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Carl Stahl®
SAVA INDUSTRIES, INC.

PUSH-PULL CONTROL ASSEMBLIES

Push-pull and pull-pull cable controls offer a reliable method of transmitting motion between two fixed points or between points which are changing their relative position. Because of flexibility, they can be routed up, down, over obstacles and around corners without intermediate links or pulleys. Fewer working parts increase operational dependability of cable controls. They are virtually maintenance free as no periodic adjustments are necessary due to wear and tear of worn connections. Cable controls do not transmit noise and vibration.

SAVA is flexible enough to handle small as well as large volume orders for cable controls. A wide variety of end fittings are available to the designer for use with the casings and core cables.

CONSTRUCTION

The basic component of a push-pull control consists of a solid wire with a casing of plastic tube or spirally wrapped wire. See Figure 1. Substituting a flexible cable for the solid wire allows the control system to be bent to facilitate routing.

Different fittings as shown in the following text can be attached to the ends of the casing and cable for ease of operation.

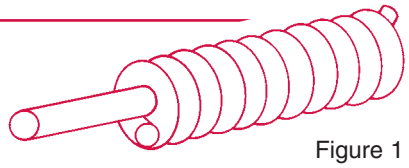


Figure 1

LOSS OF MOTION

The principal elements of lost motion in a control system are backlash and deflection. See Figure 2. Backlash is caused by the core member moving inside the casing with the change in direction of motion. It is a function of the clearance between the core and casing and total number of degrees of bend in the cable. This can be reduced by careful design. The other cause of loss of motion is deflection of the core wire under compressive load. Elastic strain in the core member due to compressive or tensile force also contributes to the loss of motion. The casing must be anchored securely to keep it from responding to the compression or tension modes of input loading.

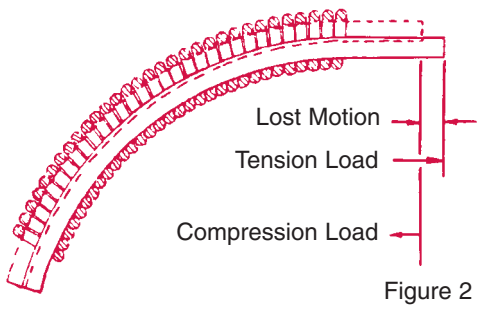


Figure 2

TRAVEL

Travel of the core inside the casing should be kept to a minimum since longer travel increases friction and decreases output. In the push-pull type of application, the chance of buckling of the core becomes greater. The travel should be limited to less than 5˝ if possible. The linear speed of operation should be relatively low.

BEND RADII AND LIFE

Cable bend radii should always be as generous as possible for maximum cable life and efficiency. Smaller bends cause reduced service life because of added friction. Depending on the size of the casing and the construction of the moving core member, the minimum recommended radius can vary from 2 to 8 inches.

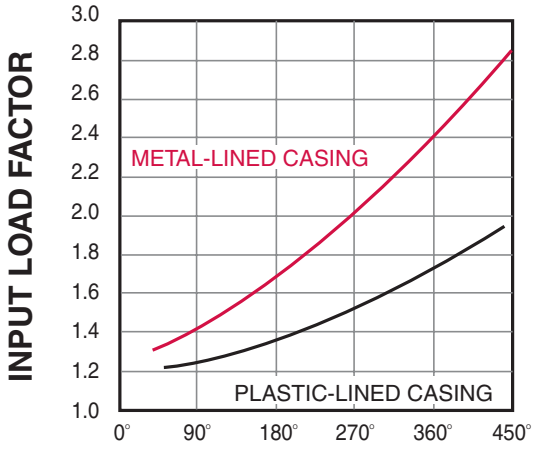
INPUT LOAD FACTOR

Friction between the core and the casing causes a loss in output force for a certain amount of input force. Friction is a function of the degrees of bend in the system. The ratio of the input force to the output force is called the Input Load Factor. The Input Load Factor has been plotted against the degrees of bend in the system and is shown in the accompanying graph. For selecting the right control system, the input load has to be determined by multiplying the output load with the Input Load Factor obtained from the graph using the following formula:

I = Input Load
P = Output Load
F = Input Load Factor (from graph)
I = P x F

Example: Consider a push-pull assembly with metal-lined casing requiring an output load of 6 lbs. Total degrees of bend in the system–270°. Input Load Factor from chart–2.05.

Input Load = 6 x 2.05 = 12.30 lbs.



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PUSH-PULL CASING AND CORES

For light load applications casing made from nylon can be used. For heavier loads casing made from a round or half round wire tightly wound to resemble a closed spring is good for most applications. This type of casing is flexible, resists kinking and can be clamped or terminated without distortion of the wall. The casing can be ordered with a plastic coating. Casing with a plastic liner offers reduced friction and less start-up inertia.

Casings available from stock are shown in the chart at right. For other types of casing such as **stainless steel** consult factory.

PART NO.	CASING O.D. REF.	CASING I.D. REF.	STANDARD CASING MATERIAL	SOLID CORE WIRE SIZE	1x7, 1x19 7x7 CORE CABLE RANGE
C090N	.090	.040	Nylon	.020 S.S.	.015 - .027
C130N	.130	.060	Nylon	.032 S.S.	.024 - .040
C070 C070VC	.070 .090 Black PVC	.035	Galv. Steel	.020 S.S.	.018 - .027
C096	.096	.050	Galv. Steel	.032 S.S.	.027 - .037
C132 C132VC	132 .170 Black PVC	.060	Galv. Steel	.036 S.S.	.036 - .050
C187 C187PC	.187 .225 Black HDPE	.080	Galv. Steel	.054 S.S.	.045 - .063
C187PL C187 PLPC	.187 .225 Black HDPE	.080	Galv. Steel with HDPE Lining	.054 S.S.	.045 - .063
C277PL C277PLPC	.277 .305 Black HDPE	.140	Galv. Steel with HDPE Lining	N/A	3/32

NOTES: Nylon casing is molybdenum disulfide impregnated for friction reduction.
C277 casing may be provided with HDPE lining, based on availability.

LUBRICATION

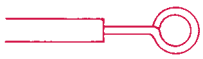
Generally, lubrication is not advised in the casing. Lubricant tends to collect dirt, which impedes the movement of the core inside the casing. The core cable can perform efficiently with little or no lubrication. If lubricant is desired for a particular application, it must be specified by the customer which lubricant to be applied to the core cable prior to the assembly.

END TERMINALS FOR CORE WIRES

The simplest core is a solid wire which is adequate for low input loads and minimum bends. If the force is only in the pull direction, a stranded cable can be used with much tighter bends.

Simple terminations can be provided on a solid core wire by forming the high tensile steel wire in the typical shapes shown below. Some catalog fittings, such as eyes, end plugs, etc. can be used on solid wire. Please consult factory.

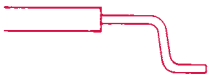
CENTERED LOOP



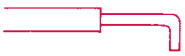
OFFSET LOOP

U BEND

Z BEND



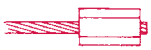
L BEND



END TERMINALS FOR CORE CABLES

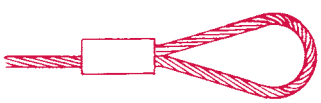
At right are shown typical cable fittings used as push-pull cable core terminals. The dimensions for these should be taken from our catalog using the proper cable core size. Special terminals can also be manufactured.

BALL
(PG. 14)



STOP SLEEVE (PG. 15)
OR END PLUG (PG. 13)

THREADED PLUG
(PG. 13)



LOOP SLEEVE
(PG. 15)

EYELET
(PG. 12)

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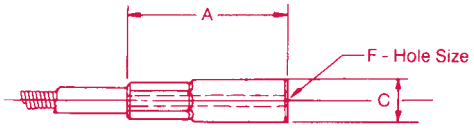
END TERMINALS FOR CORE CASING

For many applications simply clamping the casing close to the end of the control is acceptable. However, casing fittings can be applied directly to the ends. Special fittings developed for this purpose are shown below.

CAP AND GROOVE TERMINALS

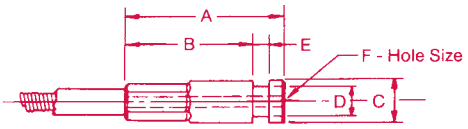
PART NO.[1]		AVAILABLE WITH CASING NO.	A REF.	B REF.	C REF.	D REF.	E[2] REF.	F REF.
GROOVED TERMINAL	CAP TERMINAL							
6005	6105	C070,C070VC,C096	.98	.74	.19	.125	.090	.047
6006	6106	C132, C132VC	.98	.74	.25	.180	.090	.063
6008	6108	C187, C187PC C187PLPC C187PL	1.00	.76	.25	.180	.090	.080
6013	6113		1.25	.87	.38	.250	.130	.125
6014	6114	C277, C277PC	1.50	1.12	.44	.344	.130	.125

NOTES: [1]State material required by suffix - B (Brass) - S (S.S.) - P (Plated Steel).
[2]This dimension can be modified for special snap rings.



SHOWN AFTER CRIMPING

CAP TERMINAL



SHOWN AFTER CRIMPING

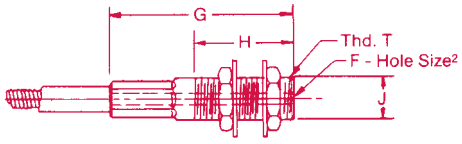
GROOVE TERMINAL

BULKHEAD TERMINALS

PART NO.	AVAILABLE WITH CASING NO.	G REF.	H REF.	J REF.	T REF.
6465	C070, C070VC	1.62	1.00	.19	#10-24
6475	C070, C070VC, C096	2.06	1.25	.25	1/4-20
6477	C096, C132, C132VC	1.94	1.00	.31	5/16-18
6480	C132, C132VC, C187, C187PC, C187PL, C187PLPC	2.25	1.25	.38	3/8-16
6482	C187, C187PC, C187PL, C187PLPC	2.81	1.50	.50	1/2-13
6485	C277, C277PC	3.38	1.75	.63	5/8-11

NOTES: Part no. 6465 is available in brass and stainless steel; the rest of the terminals are available in plated or stainless steel. State material required by suffix B (Brass), S (S.S.), O (Plated Steel). Other thread lengths and specials are available; see page 13. Jam nuts and washers furnished unless otherwise specified. To complete part no., add…casing no. desired. (such as 6475S096)

Hole size will match inside diameter of casing.



SHOWN AFTER CRIMPING

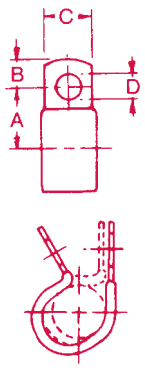
BULKHEAD TERMINAL

CLAMP TERMINALS FOR CASING

PART NO.	MATERIAL	USED FOR CASING	A REF.	B REF.	C REF.	D REF.
951N	Nylon	C130N	5/16	13/64	1/2	3/16
952N	Nylon	C070	9/32	5/32	3/8	1/8
953P	Plated Steel	C132 C132VC	11/32	3/16	3/8	11/64
954P	Plated Steel	C187, C187PLPC C187PL, C187PC	13/32	7/32	1/2	13/64
955P	Plated Steel	C277	7/16	7/32	1/2	13/64
956P	Plated Steel	C277PC	5/8	3/8	5/8	11/32

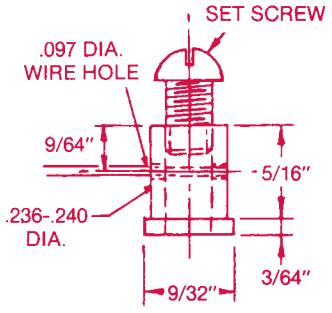
NOTE: The steel clamps are vinyl lined.

CLAMP TERMINAL



WIRE CLAMP

PART NO. WC-1
MATERIAL: PLATED STEEL



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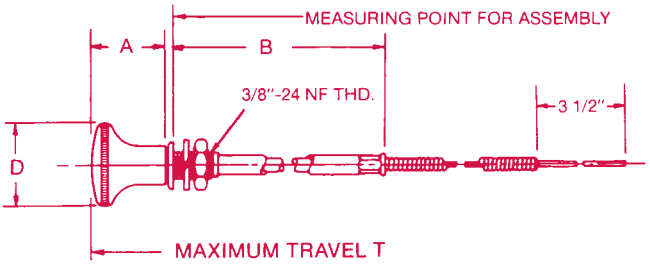
OTHER TYPES OF CONTROLS AVAILABLE

PUSH-PULL CONTROL

This type of push-pull assembly is ideal for choke or damper control.

Fits wire size .054″ or cable diameter .045-.063 with C187 series casing (see pg. 24).

PART NO. PPC1 AND PPC11



ITEM	A REF.	B REF.	D REF.	T REF.
PPC1	31/32	3-9/16	1-1/16	2-1/4
PPC11	3/4	3-1/8	7/8	1-1/2

LOCKING PUSH-PULL CONTROL

This control provides infinite adjustment for its entire travel. The operator can position the control where desired and then lock it in place by turning it clockwise.

Specially suited for applications where spring tension or vibration causes ordinary controls to creep.

Fits wire size .054″ or cable diameter .045-.063 with C187 series casing (see pg. 24).

All PPC part numbers will consist of the following:

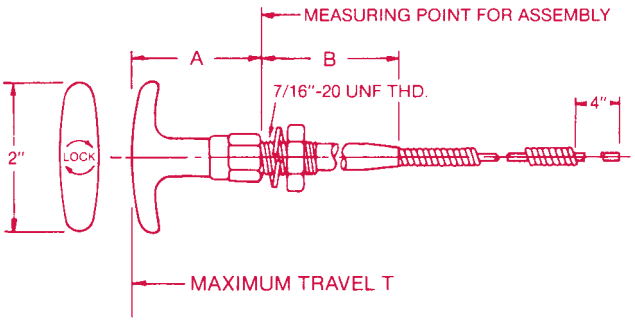
1 knob with plunger — 1 lock washer

1 sleeve with face plate — 1 jam nut

For assembly order please specify length of casing and wire.

Part numbers PPC11 and PPC22 are less expensive, have shorter travel, and are intended for lighter duty applications.

PART NO. PPC2 AND PPC22



ITEM	A REF.	B REF.	T REF.
PPC2	1-3/4	4-1/8	3
PPC22	1-5/8	2-15/16	2

NOTE: PPC2 may not be available in small quantity. Consult factory.

DESIGN PROCEDURE

1. Select a cable suitable to withstand the load. Keep in mind, the more number of wires in a cable the more flexible the cable will be. For push-pull types of application the solid core wire will be most suitable. Next to that a 1x7 or 1x19 construction cable may be used where the movement is small and the casing is adequately constrained.

   Select a casing and make a scale layout drawing. Try to keep the number of bends to a minimum and the radii of bends to a maximum. The radius should not be less than 100 times the core diameter. Remember, the lighter casing with a light load will be more flexible.

2. Build a prototype of the design in its final configuration. Apply loads to determine performance characteristics.

3. Determine exact dimensions of the assembly from the prototype. Check tolerances on all components to keep the length at a minimum so extra bends are not necessary. Indicate the movement of the core inside the casing.

4. Prepare a drawing and indicate the distance moved by the core inside the casing. Include lengths, tolerances, end fittings, casing, core, quantities, and send to SAVA with a request for quote.

TYPICAL APPLICATIONS INCLUDE

Dampers • Releases • Valves • Vents • Doors • Connectors • Linkages • Shutoffs • Reset Devices