A DESIGN OF A 12×12×14

STEAM ACTUATED AIR COMPRESSOR

... BY ...

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THESIS

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Introduction.

The construction of the modern steam actuated air compressor is not as old a science as the building of the steam engine. In many respects the machines are alike and at first thought the air compressor seems nothing more than an ordinary steam engine with an air cylinder attached; but on further study we find that the two constructions differ in the strains that come upon the various parts, in the way of taking the stored up energy from the fly wheel, and in the method of governing.

The designer, therefore, can not rely on the formulae which are given for the dimensions of steam engines for such parts as have new strains put upon them. He must analyze the forces as nearly as possible and proportion the members of the machine according to strength, of course using a suitable factor of safety.

When manufacturers have had more experience in the construction of air compressors and have had opportunity to observe how long the machines will wear, formulae can be derived similar to those for the steam engine and the designer may proceed in choosing his proportions with much less uncertainty.
Statement of Problem.

The problem was to design an air compressor whose steam cylinder should develop forty horse power.

The steam and air pressures were both assumed to be 90 pounds per square inch.

To fulfill the above conditions the cylinders were chosen to be 12 x 14, the speed 150 revolutions per minute. This gives a piston speed of 340 ft. per minute and a free air capacity of 280 cubic feet per minute.

The horizontal, self-contained straight line type was selected as this form admits of great strength and capacity in a very small space. Every part of the machine is accessible and the pistons can be removed from either cylinder with ordinary tools without disturbing the flywheel or shaft.

It is evident that a compressor with both pistons on the same straight rod will apply the power in the most direct manner and will consequently be of the simplest possible construction. It is also evident that the straight line or direct type results in an engine which has the greatest power when
the work to be done is least. At the beginning of the stroke steam is admitted at full boiler pressure behind the piston, the air piston being at that time also at the beginning of its travel with no resistance to overcome. As the piston move forward, the air pressure rapidly rises while the steam, having been cut off in the early part of its travel to secure the benefits of expansion, rapidly falls in pressure.

The apparent difficulty of equalizing the strains is overcome by making the reciprocating parts and fly wheels of such weight that the excess of power in the early part of the stroke is absorbed in starting them at the required speed on their forward movement; as the pistons approach the point where the air pressure becomes higher than that in the steam cylinder, these parts give out their stored up energy in forcing the accumulated air out through the discharge valves.

This, however, causes a reversal of pressure on the crank and cross-head pin near mid-stroke at the time when the velocity of the latter is greatest. As is well known this will produce a jar and possibly a knock in both bearings, which can be lessened to a great extent by so proportioning the reciprocating parts that they will equilibrate the strains as much as possible, leaving the flywheel to
take care of small variations and carry the machine over the dead points.

As the economy of an air compressor is to a considerable extent affected by the efficiency of the engine, it is necessary that this part of the construction receive due consideration. The Meyer valve gear with hand adjustment is peculiarly efficient when applied to an air compressor. This type of gear has long been a favorite for marine work on account of its superior steam economy. It is adjustable within a wide range and is very quick in action. In starting the machine it is handled with the throttle till the pressure is on the pipe line when steam is turned on at full boiler pressure and the speed is regulated with the cutoff in order to obtain the advantages of expansion. The range of expansion can be changed while the machine is in motion to meet the requirements of any speed or pressure.

Air valves.

Each make of an air compressor has his peculiar type of air valve which he attempts to prove is the best in every respect by reports of tests or theoretical reasoning. Each make, no doubt, has its own points of excellence and will work to better advantage, under certain conditions, than some other type. The poppet
valve was the first used and is still held to be the simplest, cheapest, and best as regards admitting and exhausting the air from the cylinder. It is used almost universally by manufacturers for the smaller and intermediate sizes. Both admission and discharge valves are placed in the cylinder cover and can be taken out and replaced in a very short time if any accident should happen. The air cylinder is thoroughly water-jacketed and the clearance of the piston is as small as can be obtained with safety.

Clearance in the air cylinder has the bad effect of reducing the capacity of the machine by containing air at the highest pressure at the end of the stroke which expands and prevents so much free air from entering the cylinder.

The bed is of the box pattern strongly ribbed and reinforced, with fly wheel just far enough apart to span the flanges of the steam cylinder which is placed between the shaft and cross-head. The connecting rods pass back past the sides of the cylinder making a short compact and rigid machine. The air cylinder is at the farthest point from the heated steam cylinder and in the most favorable position for keeping it cool.