Pipe Organ Control Systems - by Classic Organ Works

Early organs were mechanical-action trackers using slider chests in which each rank of pipes had its air fed via a sliding board (or stop) with a hole for every pipe on that rank. Every key controlled the air for a single note through a channel common to each rank. If a stop and a key were selected together, just one note at the intersection would play. It was not possible to play a single pipe only on one rank and a different pipe only on another because, if two stops were in use, four pipes would sound for two keys. The only coupling possible was by mechanical or pneumatic means which involved great complexity — once it was built, that was that.

Just over a hundred years ago, electrification of a slider chest became possible whereby the note control was replaced by an electrically-operated air valve while the stop sliders were fitted with powerful solenoids. This then allowed the organ console to be placed remotely from the chambers but the chest itself was still controlled by just a single row of magnets. Electrical inter-manual coupling was possible by having an extra contact on each key for every coupler function and using a 61-contact switch (or relay) to join, or not join, the keys in parallel with other keys for other chests. Intra-manual coupling was also possible to couple up and down in octaves on the same manual, and so larger and more flexible organs became possible. However, they also became more complicated.

Robert Hope-Jones foresaw the problems with large organs and came up with a compromise in which fewer ranks were played at more pitches — the Extension principle using Unit chests. Why have three ranks of flutes at 16ft, 8ft and 4ft. when you could get similar results from one Unit flute rank extended by an octave at each end? Every pipe was given its own air valve (or magnet). Individual ranks could then be played at any pitch. In effect, all keying could be done through coupler relays but there was a limit to how many contacts could be fitted to a key and so the next step was to have remote key-action relays in the chambers. To perform coupling required yet more relays to control the note relays which resulted in thousands of wires and contacts on large organs. The complexity was still there but there were fewer ranks and therefore lower cost. The resulting tonal compromise was minimised by careful voicing. The system was ideal for theatre organs — small, flexible, and the tones were often required to be unusual anyway!

Despite Hope-Jones, it was all expensive, complicated and unreliable with thousands of sparking contacts due to the back-e.m.f. (electro-motive force or high voltage) generated by the magnet coils when keys were released. It also required huge amounts of current to operate all the relays and magnets, especially when combination pistons were activated.

The **Classic Organ Works** control system was evolved to overcome all these electro-mechanical problems by eliminating all relays as well as switch contacts — no moving parts whatever except for the pipe magnets, stops and keys! Essentially, there is an electronic control system routing the keys to the magnets in various ways — and nothing else. All the coupling and extension is performed within the system using electronic memories controlled by mathematical logic. This is all possible through the invention of the micro-processor in which the routing of signals is controlled by numbers entered from a software program. Ultimately, it is possible to have a standard box of electronic hardware for any type of organ and put all specifications in the software, i.e., a universal control system in which the software is readily customisable for any organ. It has become possible to change the specification in a matter of moments – with no changes to the wiring unless you add some ranks or stops (relatively easy to do by adding a board or two).

This is a system ideally suited to the needs of theatre organ builders in which an organ is never really finished. Somebody always wants to add another rank or change the make-up of a resultant stop, or move tabs around. Not only that, but they also want a fast response from the pipes and, nowadays, the ability to use **MIDI** (Musical Instrument Digital Interface).

Having established such a flexible control system, various interface devices are used to connect it to the outside world to cope with different kinds of input and output devices such as lamps, dual-magnetic stops, expression shoes, keys, pistons, etc. Keyboards may be connected with one wire per note, or as a matrix (to reduce the quantity of connections). Similarly for stops and pistons. Expression shoes no longer need discrete contacts, but can use simple potentiometers. They can have digital position indicators (a bargraph) if desired.

In the **Classic Organ Works** proprietary control system there is one central Console Control Computer to which all keys, stops and switches are wired as inputs through such interfaces. The microcomputer produces outputs via other interfaces to control stop actions or lamps and also creates a serial data stream containing all on/off data for the pipes in the chambers. This connection can be reduced to a single thin cable allowing easy movement of the console. At the chamber is another micro-processor system which unravels the serial data back into parallel outputs that operate the appropriate pipe magnets through special high-current drivers that are protected against back-e.m.f. voltages from inductive loads by diodes. So there is no need to add diodes across magnets but for faster turn-off response, varistors can be used instead of the diodes. Other outputs control expression shades, tremulants, and so on.

How does such a system work? The micro-processor is instructed by the software to continuously scan all switch inputs in a sequential manner at high speed. It first collects all the stop and control-switch data, and then the key-switch data and stores it all in memories. These memories are then interrogated so that if a stop is on and a key is pressed, the relevant information is stored in another memory. The serial output sends out this processed information in an orderly fashion to each chamber in turn for the stops and keys that are being used. Due to the high rate of this serial data stream, the recovered information can change in a virtually instantaneous manner.

Coupling is then simply a matter of including a third condition for the coupler function to manipulate the numbers to determine which extra pipes are to be operated, whether these be on the same manual or on a different one. Other functions can easily be added such as transposition which can shift the key information up or down relative to normal. Prior to electronic control, this feature was almost impossible.

So, instead of masses of magnetic relays and miles of wiring, to say nothing of thousands of switch contacts, the control system is reduced to a few printed-circuit boards using complex integrated circuits and a programmable memory chip (an EPROM) whose content defines that particular organ. This system is infinitely more flexible than hard-wired relays and fits inside a normal console on a handful of boards. Not only is it far smaller than one using relays, it is also much cheaper (and can be paid for out of the copper saved on wiring and relays). In this modern age of technical wizardry, it is also far more reliable than anything with moving parts and contacts.

What does the Classic Organ Works system offer? Basically, the control of an organ of any size or style, church or theatre, pipe or electronic, including dual-consoles and MIDI capabilities, Auto Solo, Auto Pedal, and split chests. It can also handle theatre organ specialities such as Pizzicato Coupling, Sustain/Sostenuto, Effects, Traps, Re-iteration, Ventils, Second Touch and Re-programmable pistons, etc. Since it is easy to add switches or push-buttons for little more than the cost of the parts, any console can have features that were previously beyond the customer’s pocket. Wall-to-wall pistons and stop tabs are no problem (except, perhaps, what to control with them). Sophisticated capture action for combination settings is easy to do and there can be hundreds of different memory levels so that visiting artistes can preserve their own combination settings which can also be locked to avoid inadvertent changes. Registration sequences can be recorded for recitals. Performances can be recorded and replayed via MIDI sequencers and the console can play other MIDI devices and also be played by them. MIDI-stops, MIDI-traps, and MIDI-Effects can use any kind of MIDI sound module to produce special sounds and these are treated just like normal stops on tabs. MIDI settings can be quickly changed with the use of a normal personal computer or through various control switches. The PC can also download all adjustable settings to disk and restore them.

At **Classic**, we offer two kinds of control systems — individual boards of various kinds which you wire yourself, or a ‘Grey Box’ (packaged) system in which we have done all the complicated work and you simply connect up the various switches, lamps and magnets with one wire per function. You tell us what you want it to do and we produce the equipment together with the software to do your job. As no two organs are alike, we basically customise each one exactly how you want it.

What is available? Boards for Console and Chamber control, Pipe Drivers, AC or DC Chimes Drivers, Lamp Drivers, Switch Inputs, Expression Shoe kits, Bargraph indicators for shoes and various Control Panels. Then there are more specialised items such as Music Rack Control Panels which fit beneath the music rack on large organs where there is no space for normal panels, Slider Motor Controllers, Swell Engine (Shades) Controllers, Electronic Tremulant Generators (which operate on normal wind lines by cyclic air dumping), Electronic Pedal-tone Generators, Velocity-sensitive Optical Key-switching (for expressive control of MIDI-stops), and many other things.

How big is it and what does it cost? For a do-it-yourself installation, the Console processor is on a printed-circuit board 18"x8" at a cost of about $750 excluding the software and engineering costs (typically $3-5,000 for a large theatre organ). Other boards are required for driving stop-action magnets at about $150 per 24 stops. That is all that is required boardwise in the console if you matrix-wire the keys and pistons. However, some kind of push-button control panel is also necessary at about $360, as is a commercially-available current-limited power supply. At the chamber end of things, the pipe processor is 14"x4" and costs about $420 for up to 24 ranks. It is best to have one in each chamber. Pipe driver boards are the same physical size and handle up to 96 pipes or effects, shades, etc., at about $265 each board. Boards with fewer outputs are available at lesser prices and a Chimes board at about $340. Again, a power supply is required (switched from the console). If the 'Grey Box' system is used, the console one is around $4,900 (for a 4m/192-tab console), plus engineering, control panel, and a power supply. Dual-magnetic stop drivers are included in the box which handles up to four manuals, pedals, 192 stops and pistons. A chamber box handles up to eight ranks of 96 pipes (or more ranks if fewer pipes per rank) at about $3,000 and only a power supply is required. All boxes are 21"Hx15"Wx5"D.

Some installations. Classic control systems have been installed in many theatre pipe organs, including the largest one in Canada (a Kimball 3/27 with 312 tabs at Kingston), a small Compton in Jersey (Channel Islands) and the Organ Grinder (formerly in Toronto). Theatre organ installations in the USA include a Wurlitzer at Fergus Falls, MN; the ATOS 4/20 Wurlitzer (239 tabs) in the Fargo Theatre, Fargo, ND (built by the Johnson Organ Co. Inc.); a four-manual electronic theatre organ for Tom Hamilton in Columbus, Ohio (http://theatreorgans.com/ohio/); and a Wurlitzer in the Dalton, PA, residence of Tom Logan and Mike Walsh (http://www.organworks.com/Web/about/portfolio.asp?portfolio_id=11). Some of the many church organs using our control systems include the largest organ in Canada (Metropolitan United Church in Toronto, which has a five-manual console controlling a Casavant organ of 121 ranks), a two-console, four-manual, Austin of some 133 ranks in Palm Beach, Florida (featured on the January 2001 cover of the Diapason magazine), and a five-manual Casavant organ of some 220 stops in Hollywood.

While our main business is making pipe organ control systems, we also build electronic church organs using digital-sampling techniques. One of our largest (recorded on a CD) is in ‘The Holy Name’ church in Toronto and has 87 ranks. Of course, we also make smaller organs.

Want to design your own organ on your PC? You can with our free software called OrganWorks(TM); which is a graphical database. Go to (http://www.organworks.com) to download it and then create an organ console layout, defining all the chests, ranks, stops, pistons, etc., from a library of customisable standard parts. When you are done, e-mail the file to us and we will manufacture the control system for you!

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