Large Scale Model Railway Engineering

Section 4 The Steam Locomotive (continued)

The topic for this months series is the final installment of putting water into the boiler. We have discussed axle and hand pumps, injectors and this month steam driven pumps.

Steam driven pumps are the most complicated way of supplying boiler feed water, but also one of the most interesting. There is nothing like a pump hung on the side of the boiler slowly pumping away as the locomotive sits in the station awaiting its next trip.

These pumps can be divided into two basic types. The first is the single cylinder type with a single steam and a single water cylinder, and the second, the dual cylinder type with two of each. Of the two types, the dual cylinder configuration is usually considered more reliable because it can be made so that it is always self starting where the single cylinder configuration can sometimes get hung up when trying to start requiring the engineer to give it a nudge.

The enclosed drawing shows the construction of the single cylinder design vs. the dual cylinder. In the single cylinder design the piston assembly controls a small pilot valve which in turn controls the main valve that directs steam to either end of the steam cylinder. The reason this is done is that if the main valve was connected directly to the piston, as the valve moves it would eventually cut of steam to the steam piston and as soon as this happens the piston would stop moving and thus the main valve would not open the other port to reverse the piston travel and the pump would hang up. A single cylinder steam engine can solve this problem because it has a heavy flywheel to keep the engine going allowing the valve to open the other port. By using a pilot valve only a very small amount of steam is required to shift the main valve therefore causing the piston to reverse. Unfortunately this pilot valve can occasionally get hung up and not shift causing the pump to stall.

The dual cylinder pump gets around this pilot valve problem by having the valve on one cylinder controls the other. In addition to this they usually cross the ports on one cylinder so that when the piston of cylinder one reaches the top of its stroke cylinder two then is ported so that its piston is driven to the top at which time cylinder one's piston has steam admitted to the top driving its piston down. Upon reaching the bottom its valve shifts directing steam to the top of cylinder two. By doing this one can assumed that one valve is always fully open so that the pump will

always start. This cross porting is usually accomplished by cross drilling the ports in the steam cylinder block.

To calculate the capacity of the pump one can use the procedure similar to what was used when calculated the output of a axle pump. If we find the displacement of the head end and the rod end of the water cylinder and multiply this total by the strokes per minute we get the displacement per minute. Dividing this by 234 cu in /gallon we get the pump output in gallons per minute.

For example a pump with a 1/2" diameter piston, a 3/16 rod diameter, a 1" stroke and operating at 200 strokes per minute would have an output of:

.196 cu in / stroke head end displacement

.176cu in / stroke rod end displacement

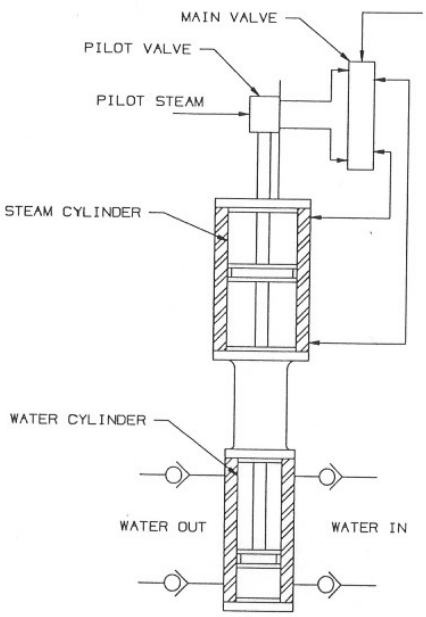
adding the two together we get the total displacement of .372cu in / stroke.

.372cu in X 200 strokes/minute = 74.4 cu in per minute

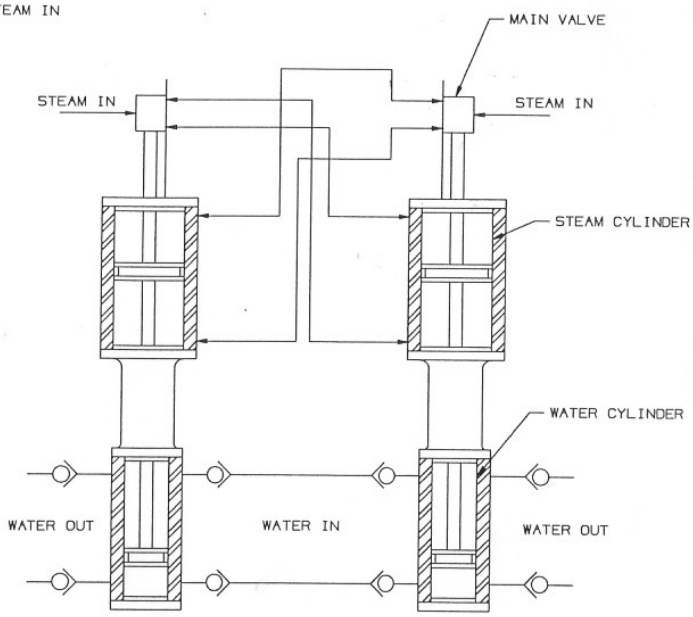
74.4cu in per minute / 234 cu in/gal = .31 gpm

Pumps usually are about 90% efficient so our pump would put out about .28 gallons per minute. Of course a dual cylinder pump would put out twice this amount.

This end our discussion on boiler feed water, at least for now. Next month we are going to talk about different kinds of bearings and how to size them.



SINGLE CYLINDER PUMP



TWO CYLINDER PUMP