revolution. If the distance between the faces perpendicular to the shaft axis alters during the revolution, then the misalignment is angular as in Fig. I. If the parallel face distances alter, the shaft axes are not coincident as in Fig. II.

Observation of the feeler readings will indicate exactly what alterations to the line of one or the other shaft must be made.

If clock gauges are available they may be mounted and used instead of feelers and the process of alignment will then be somewhat quicker.

The case of shafts which are long compared to their diameter and which are usually mounted in several bearings is a somewhat special one.

In this case, although the bearings may be in line, the shaft couplings may not be, due to the gravitational deflection of the shaft (Fig. IV). There are two alternative procedures which may be adopted.

(1) Line up the bearings by " sighting through " or similar method.

(2) Line up the couplings as previously described.

Method (1) will leave a bending moment at the couplings after these are connected ; that is to say, the couplings will have to be forced into line before they can be coupled together.

Method (2) leaves no bending moment at the couplings, but the bearings will not be in line.

It may be taken, however, that in practically every case, Method (1) will result in less load on the bearings than Method (2).