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Mechanical Manual
B3.2.7.01
Operation and Maintenance of Steam Driven Air Compressors

Issue	Prepared (P), Reviewed (R), Amended (A)	Approved by	Effective Date
1	P McCallum (P)	Heritage Technical Committee	27 June 2006

Reference Material

Source	Description	Date
NZR	Various documents relating to operation and maintenance of air compressors	Unknown
NZR	Instructions For The Overhaul And Testing Of Air Brake Equipment In Workshops – Steam Driven Air Compressors	28 April 1958
Mainline Steam	Steam Driven Air Compressors	May 1999
Y21190	W.H.B. Steam Driven Air Pumps; Speed Tables For Tests	2 May 1958

The holder of printed or duplicated copies of this document is responsible for ensuring they are using the latest version.

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Introduction

This manual includes several NZR documents describing the operation, maintenance, overhaul and testing of steam driven air compressors.

Other Information
B3.2.7.02 - Air Brake Maintenance Manual, Section 2 for recommended lubricants.
B3.2.8.01 - NZR Air Brake Handbook
Westinghouse steam compressor instructional booklets

Section 1
Westinghouse Brake Compressor
Operation and Maintenance

Source – NZ Railways
Dates - Unknown

Introduction

This document, or series of documents, describes the operation and maintenance of steam driven air compressors. Obvious spelling mistakes and grammatical errors have been corrected but some may still remain.

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Operating Compressors

Starting And Running

The drain cocks are placed at the lowest points of the steam passages for the purpose of draining off condensed steam when the compressor is stopped and when starting it. They should always be left open when the compressor is to stand idle for any length of time.

In starting the compressor, always run it slowly until it becomes warm permitting the condensed steam to escape through the drain cocks and the exhaust, until there is sufficient pressure in the main reservoir (25 to 30lbs) to provide an air cushion. Then close drain cocks and open the steam (throttle) valve sufficient to run the compressor at the proper speed, according to circumstances but then never run the compressor faster than is necessary to do the work required. Racing or running at excessive speeds should not be allowed. The pump governor automatically controls the operation of the compressor when maintaining the air pressure.

Oiling

'With a sight-feed-lubricator'

The lubricator should not be started until all condensation has escaped from the compressor and the drain cocks closed. After closing the drain cocks start the lubricator to feed in ten or fifteen drops of oil as rapidly as possible, then regulate the feed to about one or two drops per minute 'for, one compression' no definite amount can be specified, as the amount of lubrication required depends on the work the compressor has to do, the quality of the steam condition of compressor and so on. Keep the lubricator feeding while the compressor is running.

A swab, well oiled is essential on the piston rod. To oil the air cylinder, open its oil cup and blow out all dirt, close and fill it with valve oil, and on the down stroke of the piston open the cup to allow the oil to be drawn into the cylinder, closing the cup before the beginning of the up stroke. This is most easily done when the speed is moderate and the air pressure low. Valve oil only should be used in the air cylinder. A lighter oil will not last and is dangerous. A heavier oil very soon clogs and restricts the air passages, causing the compressor to heat unduly and compress air slowly: Valve oil gives the best performance.

Judgement should determine the amount for both the air and steam cylinders. It being remembered that the lack of a little oil when needed may result in much damage to the compressor.

To Stop The Compressor

Close the feed and steam valves on the sight-feed-lubricator, if the compressor has a separate one, on the feed, if supplied from the locomotive lubricator, then close the steam (throttle) valve and open all drain cocks on the compressor.

Keep the steam valve closed and the drain cocks open when the compressor is not working. The main reservoir drain cocks should also be left open when the compressor is stopped for any length of time. The compressor should always be stopped while the engine is over the ash pit and when the smoke box is being cleaned out.

If kept open, ashes and dust will be drawn into the air cylinder and infire it, besides clogging up the air strainer.

Disorders - Causes And Remedies

Compressor Refuses To Start

Cause: Insufficient oil, from scant or no feed or working water:

Worn main piston rings: or rusting having accumulated during time compressor has lain idle.

Remedy: Shut off steam, take off reversing valve cap nut and put in about a tablespoonful of valve oil. (not too much), let the oil soak down for one or two minutes, and then turn on steam quickly. In many cases when the compressor will not start when steam is first turned on, if steam is then turned off and allowed to remain off for one or two minutes, and then turned on quickly it will start without the use of any oil, except that from the lubricator.

Compressor Groans

Cause 1: Air cylinder needs oil.

Remedy: Put some valve oil in air cylinder and saturate piston swab with valve oil.

Cause 2. Steam cylinder needs oil.

Remedy: Increase lubricator feed.

Leakage past air cylinder piston packing rings or past a discharge air valve causes heating, destroys lubrication, and results in groaning. Piston rod packing dry and binding is another cause of groaning.

Slow In Compressing Air

Cause: (1) Leaking past the air piston packing rings, due to poor fit, or wear in cylinder or rings:

(2) Valves and passages dirty: or

(3) Air suction strainer closed up with dirt.

Remedy: (1) and (2) To determine which is causing the trouble, obtain about 90lbs air pressure reduce the speed from 40 to 60 single strokes per minute, then listen at the ‘air inlet’ and note if air is drawn in during only a portion of each stroke, and it any blows back. If the latter, an inlet valve is leaking.

If the suction does not continue until each stroke is nearly completed, then there is leakage past the air piston packing rings or back from the main reservoir, past the air discharge valves. One of the latter leaking will cause an uneven stroke.

Remedy: (3) Have repairs effected as early as possible, and always keep the suction air strainer clean.

Compressor Erratic In Action

Cause: Worn condition of motion parts.

Remedy: Immediate repairs.

Compressor Heats

Cause: (1) Air passages are closed up.

(2) Leakage past air piston packing rings, or

(3) The discharge valves have insufficient lift.

Remedy: (1) Clean air passages.

(2) Renew air piston rings.

(3) Regulate lift of discharge valves to 3/32 of an inch. A compressor in perfect condition will become excessively hot and is liable to be damaged if run very fast and continuously, for a long time.

Compressor Pounds

Cause: (1) Air piston is loose.

(2) Compressor not well secured to boiler, or causes adjacent pipe to vibrate.

(3) The reversing plate is loose: or the reversing rod or plate may be so worn that the motion of compression is not reversed at the proper time.

Remedy: Repair and renew worn parts and tighten loose connections.

Maintenance

The air cylinder heating is a feature of air compression which cannot be prevented. As an example of normal heating resulting from extreme duty, a 9½ compressor in good order which for one hour maintained an average speed of 174 single strokes of exhaust per minute working constantly against 100 pounds of air pressure, was discharging the air at a temperature of 408 degrees.

Higher speed or greater air pressure would have increased the heating, while slower speed shorter time of test or lower air pressure would have decreased it.

Speaking generally the speed should not exceed 140 exhausts per minute and such a speed should not be continuously maintained for any considerable time, as even this speed will cause excessive heating. This is shown by another test where an average speed of about 60 exhausts per minute after the main reservoir pressure was pumped up and a maximum of 77 strokes per minute at the completion of an hour and fifty minutes of the test, gave a discharge temperature of 316 degrees. The foregoing show plainly the great need of good maintenance, of not wasting air either by leakage or poor handling and giving the compressor as much time to do its work as is practicable.

One of the most serious leaks is through the air cylinder stuffing box as it not only quality decreases the air delivered and by the faster speed required, increases the heating, but it also causes pounding through loss of cushion. When tightening the packing do not bind the rod as to do so will damage both the packing and the rod. Be careful not to cross the gland nut threads.

With two compressors per engine the separate throttles should be kept wide open and the speed regulated by the main compressor throttle. The purpose is to equally divide the work.

If necessary to replace a broken air valve on the road or elsewhere not permitting of proper fitting, at the earliest opportunity have the repairman replace the temporary valve with another so as to insure the correct angle and width of the valve and seat contact. The needed ground joint and the requisite lift.

Never remove or replace the upper steam cylinder head with the reversing valve rod in place as to do so will almost invariably result in bending the rod. A bend rod is very liable to cause a ‘pump failure’.

It is evident that a compressor cannot compress more air than it draws in and not that much if there is any leakage to the atmosphere about the air cylinder. Bearing this in mind, practice frequently listening at the ‘air inlet’ when the compressor is working slowly while being controlled by the governor, and whenever a poor suction is noted on either or both strokes locate and report the fault.

Any unusual click or pound should be reported as it may indicate either a loose piston or a reversing plate cap screw, or other serious fault

Any steam leakage that can reach the air inlet of the compressor should be promptly repaired as such increases the dampness of water entering the intake pipe.

Keeping the suction strainer clean is of the utmost importance, as even a slightly clogged strainer will greatly reduce the capacity where the speed is at all fast. A seriously or completely obstructed strainer, as by accumulated frost, aggravated by rising steam will increase the compression speed and will also be indicated by inability to raise or maintain the desired pressure.

It is an aid to good operation to thoroughly clean the air cylinder and its passages at least three or four times a year by circulating through them a hot solution of lye or potash. This should be

followed by sufficient clean hot water to thoroughly rinse out the cylinder and passages after which a liberal supply of valve oil should be given to the cylinders. Suitable tanks and connections for performing this operation can easily be arranged in portable form.

NEVER PUT KEROSENE OIL IN THE AIR CYLINDER TO CLEAN IT.

Air Pump - Unequal Strokes.

When a pump short strokes it is usually caused from too much oil in the reversing mechanism, or because of bent reversing rod, loose reversing rod plates, reversing rod fitting loosely in the chamber bushing, or any other cause that may move the reversing rod and valve from its fixed position after the reversed motion, or insufficient friction in the bushing to hold the valve and rod in its place will cause the rod to drop down carrying the valve with it and reverse the pump before the piston has completed its stroke. This movement is called 'short-stroking'.

Also a leak on the seat of the reversing valve a bent reversing rod, or if a burr is being worn on the reversing plate, thus allowing the button on the stem to catch. Pouring too much oil into the reversing valve bush, has also been known to cause the reversing valve to fall and the air pump piston to quiver until the oil has got away.

If the exhaust opening from the top of the reversing valve rod and through the reversing valve chamber cap to the top of the steam cylinder is stopped up, the air pump will not reverse properly. The movement of the steam and air pistons will be erratic and will chatter.

Compressor Defects And Remedies

1. If the compressor will not work, what is the easiest way to try and start it again?

   A. Close the steam valve for a minute, then quickly open it again. Also oil the steam end of the compressor.

2. If that fails to start the compressor how should it be determined whether the governor is at fault?

   A. Open the drain cocks, if there is a strong and continuous discharge of steam it proves that the governor is not at fault.

3. If the compressor still fails to start, what should be done?

   A. Tap lightly on the main valve cover with a hammer, taking care not to damage the compressor.

4. If the compressor starts after all main reservoir pressure is discharged, but will not maintain over about 40lbs what does it indicate?

   A. Serious leakage at the discharge air valves.

5. If the drain cock test shows that steam is not reaching the compressor freely and inspection discloses that air is discharging from the governor air vent screw port. What is the trouble?

   A. The pin valve is open or leaking and the main reservoir pressure in the governor or the governor piston is keeping the steam mitre closed.

6. If the compressor is working but is not compressing or supplying air to the main reservoir what is the trouble?

   A. The air piston is loose on the rod. Or the rod nut is broken off.

7. To ascertain if the reversing rod or plate is at fault?

   A. Remove the reversing valves cap nut, carefully raise the reversing rod until it touches the reversing plate lightly, then pull to see if the reversing plate is loose. This will also disclose a broken reversing rod.

8. Will loose and worn packing rings in the top head main valve pistons cause the compression to stop?

   A. Yes if the gap in the piston rings are much open and the openings are together the compressor will likely stop. If the main valve is taken out and the piston ring openings placed on opposites sides the compressor will likely start and continue working until the engine arrives at its home station where new piston rings should be fitted before the engine goes into service again.

9. If none of the foregoing methods succeed in starting the compressor what action should be taken?

   A. Another engine should be obtained and hand brakes used to control the train.

10. If a top head is removed, what must be done to avoid bending the reversing rod?

A. The reversing rod must be taken out first and not put back until the top head has been replaced.

11. In what position must the steam piston that operates the reversing rod be so that this rod can be taken out and replaced?

A. About mid stroke.

12. What is the most common cause of the compressor stopping?

A. Insufficient lubrication in steam cylinder and top head.

13. If the compressor at usual speed is slow in compressing air, where may the trouble lie?

A. A stuffing box may be blowing the air piston rings loose, or the discharge air valves leaking.

14. What will cause excessive compressor speed and low capacity?

A. A dirty or closed up air strainer.

Compressor Air Piston Rings

15. Why is it of first importance that air piston rings should not allow air to leak past them?

A. Because such leakage is a common cause for low air capacity, pounding, air valves sticking and irregular strokes.

16. With reduced main reservoir pressure, should the compressor work slowly when there is a full head of steam coming from the boiler. Would it be advisable to examine the steam exhaust pipe discharging into the smoke box?

A. Yes, owing to the great heat in the smoke box the lubricating grease coming with the steam exhaust from the compressor is likely to carbonise and this with the dust and ashes may partly or altogether close up the exhaust steam pipe or silencer which is generally placed in the smoke box or chimney.

Section 2
Overhaul of Air Compressors

Source – NZ Railways
Date - 28 April 1958

Introduction
Mainline Steam has a version of the original NZR document that has been amended by them to reflect their practices. These amendments have been included here and are shown by ~~deletions~~ or [additions].

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General

When an air compressor is removed from a locomotive for overhaul it shall be dismantled and all parts thoroughly cleaned. All ports and passages are to be cleared of carbon deposits before being blown through with compressed air. All component parts are to be examined and gauged, any part found defective, or which fails to come within specified limits, must be replaced by new or reconditioned parts.

The stripping of the compressor must be carried out in such a manner that no parts or machined surfaces are damaged.

A detailed record of repairs carried out on any compressor or top head is to be maintained by the ~~officer in charge of the work~~ [Mechanical Supervisor].

All records must be available for inspection if required.

Air and Steam Cylinders

When scored or worn, air and steam cylinders are to be reconditioned as follows-

- Rebore steam cylinders when the ends are 1/32” larger in diameter than the centre of the bore.
- Rebore air cylinders when the ends are 1/64” larger in diameter than the centre of the bore.

Machining of the cylinder bore must be carried out in such a manner as to produce true alignment and a smooth finish of the cylinder walls.

In all cases steam cylinders are to be rebored ~~in steps of 1/16" and air cylinders in 1/32" steps~~ [only enough to recover the bore].

When the wall thickness becomes less than 5/16" the cylinders are to be ~~condemned~~ [sleeved to return to original size. (*note – the sleeve must have a minimum wall thickness of 3/16")*]

The depth of the counter bore is to conform to standard in all rebored cylinders. In the case of cross-compound compressors the depth of the by-pass grooves in the low pressure cylinders shall also be made standard.

All jointing faces are to be cleaned and tested for trueness, and shall be refaced as necessary. Any wasting of the faces by steam cutting shall be made good by bronze welding. Copper gaskets must be annealed and then examined for flaws or cracks. If suitable for further use they may be polished with emery cloth and lightly covered with boiled oil before fitting. Gaskets must be a free fit over studs and register accurately with the ports in the cylinders; no overlap is permitted.

Nipples, elbows and fittings screwed into the cylinders must be well fitted and in correct alignment, if necessary, by the use of copper shims.

Stuffing boxes shall be checked to ensure that they are secure in the centre piece. Should they be loose, remove peg and tighten, re-locating peg in a new position, and re-caulk on the pressure side. When the bore in the stuffing box is 1/16" larger than the piston rod they shall be renewed.

For new work the stuffing box must be a sliding fit on the piston rod (see drawing X8897). The piston packing must be renewed and all springs and followers renewed if not in a serviceable condition.

Pistons and Rods

Air and steam pistons will be renewed when-

- The air piston is 1/32" less than the smallest diameter of its cylinder.
- The steam cylinder is 1/16" less than the smallest diameter of its cylinder.

When new pistons are fitted the clearance between piston and cylinder bore shall be 1/64" in the case of the air end and 1/32" for the steam end (see drawing X13499). Ring grooves are to be re-cut to [true them up] the next oversize when they are worn more than 0.003" in width. The maximum width of groove is 1/32" above standard.

Piston rings shall be renewed when the gap is 3/32" or the width is 0.005" smaller than the ring groove. New rings are to be turned from a closed split ring drum or double turned and the gap when fitted to the cylinder shall not be less than 0.003". The rings to be just free to rotate in their respective grooves and must not be filed to obtain this fit. When rings are assembled in their respective grooves, the gap shall be diametrically opposite.

Piston rods shall be trued by grinding at each overhaul and condemned when the diameter is 1/16" smaller than standard [(new size 1.5")]. Welding of piston rod heads is not permitted [without permission from the Engineering Manager]. Any adjustment for wear shall be made up by building up the hole in the steel air piston head and re-boring to size. When fitting the taper ends of the rods, 1/32" shall be allowed for draw. The piston rod must be securely fitted and locked in position by means of the locking washer.

Reversing plates are to be examined to see that they are not loose or worn. If worn more than 0.005" on the striking points, they shall be reconditioned. When fitting new reversing plate screws they are to be a snug fit in the piston head and well tightened before being locked in position by riveting over on the underside.

Compressor Tophead

The tophead, covers, bushes, main piston valve, and slide valve shall be examined for fit, wear, and cracks.

Main piston valves shall be renewed when they are worn 1/32" less than the bore of bushes.

When ring grooves are worn to 0.003" the grooves shall be machined to 0.006" wider than standard.

The clearance between the piston and the main valve bush for new work shall be 1/64".

Piston rings are to be renewed when the gap is more than 1/32", or width 0.005" smaller than the ring groove in the piston.

New rings should be just free to rotate in their respective grooves and when fitted in the bush a gap of 0.002 to 0.003 should be allowed.

Main bushes shall be trued by grinding or turning as required in steps of 1/32".

The slide valve and seat, where this type is fitted, must be refaced and be a neat sliding fit between the collars or lugs on the piston; any wear to be restored by bronze welding.

The piston valve cylinder cover and gaskets shall be reconditioned in the same manner as for the steam cylinder.

The reversing valve and bush shall be examined for wear and cracks. Also ensure that all cavities and ports are clear. Should the bush need attention it shall be "trued only" and renewed when re-bored 1/8" over standard size.

The reversing valve is to be a neat sliding fit in the bush and should the clearance between the valve and bush exceed 0.010" a new valve should be fitted.

Should the valve have endwise slack of 0.010" the wear on the on the valve shall be restored by bronze welding so as to obtain a neat sliding fit.

The reversing valve must be properly bedded to its seat.

The camber caps are to be a neat fit in the tophead to prevent jamming the reversing rod and jointing faces shall be refaced where required. Caps are to be renewed when the guide hole has worn 0.008" when checked with a new reversing rod.

Reversing rods shall be gauged and tested for straightness, any rod failing to meet requirements to be renewed.

Air Valves and Cages

All valves, valve cases and cages, caps and seats shall be freed of all carbon deposits, examined and renewed if necessary.

Should the clearance between the air valve and its guide exceed 0.020" a new valve shall be fitted, having a clearance not less than 0.005" in the guide bush.

Valve bushes shall be rebored in steps of 1/32" and the width of the seat shall not exceed 1/8".

Air valves shall be lapped in with an approved abrasive and all traces removed when the operation is completed.

The lift of all air valves shall be maintained at 3/32" after lapping. The lift adjustment shall be made by building up the valve boss by electric welding when required.

All pressed in valve seats shall be pegged, and those that are threaded shall be coated with graphite lubricant before being screwed into place.

The jointing faces of valve caps and cases shall be faced, and graphite lubricant used in assembly.

In the case of 10"x10 ⅝" compressors, the copper gaskets shall be annealed and tested for defects. If suitable for further use they are to be polished with emery cloth and lightly covered with boiled oil before fitting.

Air Strainers

Air Strainers shall be dismantled and have all necessary repairs effected.

The straining medium shall be perfectly clean and adequate to fill the strainer, those filled with horsehair being washed in a bath of kerosene, dried and re-teased.

Those filled with metallic wool shall be washed in a bath of kerosene, dried by means of a jet of compressed air and re-lubricated with an approved viscous oil.

When fitted, the strainers intake shall be located in such a position to prevent the entry of unnecessary foreign substances.

Lubricators

The tophead lubricator, where fitted, shall have the interior thoroughly cleaned and the cap, plug valves and threads checked to ensure that they are in a suitable condition for further service.

The vertical tube, when a separate piece from the body, shall be checked to ensure that it is secure in the body.

The automatic oil cup for the lubrication of air cylinders shall have the interior thoroughly cleaned and the centre spindle checked to ensure that it is clear and secure in the body.

The sleeve and valve bushing nut shall be in good condition.

The sleeve must be a neat sliding fit on the centre spindle and the face of the valve bushing nut must not bear on the end of the sleeve which is provided with two diametrically placed notches at each end. The clearance between the end of the sleeve and the nut is to be between 1/32" and 3/64" which shall be checked after assembly by means of a hooked wire inserted in one of the lower notches.

The thread of the cap shall be in good condition and the vent hole must be clear.

Before the lubricator goes into service it must pass the prescribed test.

Drain Valves

The automatic drain valve and steam cylinder drain shall be dismantled and cleaned.

Should the valve or plug require reseating, this operation shall be carried out with an approved abrasive and all traces of such abrasives subsequently removed.

The drain valve spring shall be examined and replaced if defective.

All threads must be in a serviceable condition.

Valves and cocks shall be tested with air pressure; a slight leakage is permitted.

Assembly

When the pistons and rods are assembled in the cylinders they shall be gauged to ensure that the air piston head has clearance at each end of the cylinder when the steam piston is at its maximum stroke.

The pistons shall be sufficiently free to be moved by hand through the full length of the stroke, when this check is made the metallic packing shall be in place, no resistance owing to misalignment is permitted.

When applying topheads and covers, the nuts shall be tightened evenly and in the correct sequence.

The piston rod shall be provided with an oil cup and an approved oil swab.

Steam cylinders shall be lagged after testing with an approved heat insulating material and the covering shall be painted. Air cylinders must not be lagged and the outside shall be perfectly clean and unpainted.

Air Compressor Steam Stop Valves

Compressor steam stop valves are to be overhauled by the Air Brake Group. All stop valves must be checked for the required valve lift to prevent steam throttling taking place, and all parts must conform strictly with the appropriate drawings.

Section 3
Testing Steam Driven Air Compressors

Source – NZ Railways
Date - 28 April 1958

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Preparation

After air compressors have been overhauled they must be tested on an approved test rack, that shall have negligible leakage between air reservoir and the compressor at 80 lbs pressure per square inch. The compressor under test shall be isolated from any other that may be mounted on the test rack.

During testing an air strainer shall be fitted.

Testing must not commence until the compressor has run for two hours in the case of a complete overhaul, one hour in the case of a compressor with top head overhaul, and one quarter of an hour for a compressor undergoing test only.

Care must be exercised in starting a compressor from cold and the main reservoir empty. The steam valve must only be partly opened to ensure the compressor works slowly until the pressure is about 40 lbs.

This is to prevent pounding and the consequent damage owing to condensation in the steam cylinder, and also lack of compression in the sir cylinder to cushion the piston at the end of its stroke.

Lubrication of the top end, steam and air cylinders as well as the piston rod shall be with approved oils. Air valves must not be lubricated.

Steam End Test

This is a test of the performance of the tophead and steam cylinder of the compressor and must be made with the steam valve to the compressor in the fully open position.

Main reservoir pressure during this test is to be maintained at 75 lbs/sq.in. [520 kPa]. This is to carried out by opening and adjusting the cock provided on the reservoir and the air allowed to escape until main reservoir pressure is steady at 75 lbs/sq.in. [520 kPa].

The number of single strokes must then be counted and must not be less than that shown for the particular compressor on drawing Y.21190 (see below). The test is to be made over one minute.

If the compressor under the conditions laid down is unable to at least equal the number of strokes shown in the table it is to be regarded as having failed in the test.

Defects that should be looked for are, leaking steam piston rings or gaskets, defective main slide valve or reversing valve, insufficient lubrication.

Air End Test

This test checks the performance of the air end of the compressor.

The appropriate orifice, see [below (and B3.2.5.01 - Drawing Y21170)], must be firmly screwed into the cock provided on the reservoir and it should be ascertained that no leakage occurs at the joint.

The orifice cock should then be fully opened and the steam supply to the compressor regulated that a steady air pressure of 60 lbs/sq.in. [420 kPa] is maintained in the reservoir with the air escaping through the orifice.

Before making any reading the air pressure should be watched for one minute to ensure it remains steady after adjustment of the steam valve.

With the compressor maintaining the air pressure steady at 60 lbs/sq.in. [420 kPa] against the orifice opening, the number of single strokes made during the period of one minute is to be recorded.

The number of single strokes made by the compressor under the above conditions must be compared with the appropriate table on drawing Y.21190 (see below). If this maximum number of strokes has not been exceeded the compressor may be considered to have passed the air end test.

Should the number of strokes be exceeded, the air end of the compressor is defective, this may be due to faulty air piston rings, piston rod packing, air valves or gaskets leaking.

Recording of Tests

All tests made on compressors for whatever reason are to be recorded under headings shown as follows. The record must be available for inspection as required.

- Date of Test
- Compressor ID

Steam End Test (75 lbs/sq.in.)
  - Steam pressure
  - Single strokes per minute

Air End Test (60 lbs/sq.in.)
  - Single strokes per minute

- Name of person doing test.

Air End Test

Maximum number of single strokes per minute against 60 Lbs Per Square Inch [420 kPa] Air Pressure

Size Of Compressor	Size Of Orifice	Maximum Single Strokes Per Minute	
		"A" Test (Running Shed)	"B" Test (Workshops)
10" x $10^{5}/_{8}$"	$^{7}/_{32}$"	158	120
10" x 10"	$^{13}/_{64}$"	158	120
8" x 8½ "	$^{11}/_{64}$"	158	120
8" x 7½ "	$^{9}/_{64}$"	158	120
7" Cross Cpd.	¼"	158	120

Steam End Test For Running Sheds

Minimum No. Of Single Strokes Per Minute Against 75 Lbs Per Square Inch [520 kPa] Air Pressure

Steam Pressure In Lbs Per Square Inch						
150	**155**	**160**	**165**	**170**	**175**	**180**
77	80	82	84	86	88	90
87	90	92	94	96	98	100
95	97	99	101	103	105	107
130	133	136	139	142	145	148
96	99	102	105	107	109	111

Steam End Test For Workshops

Minimum No. Of Single Strokes Per Minute Against 75 Lbs Per Square Inch [520 kPa] Air Pressure

Size Of Compressor	Steam Pressure In Lbs Per Square Inch																
	100	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	**165**	**170**	**175**	**180**
10" x $10^{5}/_{8}$"	70	76	81	85	88	91	94	97	100	103	105	107	109	111	113	115	117
10" x 10"	77	85	90	95	99	103	106	109	112	115	118	120	122	124	126	128	130
8" x 8½ "	90	95	100	105	110	114	117	120	123	126	129	131	133	135	137	139	141
8" x 7½ "	-	-	140	146	151	156	160	164	168	171	174	177	180	183	186	189	192
7" Cross Cpd.	-	-	72	83	95	101	108	114	120	-	-	-	-	-	-	-	-

W.H.B. STEAM DRIVEN AIR PUMPS
SPEED TABLES for TESTS

REDRAWN FROM NZR PLAN
Y 21190

Date; ? Last Amended: 2-5-1958