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METROLOGICAL RANGE

MODEL 5500

5500 Series gas operated pressures balances for differential pressures at elevated static pressures

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5500 GENERAL DESCRIPTION

The 5500 Series consists of dual gas operated pressure balances,

Models 5501, 5502 and 5503.

These are designed for differential calibration at high static line pressure. A 5500 Model is the combination of two 5200 Models that are integrated into one common housing to facilitate operation and improve measurement. Complete built-in pressure controls are provided. The three models differ in their maximum operating pressure. One side of a 5500 model can also be used as a 5200 model for gauge pressure calibrations. Those interested in performing differential calibrations at high static pressure should also consider the Model 1500 Divider which is somewhat easier to operate and offers greater accuracy as statics increase and differentials decrease.

Operating principle : The 5500 Series define differential pressures on a single piston-cylinder assembly. The second piston-cylinder is used as a memory for the zero condition. The latter operation requires that a piston-cylinder has good geometry and one is using the repeatability factor not the absolute accuracy. This makes possible very accurate measurement of differential pressures.
In practice the operating procedure is to apply the same static pressure to both piston-cylinder assemblies with the measuring element floating. Taring masses are then applied to the comparison-memory element so that both pistons are balanced in their mid position.

The left-hand comparison element is then isolated and the mass equivalent to the differential pressure increment required is added to the measuring piston. The pressures on both sides are adjusted using the variable volume so as to bring both pistons back to their equilibrium condition. Note that this procedure compensates for any diaphragm movement within the instrument under test. The procedure is repeated for each pressure increment or decrement for the calibration run.

The exceptional intrinsic characteristics of high quality piston-cylinders allow the static pressure to be set and maintained with precision much greater than the absolute accuracy on either piston-cylinder effective area. This is the nominal static pressure before isolating one side from the other. The crossfloat consists of adjusting the mass load on one of the pistons until both pistons float together in equilibrium at the common static pressure.

Liquid lubricated gas operated piston cylinders are used to great advantage (see 5200 Series for operating principle). Liquid lubrication gives an hermetic seat gas cleanliness is not critical. The operator can concentrate on the delicate crossfloat procedure upon which the measurement is dependent without having to worry about deterioration in performance and without having to interrupt work frequently to clean pistons as it is common in gas.

lubricated systems. Many users operate 5500 models using natural gas directly as the test medium.

Accuracy : As with all D&H pressure balances, this is defined as the difference between the measured pressure and the true value, and includes all possible sources of uncertainty (see Metrological Specifications p 4).

The accuracy with which the differential pressure may be defined depends upon three separate terms, viz : the first term is a function of a pressure element range. It is a sensitivity at the minimum value of the pressure element that has been determined in the D&H laboratories.

The second is the contingent error on the equilibrium between the comparison and measuring piston. This term is a function of the static pressure.

The third term is the uncertainty on the effective area and masses on the measuring element.

Note that the first two terms are worst-case conditions and after some time in service they may be statistically reduced according to operational experience.

Stability of the differential pressure : Today's sophisticated differential transmitters and transducers offer resolution that makes it possible to observe the stability with which a floating piston controls a pressure. The "noise" in the two pressure defined by the two pistons of a 5500 Series pressure balance may appear large relative to the differential pressure even though it is extremely small relative to the static pressure. Indeed, to control a differential pressure of 1 psi at 1000 psi with a stability of 0.001 psi means controlling two independent pressures (nominally 1000 psi on the low side and 1001 psi on the high side) within 1 part per million.

Generally, when the pistons of a 5500 Series pressure balance are rotating freely the noise on the differential pressure will be less than the static pressure effect's contribution to the accuracy statement. This "noise", however, will be cyclical and consistent in nature at roughly the same frequency as the rate of rotation of the pistons except when the piston drive mechanism gives the piston an impulse. The piston drive mechanisms can be removed and the pistons rotated by hand but experience has shown that it is metrologically preferable and procedurraly easier to isolate and ignore the occasional spikes coming from the drives than to tolerate the distraction and inconsistencies of hand rotation. If the cyclical noise from free piston rotation is averaged and the spikes from the piston drives discarded, precision well inside the accuracy statements can be obtained. When calibrating high resolution test instruments with rapid integration times, users that follow these recommendations report that the achievable precision is three to four times greater than the accuracy claimed.

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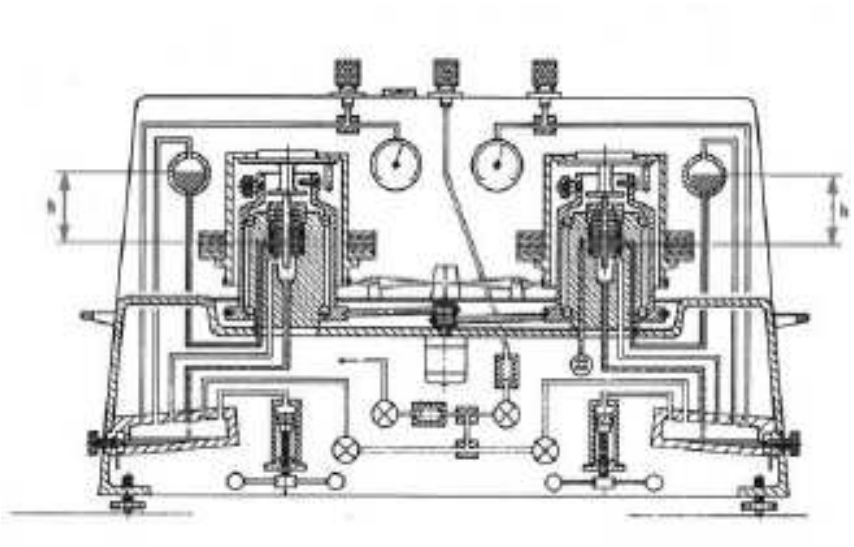
5500 MODELS 5501, 5502 and 5503



CAPABILITIES

Lowest-highest achievable pressure :
- Model 5501 : 0.02 to 20 MPa
- Model 5502 : 0.02 to 40 MPa
- Model 5503 : 0.02 to 80 MPa

Piston-cylinders available :
- Type 5000 of Kn = 0.1 MPa/kg to Kn = 300 psi/kg

Mass sets available : all Type 5000 up to 40 kg.

Accuracy classes available : all

Piston-cylinder mounting system :
- Liquid lubricated gas type (reentrant).

Piston position monitoring :
- Dual mechanical (electronic as an option).

Test medium : Any non-corrosive gas.

Lubricating fluid : Drosera (Krytox ™ as an option).

Mounting post length : short.

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5500 SERIES PISTON-CYLINDER AND MASS SET COMBINATIONS*

Piston Kn	Masses			
	1kg	20 kg	30 kg	40 kg
0.05 MPa/kg	0.5 MPa	10	15	20 MPa
100 psi/kg	100 psi	2000	3000	4000 psi
1MPa/kg	1 MPa	20	30	40 MPa
200 psi/kg	200 psi	4000	6000	8000 psi
250 psi/kg	250 psi	5000	7500	10 000 psi
2 MPa/kg	2 MPa	40	60	80 MPa
300 psi/kg	300 psi	6000	9000	12 000 psi

* The static pressure and differential pressure values are limited by the relationship DP + SP ≤ full scale pressure.

ACCURACY ON DIFFERENTIAL PRESSURE*

Piston-cylinder Kn	Static Pressure Effect	Percent of differential pressure	
		S2	S
0.5MPa/kg	10Pa + 1PPM SP	0.005	0.01
100psi/kg	0.002psi + 1PPM SP	0.005	0.01
1MPa/kg	40Pa + 1PPM SP	0.005	0.01
200psi/kg	0.008psi + 1PPM SP	-	0.01
250psi/kg	0.009psi + 1PPM SP	-	0.01
2MPa/kg	80pa + 1PPM SP	-	0.01
300psi/kg	0.010psi + 1PPM SP	-	0.01

* The accuracy on a differential pressure is calculated by summing the static pressure effect and a percentage of the differential pressure value depending upon the accuracy class of the piston-cylinder and mass set (e.g. the accuracy on a differential pressure of 10 psi at 1000 psi in S class is ± (0.002 psi + 0.001 psi + 0.001 psi) = ± 0.004 psi). When one side of the 5500 model is used alone to define gauge pressures, the accuracy is that of the accuracy class (e.g. ± 0.01 % of reading in S class).

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