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Professional Development Training Course for Registered Engineers

Valves

Tape 1 – Side 1 (01 track_1.10.25)

This is tape one, side one of a three-hour Professional Development Course, titled Valves.

I am Ed Hardin. I am a professional engineer in North Carolina, registration #7449. My experience is that I am the son of a pipe fitter, a chemical engineer, and I have an operations background for the first ten years of my time in professional work. I was involved in plant start-up for a very large liquid processing facility in the early 1970s. I have been a design engineering project leader for large solids handling in an electrolytic reduction facility; a group leader for chemical process modifications for several organic processing facilities; an engineering services sales manager and development specialist for an engineering firm with an international scope of activities; an engineering leader for an East Coast engineering firm specializing in chemical processing facilities and a site project manager for several projects constructed, designed and developed by this firm; and continued in engineering sales and project development over the last 15 or 20 years, along with periodic design responsibilities and working as a consultant to specialty chemical processing facilities. This is a background. I don't claim to know everything about valves, but I've used many and look forward to providing some guidelines that I expect to be helpful to you in your review and analysis of what valves to use on projects that you might be involved in.

The purpose of this course is not to discuss control valve sizing or characteristics, although some comments on these applications cannot be avoided for some valves, nor is it to be a definitive answer to any valve question. That would be too presumptuous. Also, it would develop into a great deal of minutia, as it isn't appropriate to a general understanding of valves and their application. For that kind of specific information, an analysis with the valve manufacturers, vendors, and those who have used or will use the valves that you're expecting to put into a given plant, and their opinions about their operation, would provide the detail level that would need to be addressed in order to be sure about applications on many specific valve questions.

My intent is to provide a general review of valve types and discuss the good and not-so-good applications of these valves. Understanding that valves and their use is a very visual exercise, I have included several pages of valve examples, drawings, appearances, and internals, for you to review as we go through the discussions. I'll probably not refer to them specifically, but leave them there for you to refer to as we discuss points on the valves. These come from a variety of publications and I've marked them on the copies that I send to you, but I would strongly suggest that those of you who are really into the responsibility of providing valve selections and valves for particular points of operations in plants get a hold of a good, general valve company catalog,

such as Lunkenheimer or Crane. These are a little more difficult to acquire today than a few years ago, but they provide a good deal of insight into the actual internals of the valves.

For good or not, the tendency today seems to be forcing a universally applicable valve to all uses. Hopefully, this review will offer some reason to assure the applicability of a given configuration rather than first-cost alone or someone else's idea of what your processing requires. I would also add to the comments that the availability of information on the web is very good and there is a great deal of valve information there. However, my experience has been, when I go looking for a particular type of valve, I am very quickly narrowed into that particular configuration and minor variations of that arrangement.

My preference and suggestion for getting a hold of a valve catalog is to give you an opportunity to be able to just page through a valve assembly and see the different types and styles and recognize that, now and then, one of those special ideas can come to you that, "Gee, with all of the things we've tried with a certain valve body, this one really looks like it would provide some specific benefit or specific help in this particular application. So, maybe I ought to change and go away from what we've been using before." Certainly, this is the point at which some further discussions with the specific manufacturer and vendor would be very worthwhile in seeking an opportunity to do some testing in a particular application.

A little bit of testing, as has often been said and quoted quite regularly in Peters Chemical Engineering Plant Design and Chemical Engineering Plant Economics, and Peters and Timmerhaus, and so on, is do the testing, learn a little bit as you're going in, and make the mistakes on a small scale so that you can make money on the large scale. Don't commit to a large number of unknown valves for an unusual or new application until you've got a little understanding that the valve will indeed be functional and serviceable in the application you want to address.

We'll begin our discussion on the specifics of valves with the gate valve, which is probably one of the original manners used for blocking liquid flows. As a matter of fact, a few years ago, while I had the pleasure of visiting in Italy and taking a walk through Tivoli Gardens, it was rather extensively reviewed with us that little plates were slid in places in the gravity channels, flowing and providing water around to the fountains through the gardens, to direct and control which fountains operated at which times. Of course, in addition to that, although this tends to border on a control application, quite regularly the plates leading to individual fountains were changed with different orifices in order to provide different amounts of flow to the different display fountains, as they want out there. So, this is something that has been used for quite a while in open channels as well as in closed channels as a gate valve. Sliding discs or plates are found in a variety of flow control applications from agrarian irrigation ditches and systems controlling flows there to many of the things we use today.

One of the key factors that limits and controls the use of a gate valve, while it's a very simple and straightforward valve, is the problem of sliding the seat into the chamber that controls the sealing rings that provide the actual closure. Quite often these were started off initially as essentially flat plates with a slide fitting between them. Looking forward to the plate itself remaining in the same configuration and just sliding very closely between two plates, two rings,

to provide the closure. I think it was recognized early that this was a less than desirable or reliable situation. So, the plates and the rings themselves were provided with a very slight taper so, when the plates slipped into place, there was a more reliable seal. One immediate problem that began to develop with this was that if there was any kind of a scale or small amounts of dirt that were in the valve, particularly if the valve was in a vertical position, a little bit of sediment would very quickly accumulate between the rings in the bottom of the valve. It would then become difficult to get the valve plate to slide down between the seal rings. So, a problem of cleanout became immediately evident. Often you'll find gate valves with a small plug at the bottom that can be used to allow periodic cleaning.

Another thing that was very significant with these valves was the idea of how to seal the stems during normal operation. So, in the initial valves, early ones that we see, we find that the stem is completely encased. There are some seals around the upper end of the stem that are usually tightened up with a seal nut that tightens down onto the stem cover and that, very regularly, a large lead thread of some kind is then used in a fixed position in the valve to move the plate up and down the stem. Of course, this very regularly led to the problems of how to maintain the quality of the worm and screw operation on the valve moving up and down. So, the next step was into a fixed worm for the shaft to move in and the ability for the shaft to turn within the valve plate itself so that as the stem turned and lifted, the valve plate could lift. This provided a more easily maintained valve by being able to take off the valve bonnet and replace the worm and possibly stem periodically. Of course, this generally required removing the valve from operation.

So, many of these little advances led to additional problems. Of course, always with situations like that, there is the problem of how to seal the shaft as it comes up. Rings around the top of the shaft were regularly used. Certainly, this was a very popular method for a long time, but we soon moved into variations. One of the other variations that came in from a sealing problem of the valve itself was to split the discs so that as they moved in between the rings, they would adapt a little bit to the ring cant, or the ring angle, and provide better sealing. Certainly, this then led to questions of: How much movement is there in the disc later on? Do they vibrate? Do they change their relative abilities to approach a given seat?

Another thing that developed a little bit later on was what was called the outside stem and yoke valves where the actual seal on the valve shaft was done between the lifted discs and the worm of the shaft that provided the lifting mechanism. This tended to give a little better life to sealing situations because it kept the seals better aligned as they were closer to the valve plates themselves and in a more strongly held situation. Of course, all of the questions of seats, the functions of closing and operation, and the possibility of blocking some material at the bottom of the valves were all still there. Many people going through time, argued on both sides of the open versus closed yoke valves.

One of the little interesting things that came out of using gate valves, certainly early in operating requirements, is that it was often recognized that there must be a very reliable method of being able to close off pieces of equipment when they were going to be taken out of service for maintenance or repairs and being able to provide good protection for workers as they began changing and removing equipment. So, the function came into many large plants, particularly

those handling very large liquid flows, of a double block and bleed arrangement. Generally, this involved two gate valves with a small spool in between them and a bleed valve on that small spool. So, when both gate valves were closed, the small drain valve could be opened to assure that there was a complete closure and separation between the valves. Then, some work could be done to begin removing equipment on the protected side of the system.

With some improvements in seal plates and rings, there have been people who have suggested that one gate valve will provide that function. So, particularly where large flows are being used, they have put a very large drain and clean valve in the cavity between the seal rings so that the gate valve itself provides the double sealing with the potential for draining between them. This reduced down to a much simpler piping arrangement of a single valve, but still with the reliability of a place that could be drained to assure closure and eliminated a second valve, the nipples and connections in between, and other special piping considerations that were required by putting in two valves.

Generally, a gate valve is used more extensively in liquid streams where there is very little solids contamination. As mentioned before, the accumulation of material in the cavity between the seal rings can have a serious effect on whether the valve can be opened or closed. That being said, almost all materials have a little bit of scale, some separations from the internals of the pipes, or some accumulations that break off periodically, and gate valves have seen excellent service in many systems for long years with a minimum of maintenance, but with some reasonable care to them. One of the very specific and typical applications of this is in steam power plants where gate valves are a regular application.

Stem seals, of course, we've talked a little bit about the questions of how that's been done either in the closed seal chamber with the enclosed worm lifting mechanism or in the outside stem and yoke. All those questions of seals have developed and been applied through the years of standard packings of various varieties, plasticized and graphitized packings, plastic chevron packings, and so on. Of course, one of the things that was very easily adapted into a gate valve, particularly the enclosed yoke gate valves, was the use of a bellows type seal that could be sealed to a shaft section on the top of the plates and sealed to the body of the valve. Then, flexed up and down inside a cover as the valve hand wheel was turned and the shaft was moved up and down to open and close the plates. Certainly, special materials handling brought in the needs for additional requirements and special needs for sealing and handling things like hot oil. Long extensions on the valves themselves were used to get the seals into a cooler area rather than having to deal with the very hot oil, using a bit of the oil to provide an insulation from the very hot flowing liquid, to a place where the liquid would be a little bit cooler and easier to seal.

A widely used minor variation of the gate valve is an item called a spectacle blind, also often called a goggle blank along with several other names. Many of the reasons for using these type activities essentially involves a plate that is large enough to have two closures for the pipeline or the flowing chamber that is to be used. Generally, this plate is arranged to look very much like a pair of glasses or spectacles. With the bolt that provides the swing around capability between the two lenses, as it were, with one of the lenses being totally blank and the other being strictly a spacer so that one of these units could be put between two flanges. More than one bolt can be left in the flange. Periodically, there have to be conditions of flow shut down in order to be able

to arrange this. The blind can be loosened, swung around in place, and the line can then be effectively blocked or opened.

Often, this is a technique that is used to assure that there is a blind at vessel entries, particularly for maintenance or any vessel entry requirements, so that a number of blinds don't have to be carried around. Of course, this does bring into question that there's a lot of metal hanging in the air and spaces, but the time usually saved in hunting up blinds for various applications can be quite extensive in large plants. So, the use of this type of blank and leaving it in position so that when a piece of equipment is removed and they want to be assured of a complete separation, the easy change of these blinds can give you that assurance and a very quick visual check for the condition of the vessel simply by looking at the various flanges. If there is an open ring outside, then you know the line is blocked. If there is a closed ring outside, you know that the line is potentially in use.

One final short discussion about the gate valve, I'll go back to my original comments and say that it's worth looking at a variety of valve manufacturing catalogs to see the subtle differences that there are in many gate valves. Of course, there are a variety of materials for gate valves, from cast steels to forged steels, their uses, and the abilities to remove and replace the gates themselves, the sealing rings, all of the packing arrangements that go on them. These things are all specialty capabilities that can be built into gate valves.

A very specific type of gate valve that is often used as a secondary block, particularly in steam service, is what is called a stop check. This is possibly an unusual one to consider as a gate valve, but it is typically a plate-type swing check valve that has mounted, above the plate in the area where the plate can swing, a moveable shaft with a ball, or small pummel of some kind, on the bottom of the shaft, that can be forced down against the flapper itself to assure that the valve is closed as a secondary protection in some applications. Of course, it then also gives you the opportunity to limit the amount of backflow in its normal operation. It would be left open with the stem up and, if there were any tendency toward backflow, it would immediately close.

This is one of the advantages in water operation and using this as a secondary valve in those cases where something might happen to a boiler tube or piece of piping at a given boiler operation. All of a sudden, one boiler becomes inoperative. Having a valve like this in its primary discharge line gives you an immediate first dramatic reduction in backflow that can occur in such situations and loss of pressure from the system because of a problem in one boiler—a catastrophic or failure problem in a boiler.

So, these are interesting valves to use in those applications. Gate valves are a long-used, widely applied, and very simple method of blocking flows. Quite regularly used mostly in clean fluid operations. Certainly, some filtering can be used in order to improve their applicability. They are very simple, straightforward valves, and something very easy to understand, repair, modify and explain in a training function.

Our next specific valve topic will be globe valves. It would appear and, of course, this is my own personal rationalization, that after learning how nicely the sliding plate can cut off flow, it was pretty well recognized that the edges of those plates were not a very good method for

controlling flow. Therefore, the globe valve seemed to come in to be. The globe valve is an arrangement whereby fluid enters a valve body, flows into a central chamber, up through a ring, then turns in the upper section of the chamber, and proceeds on through the valve. As it goes through that single ring, a globe or a ball-type can be forced down against that single ring so that there is a uniform, annular orifice around the whole ring. The flow can be adjusted or stopped with a shaft moving vertically, going down and closing completely against the ring.

This provides several real advantages. The first being, as we mentioned, the variable annular ring that can provide flow control and the second one being overflow-limitation, rather than specific control. Although, that type valve was much later adapted as a principle and primary control-type as the air-operated shafts were installed on top of them. This valve was also in the situation that the globe or the ball that is forced down into the sealing ring is now somewhat movable and has an increased probability that they will be able to find a complete sealing around the ring of the valve. Of course, a lot of this tended to relate to the age of the valve and the wear that occurred on the ring itself. So, the progression would seem to have been from a fixed globe or bubble of some kind on the bottom end of the stem that relatively quickly was seen to wear in particular areas or in such ways that it was difficult to seal. That was then replaced with a floating or replaceable globe or bubble-like unit on the bottom of the stem so that they could tend to hope that the wear would be more uniformly distributed around the valve body.

Certainly, I would suspect that, although this tends to go a little more into the aspects of control function rather than the specifics of valves, people probably began to understand that they could shape that plug in various ways in order to improve either its operating life or its flow limiting characteristics because globe valves were the primary things that were used for adjusting rates of flow into and out of vessels. They did not have to be either full open or full closed, so they could be modified a little bit. So, arrangements went into truncated cones, balls themselves, and sometimes special elliptical turning on the rings, certainly not from a round unit, but to an ellipsoidal siding much in the way of an ASME dished head. All of these varieties were available in globe valves and could be used for particular applications. Of course, many other specific configurations of that plug configuration could be used. Certainly one of the things that one could estimate was people began to use the curves of various varieties in order to give a possibly logarithmic-type flow response to these plugs. All of those things are now possible in control valves.

With the globe valves, all of the similar shaft and yoke questions came up. There were closed shafts with the internals, the sealing problems, the sealing questions, and all of the capabilities of longer necks, which are quite often used today in cryogenic valves or very high-temperature valves, or particularly in hydrogen valves. These were very long shafts with the sealing mechanism somewhat separated from the actual flowing medium in order to provide protection. Of course, also in these arrangements over the years and certainly the more current situations, there were adaptations for the extensible tubes, the corrugated tubes to be used as a fixed sealing arrangement so that only the stem moved up and down and that there was no turning of the stem. So, a complete containment valve could be used with the globe valve.

There are some configurations of globe valves that have the outside stem for movement and some capabilities. Certainly, all of the varieties that are available in globe valves can be readily

accessed in catalogs. Again, looking it up online, the information is there, but quite often you have to look at valve after valve to be assured that it is a globe valve and it is a variation. Whereas, in the catalogs, often all of the globe valves are presented in a particular area and can be reviewed and the individual differences can be commented on quite readily and easily, one after the other.

Seat rings certainly came in for their share of work also. A variety of seat rings, a variety of globe or bulb configurations and selections, could be made for the valves to take care of wear characteristics, particularly where there might have been any small solids in the lines. Certainly, the rings could be changed from the brass of the casting to a stainless steel ring for higher wear, or from stainless steel valves to titanium or stellite rings to be able to reduce wear situations, but a variety of internals were very quickly adapted into the globe valves in order to make specific requirements.

A lot of the minor variations of the globe valve that have proved very functional in a number of applications and strikes me as a globe-type valve, that's why I include it in this section of discussion, is the diaphragm valve that was typically represented many years by what is called the Saunders diaphragm. I believe IT&T is now the purveyor of that type valve. This was a valve that was regularly and uniformly used in chlorine and caustic chlorine production because of its reliability and in some other very concentrated specialty acid and chemical handling situations.

The main advantage here being that the body of the valve was a very simple casting. To this valve was mounted a relatively simple clamping arrangement that included a moveable stem for the closing. Between these two pieces was placed a rubber diaphragm that was moved by the clamping stem in the upper section against a somewhat circular or elliptic type dam that was mounted in the center of the valve. So the diaphragm became the sealing mechanism against this dam and the frame in the upper section. The clamp forced the diaphragm against the dam in the lower section of the body and provided the opportunity for both some flow control and a reliable sealing of the valve.

Now, as the industry progressed and the fluids handled progressed, there were also a variety of adaptations to this valve. Valve body materials were changed. Sometimes the bodies themselves were lined with an elastomer of one kind or another to improve their serviceability and corrosive environments. Of course, the diaphragms themselves were often changed from one material to another. The natural rubbers, the Buna-Ns [ph 35:06], the GRS rubbers, and so on, were all adaptations. Then, as the very high grade technical plastics started coming in, little liner plates over the valves and in the valve bodies themselves of all of the varieties of polytetrafluoroethylene, the monochloro, trifluoro polyethylene arrangements, and the varieties in sheet arrangements—ethylenes, propylenes—were used as liners for these valves for specialty applications as time went on.

As mentioned a little earlier, since this was a flow control-type valve, as well as a shut off valve, quite frequently, modifications were made to it and a driver of one kind or another was placed on top of the valve to be used as a mechanized opening and closing; and also often used in a control

function. The control over the dam in the center of the valve tended to provide many advantages in limiting flow or controlling methods of feeding vessels and power or use systems.

So, these valves became very reliable, widely used, and readily understood. They generally were somewhat more complicated in installation because of the arrangements and the preferences for controls and flow inlets. They were generally always made as flange situations so pipelines having quite an extensive number of flanges down through the systems became rather typical in chemical plants in order to be able to allow the quick installation and removal of these type valves. As I said, their use for automated shut off and opening was also quite typical.

We'll work to the end of this first side of the tape with a few personal comments on valves and valve reviews. You've very definitely heard me mention on several occasions that I think it is important to get a hold of pictures of the valves and be able to look at the variety of valves very easily as you're going through them. One of the things that often happens in valve selection and decisions is that you will begin talking with people about the opportunity of what valves to use. Valve vendors and the people who represent them are excellent sources of information for all of this in review. However, one of the things that we all have to recognize is that any given representative is going to be somewhat limited in what he can present by the lines of valves that he handles.

So, please be sure, as you're beginning to investigate, that you do look at a variety of valve types and manufacturers. Get an opportunity to look at a variety of constructions because some of the simple modifications in constructions can be very significant to the idea of maintenance as well as operations reliability. This is the kind of thing that must be pretty individually reviewed for any given plant. Certainly, this is where the responsibilities of the valve selector and those who will operate the plant become significant. Each of these potential benefits and requirements for the valve operation should be very carefully considered as the system is developed and should be presented for review if there are any questions so that those who have to operate the plant are in full agreement that this is a functional valve to be used in a given area of the plant.

Now, it's very simple in large engineering situations to find typical valve or full pipeline type specifications being developed by organizations of different varieties, whether they are the manufacturing companies themselves or the service providers in developing things. A simple statement of, "Oh, yes, we can provide a stainless steel spec," is true because they very regularly can. However, the valves that they select in there may or may not be a unit that has particular value to you. So, standard specifications for one company may or may not be an appropriate one for you to use. You should review the specifics of the valve types, the manufacturers that are suggested, and the recommended conditions that go into the valves.

I would throw in here an idea that became a matter of some discussion many years ago when a company began manufacturing a particular type of valve and supplying it on the market. It became very widely accepted and used. Of course, because it was a very popular valve, there were other people who were interested in finding ways to make something similar and they did. However, the replacement valve that came out on the market ended up having a very, very poor service condition.

After some considerable investigation over several years, it was learned and determined that the original manufacturer by serendipitous decision or just plain damn luck, however you want to look at it, happened to pick a casting method that provided him with a certain grain and cell structure for the valve body simply because of the manner in which it was cast. Whereas, the new manufacturer used some different method of casting and modification and came up with a different grain structure. The differences in those two grain structures were enough to make a difference between a few months of service life and a few years of service life in a valve.

So, again, the design, the details, and the specific arrangements can all be very significant when looking over and reviewing a particular valve application. Whether it's something you have an answer for as you begin the process of going into valve selection, it is something to be aware of. So, down the line, if you run into a question, you have some areas where you can begin to look and make some decisions and investigations to help your decisions on what valves to use on a continuing basis.

Tape 1 – Side 2 (01 track 1.10.25)

We've discussed the two principal valves that were mainstays of the piping industry for a long time: the gate valve and globe valve. Now we're going to begin a discussion of some more specialized valves, beginning with the valve that has become the staple and mainstay of piping systems today, which is the ball valve.

The ball valve is used in many configurations and for a variety of reasons. One reason why most of us like to use ball valves now is the fact that it is a minimum flow restriction valve. Both the gate and globe valves, because of their configurations, tended to have relatively high-pressure drops—the globe valve, of course, somewhat higher than the gate valve. Ball valves are quite typically very hydro-dynamically designed. Quite often they're with full flow ports and minimum resistance and, of course, this improves the overall pumping energy use in any system and makes the draining of systems somewhat more reliable. So, all of these things tend to augur for the use of the ball valve.

Another item that is significant with the ball valve is that it is quite regularly less expensive than many other types of valves because it can be made in many more simple configurations than some of the other valves. Of course, we'll try and get into a discussion of the few areas where ball valves could become relatively expensive rather than inexpensive.

One area where ball valves become of most interest is the idea of maintenance and replacement. In systems that are used regularly, the maintenance function may be as big a deciding factor as a number of others. There are a variety of ball valves that have given us opportunities for very simplified maintenance. One of the key functions is the three-piece valve, which has been designated that by many people. By this they mean the two inlets and one body block, as you would define it, with the center ball arrangement being removable with the other two pieces still connected in line. This can be done in a variety of ways. I've seen them with union fittings on each end. Of course, union fittings are of a lot of interest and they're very convenient to use, but they generally do require some pretty good alignment in order to be able to reassure seating.

Another configuration that's used like this is a type of flanged arrangement where the ball is held between two flange-like plates by short or long bolts. Often, they're through bolts, going through both plates and holding the ball in the center, but sometimes they're just short bolts bolting them back into a body that is containing the ball. This gives the opportunity for removing the ball and its seat and handle areas and replacing all of the things having to do with the seat and handle, if that should be something that is desired on a regular or frequent basis in the operation. It does, of course, bring in the question of alignment and support again, particularly when those pieces are taken out of the valve. It also brings into play the question of how strong those bolting arrangements are for a valve that may be placed in the middle of a line somewhere in a long run because then those bolts have to carry the supporting requirements for the pipeline and the valve that is placed in the longer run.

These configurations and the simplicity of removing and repairing or modifying the balls also bring about opportunities for some other significant benefits for the processing industries. One of these things is that there are a variety of seats and balls that can be used in these

configurations and used in different bodies. Often times, I'm sure we've all seen very good carbon steel bodies sometimes forged with stainless steel seat rings and balls. The balls as made have a somewhat harder surface than the stainless steel situation.

There are, of course, many reasons for doing this, not the least of which is the question of minimizing the number of pieces that have to be kept on hand to be able to do repairs, but also the lower tendency for the surface of the stainless steel ball to either be pitted, corroded or attacked in any way by any of the materials being held. Of course, we recognize that water is a material that can cause surface attacks. This does make the reliability of opening and closing the valve a lot better in the long term. The stainless steel valve will have less of a tendency to bond to its sealing surfaces and make the opening and closing difficult. Of course, those sealing surfaces can be anything from the metal seat rings themselves to elastomer seat rings and many of the very special arrangements where the metal seat rings back up the elastomer seat rings. In conditions of fire, the metal seat ring becomes the containing seat ring in order to protect the valve and pipelines.

An item of interest to discuss in looking at ball valves, however, is the cavity around the ball itself. Sometimes this is an area of great concern, particularly in those areas where valves are used in gas pipelines. These areas can, on many occasions, be purchased with some kind of a filler placed into it so that there is a minimum of gas held outside of the pipelines in an area where any heat or temperature effects could cause significantly different conditions inside the ball than those in the pipeline itself. This also brings into mind the idea of how the sealing is arranged and what kind of voidages there may be around there. Those are all items of some concern.

A special valve for chlorine use and a variety of other gas usages is a ball that is, in fact, drilled on one side of the closure so that there is an opening from the passage through the ball back into the closed pipeline when the valve is in its closed position. This way, the pressure inside the valve itself is always at the line pressure and would never be in a condition of being under different effects because of other temperatures. This is a matter of some interest to be assured that those lines are not accessed and approached for maintenance with a bubble of material in there that could expand and create difficulties as a ball is removed or a valve is modified or changed. A considerable amount of discussion can be made in any given application as to whether this hole for the pressure relief should be done to the upstream side of the valve or the downstream side of the valve. A lot of these questions must be reviewed and considered in HAZOP operations or reviews to determine the most practical way for this installation and the best way to provide the desired protection. The chlorine institute does have various guidelines to use on this for chlorine application and those should be considered, particularly when handling chlorine and other halogen gases.

The next item to be considered in ball valves is the idea that it is a very simple and single closure in its operations. A 90-degree turn open to close is usually very simply identified, very easy to work with, and very reliable. We've discussed the separation that could be done on the valves and because of the configuration of the balls and seats; there are a number of varieties that have very good leak-free ratings for general applications.

Ball valves can, of course, be made in a variety of materials and I'm sure that almost all of us have seen them manufactured of everything from polyethylenes through PVCs, generally for water usages. Quite regularly, PVC variety valves used for sanitary applications and many handling uses from there, but also all the way into the very exotic metals through the steels—irons, brass, stainless steels, and all of the varieties that go with it. Of course, included with that are the questions of selection of seat rings and sealing materials that can be used.

An additional key point to consider in ball valves is the idea of the sealing of the actual turning mechanism for the valve. Over time, there have been a number of investigations and discussions about this and a variety of seals installed as well as a variety of methods to provide combination sealing for those. One thing that is a little bit difficult in considering the ball valve for a totally leak-free application is the physical requirement that there be a connection between the valve handle and the ball and that it go through the sealing mechanism. It's somewhat difficult to come up with a perfect leak-free seal in that—something that will contain over time.

As I've said, many of the valves are rated with very low leak rates and many of these seals are rated with very low leak rates also, but these type valves are somewhat difficult to apply a bellows or corrugated type seal that is fixed and does not provide any path for leakage. Certainly, the idea of using a ball valve with a long stem and being able to take some torsion in the bellows assembly is a way of resolving that problem. In general, the corrugated metal containing and leak-free type valve assemblies are very difficult to acquire in a ball valve configuration.

We've dealt somewhat with the ball valve in my experience in the past. It would seem to me that the ball and all of its applications, which are many and very good, rather developed out of the idea of some of the early plug valves that were used. There were many very standardized type plug valves that started into application very early in chemical processing activities and these proved to be very reliable.

Several significant values in using these valves were the fact that the actual turning mechanism for the valve was a part of the plug itself. It would protrude through part of the containment of the valve so that you were absolutely assured that whatever condition was indicated on the handle of the valve was indeed the condition of the plug inside. This provided one of the many ways that additional safety could be done in these programs.

These valves were also, in some occasions, provided with a lubrication plug on the bottom of the valve that would serve, in addition to providing the lubrication for the valve, as a means for providing a bit of pressure on the bottom of the valve, which tended to help allow its motion after it had been in place for a while. So, lubricated plug cocks were quite often used in oil and grease applications where the valve would be closed for long periods of times and then need to be opened reliably. A small shot of a lubricant into the valve body itself would tend to lift the plug in its truncated pyramidal holding area allowing it to be turned. Then, once it was turned and shut, it could be bolted and reseated a little bit and make sure that it was sealing the conditions. There were many valuable aspects of applying and using that type of valve for the assured opening and shut off.

These kind of valves very quickly moved into the possibility of being lined because of the simplicity of the bodies of the valves themselves, as well as the plug. It was very easy to take the whole body and line it and the whole plug, slide them together, and have a complete elastomer or plastic exposed surface for use in material handling where corrosion and many other questions were very significant. These lined plug valves came to be a very common and typical solution for many problems in the chemical industries.

One of the little anomalies that existed for a long time in that was the fact that a Teflon lined plug valve in many applications was less expensive than some rather significant types of other valves. They would often be used as a standard specified valve in some steel piping systems handling, not necessarily highly corrosive materials, but materials where valve operations were very important. Also, the savings on buying a somewhat less expensive valve because there were so many being made, and being made so simply with good sealing, augured for that use in a lot of arrangements.

One other thing that came into play very easily in the plug valve was the plug itself could be modified. This tended to allow a variety of special things to be done with that valve. Not the least of which was the creation of the multi-port valve that was one body with three connections, two inlets and an outlet. That allowed for a variety of arrangements inside the plug so that it could be a 90-degree arrangement where any two adjacent 90-degree connections could be made together. The plug could also be made with a T-configuration inside it so that all three things could be connected together, or either of the two 90-degree turns, or the straight through connection could be made. So there were a number of significant varieties that could be brought into that operation. This, again, was a very simple valve to mechanize with some of the half turn, quarter turn type operating units that were applied. It gave some very broad application opportunities to using these valves for passing materials and automating the handling and flow of materials in field applications.

We've now finished speaking about ball and plug valves, in general. Both of these have picked up some very significant applications from gate and globe valves in the past, particularly the plug valve for many operations. It's still a very popular valve. Now we'll move onto what has become the essential valve of application in many uses for several reasons, including simplicity, reliability, and low cost, and that's the butterfly valve. This, of course, was quite an innovation as it began. It has many things going for it—everything that people liked—lowering costs and it usually didn't involve significant piping changes. So, there are a lot of things going for it, but let's just discuss the general conditions.

Certainly one of the things that came quickly to the butterfly valve was the idea that it could be installed between existing flanges. So, it took no extra flanges for its own operation. This was a considerable savings on installation and, of course, for simplicity of maintenance and changes later on. It did mean that there were significant support questions that had to be addressed because the valve now needed to take the full loading of any bending effects in a long run of pipe. So, this was something that had to be built into the valves and the sealing arrangements that were used on the valves; basically, the gaskets on each side of the valves.

This was an application concern as a lot of it was started, but with the simplicity, reliability and one very special effect going for it where the shaft that the flange or butterfly plate was mounted on was usually integral with the plate. Certainly that changed later on and the plates began to be bolt mounted to the flange arrangements. There were some reasons for that, but, initially, there were some very significant advantages to using this.

One of the next significant items about the butterfly valve that became very attractive and interesting was the axis of movement. There are many valves where the axis of movement is not a simple line between the far distant points, or the opposite points, of the ring that is the valve basis. The axis is shifted slightly on an angle. By doing this, there was the possibility of using a little bit different design in the operating plate and being able to get to the point of a slight eccentric so that the valve, when it got into position, could be flat pushed into the seal ring. This presented the opportunity of putting on the outside edge of the butterfly plate an o-ring that could be used as an elastomer seal and get some improved sealing conditions as it went in.

Certainly one of the things that was of interest there, then, was the valve would generally be operated only on either a full open or full closed position. This was because the velocities and the velocity flow effects of a material moving rapidly past the edge of the plate often had an effect on the ability to hold the o-ring in its position on the edge of the plate. Other sealing methods were tried with that, which were also based on the slight axis difference and slight eccentric capability that was possible to get into the sealing.

One of the things that also became evident was we were back into the question of what to do with shaft seals. Now, however, instead of one seal, often there were two because the axis of the plate would go completely through the support ring for the valve on either side. A quick elimination of that on one side was handled by using a sealed and closed valve, but this then left something that could very easily accumulate material in it, pack up, and create a problem later on.

The shaft seals were a matter of some interest. Of course, the methods of shaft sealing included all of the experience that we have had in the past with sealing the shafts on globe and gate valves. This went from packing to Chevron-types to a variety of inline types, but it did pretty well to negate the possibility of using the flexible corrugated type seals that were being proposed for a lot of the zero leakage valves. So, these were a bit of a question.

The primary concern always on the butterfly valve was it was very difficult to get a complete and accurate seal around the totality of the edge ring of the valve plate at all times. So, this brought in some specialties. One of the very special sealing and seating mechanisms used on the valves was a ring that was built into the valve. So, after the valve was closed, the ring would be air pressurized and forced against the outside edge of the valve and against the shaft on the upper or lower sections. This air pressure then would be improved sealing for the edge of the plates around the outside of the ring.

Certainly all of these things have their applications on occasion. One of the very significant things is it's really very nice to have a very inexpensive valve to be used in lots of blocking

situations. Particularly, those places where the lines can be isolated and the valves can be replaced periodically if they should create a problem or not provide enough sealing.

Another question that came into the operation of the butterfly valve as it was used was the effect of the plate in the center on flow. Generally, we don't like to be forced into a situation of very high flow rates in any given situation because this is a very high-energy user. Frequently, however, we are in the position where, in order to continue using a given flow system, a short period of pipe must adapt to an excessive flow for a short period of time. With the plates from the butterflies as they were put in there, we were then continually addressed with the question of what happens at the edge. Were the edges uniform? Were they non-uniform? Why? What effect would that have on the flow? Would that have a question of creating a downstream turbulence condition that would affect any of the operations? Would it effect the separation of the materials?

So, a variety of plate designs became of interest. Generally, not just a disc-type, if you would want, which would be a simple plate that was a little thicker in the center, thinner on the outside, with tapered and relatively sharp edges set to be the seal, and turned on a shaft. Sometimes the butterflies were designed with kind of a fishtail arrangement. This fishtail arrangement would then be very carefully prepared in order to minimize turbulence as it flowed through the valve. Sometimes plates were also used in order to improve sealing and conditions as a composition of things. A basic metal plate in the center to which was mounted or bolted, in some manner, a ring that would be supporting either one side or both sides of an elastomer or plastic sealing edge. That would give improved sealing as the plate hit its fully closed condition.

A variety of specialties have come into here. This and the wide range of manufacturers of these valves bring us back to several of the discussions made initially—a serious investigation of manufacturers and various suppliers of looking at the valves and how the sealing is effected when making a decision whether it is appropriate for your application and is reliable enough for your needs for safety and continuity in operation. Now it comes back to the forefront as a key element in your review and analysis of whether or not you use butterfly valves.

Quite often we find that there are combination situations where people will use butterfly valves for long run diversions in distribution of materials because of the financial savings there or general reliability in isolated situations and simplicity of operation. However, when we get into process applications where the valving is changed on a frequent basis and is used for immediate process control, vessel maintenance, and so on, then other valves like the plug valves, ball valves, or gate valves become more important and selected for these more critical applications.

Again, this is not to say that butterfly valves are not a reliable valve. They are. They're very good in many, many applications and there are lots of choices to use them. However, any valve application must be seriously considered to be sure that the valve that is being applied is appropriate to all of the needs of any given operation. As with anything else, sometimes it's not appropriate to use a sledgehammer; it's appropriate to use a tack hammer. Sometimes it is appropriate to use a gate valve; sometimes it's fully appropriate to use a butterfly valve. This is a matter of good experience and understanding of the applications and the needs so that these decisions are made in the best interests of the project and the process requirements.

I will give a short review now of the handouts or the presentation materials that I will provide with the tapes. There are several pages included. I believe now that it will be ten pages, but this will be defined in the initial information as it comes in as I may add additional information for special valves later in the program. These are there to give you an idea of the basic discussions that I have addressed in going through here about plug configurations, some of the sealing methods, internal arrangements that are available in a number of the valves, and the how's and whys of some of their uses. These diagrams I hope will be helpful in understanding and considering these valves in any application that you're addressing. I strongly suggest that these conditions be specifically reviewed with manufacturers, vendors of the valves, and your own operating people to be assured that the valves you're looking at are appropriate for consideration for any particular application that you want to change from what is there now or that is being developed as an entirely new application of a control or shut off and limiting device, such as a valve.

As a final discussion in the basic valve types that we've been reviewing on this portion of the tape, I would hasten to add and suggest that, in many occasions, valves are used as a way of limiting pressure and flow in pipeline systems. Not necessarily as a control valve, but just as a restriction and as a way to prevent various effects of pressure and flow in the system. Valves used in this way quite often will show very high wear. They will also be noise inducers. Quite often they are vibration inducers. There are various reasons that this can occur, not the least of which is partial openings on the valve. You could be flashing flow through the orifice and then recondensing materials downstream when pressure and flow conditions change.

These are all relatively poor reasons for using a valve. I strongly suggest that in situations like that, an orifice or particularly a flow tube, which is essentially a smaller diameter pipe of a given length, be put into the line with the valves simply as an on/off device with the flow tube actually causing the appropriate flow restriction. Of course, we're all well aware that the ratios of the diameters to elevated powers affect the equivalent length of these pipes. So, back to the basics of fluid mechanics and looking at arrangements like that. You can definitely come up with a situation of a much-improved operating condition with less difficulty, fewer maintenance problems, and probably improved overall operating conditions, by using a flow tube rather than a valve in places where you'd like to restrict some flow conditions.

With that admonition, I will conclude tape 1 of this Professional Development Course with respect to valves and will begin talking on tape 2, discussing some very specialized type valves for a number of particular uses.

Tape 2 – Side 1 (02 track 2.10.25)

This is the beginning of tape two, side one of the three-hour Professional Development Course, titled Valves, by Ed Hardin of Charlotte, North Carolina.

In our discussions of the first tape on the valve types, we went through gate valves, globe valves, ball valves, plug valves and butterflies, as the standard and most typical valves that people apply. We also discussed the options that are available with most of those valves and some particular criteria for them.

As with those, on the coming specialized valves that I'd like to discuss and review with you, I do recommend that some specific time and serious consideration be given to reviewing these valves. Not only with potential vendors and manufacturers when you're considering the use of these valves in particular applications, but also with your operating and maintenance staff. This is to make sure that there are not occasions, in the past or present, where some of these are being used for either good reasons or that might be giving particular problems. You should be aware of them before you begin recommending an application that some people will criticize or not be very favorable as you try and move forward with them.

One particular area of valves that can run into many questions as the applications are installed and used is a group of valves that are identified as pinch valves. Generally, they involve the use of a hose or a flexible medium of some kind that has an ability to be closed by a mechanical means, pushing on one or both sides of the valve in order to cause a restrictive slot for flow. Quite regularly, these valves are made up of elastomers or hose materials that are used and clamped together. Of course, the idea here would not be to use something that has inside it a spring or metal wrapping that is used for strength, but a relatively thick material. A material that is reliably abrasion-resistant that can withstand and might even have specific design criteria to allow for the flexing that will have to be done at the extremities of the flattened area when it's in its closed condition.

These valves have been very serviceable in many applications, particularly in things like slurries. Quite often in very heavy materials and they do give a range of control. The valves are generally available with a variety of closures that we'll discuss in a little bit. I would like to review a little bit the idea of the valve body itself and the variations that can occur on it.

Generally, because of the flexing of the tube or hose that is the valve basis, these valves are somewhat long in order not to effect the junction at the mounting or the holding mechanism on either end of the valve when the hose is in the closed position. The relative stretching and flexing of these units do get very serious for a lot of materials that are handled and for the various sizes. So, they are somewhat large valves. Generally, they will require some specialty support in order to be able to keep the pipe itself from hanging on the valve and the valve having to support a sheer action, as well as maintain its position and ability to open and close.

Considering the typical basic design for these of a flexible elastomeric or rubber tube, one of the things that has developed over the past ten years or so in this particular type valve is to use within the rubber casing, which provides strength and flexibility, an elastomeric or plastic lining

of a flexible material. That will also provide corrosion or other special protections inside the valve. These can be very worthwhile to consider in many of the applications, particularly where you're handling slurry that might be processed in a rather corrosive material and gives you a good reliable opening and closing capability.

It does bring up the additional question of how regularly the lining and the valve itself should be changed out so that you don't lose the values of the special lining that's put into the valve. Of course, this is something that ends up becoming an operations research activity. Certainly, you might start off with trying the valve for several months or longer to see how it works. Then come up with some schedule for a regular change at seven or eight months if the valve fails mostly at nine months. So, it would be worthwhile to be sure that you do have a schedule in order to protect the safety of the personnel who are around the valve, depending on the pressure and materials that are contained in it. Also, to protect the performance of the operation because there is nothing more expensive than a shut down at an inappropriate time in a processing stage with the relative cost of lost materials, time and effects that go on in there. So, a good investigation of the application of this kind of valve in several ways would be very appropriate.

Moving forward into another specific consideration of this type of valve is the type of closure. Some of the very earliest units that I've seen like this used a very simple arrangement. As a matter of fact, probably the earliest application I saw of this particular type arrangement was in a laboratory as I was in college, which was a few years ago. It was a very simple arrangement of a box with a secondary crossbar inside the box, one arm creating the box having a threaded mount in it, through which a threaded rod or shaft connected to a hand wheel on the outside of the box, and a separate cross piece on the inside of the box that is then forced down to clamp off the piece of hose. Very simple, very basic, and very reliable, with the usual requirements of a little bit of care and maintenance, keeping dirt from getting into the valve stems and the threaded valve stem guide.

There have been many applications where these valves have been further modified to put on them mechanical means of various kinds to affect the opening and closing. Sometimes done with an air cylinder mounted outside a lever arm and simply stroking the air cylinder to move down with a type B lever of a focal point, the bar that would close against the valve and then the air cylinder on the opposite side. Then, you have a quick opening and closing, remotely operable pinch-type valve in something that does not have to be addressed every time that it is moved.

Of course, there are variations that are possible on this, too, and that would be the air cylinder mounted directly above the valve and using a direct ram arrangement. Of course, a variety of other mechanical methods could be used for that, too. Even as they're available now, small motors with screw drives to use for limiting flow situations. Possibly even as a flow control valve, but that, again, was not the intent of discussing this. There are a variety of mechanical means, whether it's an air cylinder or air diaphragm, to operate and cause a direct action to open and close the valve.

Of course, one of the things that other manufacturers came up with in looking at this valve, as simple and reliable as it is, is what improvements are possible. There is a manufacturer that has provided a variation on this valve of taking the tube itself and enclosing it inside a metal

chamber. The reason for doing this inside the metal chamber is that now there are a variety of other things that can be used for closures. A hydraulic connection of one kind or another can be made to the chamber, the chamber filled, the valve closed by the chamber, using either air or water or sometimes even hydraulic fluids, to provide the clamping action on the exterior surface of the flow tube. The benefit here is that you now have an option of using a more flexible tube in the chamber that is possibly even longer than might be typical for the valve itself. Using the hydraulic pressure and the flexible tube, then, can actually close around things that are being carried in the pipeline.

So, there are situations where materials are being transferred in a somewhat fluid mechanism. These materials are the kinds of things that would be very difficult to control with almost any other valve because they would get in the way and prevent an opening or closing or cause a jamming in one way or another. Say, for example, you wanted to transfer large nuts that are being washed, deburred, and cleaned in some kind of a way manufacturing operation. You could take one-inch square or hexagonal nuts that might be 3/4-inch to an inch thick, carry them in the cleaning oil fluid, or in some other fluid that's being used for transporting, and pass these units through one of these flexible valves. If it was necessary to stop the flow, the valve could be activated to close and have inside it a moderately thin neoprene type tube and a light pressure, and that neoprene tube could just clamp around the nuts that are in there. The clamp would be long enough so that there is enough flow restriction and enough places where the tubes actually have an opportunity to clamp against themselves to cause a rather complete shut off of the whole system with the nuts inside the valve not creating a particular problem, being held in place. Certainly, then, whenever the downstream question, problem, or reason for shutting the valve is resolved, the pressure can be taken off of the valve and the system opened up and the flow continuing.

There are a number of applications such as this that have been promulgated and discussed in literature of the valve manufacturers and it seems to have a lot to recommend it for specialty applications. One minor variation of this that is also possible and is sometimes used with a closure, and sometimes not, is to just use the flexible tube as a very flexible nozzle and let it act as its own check valve. This can be done in a variety of methods, but a long tube, fairly flexible, with material flowing out through it, should the flow tend to reverse, the tube will generally collapse and possibly even fold over and become its own check valve.

Now, this would not be the kind of thing that would be used for very heavy flows or very high-pressure flows. Generally, it is something that is quite regularly used in the flow discharge of waste streams into large ponds where, periodically, the levels at different portions of the ponds change. So, you can have a line going down and feeding several of these outlets where a flow level increases and would create a blockage on the flow tube. It's closed off and the flow then continues to another pond, or where there is a back flow kind of condition that occurs on some occasions. So, varieties of these pinch valves have been used in a number of specialty applications. They are somewhat unique, but all very serviceable and providing some very special improvements in the ability to control and use a stopping mechanism for flow management.

A further reason for using valves such as this might also involve the delicacy of materials being handled. If something is appropriately handled in the pipeline, but would be injured or possibly broken if it got clamped at the wrong place in a pipeline or any other type valve, a pinch valve is a good potential solution. You would be able to close off the flow and transfer of these types of materials without getting the crushing and destruction that might occur in other ways.

Finally, an application that might also readily lend itself to something like this would be an area where a line clean out is appropriate on a regular basis and something needs to pass through the line. Many valves that would take a full flow of a given pipeline can be very expensive and have very serious sealing and other problems that would cause it to be a somewhat cumbersome and very expensive application. If it's suitable to rely on this flexible body valve, the body can be kept to full line opening. Whatever is used to clean the line out will very easily pass through it with the valve fully open and pass on down through the rest of the pipeline. All while still having the opportunity to be opened and closed before and after whatever the material or item is that's being passed through the line, whether it be a line cleaner or something else of a special variety, to be able to avoid some of the potential questions of an item being stuck in a mechanical valve of one kind or another. This may also possibly give a better way to allow for a pigging system or a line transfer wiping mechanism to pass through a pipeline.

At this point in our discussion, I'm going to shift directions a little bit and, rather than speak about the particular valves, speak about applications of valves in various services.

One of the first and more prominent areas that I've experienced questions and significant interest in my career, and I think a lot of us have run into this, is the area of slurries and slurry handling. The characteristics of the slurries, of course, are very important in looking at this. We made some comments earlier about the types of material that might be handled, whether the material is relatively easily friable, whether it's a very sharp and hard material that has damaging characteristics for the pipelines and the valves as they're processed, or some other varieties like that. All of those become key factors in making a decision about valves.

I commented before, particularly in the gate valves, that something we have to be very concerned about is the area between the seal plates and if that becomes packed with a material that will prevent the closure of the valve because of a crusting or buildup in that seal plate area. With some slurries, this would not necessarily be a problem. If you're dealing with a slurry of a very soft mud, possibly a clay, or slurries that are really more thick pastes of somewhat compressible materials, when you close the valve, the material in the bottom of the casing area would spread up along the sides of the gate and that would generally not be a difficulty.

With some other valves, certainly with the ball valve, if the slurry material were to accumulate in a dead area of the ball valve and there were aspects of life and retention quality for the solids as they pass through a processing, then, certainly, a question has to come in of how much it will possibly effect quality of the continuing processing. What if it remains there for a while? What if it were to get locally overheated or locally frozen? Consider all of the varieties that can occur in there. So, slurries have a big part to play in all of our processing activities and are something that we have to be very concerned about handling. Certainly, ball valves generally do a pretty

good job on slurries if they do not have the kind of material that is time sensitive during processing and transfer.

This, of course, follows very quickly on our discussion of the pinch valves. Things like the pinch valves have been very effective in handling the slurries. Some other rather specialized valves have also been very helpful in that area. Sometimes the block check valve that was mentioned earlier would be an option for use in a slurry line so that you would get some prevention of back flow and yet have something that could close off a slurry flow. Again, it would require a slurry material that was relatively soft, easily separated, and squeezed out from a sealing area.

When slurries such as sands, some oil materials, or some other minerals, are passed through valves, one of the very significant concerns has to be velocity where there is a high probability of erosion. Once erosion occurs on some of the corners or seat areas of a valve, then it's function is seriously diminished and something else must be considered. So, in the area of a valve, quite often in slurry line, an enlarged-size valve is used in order to slow down the velocity; thereby, avoiding some of the erosion problems in using a typical valve. Of course, the options go into the other varieties of valves, some of the specially lined butterfly valves, that can be very effective on some slurries or, back into the pinch valves, in order to be able to have the protections there.

Steam is another area where specifics of valves come into significant play. Certainly, as the industry and piping activities developed, steam was a very important factor in helping us decide what kind of valves should be used in given areas. One of the things that we often are not immediately faced with in handling a steam line situation is a failure situation where velocities passing through the line increase very rapidly because of a failure of some kind. Then, the effects of very high velocity steam flow become more pronounced. So, periodically, those considerations are important. One method that has been used in the past to protect against some of these questions for steam valves is to use a forged valve rather than a cast valve. The hardness of the forged valve, its components, and specialized area in such a valve, is a much more reliable method of handling steam, particularly if something should happen and the velocity should increase.

Steam also brings to us the question of contained water. A little bit of water in a steam line is always going to be there. Under some conditions, that water can be very dangerous and very effective in creating destruction and problems in the steam valves. Of course, not the least of which might be that situation where a little water was in a pocket in a given area and the valve was shut down for a period of time. The water remained in place and was then affected by a freezing problem and caused a portion of the valve to be affected by the freezing of the ice and cracked in one way or another.

A second thing would be water getting into a place where it's relatively difficult for it to drain away. Then, a line is placed back in service very rapidly and some very hot steam comes down, causing the water to be reheated and re-evaporated. With it being in a relatively enclosed area, the expansion of the steam as the water boils now causes something like the movement of a seal or collapse of a packing of one kind or another to create difficulties for us in a valve. These are

not regular functions, but there are things to be aware and to be concerned about as valve applications are made into specific services.

I'll take advantage of the discussion of steam here to relay a little anecdote that was a very informative activity for me on one occasion. I was working in a plant that has as a portion of it a large powerhouse. Large, of course, being a relative function, but it had the generating capability of about 50 megawatts and steam capability of something over two million pounds an hour. One of the functions in that powerhouse was a reduction valve for being able to change pressure on the steam under those occasions when a high-pressure turbine was out of service and it was elected not to use it.

In the particular instance of discussion here, a portion of the pipeline right near this very large high-pressure let down control valve happened to snap. It was the bypass line that was used for warming up the pipeline when the line had been down. So, we now have an eight-inch pipeline with 700 pounds of steam in it that's blowing because of a crack, also with some back flow conditions, and the control valve that can't provide a complete shut off of the steam flow. So, we needed to close off the block valves.

These, of course, were very nicely designed and well-sized block valves for the system. However, as two or three of us were there trying to close these eight-inch valves, when we got down to the requirement of closing the last two or three turns of the valve and being able to get the full closure, it was very difficult to get that last turn against the very high pressure drop. Fortunately, there was a gentleman who was there with us who was very experienced in powerhouse situations. He came down near us, opened the bypass line, and took some of the very high flow requirements off of the valve. The large valve could then be closed very easily, even with the relatively high-pressure drop. Then the small bypass line valve could be closed very easily by hand because of the relative forces that were involved.

So, it's always interesting to be around people who are familiar with and very knowledgeable about a particular situation and to learn those things that can be done. Just a little bit of relief of the pressure drop made our valve closing activity a lot more suitable and we were able to get things closed down in a safe manner and initiate appropriate repair actions. It certainly was an interesting few minutes while we were resolving that problem for those of us who were trying to provide help in an area where we had not had a lot of prior operating experience.

The next area of specialty interest and concern is a very simple area that we regularly run into on a continuing basis and that's our good old friend, water. We tend to think of water as the basic material for a great deal of our piping and fluid handling and for the application of our valves. If it's not 100% water, the water content of the stream is usually very high, in the 70 to 90% range, and we can generally consider it to be primarily water being handled. However, that's both good and bad because the other 30% is very significant. Whatever that might be, it will have serious effects on what we consider in looking at valves to be applied to those situations where we're going to use it.

The other thing is that even though 70% of it is water and is a thing that we normally handle, it does have all of the concerns of handling water at any occasion. Of course, all of those concerns

include the very high probability that the water will evaporate if the line is made hot and will create steam. If it's water under pressure, relieving the pressure in any way will allow the water to flash into steam, which can be a very serious problem. So, leakages around there and any changes that have to be made would be of some serious consideration.

Certainly, the idea of water as an item that might freeze, and one of those areas that is often, I think, neglected or possibly forgotten about by those who don't normally work in a variety of situations, comes back to the idea that water can freeze at almost any temperature as long as the pressure is low enough. I have quite regularly seen this where a vacuum system has a little bit of water in it and is not considered a particular problem. It's something that water vapor is what the vacuum system is designed to handle, but at a given point in time, something occurs that allows a restriction of flow and a change of pressure conditions. All of a sudden, there is a change again and the pressure drops very rapidly. Then, the water in a given portion of the system might begin to boil and expand very quickly, absorb the heat, and cause any remaining liquid there to freeze. Of course, once water freezes, it begins its expansion and that can cause a rupture or cracking of a pipeline if the conditions are inappropriate. So, various concerns about valve placements and the use of valves around through systems to help guard against this become very appropriate.

So, we find that there are many applications that now follow what we talked about before—slurries, steam, and general water system handling—where it's appropriate to have drain valves in various places in the system to be assured that appropriate conditions are met for startup, shutdown, or preparation for maintenance activities or line entry. So, a very serious consideration must be made about some kind of valve that will reliably allow the removal or draining of liquids from given pipelines through a valve and into an area that will safely remove that material.

One area where it's rather interesting to go back and look at is a slurry handling application that I had experienced a number of years ago. The material that we were processing was generally a relatively soft and easily handled slurry material, but it had as a minor constituent in it a material that would very readily plate out, coat the walls of the pipeline, creating an almost cement-like coating, and periodically break off and have various needs for processing that in the pipeline.

However, in addition to it breaking off, on the drain valves that we considered using there, we always had to be concerned that the valve itself would be covered over and that we would not be able to drain it when necessary. So, for this particular type service, there is a special valve that is made and several very large manufacturers make it. They call it a bayonet angle valve where the actual opening of the valve itself is not within the valve body, but is functioned as a plug that is near the end of the chamber that connects to the flowing pipeline. When the valve handle is turned and the valve is opening, the plug will actually move up into the flowing system and crack this coating that can form over the top of it. Then, flow can proceed around this plug, come out through the valve body, and be directed off through piping to an appropriate draining and discharge position.

This type of plug, with the shafts that are used in order to be able to cause this movement of the plug and breaking of the crust, is a very rugged valve. It is something of significant interest if

that particular requirement is something that you have to address on a regular basis. There are valves available to handle that type of problem.

So, the reason I bring this up is to, again, go back to the idea that there are many times when, as we go looking for the solution to a given problem, we are limited by those things that we have experienced before. We try to apply something that we know to the problems that we anticipate, but it may not be a good application in those particular instances. Again, when you run into a special need for a type of valve or type of operation where you think a valve would be required, it's probably appropriate to go to a variety of vendors and ask them, "What have you got that will do this job?" You'll find that many of them will say, "Oh, yes, I've had particular experience in doing something similar to that. This was the experience, this was the type valve we used, and this is the kind of exposure that we had." These are the methods of education and information transfer that help us all create better, more reliable operating systems and safer operating systems for everything that we put together.

Finally, from a special application standpoint, let's discuss for a little bit the idea of organics. Certainly, everything that we've discussed before applies to many of the organics and a few other things also. Quite regularly, in some of the organic materials you'll find that you are processing material that will either freeze or will, under varying temperature conditions, allow materials to crystallize out, and exhibit all of the conditions that we talked about earlier. Vaporization causing potential freezing or vaporization causing crystallization, all of these things will have an effect on the mechanics of the valves and the pipeline systems handling them. They are all part of the question of finding the right application. One of the fascinating aspects is finding good ways to put together piping systems to handle the variety of things that we're regularly faced with.

The last little item of organics is that we quite often find that there are dissociations that occur in organics, which make them much more acid than we expect or much more basic than we expect. These too have significant effects on the materials of construction that we might like to use. So, we have to be very careful about valves that we select or recommend into many organic services to be sure that, if there are these varieties of exposures, we have the right kind of sealing surfaces, sealing gasketing, or connections, that will stand up under the service conditions that are required by whatever fluid is being processed.

This will be the end of tape 2, side 1 of the Professional Development Course, Valves.

Tape 2 – Side 2 (03 track 3.10.25)

This is the beginning of tape two, side two of the three-hour Professional Development Course titled Valves by Ed Hardin of Charlotte, North Carolina.

We've discussed the various types of valves and some of their applications. I've given my comments on some relatively specialized valves, such as pinch valves. Now, I'd like to go into a discussion of some of the uses and other rather specialized types of valves.

One of the things that we have to recognize is that this is not really a course or discussion of control valves. That's a whole different discussion and it deals an awful lot more with the actual sizing and selection of types of control valves that might be used with instrumentation and its reasons. However, in one way or another, all valves are a type of control valve. There are a variety of uses for which valves are placed in lines and not necessarily just to start or stop flow, but also to regulate flow in some ways. Of course, we mentioned this as a primary purpose of the globe valve. It was originally the method of giving a little better and more uniform control with hopefully a longer term of life for the valve itself.

There are a few things that come into valve technology and application that are more specifically related to the piping configuration and valve selection itself. One of these things is flow distribution. Today, we are very fortunate that there are many ways of avoiding what used to be referred as the Hardy -Cross distribution network analysis. These were rather cumbersome and time consuming because they were iterative procedures for solving rather complex networks of piping. They involved going through the systems, making assumptions and calculations, and then, of course, having to redo it when pressures from one path and those down another path differed somewhat. So, valves are a way to resolve some of these questions.

Of course, the idea of using pipelines or valves of various sizes and types in order to affect flow distribution has been something that has been used regularly through time. We started off with a brief discussion of Tivoli Gardens in Italy. Here, the channels that were used to supply water to the fountains there had little plates that were used to block certain channels when certain fountains were taken out of operation. Also, other plates were put in with small orifices in them in order to direct a certain quantity of flow to each of the different fountains in the gardens.

This same thing is done with piping in distribution through networks. Of course, a key factor is pipeline sizing when deciding what the needs are going to be in given areas. Another key factor is the basic need that a utility, whether it be water, steam, gas of one kind or another, such as chlorine or hydrogen gas, and so on, needs to be distributed in plants of various varieties and have methods of reliably transferring these materials from one place to another in the plant and being able to get the quantity of flow needed at a given portion. Of course, this now involves selecting and deciding how much flow or need there is for a given product in various portions of the plant. Valves help in doing this because they will either provide a sufficient orifice and handling capacity to provide a given area or act as a limit so that there is only a certain quantity given to a certain area. This then forces some material on into other areas. Obviously, some aspects of piping configuration fit in this, too.

However, a variety of valve has been developed and been in service for some time and that is an internally spring-loaded valve. It is based on a variety of orifice designs of a moving plug in the valve working on the spring. These valves can be used to provide balanced and uniform flows to a variety of services. One place that I would specifically offer for consideration is a fairly large reactor that might have two or three distributions of water, up or down the side or to the bottom of the reactor. One of the things that has plagued a number of people through time is the fact that the flow through the bottom head of a reactor, which might have on it either a half-pipe or a dimpled-jacket type design, is generally the lowest pressure drop flow path on the reactor. So, for example, if a pipeline configuration is connected with two-inch lines feeding the side of a 4,000 or 5,000 gallon reactor in three or four places as well as feeding the bottom, it's quite easy to find that 30 to 50% of the flow goes through the bottom of the reactor with relatively little flow to the top of one of the reactor sides. So, the uniformity of operation is not achieved. Something like these spring-loaded distribution valves help in those services.

What you can do is make minor adjustments in the tension on the springs and use these units to give uniform distribution of flow through all of the areas of the vessel. They are also used for uniform distribution feeding a variety of flow or use processes in other areas, such as distribution of flow over processing beds, in sewage treatment plants, or in other large flatbed treatment facilities where uniform flow is desired. Of course, there are a variety of other ways of achieving this same kind of distribution. Many of you have seen them, but I did want to mention these spring-loaded valves that can be put in the lines. The valves adjust themselves for the various changes in pressure and conditions, so that uniform flow is achieved in several of the distribution pipes.

Certainly, another area that has been used for flow distribution and control is the idea of the specifics of the plug design in a valve. By plug, I mean anything that is the internal portion of the valve that actually causes the flow control. In a globe valve, it would be the vertically lifted plug, which quite often is in ball-type configuration or an ellipsoidal shaped side and round solid, moving into the seating area. Of course, the plugs in something like a ball valve, or what is designated as a tapered plug valve, are also of interest in considering these flow distribution functions. The actual configuration of the valve body and the plug that is in there can be used to affect the flow control. This is regularly done in control valve design.

However, one of the areas that has become more significant in doing items like this is where we now have processes that we understand because of the kinetics that they perform in logarithmic functions rather than in straight line functions. So, we can actually pick a valve and use a plug to give flow variations that are affected more logarithmically than arithmetically or geometrically. All of these things can be done with the design of the plug itself. Certainly, this can be done for automated control, but it can also be done for manual control for those areas where minor variations are occurring over time, rather than rapid variations, or where you might want to have an automated control. The plug design and how the plug opens can be modified.

Generally, with almost any manufacturer, you can find a variety of plug designs that are available. There may be a particular reason in your process that you'd like to feed it on a manual basis, but you'd still like to get a different plug type so that there is a very slow flow initially, followed soon after by a relatively high flow. That can be done in the design of the plug as you

use it to feed whatever processing you're doing. The opposite is obviously also possible where you can get very high flows initially with relatively small changes later on.

We've discussed the idea of using line sizes for variations in the flow control. As I said before, this was a tedious calculation. Most of the time, now, there are process programs where line sizes that are networks of valves and flow can be used and shown within a software package. By making simple changes of a line size or length or valve size, type, or opening, variations in flow patterns can be achieved and you can get the balance flow that you want by doing it with software. Certainly, the critical function in a lot of these things is being able to know what the response characteristics are of a given valve to the changes in opening or in a percentage movement of the valve so that it can be used as a function in the design calculation. These are situations where, in large water or flow distribution networks in plants or irrigation situations, you might want to set them up on a manual control basis rather than an automatic control since they will be changed on a relatively infrequent basis. That can be arranged by doing the software analysis with a variety of line and plug types in valves.

I'd also like to address as essentially a final item in our discussion the idea of check valves. Check valves are like any other piece of operating equipment in plant use. There are certainly many places where they are very appropriate and even necessary. There are other places where you must be very concerned about how much reliability you can place on it.

One of the typical applications for a check valve is on the discharge of a pump in order to prevent back flow through the pump in the event the pump turns off or cuts off for some reason. This is particularly true in parallel pump operation where more than one pump is feeding a given system of operation. The key purpose for putting a check valve in that discharge line in those pumping situations is to prevent the situation of liquid flowing backward through the pump and possibly spinning off the impeller. This is an infrequent arrangement, but it is one of the key reasons for putting a check valve in under those conditions.

Certainly, this can be done with a variety of valves. A typical situation is a hinged flapper valve to provide that check. It's usually placed in the vertical situation so that the flapper will indeed fall back in lower flow conditions. Certainly, balls can be used in those configurations. Ball checks are much more reliably used in vertical arrangement, particularly up-flow vertical, than in anything else. A down-flow vertical position of a ball check hoping to stop a reverse up-flow is a very tenuous kind of selection for this kind of flow control because the actual velocity or movement of the liquid as it comes back through the valve may be insufficient to lift the ball and put it against the seat. So, the application, the direction of flow movement, and the kind of flow movement become very significant when selecting check valves for many applications like this.

These installation concerns fit with almost all valves. Of course, earlier in our discussion of check valves, I mentioned that there is a type of valve that can essentially be considered a type of check valve and that is a pinch valve. It is essentially a flat tube that is only mounted on one end and extends out in such a way that flow through it will open the tube, but if the flow tends to reverse in direction, the tube will collapse on itself. This is very regularly used in discharges into waterways of a variety of types. Certainly, natural waterways, but also some collection waterways in plants where it is undesirable to have back flows and there are only periodic

inflows from certain areas. So, a valve such as this, the tubular unit, is placed on the discharge and as long as there is discharge, then there is flow. When the discharge stops, then the valve will collapse on itself and other materials flowing in the collection trough, ditch, or other arrangement, will continue passing on down the line and not back flow into the operation.

However, in all of these arrangements, as I've suggested before with the relative positioning and placement of the ball check and whether it's in the vertical or horizontal position, there are concerns about sealing. Generally, it is my experience and my suggestion that a check valve never be relied on to provide a 100% seal. We have discussed in earlier valves, such as gate valves and other operations, what's called the stop check. There is a valve that is quite regularly used as a secondary backup to a typical valve operation in steam lines that is essentially a check valve, but in addition to that it has a threaded shaft on it that can be used to hold the check in place once it has closed or hold the check in place as a closure. This is the general function to use and always consider in the check valve. The check valve is there for a convenience and prevention of significant back flows, but, in general, it should not be completely relied upon as a seal. If there is a need for sealing in a case where a check valve is located, then a second valve should be placed in an appropriate position, either upstream or downstream of the check valve—generally, it would be downstream—to provide the close off from the operating system. So, the check valve and the piece of equipment that it might be helping to protect from back flow can both be arranged for maintenance, removal, and correction.

Now, we'll discuss the idea of jacketed valves. There are some wonderful advances that have occurred over the last 10 or 15 years in providing the services that originally demanded jacketing on valves. In many cases, there were valves that the only way that we had of providing temperature control of a fluid inside piping systems was to use jacketed piping systems. Essentially, this is one line within another one, with flow connections, and variations capable within both of the lines, which very regularly required valves and jacketing on them.

A very typical jacketing was the use of steam. Certainly, steam traced and with tubing wrapped around a valve is a very common thing that is seen. However, in some cases, for more reliability, the valves were in fact encased in a secondary layer and steam was directly applied to the valve, not just a wrapping of tubing. This was also done in handling some very high temperature, high viscosity materials, such as tars and pitches. In these cases, usually a hot oil system was used as a jacket for the valves.

Of course, being able to put this kind of jacketing around the valves added considerable additional effort in requirements to the design of the valve, to the way it was arranged, to the connections that were made on it, to its quality control, and to its heat history as it went through the covering operations in a variety of ways. Certainly, things came to be integrally cast with valves clamped together to achieve the jacketing. This helped improve some of the metallurgical requirements of the valves and the problems that occurred with welding a jacket on.

We now have the convenience of an additional variety of achieving the same kind of control. There are a number of cases where, instead of having to put a jacket on a valve, a cast aluminum heating unit can be purchased to fit a variety of valves. This will provide the temperature control that we'd like to have for a given valve for whatever protection needs that we might have.

Certainly, the idea of wrapping electric tracing tape that is used on systems today is a worthwhile way of achieving this same kind of requirement. Providing a whole separate welded on or connected on arrangement of temperature control, heating medium, or possibly even cooling medium, on a pipeline system was a very costly and time consuming function that was used for many years in order to achieve these temperature controls. The variations of electric heat tapes available now and sometimes even some of the more flexible heating rod wraps on valves, which are then followed by insulation wrapping, are ways to help improve these changes.

I do want to come back to the basic idea that you'll still find that there is a tremendous variety of valves that are available in jacketed configurations, essentially as on the shelf situations. Of course, with a little searching, there are a number of valve manufacturers around who will take any given valve and provide a jacket for it. They also have their own specialty designs of jacketed valves and control means for application in many industrial functions. Recognize that these are available and, if you should run into a need for them, a little bit of searching will turn them up.

Now to finish off our discussion of valves, I'd like to share a little anecdote from the past that you might find humorous regarding an application of a valve that wasn't necessarily planned, initially. This came from a friend of mine who, many years ago in the early days, had a responsibility for a pipeline operation of moderate size in South America. They had a great deal of difficulty with this system, as it was originally put in, achieving continuing operation. They finally resolved the question by understanding that the methods they had anticipated for limiting and regulating the flow and pressure in the system were not really functioning. So, someone very ingeniously came up with some recommendations and took over the responsibility. Lo and behold, within a few days the system was operating.

Although the system was operating and generally reliable, it was noticed that there were still some rather unusual swings on the pressure in the system. So, the responsibility was given to my friend to try and ascertain why these wide variations were still occurring even though the system seemed to be operating reasonably well. So, he searched the pipeline and didn't find anything particular within the plant environs. So, he then began walking through the woods of the jungles there to check the accumulation lines and see if there was something that was creating a problem. As he walked down, he came to a very large valve in a particular point on the line that was a collection point. He noticed that there was a gentleman sitting up there on the line who was rapidly turning the valve handle in one direction or the other. He walked up to him and asked him what he was doing and he said, "Well, Senor, I've been told that the line pressure needs to be maintained. So, on the line here, there is a pressure gauge and it is my responsibility to keep the needle within these two marks. So, I open and close the valve to do it."

They began to understand then that they had been achieving the operation by the manual operation of a 16- to 18-inch valve with a gentleman sitting out there regularly. Fortunately, they had made arrangements for several gentlemen to share this responsibility around the clock. These guys did, in fact, become the protection for the plant operation for a period of time until they found an improved way to get more reliable operation out of the automated system to give pressure control. So, recognize that valves through time have been used for a lot of purposes and

in a lot of different ways. Even the continuous movement of a valve can affect and help improve plant operation, whether it is done manually or in an automated method.

Well, thank you for your interest in looking over and working with me on the variety of applications of valves and the variety that is available. Certainly there is now, in relation to the program, the regular review of a few questions of things that we've discussed along the way. I certainly don't believe that any of you will have any difficulty in going over that. I look forward to the opportunity of offering some service to you in another program, maybe sometime in the not too distant future.

This then will be the end of tape two, side two of the three-hour Professional Development Course titled Valves. Thank you.

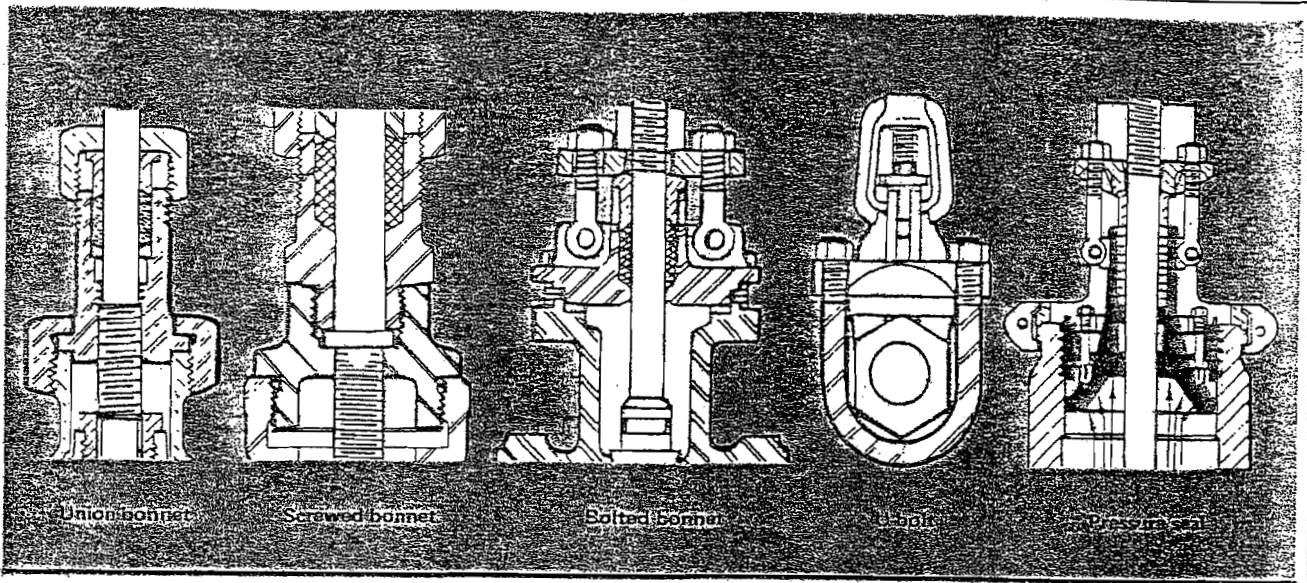


Valves

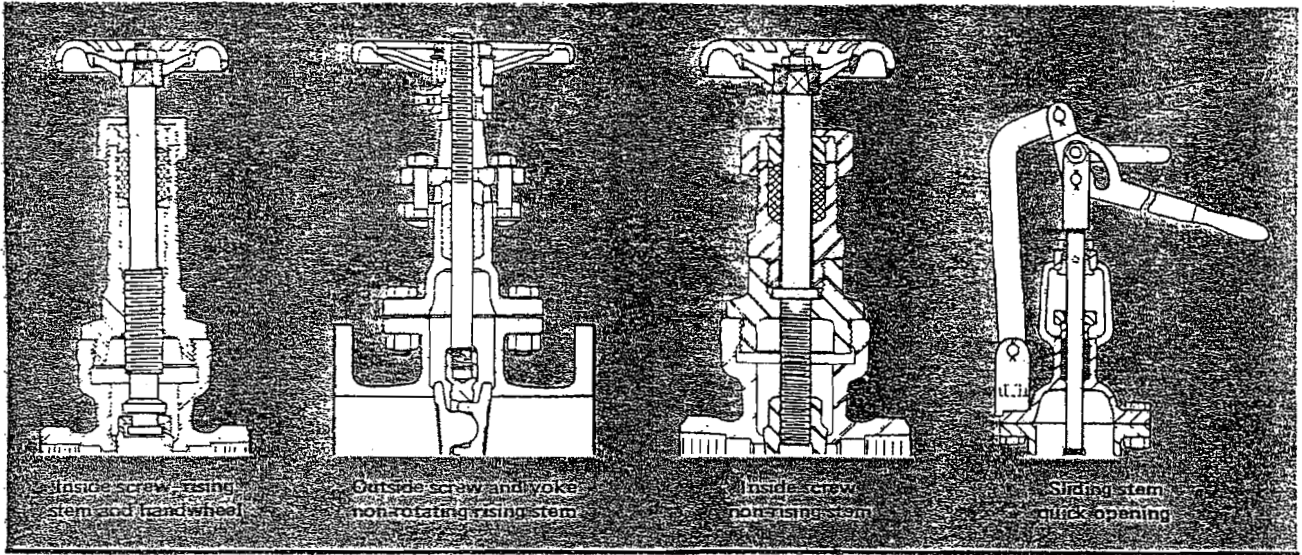
Sample Diagrams of Valves and Components



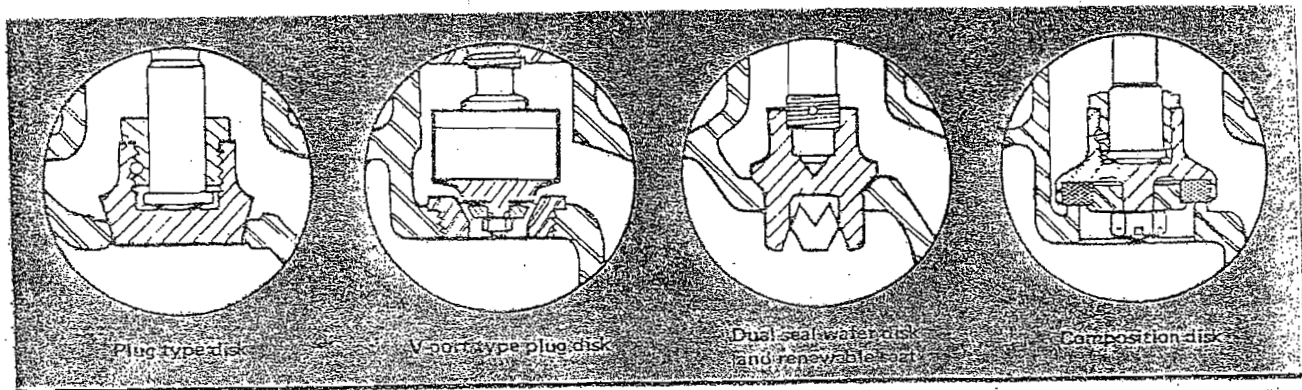
By Ed Hardin, P.E.



Bonnet variations in various gate-valve types

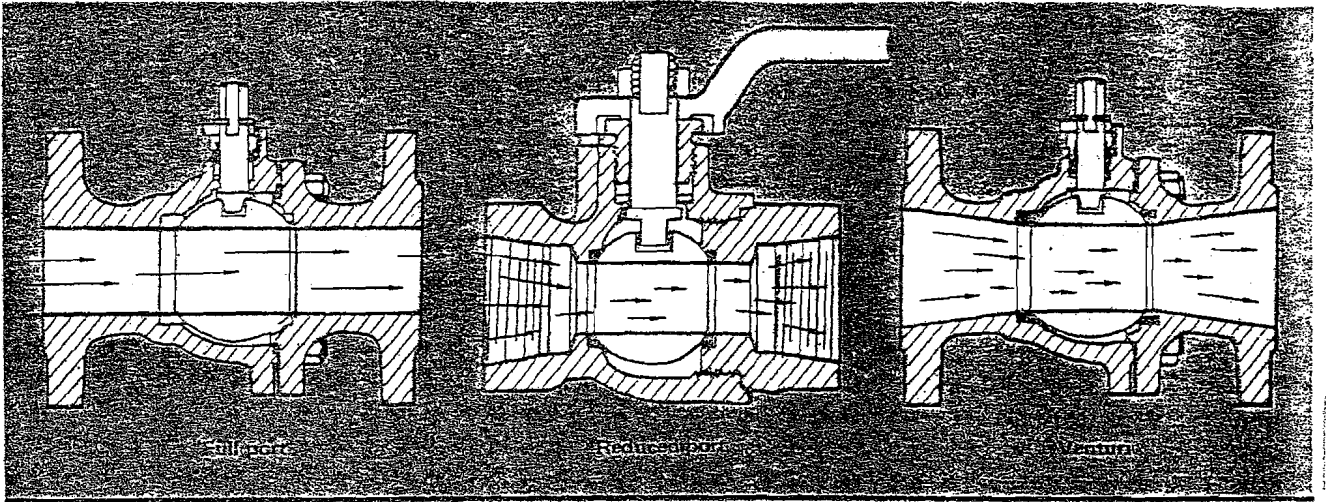


Variations in gate-valve stem mechanisms

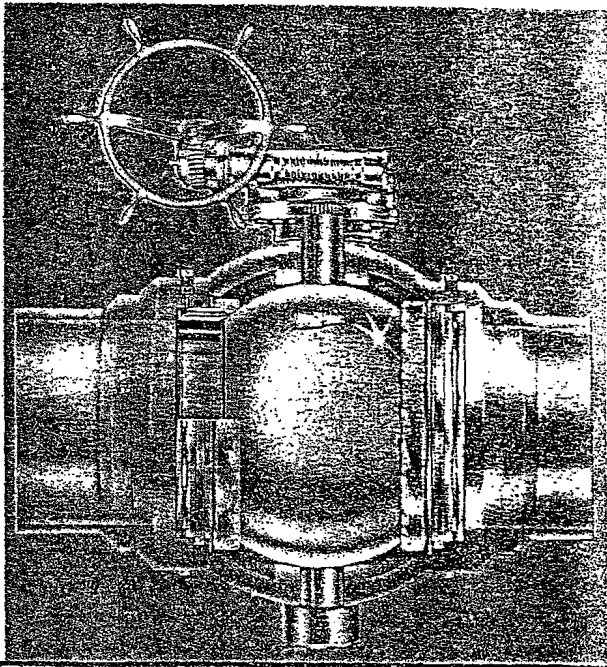


Globe-valve disks of various designs

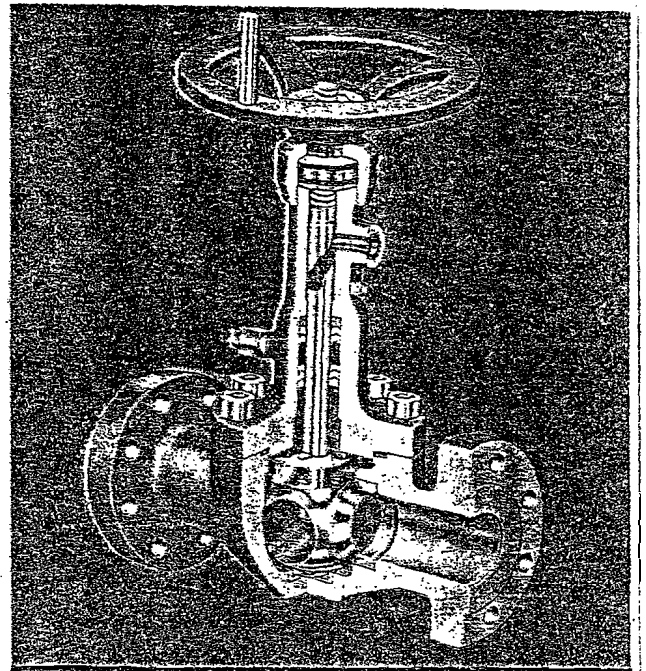
COMPONENTS OF GATE GLOBE VALVES



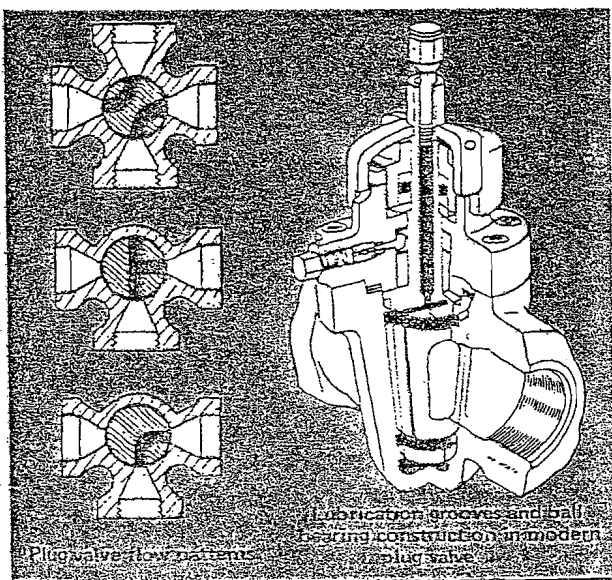
Ball valves: full and, reduced port and venturi types



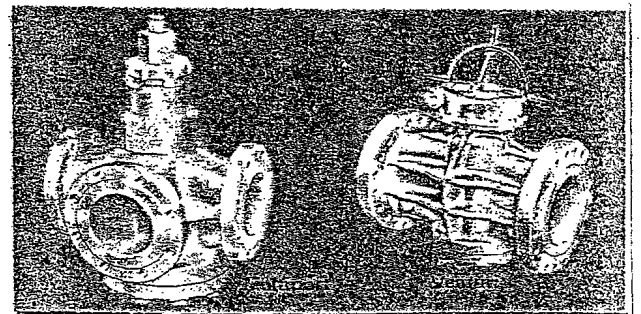
Trunnion-mounted ball valve with rotating seats



"Rising stem" ball valve has unique actuator

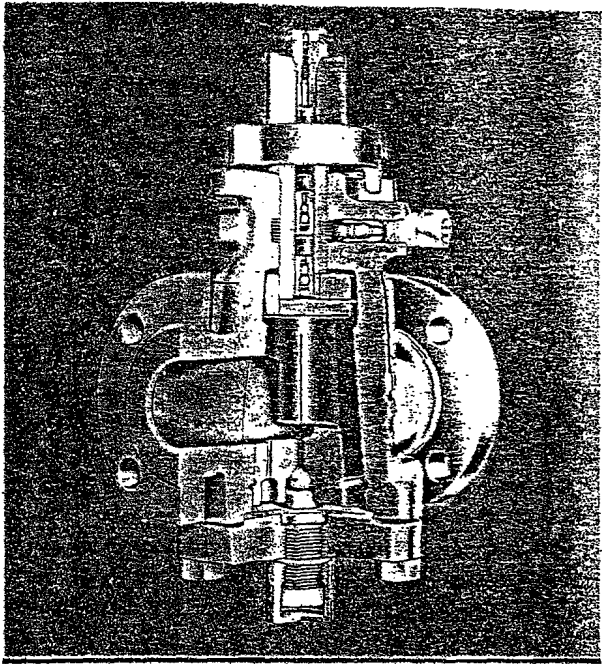


Flow patterns in multiport plug valves

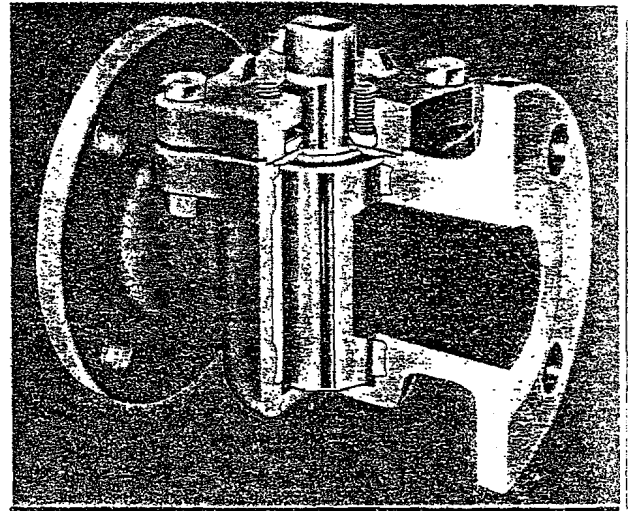


Multiport and venturi varieties of plug valves

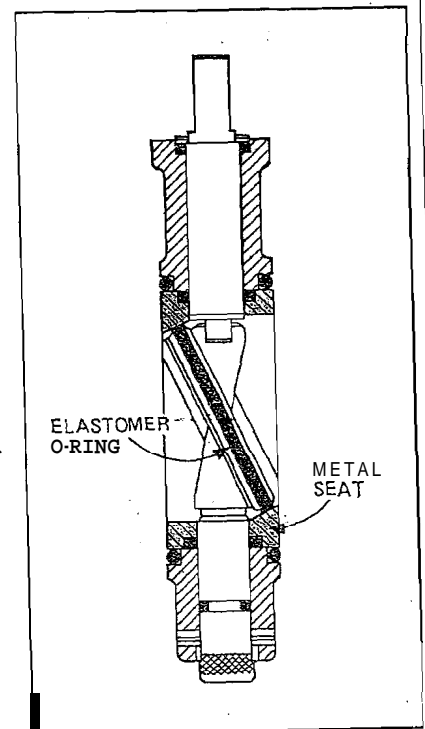
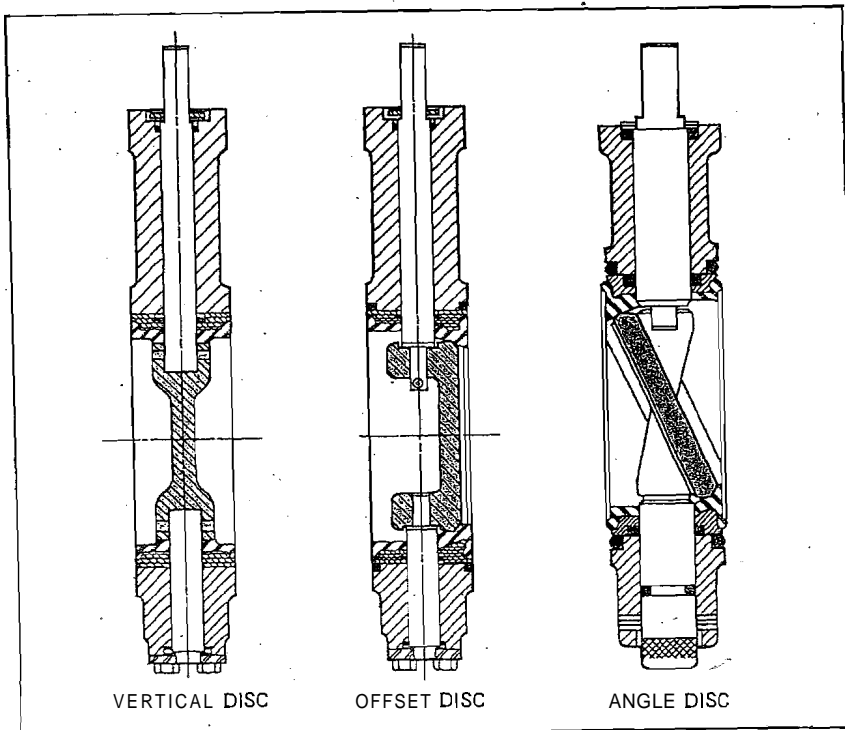
BALL & PLUG VALVES



Lubricated plug valve (bolted bottom cover type)

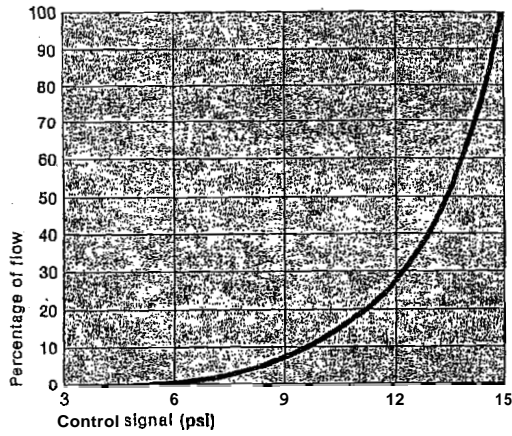
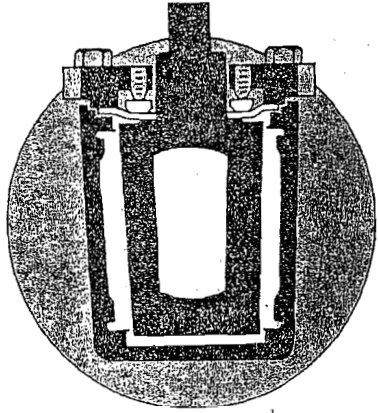


Sleeve-lined nonlubricated plug valve

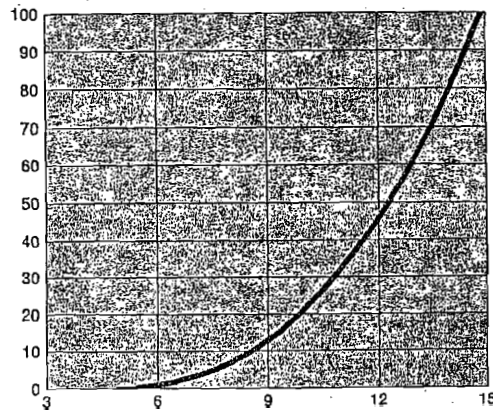
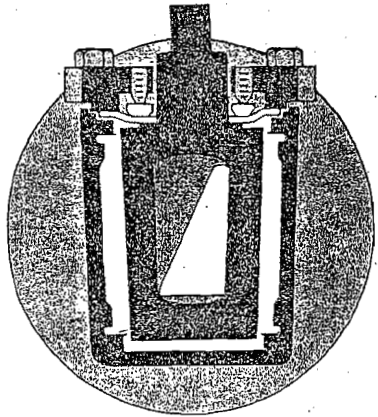


PLUG & BUTTERFLY VALVES

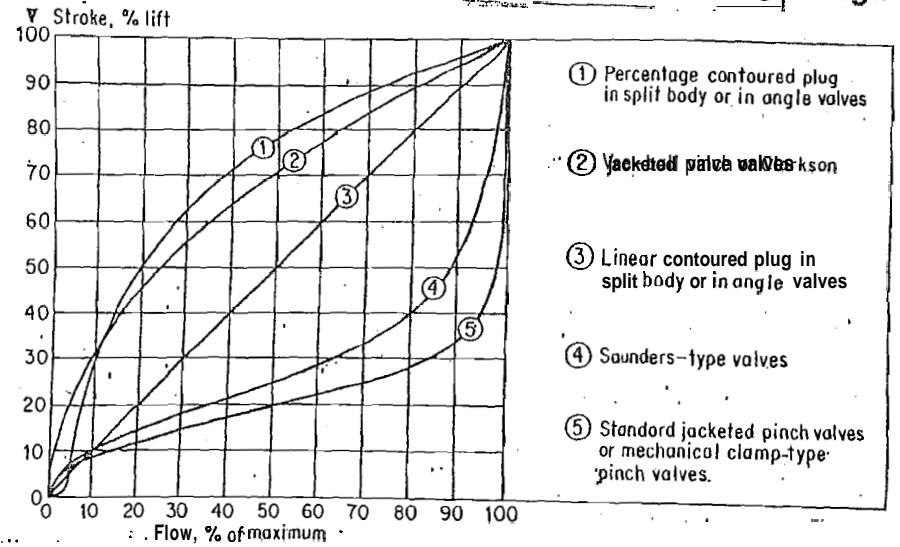
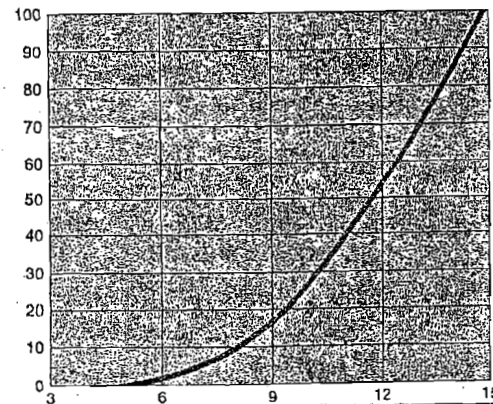
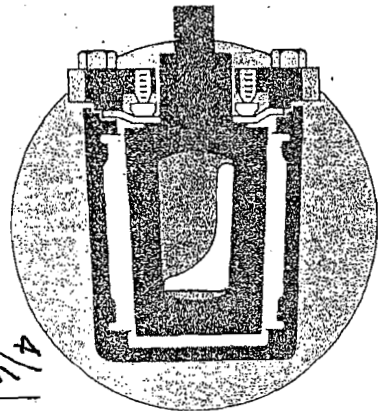
Flow curve : equal percentage



Flow curve : semi-parabolic



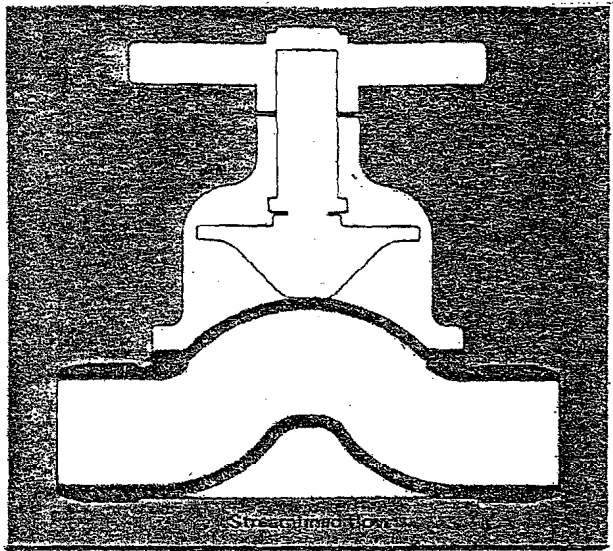
Flow curve : modified linear



Standard flow characteristics

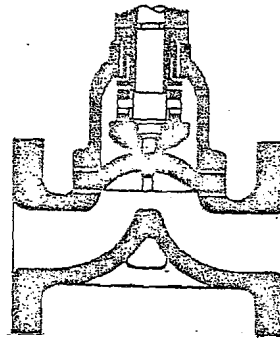
Other flow characteristics and CV's are available in both the cage and plate designs.

4/6

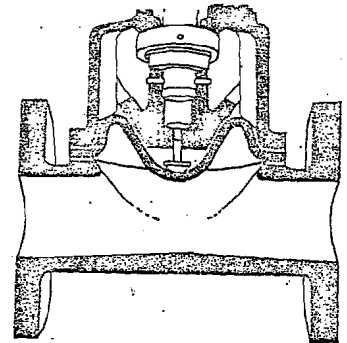


Weir-style (Saunders patent) diaphragm valve

DIAPHRAGM (Saunders-Type)



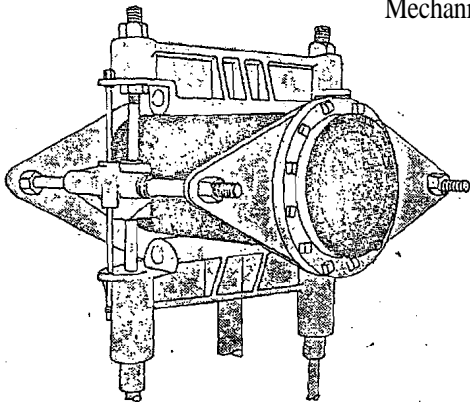
Weir pattern



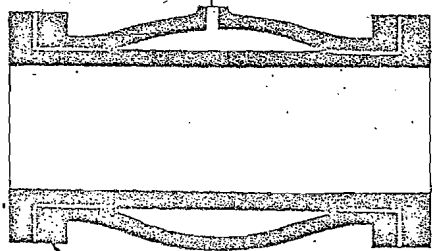
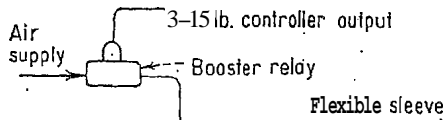
Straightway pattern

PINCH

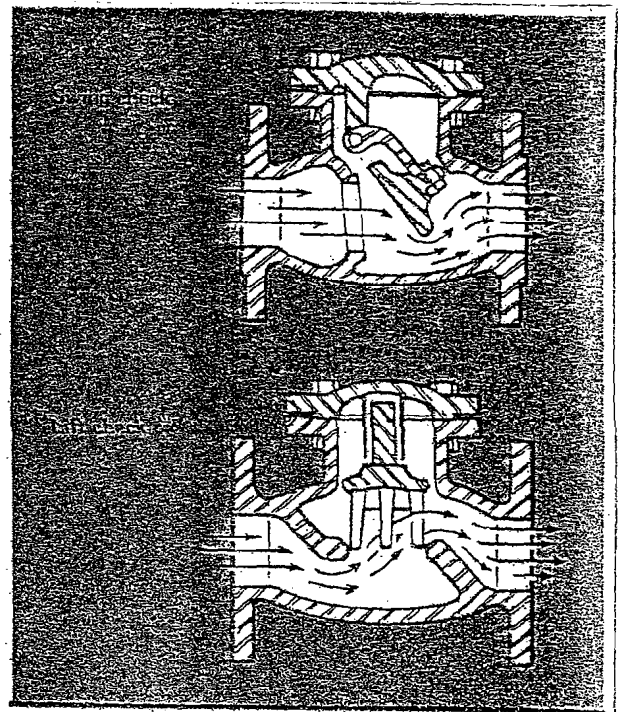
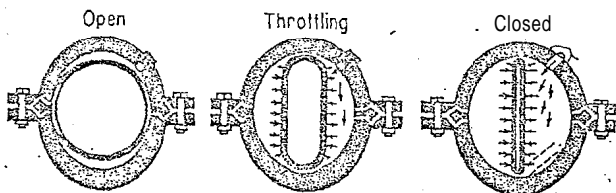
Mechanical operator



Fluid-force operator



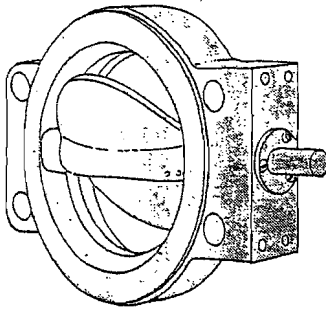
Metallic jacket



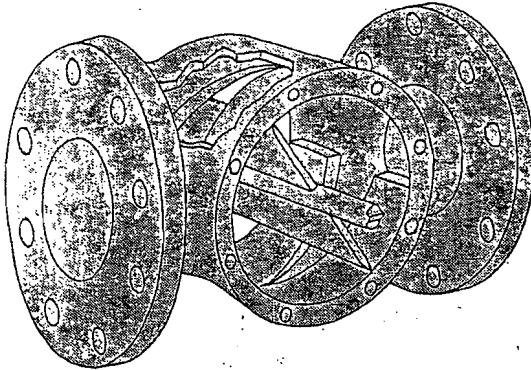
Check valves of swingcheck and lift-check types

SPECIAL VALVES

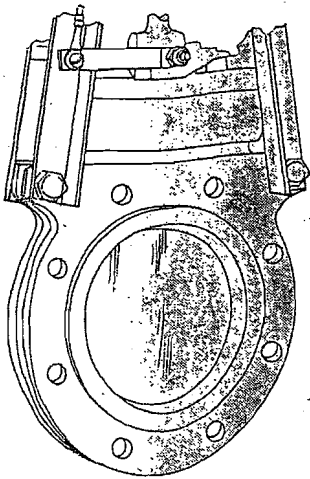
MISCELLANEOUS



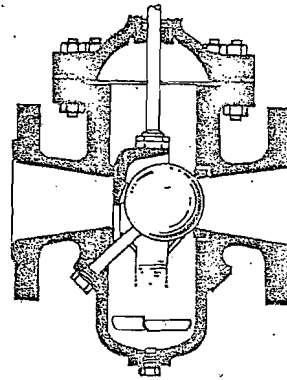
Standard butterfly



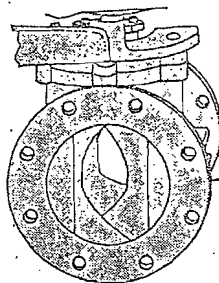
"V"-port butterfly



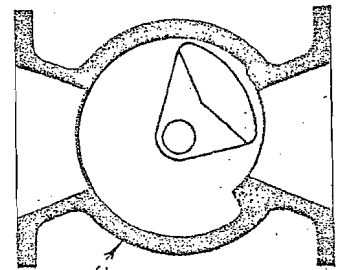
Standard slide gate



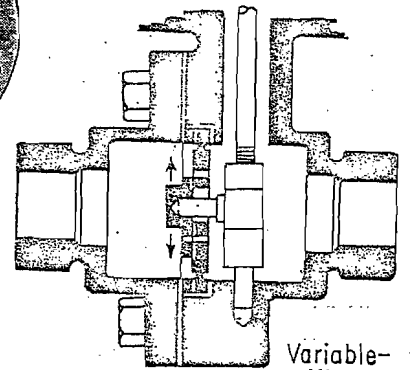
Ball valve with cage holder



"V"-port plug valves

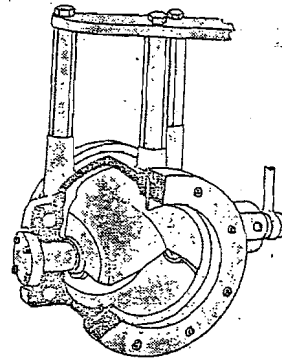


Variable-orifice slide gate



"V"-orifice slide gate

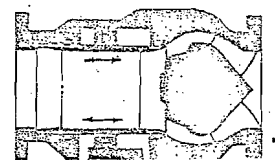
VEE-BALL



SPECIAL VALVES

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Annular-sleeve slide valve



ANGLE

