The Use Of Ready Wound Springs In Ordinary (non pop) Safety Valves. by David Hudson.

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The formula for calculating the area of one safety valve, based upon a clear unobstructed opening equal to the bore and, derived from the formula for a Ramsbottom type safety valve is given by:-

$$\text{"A". in sq.ins} = \frac{\text{total boiler heating area in square inches}}{72 \times \text{working boiler pressure in PSI}} \qquad \text{--(1)}$$

Alternatively,

$$\text{The diameter "D". In inches} = \sqrt{\frac{\text{Total boiler heating area in square inches}}{56.55 \times \text{working boiler pressure in PSI}}} \qquad \text{--(2)}$$

If two safety valves are required, the area of each will be "A" X 0.5 and the diameter of each will be "D" X 0.707 also, if four safety valves are required the area of each will be "A" 0.25 and, the diameter of each will be "D" X 0.5.

The spring force required to balance the boiler pressure may be expressed as:-

"F" . In Lbs.= Area "A" in square. Inches X boiler pressure "P" in P.S.I. --(3)

if we assume that a valve must be allowed to lift by 10% of "D" with an increase in boiler pressure of 10%, then the maximum spring rate allowed can be determined as followers:-

$$\text{Max spring rate "S.R"} = \frac{\text{"F" X 0.1}}{\text{"D" X 0.1}} = \frac{(3)}{(2)} \text{ Lbs/ Inch.} \qquad \text{--(4)}$$

Messres A.j.Reeves, let me have samples of three grades of stainless steel springs in three inch lengths for cutting to size. Tests carried out on these samples have yields the following information:-

24 g. 14 T.P.I. D/d ratio = 8.14 "S.S.R. =64.2 Lbs/inch/turn.

22g. 12.5 T.P.I. D/d ratio = 6.64 "S.S.R." = 156 Lbs/inch/turn.

20g. 11.5 T.P.I. D/d ratio = 5.69 "S.S.R." = 314 Lbs/inch/turn.

Note;- Sample springs were fully compressed for twenty four hours before cutting to size and testing. This procedure should be followed before cutting springs to size.

Now the actural spring rate "S.R." In Lbs/inch. Is given by:-

$$\text{"S.R."} = \frac{\text{Specific spring rate "S.R." Lbs/inch/turn}}{\text{number of turns "N"}} \qquad \text{--(5)}$$

When expressed in terms of "N". This becomes:-

$$\text{Minimum number of turns "N"} = \frac{\text{"S.S.R."}}{\text{"S.R."}} = \frac{\text{"S.S.R."}}{(4)} \qquad \text{--(6)}$$

Note:- If springs do not have closed coil and ground ends then, "N" = the total number of turns, and should never be less than five when using these D/d ratio.

The minimum free length maybe calculated using :-

$$\text{"L"} = \frac{\text{Number of turns "N".}}{\text{Turns/inch "T.P.I."}} = \frac{(6)}{\text{"T.P.I."}} \qquad \text{--(7)}$$

The yield the required, spring force "F". The spring should be compressed by:-

$$\text{"C"} = \frac{\text{"F"}}{\text{"S.R."}} = \frac{(3)}{(5)} \qquad \text{--(8)}$$

To check that the right choice of spring has been made, use the following :-

$$\frac{\text{Compression in inches "C"}}{\text{Length in inches "L"}} \times 100\%$$

Ideally this should give a figure below 25% using these D/d ratios, this recommended figure is to keep the stresses within acceptable limits and to prevent undue fatigue due to continuous stress and creep.

Table Of Springs

Table Of Max Spring Rate Assuming Valve May Lift By 10% with 10% Increase In Boiler Pressure.

Valve Diameter "D" And unrestricted Bore for one safety valve		Boiler Working pressure											
		25 PSI		50 PSI		75 PSI		100 PSI		125 PSI		150 PSI	
		Spring Force	Max Spring Rate	Spring Force	Max Spring Rate	Spring Force	Max Spring Rate	Spring Force	Max Spring Rate	Spring Force	Max Spring Rate	Spring Force	Max Spring Rate
Diameter (Inches)	Area ($Inches^2$)	LBS	LBS/ inch	LBS	LBS/ inch	LBS	LBS/ inch	LBS	LBS/ inch	LBS	LBS/ inch	LBS	LBS/ inch
0.066	0.00342	0.086	1.3O	0.171	2.59	0.257	3.89	.342	5.18	.428	6.48	.573	7.78
0.109	.00933	0.233	2.14	0.467	4.28	.700	6.42	.933	8.56	1.166	10.70	1.400	12.84
0.133	0.01389	0.347	2.61	0.695	5.22	1.042	7.83	1.389	10.45	1.737	13.06	2.084	15.67
0.154	0.01863	0.466	3.02	0.931	6.05	1.397	9.07	1.863	12.1	2.328	15.12	2.794	18.14
0.0168	0.02217	0.554	3.3O	1.108	6.6O	1.663	9.9O	2.217	13.19	2.771	16.5O	3.325	19.79
0.188	0.02776	0.694	3.69	1.388	7.38	2.082	11.07	2.776	14.77	3.47O	18.46	4.164	22.15
0.194	0.2956	0.739	3.81	1.478	7.72	2.217	11.43	2.956	15.24	3.695	19.05	4.434	22.86
0.206	0.03333	0.833	4.04	1.666	8.09	2.5OO	12.13	3.333	16.18	4.166	20.22	4.999	24.27
0.217	0.03698	0.925	4.26	1.849	8.52	2.774	12.78	3.698	17.04	4.623	21.3	5.548	25.56
0.23O	0.04155	1.039	4.52	2.077	9.03	3.116	13.55	4.155	18.06	5.193	22.58	6.232	27.1O
0.0243	0.04638	1.159	4.77	2.319	9.54	3.478	14.31	4.638	19.09	5.797	23.86	6.957	28.63
0.266	0.05557	1.389	5.22	2.779	10.45	4.169	15.67	5.557	20.89	6.946	26.11	8.386	31.34
0.287	0.06469	1.617	5.64	3.235	11.27	4.852	16.91	6.469	22.54	8.087	28.18	9.704	33.81
0.297	0.06928	1.732	5.83	3.464	11.66	5.196	17.49	6.928	23.33	8.66	29.16	10.392	34.99
0.315	0.07793	1.948	6.19	3.897	12.37	5.845	18.56	7.793	24.74	9.741	30.93	11.69O	37.11
0.326	0.08347	2.087	6.4O	4.173	12.8O	6.26O	19.2O	8.347	25.6O	10.434	32.OO	12.52O	38.41
0.376	0.11104	2.776	7.38	5.552	14.77	8.328	22.15	11.104	29.53	13.88O	36.91	16.655	44.3
0.406	0.12946	3.237	7.97	6.475	15.94	9.71O	25.92	12.946	31.89	16.183	39.86	19.419	47.83
0.421	0.1392O	3.48O	8.27	6.96O	16.53	10.44O	24.8O	13.92O	33.07	17.401	41.33	20.881	49.6O
0.498	0.19478	4.87O	9.78	9.739	19.56	14.609	29.33	19.478	39.11	24.348	48.89	29.217	58.67
0.595	0.27805	6.957	11.68	13.903	23.37	20.834	35.05	27.805	46.73	34.756	58.41	41.708	70.1
0.704	0.38926	9.731	13.82	19.463	27.65	29.194	41.47	38.926	55.29	48.657	69.12	58.388	82.94
0.841	.5555O	13.887	16.51	27.775	33.03	41.662	49.54	55.55O	60.05	69.437	82.56	83.325	99.08

$D^2 \times \frac{\pi}{4}$ = "AREA" "A"

A X PSI = "Spring Force 'F"

F X 0.1 ÷ D X .01 = Max Spring Rate. "SR"

With two safety valves use area ÷ 2

With four safety valves use area ÷ 4

Spring Formula