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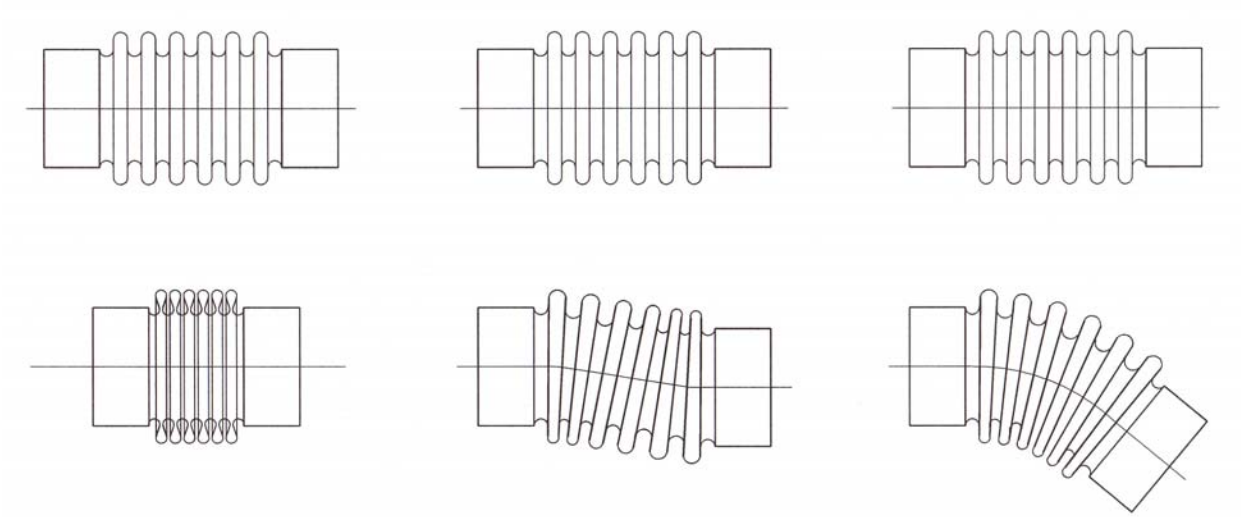
METALLIC EXPANSION JOINTS

FEATURES AND PARTICULARS

Expansion joints are flexible elements composed in the foundamental part, from multiply bellow in stainless steel, that allows to absorb axial, angular and lateral movements, but it can to be used also like anti-vibrations with engines, pumps or other machines.

AXIAL LATERAL ANGULAR



Normally these expansion joints are used with pipeline where because of the variations of temperature, expand, provoking (if done not compensate for note) of the disruptions either of the deformations to the same pipelines or to the rigid parts to are connected.
Bellow's composition (number of plies and thickness) is different and it depend from design pressare "PN" (pressure at 20 degC); one bellow PN 2,5 it will have except plies of PN 10 and/or plies with inferior thicknesspare.
Bellows building with multi-ply method, guarantee simultaneously:

- High pressare resistance, because all bellow's plies workint to contain it.
- High flexibility, thanks to the reduced thickness of the individual ply.

To corrected project of expansion joint type, is very important to know exactly, following working conditions:

- Fluid conveyed
- Max working pressure
- Max working temperature
- Required movements
- Axial guide and anchor points
- Other adding forces on expansion joint

Only in this manner is possibile to guarantee a long working life to expansion joint, eliminating following effects:

- Local instability (corrugation's instability).
- Axial instability (column's instability).

PRESSURE AND TEMPERATURE

Expansion joints were planned considering the temperature environment (20°C). In fact the variations of temperature, like all know, is in a position to alter the features of the materials, and also the expansion joints, being in stainless steel, decrease their resistance to the pressure all' to increase some temperature, according to the corrective factor "KP"; the same thing is valid for the movements that is able compensate for corrective factor "KC" (you see table to page 4 valid for stainless steel 321).
Into following table you can see others necessary values to calculate previous mentioned corrective factors:

- E (elasticity module to EJMA ed. '93 Tab. 2 Sez. C).
- Sa (bellow's acceptable stresses to ASME B31.1 Tab. A-3 Ed. '92).

We write following the formulas to calcolate two previous mentioned corrective factors, used elasticità module "E" and bellow's acceptable stresses "Sa":

KP = Sah / Sac

Sah = Acceptable stress with working temperature (Te) measured in MPa (Mega Pascal).
Sac = Acceptable stress with environment temperature (20°C) measured in MPa (Mega Pascal).

Obviously for calculate correct expansion joints property, its design pressur "PN" it have to be grater or like at equivalent pressure at 20 degC "Pc", calculated from working pressure "Pe" (at working temperature "Te") and corrective factor "KP" rate (corresponding at working temperature "Te").

PN >= Pc = Pe / KP

Pc = Equivalent pressure at 20 degC measured in bar.
Pe = Working pressure at working temperature (Te) measured in bar.

Same for the acceptable movements:

KC = (Sah / Sac) x (Ec / Eh)

Eh = Elasticity module at working temperature (Te) measured in MPa (Mega Pascal).
Ec = Elasticity module at environment temperature (20 deg°C) measured in MPa (Mega Pascal).

For calculate correct expansion joints property, its designed movement "CN" it have to be greater or like to equivalent movement at 20 degC "Cc", calcolate from working movement "Ce" (at working temperature "Te") and corrective factor "KC" rate (corresponding at working temperature "Te").

CN >= Cc = Ce / KC

Cc = Equivalent movement at 20 degC measured in millimeters.
Pe = Working movement at working temperature (Te) measured in millimeters.

PRESSURE AND MOVEMENT CORRECTIVE FACTORS FOR STAINLESS STEEL 321

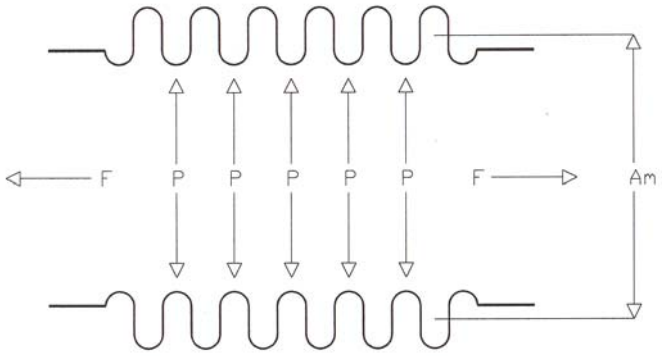
TEMPERATURE		ELASTICITY MODULE "E"	ACCEPTABLE STRESS "Sa"	CORRECTIVE FACTORS	
Deg C	Deg F	EJMA (ED. '93) Tab.2, Sez. C [N/mm^2] [MPa]	ASME B31.1 Tab.A-3, (Ed. '92) [N/mm^2] [MPa]	Pressure "KP"	Movement "KC"
20	68	195.179	129,62	1,000	1,000
40	104	193.859	128,82	0,994	1,001
60	140	192.523	121,62	0,938	0,951
80	176	191.186	114,43	0,883	0,901
100	212	189.799	108,22	0,835	0,859
120	248	188.310	104,00	0,802	0,832
140	284	186.820	99,78	0,770	0,804
160	320	185.469	96,11	0,741	0,780
180	356	184.228	92,89	0,717	0,759
200	392	182.987	89,66	0,692	0,738
220	428	181.360	87,20	0,673	0,724
240	464	179.622	84,97	0,656	0,712
260	500	177.885	82,74	0,638	0,700
280	536	176.644	81,25	0,627	0,693
300	572	175.403	79,76	0,615	0,685
320	608	174.162	78,38	0,605	0,678
340	644	172.921	77,39	0,597	0,674
360	680	171.680	76,39	0,589	0,670
380	716	170.218	75,62	0,583	0,669
400	752	168.480	75,13	0,580	0,671
420	788	166.743	74,63	0,576	0,674
440	824	165.171	74,13	0,572	0,676
460	860	163.682	73,64	0,568	0,677
480	896	162.192	73,14	0,564	0,679
500	932	160.482	73,08	0,564	0,686
520	968	158.745	72,59	0,560	0,689
540	1004	157.008	71,04	0,548	0,681
560	1040	155.270	65,09	0,502	0,631
580	1076	153.533	55,19	0,426	0,541
600	1112	151.630	44,43	0,343	0,441
620	1148	149.396	35,00	0,270	0,353
640	1184	147.162	27,91	0,215	0,286
660	1220	144.790	22,06	0,170	0,229
680	1256	142.308	17,18	0,133	0,182
700	1292	139.826	12,71	0,098	0,137
720	1328	137.344	9,40	0,073	0,103
740	1364	134.862	7,01	0,054	0,078
760	1400	132.379	5,52	0,043	0,063
780	1436	129.649	4,03	0,031	0,047
800	1472	126.919	2,84	0,022	0,034
820	1508	124.188	1,85	0,014	0,022

BELLOW'S REACTION FORCES

During the expansion joints installation, it is necessary always it hold account of the forces that develop themselves to its inside because of the pressare. The more mattering of these forces, that it is cause often of disruptions or deformations considered unjustified, is without doubt the Back Push.
This force that stretches out to extend the bellow, if done not clash from adequate anchor points or binds, is bred from the pressure that works on the waves it of the bellows, trying of "to flatten them" and causing in this manner a push, directed by the center verse the two ends of the bellow.
See follow for calculate this back push:

F = p x Am

p = Pressure (bar).
Am = Effective surface (bellow middle diameter) (cmq).



You consider that the presence of the back push, is cause of installation's problems, when in decisive areas of an installation, is not possible to realize anchor points supplementary to contain it. For this reason is possible to build expansion joints, that thanks to their special construction, can to contain autonomously this force, without to need of other anchor points.

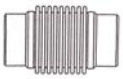
EXPANSION JOINTS THAT THEY CONTAIN AUTONOMOUSLY BACK PUSH	EXPANSION JOINTS THAT THEY NOT CONTAIN AUTONOMOUSLY BACK PUSH
- Angular expansion joints - Gimbal expansion joints - Lateral expansion joints - Spherical lateral expansion joints - Dismantling joints with pressure bearing tie rods	- Assiale - Universale - Dismantling joints without pressure bearing tie rods

Another bellow's reaction force that it not depend to internal pressure, but from bellow's building features, is the named Spring rate.
This force is born from the resistance that the bellows offers to the deformation caused from the work that should develop (movement); Different types are:

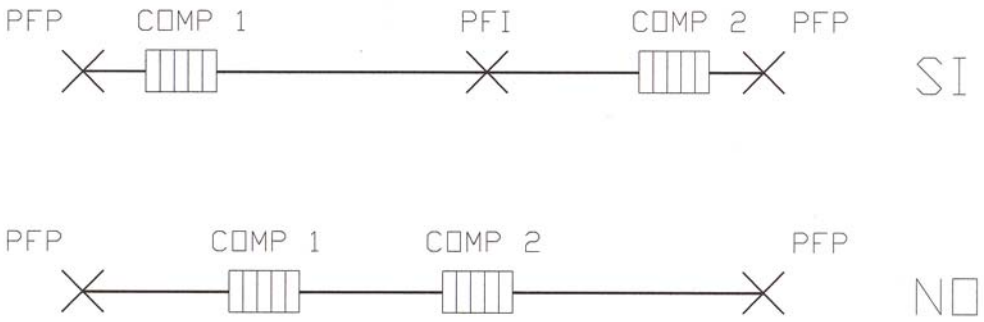
- Axial spring rate (axial exp. joint) is axial force measured in Newton / millimeter (N/mm).
- Angular spring rate (angular exp. joint) is a torque measured in Newton meter / grado (Nm/grado).
- Lateral spring rate (lateral and universal exp. joint) is a transversal force perpendicular at movement measured in Newton / millimeter (N/mm).

Is possible to calculate total bellow's reaction multiplying spring rate for movement request.

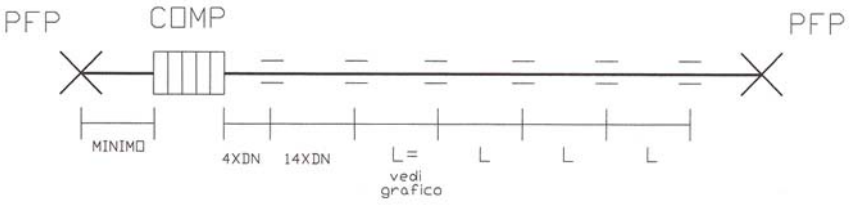
EXPANSION JOINTS TYPE

AXIAL EXPANSION JOINT: 

Axial expansion joint is projected to absorbe only axial movements and it have to be installed always between two primary anchor points (PFP); it is not possible to install two axial expansion joints consecutively, if it there is not it is necessary it create intermediate anchor points (PFI)



Besides it is good rule to install the expansion joint the more possible near to the anchor point, giving back in this manner one of two ends practically fixed, increasing the total stability of the pipeline. Another fundamental detail for the correct installation of the expansion joints, is the predisposition of the axial binds, that give guarantee of perfectly axial motion of the pipeline, avoiding unwanted damages.

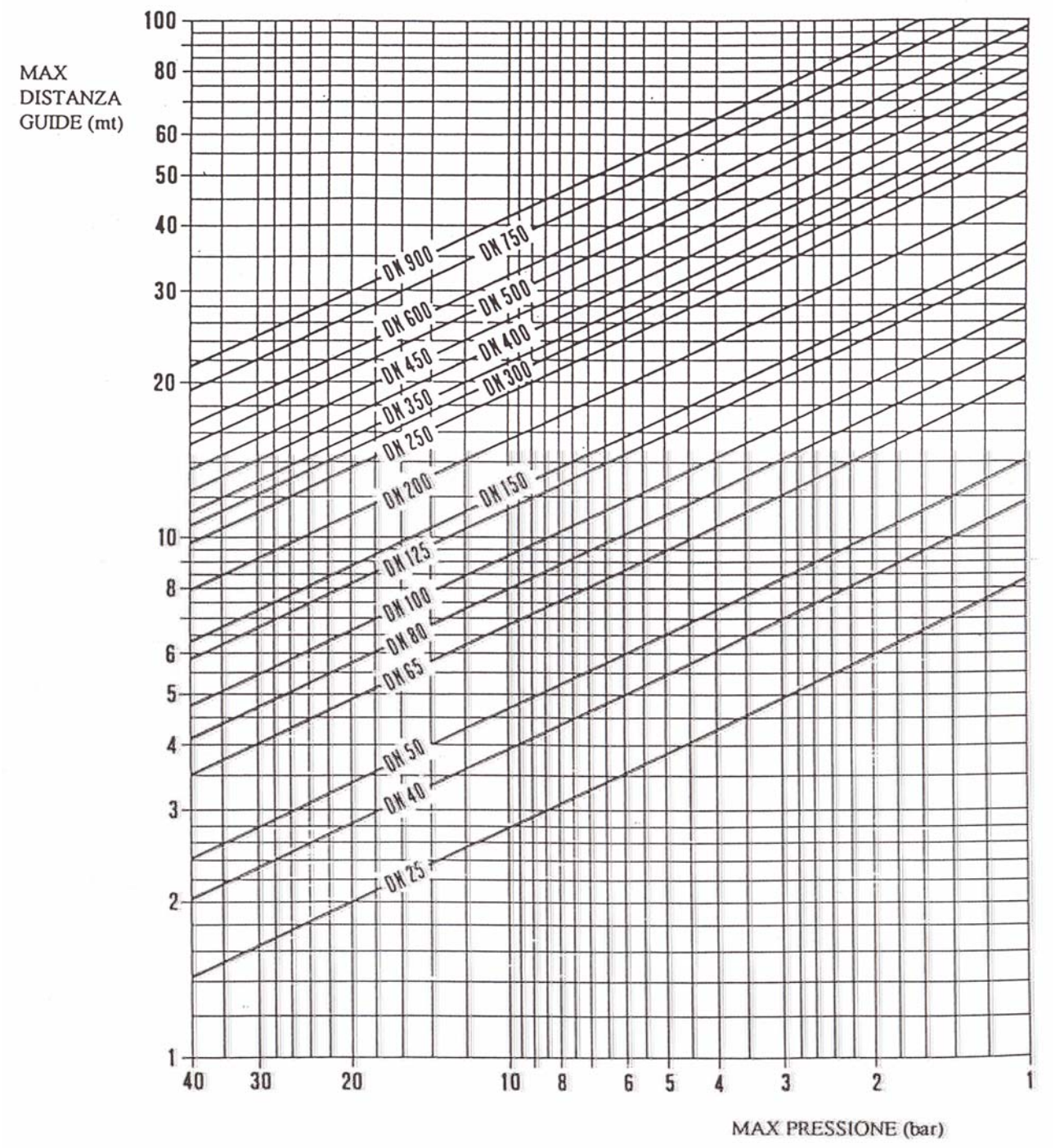


The distance of the first axial bind have to be 4 times the nominal diameter of the pipeline, the second one 14 times and from the third one in then is necessary do reference to the chart restored to page 7 summary from the rules E.J.M.A..
For anchor points project that they contain one axial expansion joint, is therefore necessary to consider the following forces:

Primary anchor point (PFP):

- Expansion joint's back push, caused by pressure.
- Expansion joint's elastic reaction, caused by movement.
- Summation of the bind's friction forces, caused by pipeline.
- Fluid conveyed dynamic action, when the anchor point is near to one elbow.
- Eventual outside loads.

DISTANCE INSTALLATION'S CHART OF AXIAL BINDS FOR STANDARD PIPELINE CARBON STEEL, REFERRED TO RULES E.J.M.A.

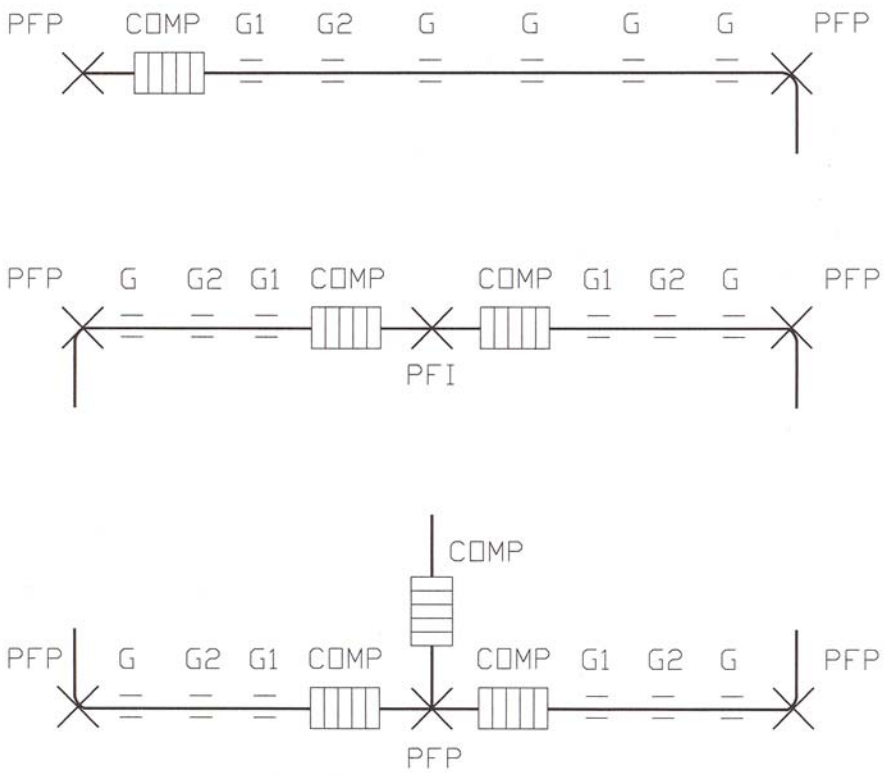


Intermediate anchor point (PFI):

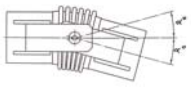
- Force resulting from the composition of the expansion joints elastic reactions (to the right and left of the intermediate anchor point).
- Force resulting from the composition of the pipeline's friction forces (to the right and left of the intermediate anchor point).

How does it see the PFI should not support the back push, as the two expansion joints (to the right and left of the PFI) exercise an equal and opposite push on the PFI, canceling itself mutually (that is true if the two expansion joints are identical is in the features, that in the work conditions). Is however advisable to plan the PFI in such manner to resist the forces developed from one of two pipelines.

Installation examples:

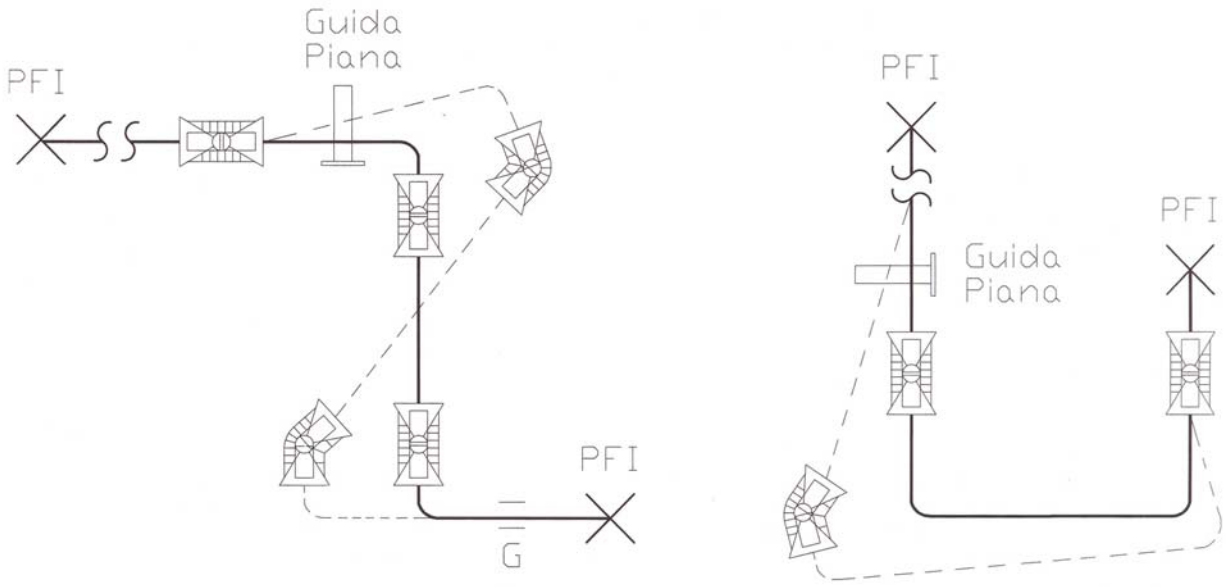


ANGULAR EXPANSION JOINT:



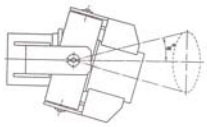
Angular expansion joint (hinged) is a good solution when the movements to absorbe, are very high; in fact thanks to the angular movement it is possible to exploit linking of 2 or 3 expansion joints, installed in decisive configurations, to obtain a result that would ask for a number a lot more raised of axial expansion joints!
This type of expansion joint is composed from a bellows in stainless steel, that however because of the type of movement that develops (angular), should have a superior PN to the declared PN for the expansion joint.

Example: If the line requires of a PN 16, the bellows will be a PN 25, but the expansion joint's PN is declared 16. The other metallic parts are composed from two couples of braces flat on coaxial pivots, positioned in half of the bellow; these braces are designed to contain autonomously the back push and require therefore alone of intermediate anchor points, to the initial and final ends of pipeline to compensate.
Obviously how restored in priority, the line from compensate for should allow some special configurations defined to "L" and to "Z":

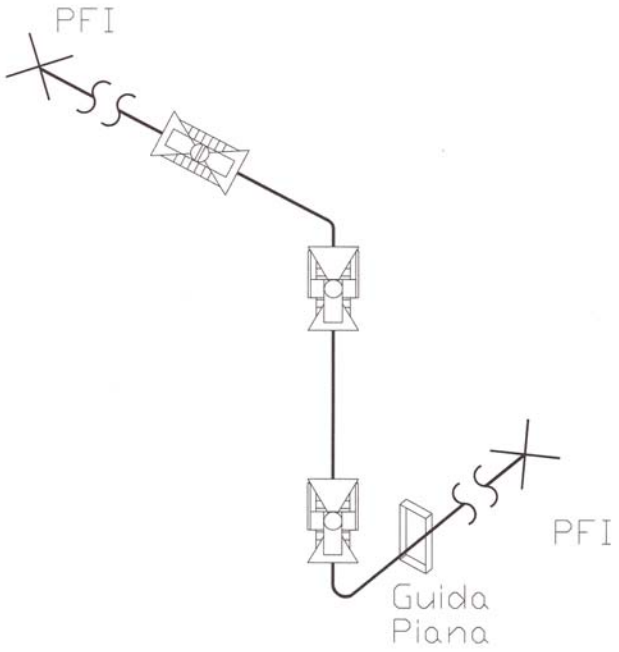


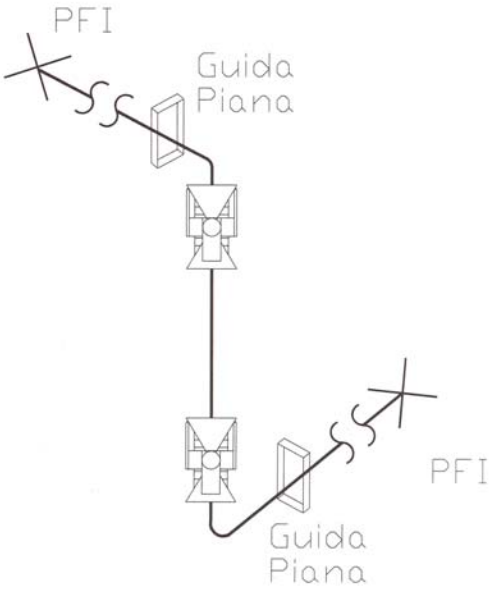
When they use themselves the angular expansion joints in these configurations, is necessary to arange (in proximity of the same expansion joints) of the plain binds, to agree bendings to the rigid pipeline, because of the final composition of the movements carried out; the better solution consists to use the configuration that expects 3 expansion joints.

<u>GIMBAL EXPANSION JOINT:</u>



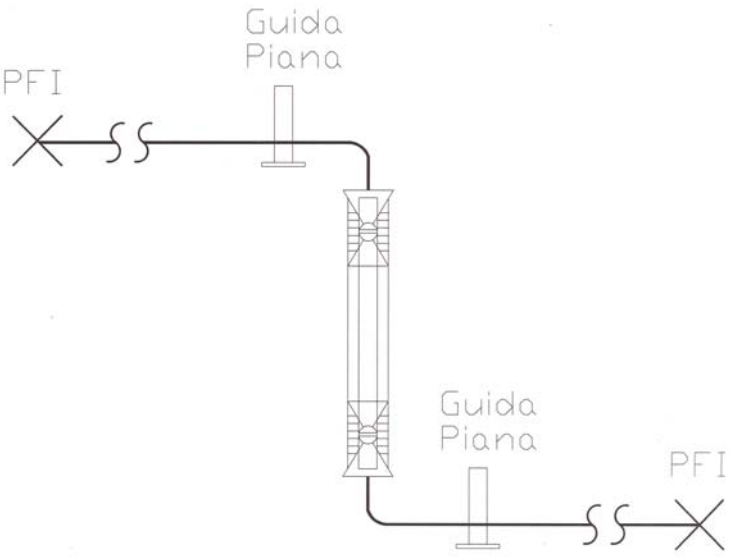
Gimbal expansion joint is built using the philosophy of construction of the angular expansion joint, with the difference than the angular having alone two couples of braces flat on coaxial pivots, allows angular movements on one alone plan, while the gimbal, thanks to four couples of braces offsetted ascended on a central gimbal ring, allows movements on any plan!
Also this expansion joint like angular, is in a position of to contain autonomously the back push caused from the pressure.
In the figure under restored it is yourselves an example of how installed the gimbal expansion joints; the optimal solution consists to istall two gimbal and one angular expansion joints; but also two gimbal in couple, can to be used.
How for the angular expansion joints, it is necessary it use plain binds in proximity of the expansion joints and installations in configuration to "L" and to "Z".





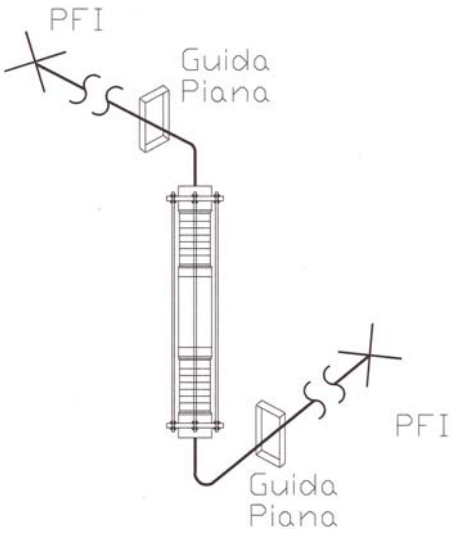
LATERAL EXPANSION JOINT:

Is practically composed from two angular expansion joints united directly between them from an intermediate tube and from two couples of braces flat on coaxial pivots, longer of the normal. It allows lateral movements on an alone plan and like for the angular, is necessary to install plain binds in proximity of the expansion joints. Also this expansion joint, is in a position of to contain autonomously the back push and for installation are necessary configurations to "L" or to "Z".



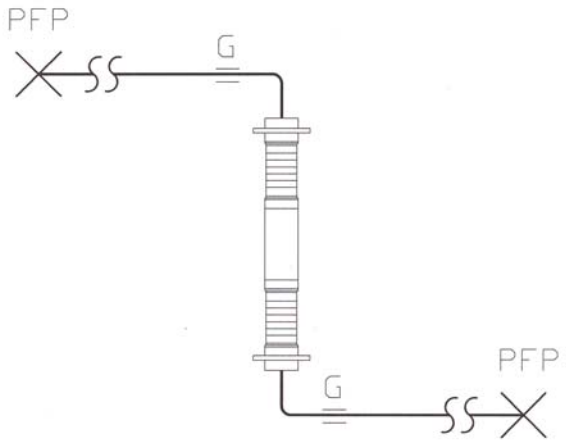
SPHERICAL LATERAL EXPANSION JOINT:

To difference of the lateral expansion joint, the spherical one resembles of more in the operation to a double gimbal expansion joint, but has not couples of braces flat on coaxial pivots, but set of tie rods with spherical whashers. It allows lateral movements on all of the plans and is in a position of to contain autonomously the back push. Also for this expansion joint, are requests installations to "L" or to "Z".



UNIVERSAL EXPANSION JOINT:

This type of expansion joints derives directly from the lateral spherical, as the base of construction of philosophy is the same one: two bellows and an intermediate tube.
The difference is that don't have spherical tie rods and therefore is not the degree of to contain autonomously the back push, but can to absorb in this manner, also axial movements of the pipeline, beyond to carry out lateral movements on any plan like the spherical lateral expansion joint.
For installation is necessary that the binds in proximity of the expansion joint are designed to resist the back push produced from two bellows; in this manner the expansion joint will be in a position of to absorb also the axial expansion of the pipeline.



OPTIONAL AND MATERIALS

OPTIONALS:

All of the models of expansion joints described in the previous sheets, can to be supplied to request of an inner sleeve that has the specific function of to avoid:

- Noises due to high speed of passage of the fluid conveyed.
- Turbulence due to bellow's corrugations.
- Losses of load.
- Damages due to fluid passage (solid bodies eventually presents).

Besides it is possible to supply the flanged expansion joints, rather than with fixed flange (welded directly to the bellows), with floating flange, constituted from flange corrected in the diameter of passage and ascended on bands in stainless steel, to them time welded to the bellows. In this manner the flange is free of to rotate on the band, agreeing an easy assembly in case of no axial line of the holes of the other flange (pipeline or other).
GT FLEX S.r.l. can to build special expansion joints, on request and design of the its customers.

MATERIALS:

Bellow:	Stainless steel 304 and 321 (Standard) Stainless steel 316L (to request)
Inner sleeve:	Stainless steel 304 (Standard) Stainless steel 316L (to request)
Flanges and welding ends:	Carbon steel (Standard) Stainless steel 304 (to request) Stainless steel 316 (to request)
Floating flanges bands:	Stainless steel 304 (Standard) Stainless steel 316 (to request)
Dismantling tie rods:	Stainless steel 304 (Standard) Stainless steel 316 (to request)
Other tie rods and metal parts:	Carbon steel (Standard) Stainless steel 304 (to request) Stainless steel 316 (to request)