

# The Pedal-Electric Duo-Art

## How it works, and how to adjust it

By Julian Dyer

The Pedal-Electric Duo-Art was the commonest model sold in the UK, but there is very little information available to explain its operation. This page sets out to correct this unwarranted omission. It does not attempt to explain the fundamentals of the Duo-Art expression system.

The article is in two parts: firstly, how the Pedal-Electric Model works; secondly, a more general discussion about regulating the Duo-Art system, which is applicable to most instruments.

### Duo-Art models and varieties

There are many varieties of Duo-Art, and no two instruments ever seem to be exactly alike. They appear to have been made up from individual pre-prepared items taken off the shelf, each installer having some degree of leeway in how the bits were fitted together. Underneath all this complexity, the instruments (and their all-electric brethren) are fundamentally similar. Because of this, I thought it would be more useful to discuss the various components, and how they work together. This should prove to be of more wide-ranging use than a tubing diagram of a single instrument.

It seems as if the Pedal-Electric Duo-Art (PEDA) was created in 1921 or 1922, about the time the UK production of these instruments was started. Earlier than this, all-electric installations from the USA were fitted. The UK PEDA expression box is not related to the all-electric American one (which is the type illustrated in the service manual which Vestal Press reprinted for many years), or to the rarely-encountered American pedal-electric model. This is the source of a great deal of confusion! Both upright and grand pedal-electric instruments use the same form of expression box, but electric-only expression boxes can be quite different. Some electric instruments have PEDA expression boxes with the unused bits blocked off.

### Tubing the PEDA expression system

The diagram shows the main components of a typical PEDA expression system in a highly schematic manner. It has been simplified as much as possible. The rest of the instrument is a standard Pianola, or obvious bits such as rewind and on/off switches, and has been omitted to show just the Duo-Art part of the instrument. Where there are multiple tubes connecting a similar set of functions, they are shown as one line branching out at each end.

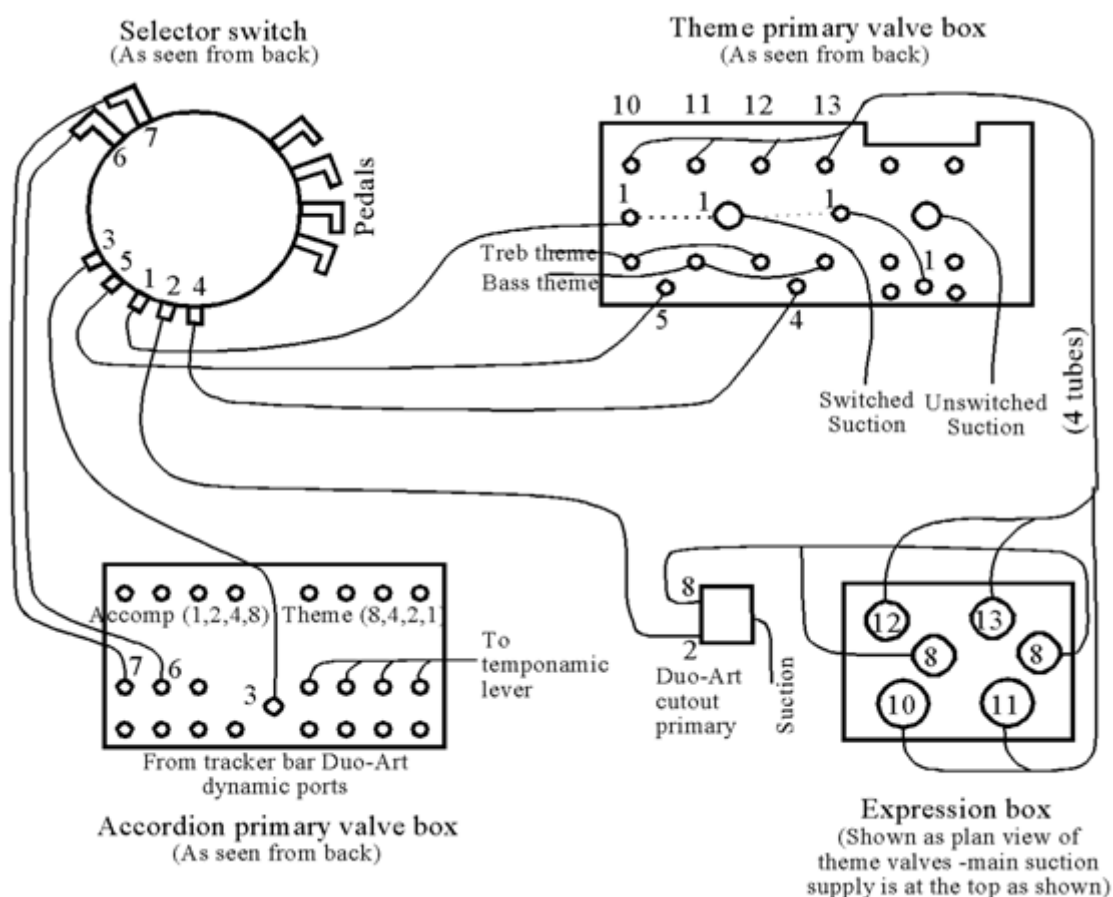
While pretty well all Duo-Arts from 1914 to the 1930s work in the same way and consist of much the same set of functions, the way they were put together varied quite a lot. This article cannot possibly provide a definitive list of varieties, but

hopefully if care is taken to understand the various functions, it should be possible to decipher all the various components in an instrument.

The diagram shows the following fundamental components:

- 1) Rotary selector switch (earlier instruments will have wooden sliding switches instead).
- 2) Theme primary valve box / tracking system.
- 3) Duo-Art accordion valve primary valve box
- 4) Expression box

(To answer a common question: UK instruments were not fitted with a crash valve, which was a late addition of questionable value - more regarded by engineers for its gee-whizz factor than by musicians for its contribution to the accuracy of reproduction).



## Rotary selector switch

This is probably the cause of more confusion than any other component, because connecting the various tubes is distinctly complicated. The valve has three completely independent functions. One switches the pedals on and off; another admits air to set Themodist accompaniment levels for non-Duo-Art rolls, and the final segment turns on and off the various Duo-Art functions.

The Duo-Art switching functions are connections 1 to 5.

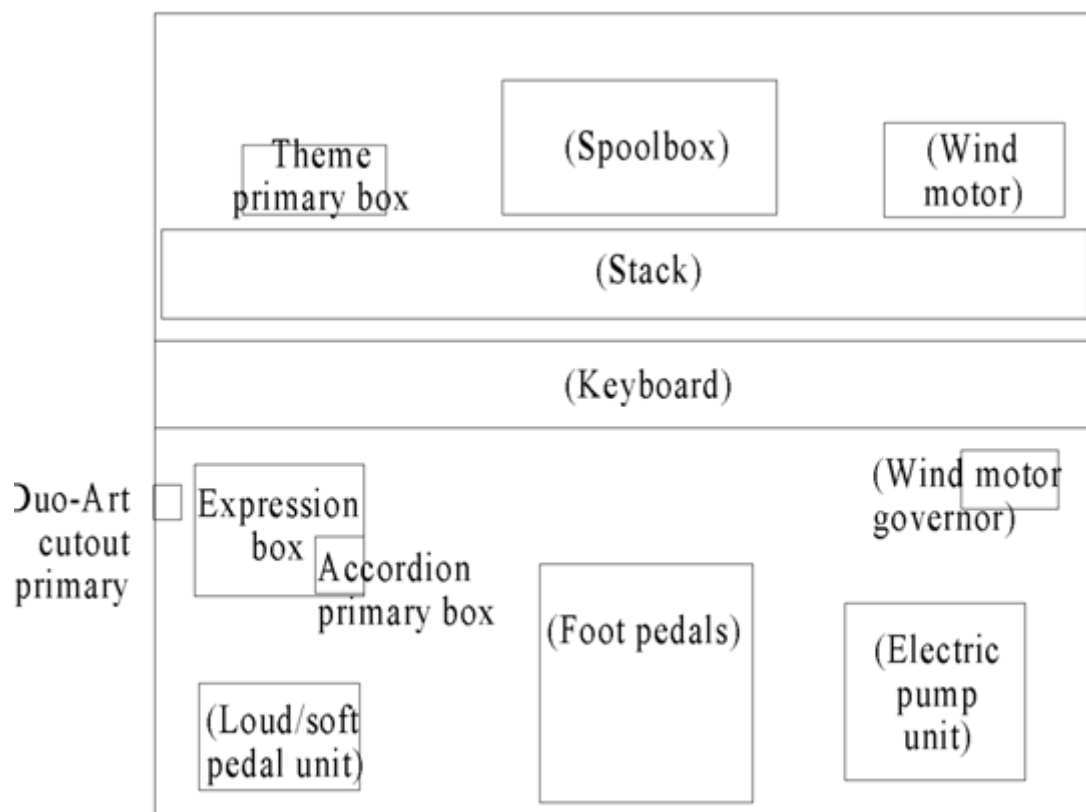
1 is the suction supply to the switch. This may be supplied from any convenient source of suction. In many instruments it is supplied from the theme primary box either via a tee-connector in the tube or from a separate connector inserted into the box. It may be supplied directly from the expression box via its own tube through the connector block.

2 switches the Duo-Art expression box between 88-note Themodist operation and Duo-Art operation. It operates a primary valve (described as part of the expression box) which in turn operates a pair of valves which block the normal flow of air through the expression box. (They provide the same effect as fully-closing the themodist sliders). Air down this line operates the valves and so causes Duo-Art operation.

3 switches the Duo-Art expression primary valves on and off, so that opening tracker bar holes 1-4 and 85-88 either plays a note or sets a Duo-Art expression. The precise way this works varies according to the construction of the instrument. If it has a full 88-note stack, the switch must be connected to block either notes or Duo-Art valves. If the instrument has an 80-note stack (which is more common), then it is only necessary to block off the Duo-Art valves. There are two ways in which the Duo-Art valves may be isolated. Either the Duo-Art primary valve box will have an integral cutout mechanism (as shown in the diagram), or separate cutout blocks will be mounted on the stack to block the tubes running from the tracker bar. The actual operation and effect is the same in both cases. The cutouts are operated by admitting air to the part to be isolated, so hole 3 has air admitted during 88-note playing and suction during Duo-Art operation.

4 and 5 are cutouts for the theme primary valves. The double-width accent ('snakebite') holes in the tracker bar are connected to both the Themodist (88-note) and Duo-Art theme primary valves, so it is necessary to make sure only the required one is operated. This is done by means of a cutout pouch underneath each valve: as before, admitting air cuts out the valve. Hence air is admitted to 4 during Duo-Art playing and to 5 during 88-note operation.

Because the instrument can play Duo-Art rolls with manual expression (as if they are ordinary Themodist rolls) the various cutouts work in a complex pattern. This doesn't need to be understood to get the instrument to work, but it's the reason there are several independent cutouts rather than a single Duo-Art on/off tube.



### Theme Primary box

This box contains the four theme primary valves—bass and treble for both Duo-Art and 88-note Themodist operation. These primary valves operate the theme valves in the expression box. The tubes from the tracker bar are connected to both Duo-Art and Themodist valves: as discussed above, each valve has a cutout below it so that only the required one operates.

The other part of this box contains the valves for the tracking system. This will either be the twin-ear tracking system used on earlier instruments, or the 4-hole system used later (or possibly the less common 'Phillips' system that uses a number of slots above notes in the centre of the tracker bar). The four-hole system is infamously complicated to tube: the secret is that the *outer* hole is connected to the upper inlet, and the *opposite inner* hole to the lower inlet. The two sides are identical so just switch the connections to the tracking bellows to get it to operate once tubed. (The tracking system incorporates no less than two cutout pouches on each side—one is operated by the inner hole, so that air flow from the outer hole is cut off when air is admitted to the inner hole. The other cutout is to isolate the tracking system in rewind, and is discussed below. To track properly these cutout pouches must be functional: often they are made of rubber cloth rather than the leather used elsewhere, in which case replacement is inevitably needed. Leather pouches often survive in perfect condition.)

The connections on this box are complicated by the way in which the suction supply is arranged. This is because the twin-ear tracking system moves the top spool, and has to be held in the centre position during rewind to stop the roll

moving to one side and thus tearing. Two suction supplies are provided—one is on all the time, and the other is turned off during rewind. The switched supply is used for the theme primaries (12), and the unswitched supply is used for the tracker system (13). The switched system is then connected via a short tube to a cutoff pouch under the tracker valves in order to isolate them during rewind (14). So, in rewind, the tracking pneumatics are powered but the tracking ears isolated, so ensuring the roll stays centred during rewind. It is *vital* to get these suction supplies the right way round!

Testing is easy: simply see if the theme valves move during rewind, and reverse supplies if they do. If the supplies are the wrong way round rolls will be shredded along their left hand edge during rewind—looking at rolls, it seems as if this important detail of tubing is wrong rather often! (The twin suction supply is just the same in Pianola instruments, by the way, and just as important.) The unswitched supply is comes directly from the foot pump box, and the switched supply from the expression box.

Instruments with 4-hole tracking which move the tracker bar instead of the upper spool cannot cause the same problems on rewind. These instruments still have the same twin suction supply, but in some later models both supplies may be switched, which can be rather confusing.

### **Duo-Art accordion primary valve box**

There are different varieties of this box—as explained above, some of them are combined with a cutout block, while others have a separate cutout block mounted on the upper action. The position of this box will vary between upright and grand instruments—in uprights, it is slung underneath the expression box on a pair of supports, while in grands it is mounted separately.

The other variation in these primary boxes is whether they contain additional inputs to operate the expression accordions independently of the coding on the roll. Some instruments (typically those with separate cutout blocks) simply tee any additional inputs into the tubing from cutout box to primary valve, so have a single connection at the primary valve box. Others (those with the integral cutout block) have two sets of inputs for each primary valve—one which is affected by the cutout and another which is not affected. The additional inputs are connected directly to the valve box. The second type of box is shown in the diagram.

The additional inputs are used for two reasons. During the playing of non-Duo-Art rolls, it is necessary to set an accompaniment level for the Themodist expression. This is done by setting one of levels 1, 2 or 4 directly—by means of the selector valve, as mentioned earlier. Typically a lower level is selected for the electric playing of rolls and a higher level for pedalling. The boxes seem not offer an additional input for accompaniment level 8, presumably because it was not thought of any use.

The other sort of additional input is used where instrument has a pneumatically-connected Temponamic lever. This is the combined speed and accompaniment control for manually adding expression when playing 88-note rolls electrically. This is connected to a rotary valve that progressively opens theme levels 1, 2, 4 then 8, giving a rather lumpy crescendo as the knob is turned. Other instruments have a

mechanical link for this function, which simply presses down the theme arm on the expression box: this gives a smoother crescendo. The whys and wherefores of which instruments have which system I don't know. Uprights seem to have the mechanical link. Perhaps it was simply because it was easier to install in an upright?

### **The expression box**

The PEDA expression box has six valves in it: each side (bass and treble) has a Themodist theme valve, a Duo-Art theme valve, and a cutout valve to switch between the two modes of operation. These valves are connected to their respective primaries: the theme valves to the theme primary box and the two cutout valves together to the single cutout primary.

Showing the nature of the 'off the shelf' way which these instruments were made, the Duo-Art cutout primary is an ordinary outside valve, with a pouch and bleed. However, it is supplied with either air or suction—so it is quite unnecessary for it to have a bleed. All it does is act as an unwanted additional leak when open to the air—in other words, during Duo-Art playing. The bleed can be blocked off. The instrument will work without the primary valve (it is in effect an amplifier), so undoubtedly there will some be instruments where the cutout valves are connected directly to the selector switch.

### **Regulating the Duo-Art expression system**

So, now the tubing has been discussed, how should the instrument be adjusted? All Duo-Arts work in the same principles, so any available Duo-Art adjustment literature applies to the PEDA equally as well as any other instrument. This is a big subject, and all I offer here are some random notes and ideas that I've found useful.

The original UK setup manual for the Duo-Art is a little vague, assuming that the basic adjustments have been made in the factory. In particular, the manual does not describe how to adjust the linkages between accordions and expression box. It actually goes as far as saying that they are set in the factory, and if they have been altered a set of jigs may be obtained for them! This is of no help whatsoever (does anybody possess a set of these jigs?).

To get the theme and accompaniment sides of the box to work consistently, they must be set up *exactly* the same as each other. Once they are identical, the difference between theme and accompaniment may be introduced.

The first stage of set up concerns the geometry of the accordion – linkage – knife valve system only: the adjustment for loudness of playing comes later. To ensure both sides of the expression box are the same, it is best to start with the internal arms which connect to the knife valve. This can only really be done when the expression box is out of the piano and the covers have been taken off the bottom of the regulators. Having looked at the original screw marks on my instrument, it is clear that the internal and external arms were set to exactly the same position—so that the top of the accordion connection on the outside is at exactly the same position as the connection with the knife valve on the inside (when the adjusting

screws are in the middle position). Of course, if the instrument has never been taken apart and fiddled with, the arms are going to be in the original factory position. Unfortunately, to dismantle the expression box, the arms have to be removed—which is possibly a reason why many rebuilt Duo-Arts just don't play very convincingly. (Readers who are trying to use this article to improve the regulation of intact instruments will just have to assume the arm adjustments are correct and carry on for the time being.)

To make sure that both sides of the box are the same, and the internal and external arms on the regulator are correct, a simple technique is to line up all four arms with a ruler, and carefully lock the inner arms to the rotating shaft. This guarantees that both sides are the same, and correct. Minor variation from factory positions will not really matter, because they can be regulated for. It is the similarity between theme and accompaniment sides that really matters.

Once all this has been done, the position of the arms at zero level can be set by adjusting the accordion linkages. The outer wooden arms should probably be just about level—the detail adjustment is to set them so that the spill valve just shuts at level 10 for both theme and accompaniment.

If all is well, the regulators should now be about right. At zero level, when a blank piece of roll is across the tracker bar and the electric motor switched on, both regulators should rise half an inch. This stretches the regulator spring and provides the zero level suction. The regulators should rise *exactly* the same amount at this stage. Then, as the dynamic holes are opened in the tracker bar, both regulators should rise the same amount for each successive level. If they don't, then the geometry of the box is not correctly set and there is absolutely no chance of the instrument playing correctly!

The next adjustment is to make the theme side 'one degree' louder than the accompaniment. According to the service manual, this is done by tweaking the adjustment screw on the regulator arm so that the theme regulator rises just a little further than the accompaniment—so stretching the regulator spring a little more and thus raising the suction. It seems to me that an alternative way would be to make the theme spring a little stronger by giving its adjustment collar an extra half-turn or so.

Incidentally, it seems as if English-built Duo-Arts always used springs of identical strength on theme and accompaniment regulators, as did earlier American instruments. Some time in the early 1920s American policy was changed to use a stronger theme spring—so the theme gets progressively higher above the accompaniment, rather than interleaving with it. As a result, English instruments play quieter at higher theme levels than American ones do for the same coding—a fact noted by some pianists at the time when they edited or approved their rolls. To be purist about things, the correct ratio of spring strengths need to be fitted to play a roll as its coders intended.

## Faults

The Duo-Art regulator is not working properly if any of the following easily-visible things are happening:

- The two regulators rise different amounts for the same dynamic level;
- Either regulator stops rising before level 15 is reached—just pull the accordions shut by hand to check this (it indicates that either the instrument has run out of suction, the accordion travel is too great, the knife valve linkage is wrong so is reaching the end of its travel too soon, or the knife valve is leaking so needs to rise higher to reach a balance position);
- The regulators creep up to their top position when no notes are playing (the knife valve is leaking and does not reach a balance position, so must be fixed);
- The lower of the two outer regulator arms does not rise to its top position when the dynamic level drops to zero—the upper arm, connected to the accordions, will rise as the accordions open, but the lower arm may be held back by friction of the knife valve. See if there is ever a gap between lower and upper arms, or try pushing up the lower arms by hand when the instrument is playing to see if there is any slack (if so, the return springs are too weak to pull the knife valve fully closed: strengthen them, they need to be surprisingly strong).

And remember, the lack of feedback in the regulator means it will play only as well as the worst note in the instrument—leaky notes cause the suction level to drop and so the instrument plays quieter. A stack with all the notes evenly set is necessary for successful Duo-Art playing, and the instrument will only play with original dynamic response if the stack leakage is at a level comparable with a new instrument. The leakier it is, the quieter larger chords will play. The worst note in the stack will determine the best the Duo-Art can play.