ORGAN BUILDING FOR Amateurs

By MARK WICKS
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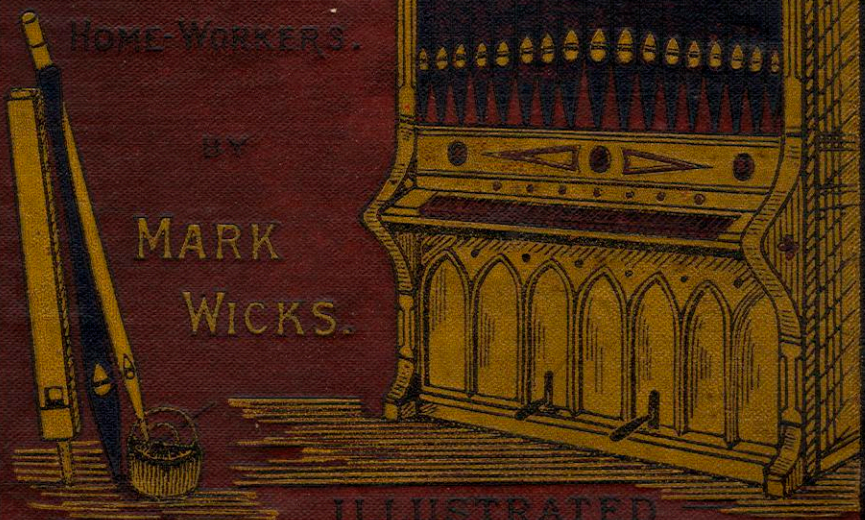
WARD-LOCK & Co

ORGAN-BUILDING FOR AMATEURS

A PRACTICAL GUIDE FOR HOME-WORKERS.

BY

MARK WICKS.



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ORGAN BUILDING

FOR

AMATEURS.



ORGAN-PIPE DECORATIONS.

DESIGNED AND ILLUMINATED BY MARK WICKS.

ORGAN BUILDING

FOR

AMATEURS.

A

Practical Guide for Home-Workers.

CONTAINING SPECIFICATIONS, DESIGNS, AND FULL INSTRUCTIONS FOR MAKING EVERY PORTION OF THE INSTRUMENT.

BY

MARK WICKS.

WITH OVER TWO HUNDRED ILLUSTRATIONS AND EXPLANATORY DIAGRAMS.

SECOND EDITION.

LONDON:

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WARWICK HOUSE, SALISBURY SQUARE, E.C.

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PREFACE.

IN submitting this little work to the public I must, in the first instance, warn the reader that it is not written with the intention of dealing exhaustively with organ building generally, but, as its title implies, only with that particular phase which comes within the means and scope of an intelligent amateur workman. Therefore, such refinements as electric and pneumatic actions, not being required in small instruments, find no place in this work, but everything of interest to a home-worker is touched upon in a thoroughly practical manner.

There are many works on the subject to which builders, purchasers, or general readers may resort for information respecting organs, but the instructions contained in most of these works being limited to general, and often vague, description, are of little service to an ordinary amateur desirous of building the instrument himself, as in most cases the idea of building an organ at home is taken up by persons having little knowledge of the construction of the instrument which they so ardently desire to possess. It is indeed rather surprising that there is not a larger supply of literature dealing with this subject from an amateur's point of view, for it is a matter which is constantly claiming the attention of young men of mechanical proclivities, and also one which exercises an astonishing and peculiar fascination

over them. But beyond isolated papers in magazines, and the little manual of the Rev. W. E. Dickson, there does not appear to be anything which can rightly be considered as meeting the requirements of persons of the class referred to. It is with the object of supplying this want that I have been induced to compile the little manual which now seeks the suffrages of home-workers. As an amateur organ-builder I may fairly claim to have some knowledge of the necessities of that class, and of the difficulties which beset them at every turn. It has been my endeavour to smooth away those difficulties by describing every part of the instrument in the fullest detail, and by supplementing the instructions, wherever practicable, with carefully-drawn illustrations.

The method of making pipes of paper, which is an invention of my own, will, I trust, prove a boon to amateurs, especially those of limited means, as by making pipes of this material the most expensive item in the cost of the instrument is reduced to a comparatively nominal sum. I do not think I could adduce better testimony of their efficiency than the fact that a practical organ-builder, who is quite unknown to me, has thought it worth his while to take up the manufacture of these pipes, and to enlarge his workshops for the purpose.

I would add that the care, patience, and perseverance devoted to building even a small organ at home must necessarily afford most valuable training to young men, and the moral value of the instrument itself in a home where children are growing up cannot, I think, be over-estimated.

July, 1887.

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ORGAN BUILDING FOR AMATEURS

CHAPTER I.

TOOLS AND APPLIANCES — SPECIFICATIONS — NEW METHOD OF MAKING PIPES.



HERE are few things that possess more fascination for the amateur mechanic than a musical instrument, and few, indeed, that, if the work be well carried out, will so fully reward him for his patience and labour. The organ, that acknowledged king among keyed instruments, is of such construction that every portion of it may be made by a person possessing a little skill and a fair amount of patience and ingenuity. In this respect it differs from the piano or harmonium, as in those instruments the really music producing portions would not be placed to the credit of the amateur, but would necessarily be purchased, whereas every pipe in the organ could be made by the amateur himself.

Before proceeding with the instructions for the building of the instrument it will doubtless be well that I should indicate the principal appliances and tools required for the work.

First and foremost, a good, firm, and level bench is absolutely necessary, and this should be at least 6 feet long, or capable of being extended to that length by means of an end flap with firm supports. It must also

be provided with the usual appliances for holding the wood firmly whilst it is being planed, etc.

We shall require one or two hand-saws for ripping planks and for general sawing work, and also one large and one small tenon saw.

Of planes we must have at least three, viz. :—a jack-plane for rough work, a trying-plane for planks and for shooting joints, and a smoothing-plane for finishing off. In addition to these one or two small American iron planes would be found very useful.

A tool commonly known as an "old woman's tooth," or router, will also be necessary for clearing out and levelling groovings.

At least four chisels, viz. : $\frac{1}{4}$-inch, $\frac{3}{8}$-inch, $\frac{5}{8}$-inch, and $1\frac{1}{4}$-inch. One or two of the intermediate sizes and a $\frac{3}{8}$-inch mortise chisel would be very handy, but are not absolutely necessary.

A gouge or two, say $\frac{1}{2}$-inch and $\frac{3}{4}$-inch, for making conducting grooves, etc.

A hammer and mallet and a marking gauge are, of course, indispensable.

A good brace and set of at least six bits of different sizes, ranging from $\frac{3}{16}$-inch up to $1\frac{1}{4}$-inch will be needed, and an expanding bit would be an acquisition. These bits may be either American twist bits, or the ordinary nosed centre bits.

A small Archimedean drill, with three or four drill-bits of various sizes.

Three or four gimlets and bradawls of different sizes.

A screwdriver, and two or three files of different shapes and degrees of fineness.

A glue-pot holding at least a pint of glue, and two or three glue brushes of various sizes.

Two or three paint brushes, one very small and the others medium-sized sash tools.

A wood T-square, not less than 30 inches long, and a metal-bladed carpenter's square, 9 or 12 inches long.

A few screw cramps.

A soldering iron for metal work, if it is intended to do this work at home.

A pair of cutting pliers, and also a pair of round nosed pliers of small size, for wire work.

A few other special tools may be required, which will be described when dealing with the work.

Of course, it will be understood that these tools need not all be purchased before commencing the work, but only such as are needed for the operations actually in hand. The others can be acquired as the progress of the work calls for their aid. It is, however, absolutely necessary that all tools should be of good quality and always kept in thorough order, for it is impossible to work well with bad or blunt tools.

As regards skill in workmanship, if the would-be organ-builder can plane a board true, make a good joint (such as a butt joint, dovetail or mortise and tenon), and possesses a general knowledge of the use of the various tools mentioned herein, he can, with patience and perseverance, accomplish nearly all that is set out in these pages.

All wood used must be of the *best* quality, thoroughly sound, well-seasoned, and free from knots and shakes. It should be purchased and kept in a warm dry place, as long as possible before using.

The leather used in organ building is white sheepskin, specially prepared for the purpose, and *no other kind* will be suitable. It can be procured at any shop

where organ requisites are sold, and generally costs about 3*s.* or 3*s.* 6*d.* a skin. Shoemaker's white leather will be of no service whatever.

I now propose to give such instructions as will enable amateurs to build themselves a really useful instrument, that may be a source of pleasure to themselves and their friends for many years to come. In order to meet the requirements of all, and with the view of making the instructions as intelligible as possible, I shall describe a specific instrument, and add such information as may be requisite to enable the amateur to build either a smaller or a larger one, as the length of his purse may permit. But I would here urge upon all intending workers that, whatever scheme they may adopt, they should keep to, and work away at it steadily until all is completed, for many commence upon work which they have not sufficient patience to carry out, and consequently, they never have anything to show for the time and money which they have expended.

Amateurs should also consider the time and means at their disposal, before deciding on the work, and will do well to remember that a very small organ, if built in spare time, after ordinary working hours, may require months, or even years of patient application before the work can be completed. The greatest pains should be taken in the construction of every part, and all should be done as though one's life depended on the result.

The specification for the instrument to be described is as follows:—

1. Open Diapason to Tenor C	44	pipes.	8	feet tone.
2. Stopt Diapason, Bass ...	12	„	8	„
3. Stopt Diapason, Treble ...	44	,	8	„
4. Flute (for Principal) ...	56	„	4	„

5. Keraulophon (small scale, to Tenor C)	44 pipes.	8 feet tone.
6. Flageolet (for Fifteenth) ...	56 „	2 „
7. Bourdon (pedals)	25 „	16 „
Total	281 pipes.	

Couplers: octave; great to pedal.

The whole may be enclosed in a general swell. Size about 6 feet 6 inches wide, 9 feet high, and 3 feet deep.

There will be room for another stop of twelve pipes in the bass, which may be utilised at any time by the insertion of a stop of the violoncello type.

If the Bourdon were omitted it would reduce the size of the instrument considerably, or a nice little instrument could be made by having the first four or five stops only.

For a small two-manual instrument, the following would be a good specification:—

Great organ—				
1. Open Diapason to Tenor C.	44 pipes.	8 feet tone.
2. Stopt Diapason, Bass ...	12 „	8 „
3. Principal (flute)	56 „	4 „
4. Flageolet	56 „	2 „
Swell organ—				
5. Lieblich Gedacht	56 „	8 „
6. Keraulophon to Tenor C ...	44 „	8 „
Pedal organ—				
7. Bourdon	25 „	16 „
Total	293 pipes.	

Couplers: swell to great unison; swell to great octave; great to pedal.

Same size as No. 1, but 6 inches deeper.

A smaller two-manual might comprise the following stops :—

Great organ—			
1. Open Diapason	44 pipes.	8 feet tone.	
2. Stopt Diapason, Bass ...	12 „	8	„
Swell organ—			
3. Lieblich Gedacht	44 „	8	„
4. Flute (or Principal, small scale)	44 „	8	„
Total	144 pipes.		

Couplers: swell to great unison; swell to great octave; octave on great.

The pedal-Bourdon may, or may not, be added, according to the will of the amateur. If it is, a coupler, great to pedals, would be needed.

NOTE.—If octave couplers are attached to any of these organs, they will be made much more efficient by carrying each stop on which they act an octave higher in the treble, so that *every* note in the compass of the key-board will be connected with one an octave higher when the octave coupler is in action.

The intending organ-builder has thus several schemes to choose from; and, as the dimensions of the sound-board and all other portions will be fully set out in the succeeding articles, he will be enabled to find all the dimensions he will require. The scales for the pipes will be the same for each organ.

It will be noticed that in neither of the above specifications have I mentioned the materials of which the pipes are to be made, and my reason for not doing so is, that I have worked out a new method of making them, and now propose to give the amateur the benefit of my experience. Many who would much like to

build an organ are deterred from doing so by the great outlay necessary to purchase the pipes, or the materials for making them; but it is now open to anyone, by following my instructions, to make the whole of the pipes required for Scheme 1, for a very much smaller sum than would be required to purchase the open Diapason alone. That stop, in metal, would cost about £5 to purchase, a wood stopt Diapason, £8 15s.; a Bourdon, about £11 or £12; Principal, metal, £5 10s.; Keraulophon, £6; Flageolet, £3 10s.;—thus running up to something like £40 for the pipes alone. The cost of the materials for making these pipes would also be something considerable, whilst for pipes made on my system, about 10s. for each stop will cover the cost, and leave a margin. The Flageolet will cost less than 5s.

Many of my readers will no doubt smile incredulously when I state that the pipes are simply made of paper; but I can only assure them that they answer thoroughly, and I have spent years in making various experiments for perfecting them. The idea, I believe, is not a new one, but I am not aware that it has ever before been practically worked out; and, indeed, it was the ridicule cast on the plan by would-be scientists that induced me to persevere with it until I succeeded. All pipes up to 2 feet long may be made of cartridge paper, but for longer pipes stout brown paper is the best.

The advantages I claim for my system are, that it is very cheap, far cheaper, in fact, than any system ordinarily followed, as the prices above quoted will show; that the pipes are exceedingly light, a 4-foot stopt Diapason weighing about twenty ounces, or an open pipe the same size fourteen ounces, which will contrast very favourably with the weight of metal or

wood in a similar pipe. They are easy to make, an amateur being more likely to succeed with these than with ordinary pipes, as they require but little skill, and no expensive tools; and having, practically, no join throughout their length, there is no long glue joint, as in wood, or soldered joint, as in metal pipes, and, consequently, no risk of leakage. They take up only the same room as metal pipes, though they are much stronger, and cannot so easily be damaged by rough knocks, and any form of pipe can be made; and last, but not least, you can try your pipes before completing them, and will thus be sure that they will answer.

Before starting on the pipes, set out the scale for them in the following manner:—on a nicely-planed board draw a line 4 feet 6 inches long, and at right angles to the top of this line draw another, $2\frac{5}{8}$ inches long, and join the end of the short line to the bottom of the long one by a sloping line; 2 feet below the top line draw another thick line across from the long line to the sloping one, 1 foot below that draw another, 6 inches below that draw another cross line, and others at 3 inches, $1\frac{1}{2}$ inch, and $\frac{3}{4}$ inch, one below the other. Mark a c against each of these cross lines, and 6 inches from the bottom set off a thick line and mark it with the word "mouth." Now divide the spaces between each c into twelve equal parts; the top one will thus be divided into twelve spaces of 2 inches each, the next one into spaces of 1 inch, the next into spaces of $\frac{1}{2}$ inch each, and so on, each set being exactly half the size of the preceding one. Against each of these lines write the names of the notes in the same order as I have shown them in Fig. 1, but I have not been able to show them all through as the scale is too small to admit of it. To find the size of any pipe, you measure from the line

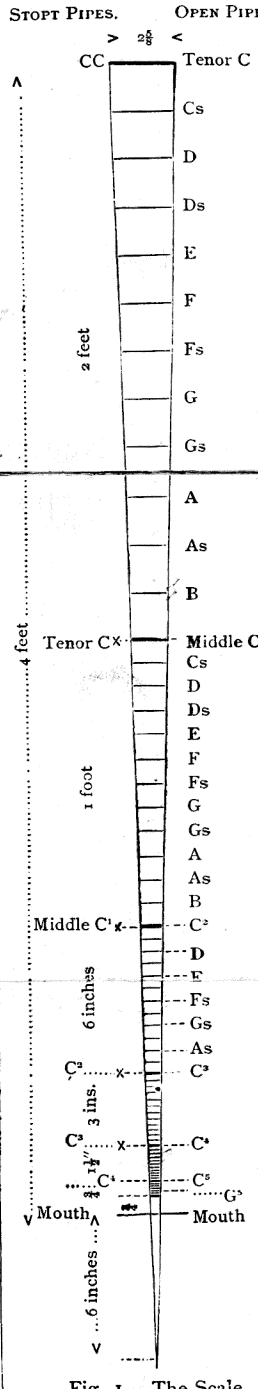


Fig. 1.—The Scale. $\frac{1}{8}$th full size.

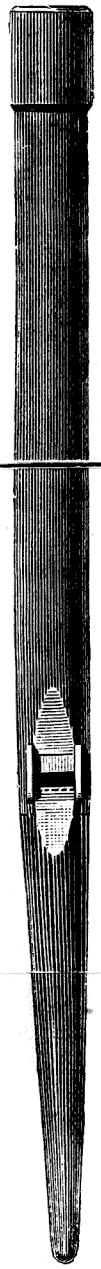


Fig. 2.—Sketch of Finished Pipe. Drawn to Half Full Size.

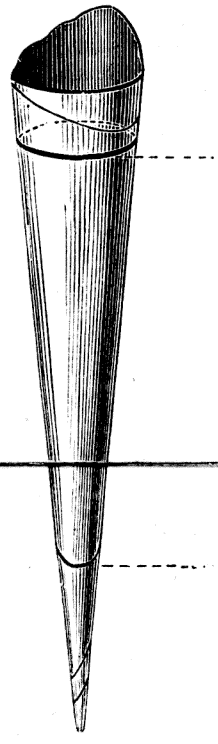


Fig. 3.—The Cone in the Rough, showing where it is to be Trimmed Down.

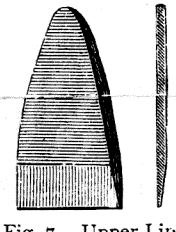


Fig. 7.—Upper Lip. Full Size.

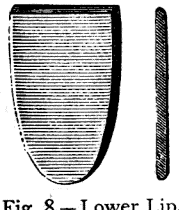


Fig. 8.—Lower Lip. Full Size.



Fig. 4.—The Languid. Full Size.

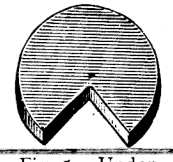


Fig. 5.—Under Languid. Full Size.

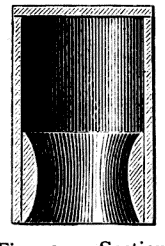


Fig. 9. — Section of Cap of Stopt Pipe.

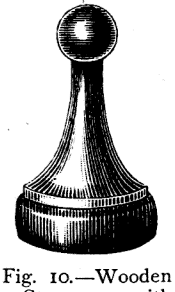


Fig. 10.—Wooden Stopper with Leather round the Lower Edge.

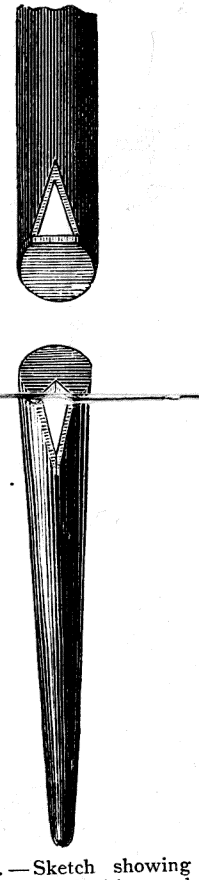


Fig. 6.—Sketch showing Languids in Position, and Holes cut ready for Lips to be put on.

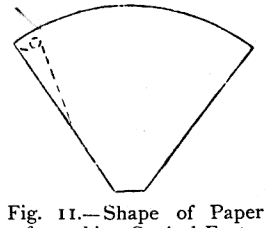


Fig. 11.—Shape of Paper for making Conical Foot.

Folding Plate No. 2, containing Figs. 1—11, to face page 17.

marked "mouth" up to the cross line against which is the name of the required note; this gives you the speaking length of the pipe, and the length of the cross line is the interior diameter of it, and so you will proceed to find the size of any pipe you may require up to 4 feet long.

Before proceeding farther, it may be as well that I should state that an open pipe 8 feet long, which sounds the note CC, is termed an "*8-feet tone*" pipe; and the same term is applied to the whole stop, notwithstanding the fact that the stop may not extend down to CC on the instrument. Thus both the open diapason and the keraulophon are 8-feet stops, although they cease at tenor C; but if carried down to CC, the lowest note would require an open pipe 8 feet long. Closed, or stopt pipes, sound an octave lower than open ones; so the stopt diapason, sounding CC with its pipe *only 4 feet long*, is still termed an *8-feet tone stop.*

Four-feet tone stops, such as the principal, flutes, etc., sound an octave above the unison, or 8-feet toned stops, and their longest pipes on the manual sound-board are only 4 feet long, unless they are what are termed *harmonic* stops, in which case, though the pipes give only the 4-feet tone, they require to be made as long as an ordinary pipe sounding the 8-feet tone.

Two-feet tone stops sound two octaves, or a *fifteenth*, above the unison stops.

Sixteen-feet tone stops, which appear on the pedal organ only, unless in a large instrument, sound an octave below the unison, and *32-feet tone* stops sound two octaves below the unison; but these latter stops are only found in instruments of the very largest size.

It will be noticed on setting out the scale, that each octave of pipes is, roughly speaking, double the length

of the succeeding octave. Thus all the pipes from CC to B, are double the length of those from tenor C to the B above. It will also be observed, that in the 4-feet octave, each pipe is 2 inches shorter than the preceding note, in the 2-feet octave, each pipe is 1 inch shorter than the one preceding it, and so on up to the smallest pipe.

It will be best for the amateur to make a small pipe or two, for experiment, before he starts on the set for the organ. A convenient size to commence with will be the G^2 in the treble of the open diapason. This pipe, as you will find from the scale, is $8\frac{1}{2}$ inches speaking length, and about $\frac{11}{16}$ inch diameter. You will require a mandrel to form it upon, and my method of making this is cheap and simple, viz., take a sheet of stout, smooth paper, 12 inches wide, and roll it up tightly until it is $\frac{11}{16}$ inch diameter (the size required for our pipe), taking care that you roll it straight, and have the ends square, or your pipe will not be a true cylinder, but slightly conical. When you have rolled it to the right size, glue the edge down smoothly, and let it dry, which will only take a few minutes. If you have used a sufficient length of paper, you will now have a perfectly round straight firm mandrel to work on. I may say that an ordinary round lead pencil will answer very well for starting the rolling up of the paper. Now cut a piece of nice smooth cartridge paper 9 inches wide, and long enough to go four times round the mandrel, which will take about 9 inches. Cut the sides of the paper perfectly square, and then roll it once round the mandrel and mark that distance by a pencil line, take it off the mandrel, and then with a brush full of hot, thin glue, go over all the rest of the paper up to the pencil line; *allow the glue a minute or so to*

soak in and the paper to stretch, and then carefully roll it round the mandrel, rubbing it well down with the fingers, or with a small round stick (the lead pencil will do very well) as you roll it up. When it is all rolled up, roll it between your hands on the table, like a cook rolling out dough, and rub the joint well down, and also rub the pipe all over with the round stick. Slip it off the mandrel (there being no glue on the first turn it cannot stick to it), and stand it up on end to dry, and it will be a tube 9 inches long, $\frac{11}{16}$ inch internal diameter, perfectly straight and smooth inside and out. All this can be done in less time than it takes me to write the directions.

While the tube is drying, you may make the conical portion for the foot, this being formed of a piece of paper shaped as in Fig. 11, about 9 inches wide and 8 inches deep. Commence rolling it from the top corner as shown by the dotted lines in the sketch, and when rolled up it will assume a conical shape of any diameter you may like to make it. Unroll it, give it a coat of thin glue, and *when it has had time to stretch,* roll it up again, rubbing it well down, inside and out, with a pointed stick to make each layer adhere thoroughly. When this is completed you will have a conical tube like Fig. 3, running almost to a point at one end, and irregular at the top. The outside join should be a straight line right down the cone, not winding round it; the paper can be cut so as to ensure this just before you finish rolling it up. When this is dry, both the tube and the cone must be painted or varnished inside. Though it may seem rather a difficult job to paint the inside of so small a tube, it is, however, quickly and easily accomplished by tying a piece of sponge on to the end of a thin cane or wire, so that it forms a kind

of mop that will just go into the pipe; dip this in the paint and work it up and down the inside of the pipe two or three times, and the job is done in less than a tenth of the time it would take with a brush, and securing a much smoother coat of paint. The cone may be painted with a smaller mop, or a fine brush.

The paint must be allowed to get thoroughly dry and then you may trim off the top and bottom of the pipe with a pair of small pointed scissors, and trim off the top of the cone in the same way till it is exactly the same diameter as the tube, then rub the ends of the pipe and the top of the cone perfectly level on a piece of glass-paper stretched over a block of wood covered with cork. Cut out a flat piece of mahogany or cedar $\frac{1}{10}$ inch thick to the shape shown in Fig. 4, the straight part being two-ninths of the circumference; the top and bottom edge of this straight part should be slightly rounded off with fine glass-paper. This circular piece, which is called the languid, should just fit the bottom of the tube on which you may now lay it, and mark where the ends of the straight part come, then cut a three-cornered piece of that width, and about 1 inch long out of the tube immediately over it, as shown in Fig. 6. A similar piece must now be cut out of the front of the cone, but the gap must be slightly narrower, so that, when it is placed against the end of the tube, the front of the cone will project slightly beyond it, to allow for the windway. A piece of thin mahogany, or cedar, shaped as in Fig. 5, is cut to fit on the top of the cone. Lay the tube on a piece of glass-paper so that the part where the piece is cut out lays flat on the paper, and rub it down level, and proceed in the same way with the cone. Cut out two pieces of wood like Figs. 7 and 8; the first piece is chamfered on the

front to form the upper lip, and the other is just rounded off at the top edges to form the lower lip. Glue the languid on to the bottom of the tube, and the under languid on to the top of the cone; when dry you may bind on the upper and lower lips in their proper position with a piece of narrow tape. The height of the mouth is about a quarter of the diameter of the opening.

You may now place the cone and the pipe together in their proper position, leaving a narrow windway between the straight edge of the languid and the lower lip; hold it in that position and blow gently through the pointed end of the cone, and you will be rewarded by a musical note. If the note is not quite satisfactory, the upper lip may want shifting a little higher or lower, or the lower lip may require a little shifting. The top of the lower lip should be level with the top of the languid, or but very slightly below it. The windway should be about wide enough for a piece of thin playing card to pass. On the front edge of the languid, fine nicks should be made in a slanting direction with a fine penknife: about twenty to the inch for this pipe—this is the voicing, full directions in regard to which will be found in the chapter on voicing and tuning. Mark on the pipe the height of the mouth, then take off the lips, glue them and bind them in their places with tape. Even in the matter of binding on, there is a right and a wrong way; the proper way being to bind with both ends of the tape, so that it crosses down the centre of the lip, you will then get the edges of the lip parallel with the edge of the languid. This is a point to be gained, as, if it is not parallel, the note will be faulty, either squeaking or chiffing, as it is termed, before it speaks the proper note. If it is satisfactory you may

now glue the foot on to the tube and stand it up, and when dry, rub down the sides of the lips and round the joint of the languids with glass-paper to make it look neat. Cut a piece of glazed dress-lining as in Fig. 17 (the marks show where it is to be cut to make it lay even on the cone), and glue it round the joint of the pipe, to strengthen it. There may be a little piece of the pipe projecting on each side of the mouth, which should be taken off with a sharp penknife. This is the smallest pipe that will require ears, which are simply pieces of veneer shaped as at A, in Figs. 13, 14 and 15, and glued on to the pipe against the edges of the lips, so that no wind may be lost. They will want chamfering on the edge where they are glued to the pipe, to make them fit on; this may be done with glass-paper.

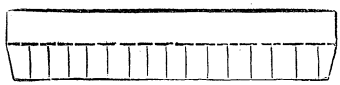


Fig. 12.—The Linen Band.

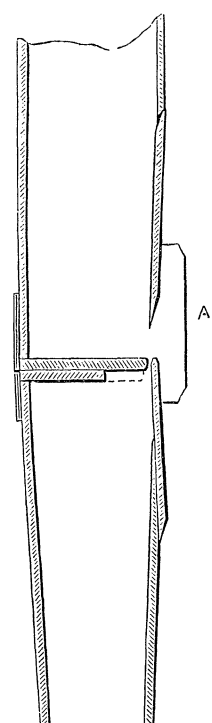


Fig. 13.—Section of Pipe (full size).

Cut off the bottom of the foot to the size required, about 6 inches will be long enough, and chamfer it off at the bottom about $\frac{1}{4}$ of an inch with a sharp knife. This chamfer has now to be coned in, just the same as metal pipes are, a metal cone being used for them; but the

amateur need not lay out *7s. 6d.* in buying a metal cone, as a common china egg-cup, costing a penny, will answer the purpose equally as well. The under part of the foot will do to cone small pipes, and the cup

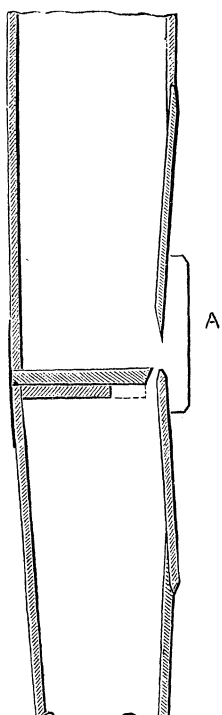


Fig. 14.—Section of Pipe with inverted mouth.

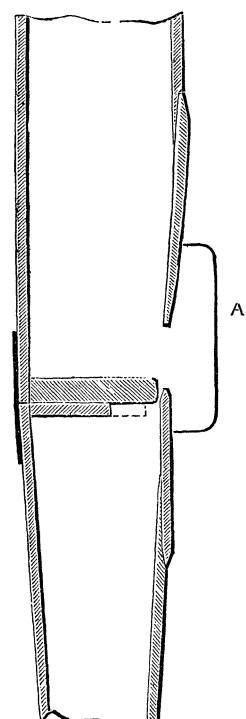


Fig. 15.—Section of Stopt Diapason shown in Fig. 16.

itself will be used for large ones. You have merely to wet the chamfered part with your lips, place the foot of the egg-cup on it, and work it gently round with your hands till it is coned in sufficiently. The hole should

come in the centre of the coning, and is about $\frac{1}{10}$ of an inch in diameter for this pipe; it may be made quite round by inserting the point of a lead pencil with a slight screwing motion. When dry, the coning is quite hard, but the hole can be enlarged with the pencil, or closed with the coning cup, as may be required, to admit the proper amount of wind. Trim down the top of the pipe with the scissors until it speaks rather too sharp a note; then make a short piece of tube about 1 inch long that will just fit on the pipe, and slide easily up and down. This is the tuning piece; raising it will flatten, and lowering it will sharpen the tone. The appearance of the pipe will be improved if you chamfer off the top edge, and also the top and bottom edges of the tuning cap. Give the pipe and slider two or three coats of oil paint to preserve it, and it will now be finished. The experience gained in making this pipe will be very useful, and you will very soon acquire the method of manipulation, so that you can go to work with certainty. Making a single pipe takes some time, as you have to wait about for the parts to dry, but when you commence on the sets of pipes required for the organ, you will find that no time need be lost.

The first thing you will require to make will be several mandrels, say one for every fourth pipe; make them considerably longer than the pipe to be formed on them, for one mandrel may be used for more than one pipe. It is a maxim in organ building, that each stop should be of a different scale, but it will only be necessary to make one scale for these pipes, except the bourdon and the lowest octave of the stopt diapason.

The scale as it stands is for the open diapason, the stopt diapason treble will be one scale larger, that is

the C of that stop will be made on the B mandrel of the open pipe, and so on. The flute, or principal, will be one scale smaller than the open diapason, the flageolet may be two scales smaller, while the keraulophon will be six scales smaller; thus we may proceed with the tubes for all the pipes simultaneously. Having cut the sheets of paper to the necessary size, *allowing sufficient length in each pipe to cut off the tuning-pieces* —as the piece cut off one pipe will fit on to a smaller one and thus save having to make separate pieces— mark the distance of one turn round the mandrel by a pencil line on all of them, and mark them also with the name of the note of the pipe they are intended for. Suppose you start on 6 inch C, open diapason, you glue that sheet and lay it aside, glue another sheet for $6\frac{1}{2}$ inch B for the flute, and another for $5\frac{3}{4}$ inch Cs. stopt diapason. Now take up your first sheet and roll it round the mandrel, proceeding in the same way as with the experimental pipe; when finished draw it off and stand it up to dry, roll up the second sheet, and slip that off, then proceed with the third. The reason for doing three sheets at a time is that it allows just sufficient time for the paper to stretch and the glue to get right for rolling up. You then glue three more sheets, viz., 7 inch As. flageolet, the 9 inch Fs. of the keraulophon, and one of the sheets for another mandrel, thus you can keep on making these tubes at the rate of twenty or thirty an hour when you get used to it, and have all the stops in hand simultaneously. Mark each pipe in ink with the name of the note and the stop it belongs to, so that you may be able to keep each stop separate. When you have made all the pipes you require on one mandrel, roll more paper round it and glue the edge down, to bring it up to the proper size of

the next pipe, and so proceed till you have made all the tubes. Use cartridge paper for all pipes up to 2 feet long, using stouter paper for the larger ones, or else have five thicknesses instead of four. All pipes above 2 feet long should be made of stout brown paper, of which an excellent sort for our purpose is sold for laying under carpets; it runs 4 feet 6 inches and sometimes 5 feet wide, and is continuous; the price at small shops is 3*s.* per dozen yards, but at large, or wholesale shops, it may be purchased much cheaper. The 4-feet pipes should have five or six thicknesses, and the larger bourdons seven or eight thicknesses. It will be more convenient if you make the large bourdons in two lengths, and then join them in the centre, covering the joint with a band of linen or thin American cloth, to strengthen it, or preferably gluing an extra thickness or two of paper over the whole length of the pipe. The bourdon CCC is 8 feet long and $5\frac{3}{4}$ inches diameter, the smallest is 2 feet long and $1\frac{7}{8}$ inch diameter. The stopt diapason CC is to be $3\frac{1}{4}$ inch diameter, and tenor C $1\frac{3}{4}$ inch diameter. I apprehend that no difficulty will be experienced in setting out the scales for these similar to the scale previously made.

Having completed the tubes we may now proceed with the cones for the feet, and may use up the paper in the tube mandrels for that purpose. No mandrel will be required for the cones for pipes less than 1 inch diameter, as you can roll the paper up without being particular as to the size, for they are sure to fit some pipe, and can be cut off at either end to the requisite size. Six inches is long enough for all pipes up to 18 inches long, but for pipes above that length they should gradually increase till they are about 12 inches

long for a 4-foot pipe. The length of foot makes no difference in the tone, so it is a mere matter of convenience and appearance. For the cones of the larger pipes you had better make two or three mandrels about 15 inches long and of different diameters. Make them in the same way as the cones, only very much stouter. The cones should be stouter than the pipes as they have to bear all the weight, and are exposed to a good deal of wear. Having completed the cones you may next proceed to paint the inside of both them and the tubes, starting with the largest, as you can trim your sponge mop smaller so as to suit the smaller pipes. While the paint is drying you can prepare the other parts. The stoppers for the stopt diapason and bourdon pipes may be made of wood shaped as in Fig. 10, covered with leather round the lower edge, so as to fit tightly inside the pipe. I prefer to make a different style of covering or stopper as follows:—Make a short length of tube the same as for the sliding piece for tuning the open pipes, glue a piece of stout card on the top of this, thus forming a box or lid. Glue a strip of soft leather round the inside, having previously pared down the edges of the leather; this cap is to fit tightly on the outside of the pipe like a lid. The leather should be rubbed with a mixture of tallow and black lead to make it slip easily, for it should not fit too tightly to be moved, as the pipe is tuned by moving it up or down. This cap is much lighter than the wood stopper, easier to make, and there is no danger of it slipping down, as stoppers sometimes do when there is a sudden change in temperature. The caps should fit loosely on the pipes at first so as to allow for three coats of paint on the pipe, when they should fit perfectly air-tight. As it is best to put the stopt pipes together with caps on,

they may be temporarily fitted by wrapping two or three thicknesses of paper round the pipe.

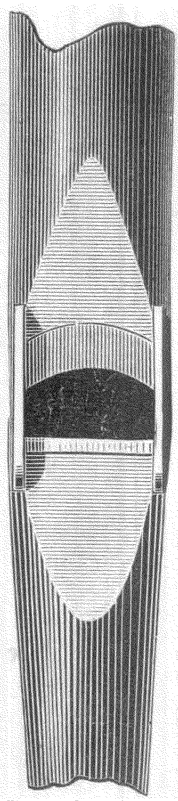


Fig. 16. — Front view of Stopt Diapason, showing Arched Upper Lip.

The caps of the stopt diapason should be 6 inches long for CC, and $\frac{1}{2}$ inch long for the smallest G. The tuning caps of the keraulophon are not closed at the top, they should be 6 inches long for tenor C, and $1\frac{1}{2}$ inches long for the smallest G. In the centre of the side of the cap, a distance of one diameter from the top, there is a round hole $\frac{3}{8}$ inch in diameter for tenor C pipe, and about $\frac{1}{16}$ inch for top G. The best way to make this hole is by a taper bit of such size that when it is bored through the cap so that the point just touches the further side of it, the hole in tenor C is $\frac{3}{8}$ inch in diameter, and as each cap gets smaller, the pushing the bit through so that it touches the further side, will cause the hole to diminish regularly. A sharp pointed stick will do instead of a bit, as the burr could be cleared off with a hot wire. The small scale high mouth, and the hole in the sliding cap of the keraulophon cause it to give a rich, though quiet, stringy tone, which is very useful in solo passages.

The flute and flageolet pipes are made with the upper lip turned so that the chamfer comes on the inside of the pipe, and the languid is sloped down-

wards on the front edge, as shown in Fig. 14. This causes it to give a soft quiet tone. The flute should be softer in tone than the diapason, and the flageolet should be softer than the flute. The stopt diapason is made with a high mouth, and the upper lip is cut slightly circular, the lower lip may be a little below the top edge of the languid.

The approximate lengths of the pipes from the mouth up to the top, and the sizes of the mouths for the several stops are as follows :—

	Width of Mouth.	Height of Mouth.	Approximate Length of Longest Pipe.	Length of Shortest Pipe.
Bourdon.....	One-fourth of the circumference	One-third of its width	8 ft.	2 ft.
Stopt Diapason...	One-fourth	One-third	4 ft.	$2\frac{1}{8}$ in.
Open Diapason...	Two-ninths	One-fourth	4 ft.	$4\frac{1}{4}$ in.
Keraulophon.....	One-fifth	One-third	4 ft.	$4\frac{1}{4}$ in.
Flute	One-fifth	One-fifth	4 ft.	$2\frac{1}{8}$ in.
Flageolet	One-fifth	One-sixth	2 ft.	$1\frac{1}{16}$ in.

The sizes of the holes at the bottom of the coned feet are about as given hereunder, but the pressure of wind and the voicing affect the sizes considerably, and they may have to be a little larger or a little smaller according to circumstances.

	CCC.	CC.	Tenor C.	Middle C.	Top G.
Bourdon..... ..	$\frac{7}{8}$ in.	$\frac{5}{8}$ in.	$\frac{3}{8}$ in.	...	...
Stopt Diapason	...	$\frac{5}{8}$ in.	$\frac{3}{8}$ in.	$\frac{1}{4}$ in.	$\frac{1}{8}$ in.
Open Diapason	...	$\frac{1}{2}$ in.	$\frac{3}{8}$ in.	$\frac{1}{4}$ in.	$\frac{1}{8}$ in.
Flute	...	$\frac{3}{8}$ in.	$\frac{5}{16}$ in.	$\frac{3}{16}$ in.	$\frac{1}{8}$ in.
Keraulophon..... ..	...	$\frac{3}{8}$ in.	$\frac{5}{16}$ in.	$\frac{3}{16}$ in.	$\frac{1}{8}$ in.
Flageolet	...	$\frac{5}{16}$ in.	$\frac{1}{4}$ in.	$\frac{1}{8}$ in.	$\frac{1}{16}$ in.

The Lieblich Gedact is simply a stopt diapason of the same scale as the principal, but with a straight upper lip, and the lower lip slightly below the upper

edge of the languid. The languid increases in thickness with the size of the pipe, that of a 4-foot pipe should be $\frac{1}{4}$ inch thick. The same remark applies to the lips, which should increase in size and thickness with the size of the pipe. The upper lip of the CC stopt diapason should be nearly $\frac{1}{8}$ inch thick at the thinnest edge. The lips can be expeditiously cut out of a piece of thin wood, by marking it out as shown in Fig. 17, and cutting through the marks with a tenon saw. The very best wood you can use for the languids and lips (except the smallest, which are simply veneer) is cigar-box wood. Cigar boxes can be purchased for twopence or threepence at most tobacconists or public-houses, and many shopkeepers will give them away to their customers. The languids of the larger pipes may be fitted into the ends of the tubes instead of being simply glued on to them.

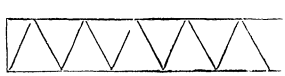


Fig. 17.—Method of Cutting out the Lips.

Having prepared a quantity of languids, lips, etc., glue them on, having previously cut out the portion of the tube and cone where lips come.

About a dozen pipes will be found a good number to have in hand at one time for putting together.

The windway for the largest bourdon is nearly $\frac{1}{8}$ inch wide, for a CC stopt pipe $\frac{1}{16}$ inch wide, and gradually smaller for each succeeding pipe. Stopt pipes require a larger windway than open ones, as the mouths are cut higher and the upper lips are much thicker. The voicing nicks are nearly $\frac{1}{8}$ inch apart in a 4-foot pipe, but get closer and smaller as the pipe diminishes in size, until in the smallest pipes they are scarcely perceptible scratches very close together. They may be made with a very fine tuning file, or a

small penknife. For a loud tone, the nicks should be few and deep, for a soft, sweet tone, they must be very fine and close together, the burrs being taken off by a slight touch with a piece of fine glass-paper. The upper chamfer should not be nicked. Wherever the wind passes there should be no sharp edges or it will cause a hissing noise, therefore, the top and bottom edges of the languid, the edges of the lower lip, and the front edge of the upper lip should be slightly rounded off, but the inner edge of the top lip should be left square.

If it should happen that when a pipe is finished the windway is too narrow, it may generally be set right by passing the thin blade of a penknife flat down between the lip and the edge of the languid, but if this is not sufficient, cut a slip of fine glass-paper and insert that, moving it gently up and down, so as to take a very little off either the edge of the languid or the inner edge of the lip, whichever may be required, and then carefully touch up the voicing. For cutting the lips a little higher, and touching up the pipes generally, you will find the following tool very handy, and should make five or six of different sizes:—a thin slip of wood, or veneer, say 1 inch wide at one end, and ½ inch wide at the other, covered on one side with very fine glass-paper and on the other with some a little coarser. You will thus have four files in one. Another handy little appliance is shown at Fig. 18; it

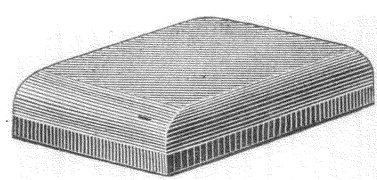


Fig. 18.—Block covered with Cork for using with Glass Paper.

is a block of wood, 5 or 6 inches long, 3 inches wide, and 1½ inches thick, covered on the bottom with a flat piece of cork. A piece of glass-paper can be stretched over this, and grasped in the hand, and may then be used to smooth off the ends of the pipes, the edges of the lips, and any small chamfering. You will have this block in requisition at all stages of the work.

The pipes, caps, and tuning pieces, should have three coats of oil colour, a little varnish being mixed with the last coat, and it will be found a good plan to paint each stop a different colour, as any stop can then be picked out at once.

Write the name of the note, and the stop, on the back of each pipe, using ordinary ink and a Waverley or Pickwick pen, as the points will not scratch the paint. Breathe on the place and pass the finger over it, the ink will then flow as nicely as on writing paper.

The painting or varnishing of the pipes preserves them from the damp, and improves both their tone and appearance.

The following points should be strictly adhered to, viz., all pipes above 12 inches long should be allowed to dry on the mandrel, or they may be apt to cast a little, which will not improve their appearance; the foot to be perfectly straight with the pipe, the lips to be quite parallel with the edge of the languid and with each other, the nicks for the voicing to be even and regular, and the caps of the stopt pipes to fit perfectly air-tight.

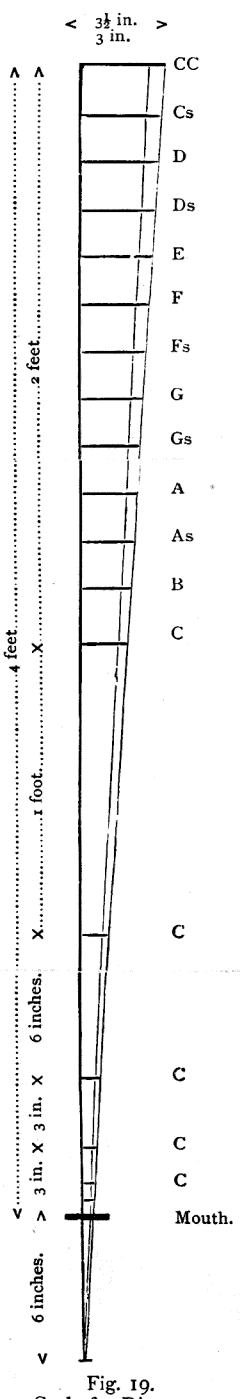


Fig. 19.
Scale for Diapason.
⅛th full size.

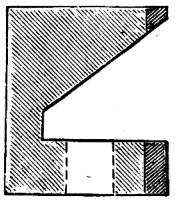


Fig. 20.—Block for Stopt. Diapason. Side View.

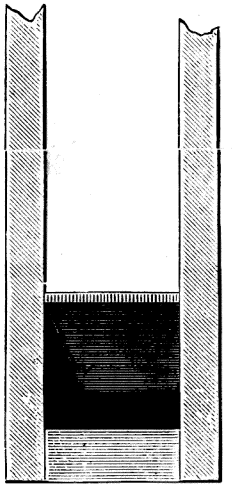


Fig. 21.—Block glued between the Sides. Front View.

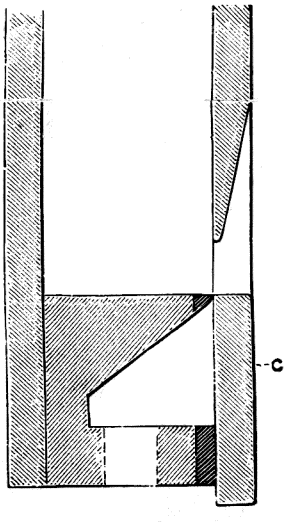


Fig. 22.—Side View of lower part of Stopt Diapason.

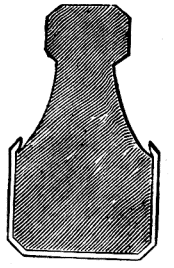


Fig. 23.—The Stopper, or Tompion.

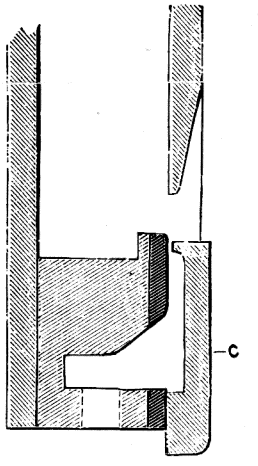


Fig. 26.—Section of lower part of Lieblich Gedacht.

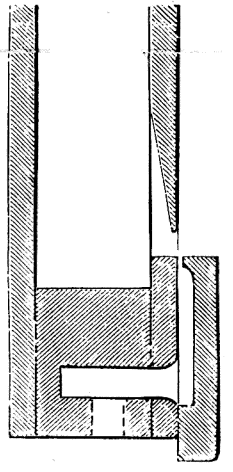


Fig. 28.—Section of lower part of Flute.

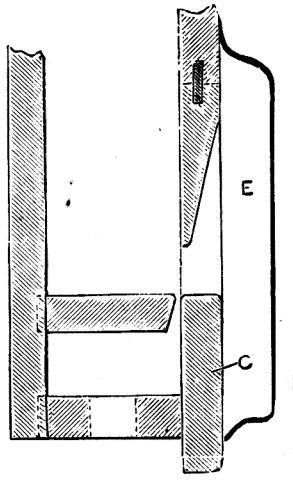


Fig. 25.—Section of lower part of Bourdon Pipe.

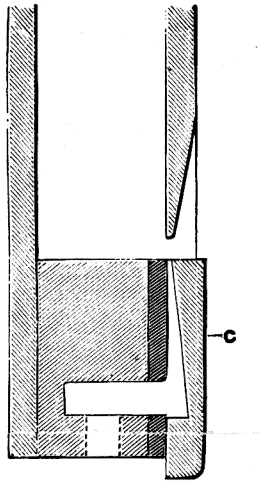


Fig 27.—Section of lower part of Open Diapason.

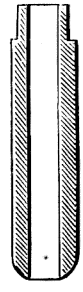


Fig. 24.—Section of Pipe Foot.

CHAPTER II.

WOOD PIPES.



NOW proceed to describe the process for making wood pipes—so that the amateur may be able to place them in his organ for use either by themselves or in conjunction with the paper pipes described in the previous chapter. I would remark, however, that every variety of tone required may be obtained from the paper pipes, whilst the wood pipes afford but a limited range of tone. The Keraulophon stop, for instance, cannot well be made of wood, but is very successful in paper.

As with the other pipes, we shall, of course, require a scale to work from, only it will be necessary to set out a fresh one for each stop. Draw the line on a board 4 feet 6 inches long, and divide it out exactly as described in the last chapter, but as wood pipes are not round but oblong in plan, two diameters are required for each pipe, instead of only one as in round pipes. The size of the largest stopt diapason is $3\frac{1}{2}$ inches deep by $2\frac{5}{8}$ inches wide, so you set off those distances on the topmost cross-line, and draw the sloping lines from them down to the point 6 inches below the mouth, as shown in the sketch, Fig. 19. By measuring in just the same way as before described, you will be able to obtain the length, width, and depth of each pipe. I

have only shown the largest octave on the sketch, as I think you will have no difficulty now in making a scale for any sized stop you may wish for.

The six largest pipes of the stopt diapason will be made of $\frac{3}{4}$ inch pine, and the others will be graduated in thickness till the smallest is only $\frac{3}{16}$ inch thick. You need only take the roughness off the side of the wood which is to form the outside of the pipe, for it is best to plane them up when you have put them all together, as you can make them look nice, and also graduate the thickness of the wood in regular proportion to the size of the pipe. Let all the wood be of the best quality and free from knots or shakes, as knots are almost sure to loosen some time or other and thus spoil your work, perhaps when you are least able to remedy it. Keep your wood by you as long as possible before using it, so as to ensure its being thoroughly well seasoned. First prepare some wood for the blocks of your pipes, by planing up some lengths of pine about 2 feet long, and gluing a piece of $\frac{3}{8}$ inch mahogany on one side of them. The scantlings of these pieces will be indicated by the diameters of the pipes for which they are to form the blocks. Plane the first piece down to the size required for the largest pipe, viz., $3\frac{1}{2}$ inches by $2\frac{5}{8}$ inches, the mahogany facing being on one of the narrow sides, and cut off a piece 4 inches long; dress the remainder down to the size of the next pipe, but do not touch the mahogany side again, and cut off 4 inches for that one; dress the remainder down for the next sized block, and cut that off, and so keep on till you have cut off all your blocks. The first twelve will be 4 inches long, the next twelve 3 inches, the next $2\frac{1}{2}$ inches, the rest about 2 inches, and these proportions may be used for all the pipes in each stop, as the length

of the block is not a very material point provided it is long enough. Now shape the block as shown in Fig. 20, by cutting a gap with a tenon saw through the mahogany facing into the block, keeping the same proportions for each block, and using a chisel to take out the piece. The sloping part should be cut up to within about $\frac{1}{4}$ inch of the top edge, but be extremely careful not to damage the edge. The opening shown in the bottom is a round hole, which will be bored after the pipe is put together, and the foot will be inserted in it. When you have got a dozen or so of these blocks ready, get out the wood for the sides of the pipes, remembering that the sides are the deepest measurement of the block, and also that the sides and backs must be long enough to come down to the bottom of the block as the scale length does not include this. After planing them true give them all a coat of very thin hot glue on the inside, to stop all the pores, and, when dry, glue the block in between them as shown in Fig. 21. It will be well to preserve the pieces you cut out of the blocks, and glue them between the sides at the top of the pipe, and you will thus have them quite parallel. The pieces glued at the top will be cut out when trimming down. If you cannot get these pieces out of the blocks without breaking them up, you must cut a slip the same width and use that when gluing up the pipes. While this is drying prepare the backs, treating them with thin glue the same as the sides, and then glue them on to the sides. It will be well to allow both the backs and fronts to lap over about $\frac{1}{8}$ inch on each side, so that the dents made when you bind the pipes up with strong tape or string to secure the glue joints may be no detriment, as they can be planed off afterwards.

Now prepare the fronts—which only extend down to

the top of the block—and cut the chamfer for the upper lip, and the opening for the mouth, as shown in Fig. 33. It is a very good rule to cut the chamfer as high as it is wide, but the lips had better not be cut too high nor too thin at first, as the height of the mouth will have to be regulated when you are engaged in voicing and tuning, instructions for which will be given in a subsequent chapter. All dimensions for the heights of the mouths, the widths of the windways, the holes in the blocks and feet—in fact, every size except the diameters of the pipes, will be the same for the respective stops as those given in the last chapter for the paper pipes, so there will be no need for me to recapitulate them here. The sizes given for the holes in the feet of the smaller pipes in page 29 must be considered as only approximately correct, as they may require to be coned in much smaller in some instances. In the wood pipes it is especially necessary that the hole should be large enough to allow plenty of wind to pass. If it should be too large, a small wood plug is inserted at the bottom to stop off a little of the wind, but it would be awkward to remedy if the hole was too small, as it would entail the enlargement of it right through the length of the foot. You will find the small American planes, which are made of iron, very useful for smoothing the chamfers, etc.

Before gluing on the fronts or backs be sure that they will lay perfectly flat on the edges of the sides, and in order to secure this it is best to shoot the edges with the plane after the blocks are glued in. The front and back surfaces of the blocks should *coincide* with the lines of the front and back edges of the sides. Glue on the fronts, and bind them up tightly with stout tape or string, and then leave them to dry while you

prepare the caps. These caps are the pieces of wood which cover the gaps in the front of the blocks. All the caps should be made of mahogany, those for the stopt diapason being simply flat pieces the same thickness as the fronts of the pipes. The windway in the block (on the top front edge) should be made with a flat file; do not make it too deep, but leave the final touching up for the time when you are tuning. You may now with a centre-bit bore the holes in the centre of the bottom of the blocks to receive the feet, which are simply round pieces of wood about 6 inches long, with a hole through them of the size required. They can be purchased ready made at a very cheap rate, but if you have a lathe they may be made at home.

Next prepare the stoppers, or tompions, which are shaped as in Fig. 23, and covered with soft sheepskin, so that they will just fit into the top of the pipes so as to close them in quite air-tight. The stoppers must not, however, fit so tightly as to prevent their being moved up and down. The leather is to be glued on the grained side, and this must be first well rubbed over with glass-paper to take off all the smoothness, or the glue will not hold. A mixture of tallow and black-lead should be rubbed on to the outside of the leather when the stoppers are completed, and they will then slip up and down easily, but be sure that they are perfectly airtight. Let no one persuade you to make stoppers of a piece of board with a handle stuck in the middle, as in consequence of the bearing surface being so small they slip askew and force the seams of the pipes open, thus ruining them. The stoppers should have, at least, 2 inches in depth of bearing surface. I may say that brads may be used in addition to glue for putting the larger pipes together, but be careful not to

drive any nails into the blocks or you will ruin your bits when boring the holes for the feet. The feet should not be glued in till it is time to plant them in their places, as you will then be able to regulate them so as to ensure the pipes being upright. File no notches on the edges of the blocks, but leave them quite smooth.

The bourdon is simply a stopt diapason, and is made in exactly the same way. The largest pipes may, if you like, be made with languids instead of a solid block, by cutting two pieces of wood, and fitting them into the pipe as shown in Fig. 25, and they may be secured with glue, and small brads. The largest pipe CCC, which may be made of 1-inch pine, is 8 feet long, $5\frac{3}{4}$ inches deep, and $4\frac{5}{8}$ inches wide; the smallest is two feet long, $2\frac{3}{8}$ inches deep, and 2 inches wide. The bourdons should also be furnished with ears as shown at E in Fig. 25. You must not be disappointed with the bourdons if they do not appear to sound very loud. Close to the organ a mere rush of wind might be heard, but some distance away the sound would be overpowering, in the next house, or two or three houses off, it would, most likely, be voted a nuisance. I may state, however, in order to prevent misapprehension, that it is not advisable to have a separate pedal organ for a room less than 16 feet square. An additional bass stop on the manual, to be used in lieu of a 16-feet pedal stop, will be described in the next chapter.

The Lieblich Gedacht (German, lovely stopped pipe) is simply a stopt diapason of the same scale as the open diapason. The block is cut out as shown in Fig. 26, and the mahogany facing projects $\frac{3}{4}$ inch above it for CC, and about $\frac{1}{8}$ inch for the smallest. This stop

is described to be used in the swell organ of the two-manual instrument, but it may be substituted for the stopt diapason of the single manual from tenor C upwards. The stoppers are made in the same way as for the stopt diapason. The cap is hollowed out, as shown at c in Fig. 26, and Fig. 30 is an inside view of a similar cap. The top of the cap should be slightly below the edge of the mahogany facing, about $\frac{1}{8}$ inch in the largest and $\frac{1}{24}$ inch in the smallest.

We now come to the open diapason, which is the chief stop in the instrument, but in our small instrument it is only carried down to tenor C, which, however, being an open pipe, is 4 feet long, the same as the CC stopt pipe; the width of it is $2\frac{1}{2}$ inches and the depth $2\frac{3}{4}$ inches. It has a straight block with merely a throat cut in it, as shown in Fig. 27; the cap c is cut out as there shown, and another view of it is given in Fig. 32. The upper part of this hollow should not be made with the chisel, but with a flat file, as it is very easy to make too deep a windway, and then you would have to reduce the thickness of the cap by rubbing it on glass-paper in order to remedy the defect. All hollow caps should be slightly thicker than the fronts of the pipes, and project below the block so as to allow of screwing them on without splitting them. Three, or at most four, small screws to each cap are all that should be required, and the cap should fit so nicely that no wind can escape except through the windway.

We next come to the flute's top, which is made in a rather different manner, as it has what is termed an inverted mouth, that is the chamfered side of the lip is turned to the inside of the pipe so that the front would appear quite plain all the way down, with merely

the mouth cut in it. You must not plane the front of this stop after it is put together, or you will spoil it, all planing for the front must be done before it is glued on. This pipe will require two caps, the inner one being merely a flat piece of mahogany, as in Fig. 29, the exact thickness of the front of the pipe, and having a round hole bored opposite to the throat, and countersunk on the outside. This cap projects above the edge of the block exactly the same height as does the mahogany facing in the Lieblich Gedacht. The outer cap is also hollowed out exactly in the same way as for that stop, but should be level with the top edge of the inner cap. The scale for CC is $2\frac{1}{2}$ inches deep and $2\frac{1}{4}$ inches wide.

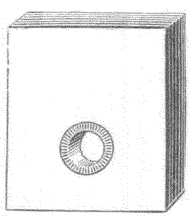


Fig. 29.—Front View of Inner Cap.

Another stop, which may be made of paper or wood, and is called the Gemshorn (German, goat's horn) may be substituted for the flute. It gives a beautiful, slightly stringy tone, not quite so powerful as the flute, but more penetrating, and is much used in small organs as a substitute for the principal. It is conical in shape, the diameter at the mouth being the same as in the flute, but at the top it is only one-third of that diameter. Of course it is rather more trouble to make than the straight pipes on account of the necessity of preserving the proper proportions. If made in paper, one mandrel for every three pipes will be all that is necessary, as you can cut the pipes down at either end to get them

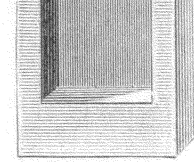


Fig. 30.—View of Inside of Outer Cap of Flute.

to the proper size, and you would make them in much the same way as you make the conical feet, only taking care to have the inside join in a straight line down the pipe. The mouth is cut up one-third of its diameter, and, if made of wood, the block and cap may be like either the flute or open diapason, which ever you may desire (see Fig. 34).

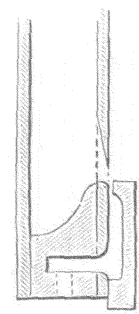


Fig. 31.—Section of Lower Part of Flageolet.

The keraulophon, as I have already stated, should not be made of wood.

The flageolet stop is made with a block shaped as in Fig. 31, and has an inverted mouth like the flute. The largest pipe is only 2 feet long and the scale is $1\frac{3}{8}$ inch deep by $1\frac{3}{16}$ inch wide. This stop will need great care in making as the pipes run so very small in the treble, and you must be very careful not to let it be too loud and shrill. If you can possibly afford it, make these pipes entirely of cedar or mahogany. The holes through the feet are very small, so the best way will be to glue a disc of thin mahogany on the bottom of the foot so as to close it up entirely, and then drill a very fine hole through it. This, of course, applies only to the pipes of the smaller octaves.

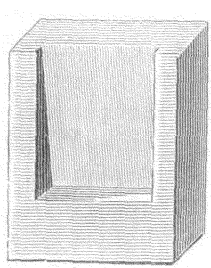


Fig. 32.—View of Inside Cap for Open Diapason.

The thickness of the wood will be nearly the same for the same sized pipes of any stop, but you may allow stopt pipes to run thicker than open ones, as they give a note an octave lower. The rule is that the thicker the wood the fuller and rounder is the tone. Open pipes are

tuned by a lid of soft tin or zinc which is bent down and let into a saw cut made in the thickness of the back of the pipe. This lid should be rather larger than the top of the pipe, but should never be shut right down; raising it sharpens, and closing it lowers the tone.

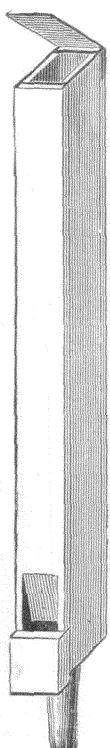


Fig. 33.—Open Diapason Complete.

The pipes are all to be made according to the lengths given in the scale, with the addition of the length of the block. They will all be slightly longer than the tone speaking length, but this is necessary in order to allow for the stoppers in the stopt pipes, and for cutting down to the right note in the open pipes. The same remarks apply to the scale lengths of the other pipes. When trimming the pipes down only very narrow pieces should be taken off with the tenon saw, for you can always take off more if required, but it becomes an awkward matter to remedy if you cut the pipe too short. The scales of all the pipes described are small scales, suitable for chamber organs. For a church organ the scales would be much larger.

The lips of the large bourdons may be made of mahogany and tongued on to the fronts, as shown in Fig. 25, which is to a scale of $1\frac{1}{2}$ inches to the foot. All the *sections* in this chapter, with the exception of Fig. 25, are to a scale of 3 inches to the foot, or one-quarter of the full size. They represent the largest pipe in each stop. The sizes of the throats in the

blocks and the sinkings in the caps may be taken from these sections, and should be gradually lessened for each successive pipe, preserving about the same proportions to the size of the block. It is, however, not requisite that the dimensions of the throat should be set out with mathematical nicety.

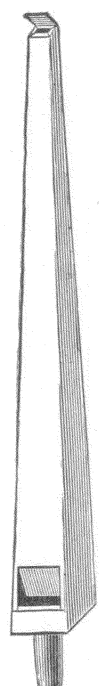


Fig. 34.—Gemshorn.

The pipes, when completed, should be carefully packed away in a dry place in a room where the temperature is about the same as that in which the organ will be built. It is best to complete all the pipes, if possible, before commencing on any other portion of the instrument, as it gives them time to season and settle down, and should there be any defects in the joints they will have time to demonstrate their existence. It is very annoying to find out these defects after you have got the organ into working order, and thus have to leave other work to remedy the mischief. As regards painting the pipes, some persons advocate plain wood, for the excellent reason that the paint is often used to hide bad materials and worse workmanship. This, however, is no reason why paint should not be used on material and workmanship known to be good, and my own experience justifies me in saying that it improves the tone in many cases, and undoubtedly preserves the material, whilst it looks better than plain wood for pipes that are in sight.

In the concluding chapter will be found a few specifications for organs of a larger size, so that amateurs who

have plenty of time and money at their disposal, may gratify their wish to possess the best instrument within their reach.

In the meantime I would urge the would-be organ-builder, before starting on the work, to consider the size of the apartment in which the instrument is to be placed, so that the organ may be suited to the surroundings. It must be remembered that, though a single pipe does not sound very loud, a full chord on one stop gives a considerable increase in tone, and when all the stops are out and the couplers in action, the noise would be simply unbearable unless great care were exercised to keep down the power of the pipes when in course of construction. For this reason I advocate pipes of small scale, with the mouths not cut too high, as they can be made to speak up well and yet not be noisy.

CHAPTER III.

PIPES OF METAL—CASTING BENCH AND CASTING BOX — METAL FOR PIPES — MELTING METAL — NECESSARY TOOLS—SCALE FOR CUTTING METAL FOR PIPES—FORMATION OF SHEET METAL INTO PIPES.



N giving instructions respecting metal pipe making I may say that I have generally rather deprecated amateur attempts in this branch of organ construction, for two reasons, viz. (1), because it is undoubtedly a fact that but very few amateurs possess the requisite skill; and (2), because in most cases metal pipes could be bought at a less cost—when the outlay for tools and apparatus is taken into account—than that which would be incurred by an amateur in making them for himself. But, as it is quite true that amateurs have before now turned out very creditable work in this branch, I will now endeavour to describe, in as clear and concise a form as possible, the *modus operandi*, for the benefit of those who may be ambitious of trying their hand at this rather difficult work.

If amateurs intend to cast their own pipe metal, it will be necessary that they should have a proper bench, for which purpose many manufacturers use a large slab of York stone or slate, whilst others have a wooden bench.

As this latter form will probably be that most within the reach and requirements of the amateur, I will describe it more particularly. The top or table of the bench is formed by placing pieces of stout wood—yellow deal will do—about $\frac{1}{8}$ inch apart, and then bolting them tightly up, but keeping them apart by pieces of thin stuff. If you do not propose to cast metal for pipes larger than tenor C open diapason, the bench top will require to be about 5 feet long and 18 or 20 inches wide, and should be formed of deals $1\frac{1}{2}$ inch thick and about $4\frac{1}{2}$ inches wide, placed *edgewise*, $\frac{1}{8}$ inch apart, and bolted up in the manner described. The planks should run lengthways of the bench. True up both top and under side of this table, and square it at each edge. The bench or table top is now to be covered with a piece of good linen bed-tick or moleskin cloth. This should be stretched tightly over the top, brought down all round, and then securely tacked on the under side of the bench. See that this work is well done, and that the ticking or moleskin lays perfectly smooth and without wrinkles, and be careful that there are no chips between the table and the ticking, or anything that would cause the slightest deviation from a level surface. The table top should now present an appearance similar to that of an artist's canvas stretched ready to paint upon. The bench is then placed upon a pair of trestles, or otherwise firmly supported, so that it lies quite level.

The casting box is a simple affair, but it must be strongly put together. Fig. 35 shows both the bench and the casting box, and it will be seen that the latter is a square box with a sloping back, and is nearly as long as the bench is wide. It should be made of oak at least 2 inches thick, and may be 5 or 6 inches wide

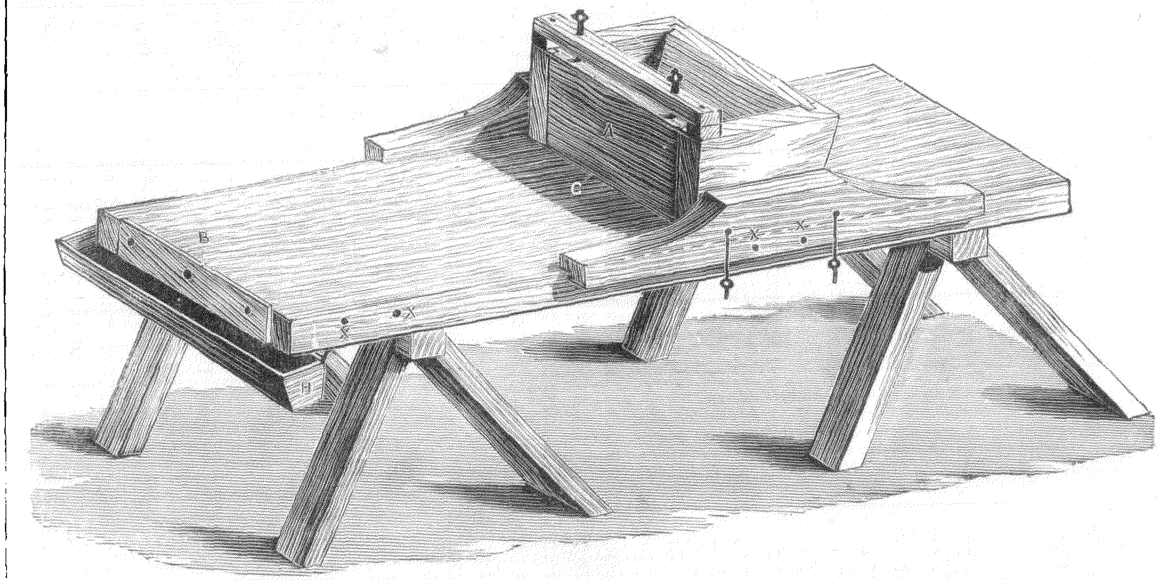


Fig. 35.—View of Casting Bench and Casting Box.

at the top, and about 5 inches high. It has no bottom, and the front is made to slide up and down a little way. This may be managed by cutting a tenon on each end of the front, and carefully fitting it into a groove at each end of the box. A strip of inch oak is fixed to the ends, so that it is raised about ½ inch above the front, and a couple of fine-threaded thumb-screws, or screws with fly nuts, are then screwed through the slips into the top of the front, so that by turning them the front may be raised or lowered, so as to regulate the width of the opening marked c in Fig. 35 at the bottom, through which the metal will flow when casting. The bottom edges of the box must be planed perfectly true, so that no metal can run out except at the proper opening. A rebated runner is fixed on each end of the box, so that the rebates just fit over the edges of the bench, and allow the box to be pushed freely backwards and forwards along the top of the bench. Now screw a slip of brass along the front end of the bench, as shown at B, bring the casting box close up to it, so that the brass securely closes the opening at the bottom, and with a bradawl bore a couple of holes through each runner into the bench side; about an inch will be sufficient. If a stout wire is inserted in each of these holes, the box will be kept firmly in its place, in order that the metal can be poured in. The wires can be pulled out when the casting is to be made.

The next thing is to decide on the composition of the metal of which the pipes are to be made. The metal generally consists of a mixture of tin and lead. Tin is the best metal to use, as it is light, strong, durable, keeps its lustre and colour, gives a fine tone, is not much affected by changes of temperature, and does not easily corrode when it comes into contact with

the rack boards or stock boards. Lead pipes, or those which contain a very large proportion of that metal, have many faults. They are very heavy, so much so that they are apt to crush up under their own weight; they oxidise easily in damp air, and at the points of contact with wood—especially with oak—forming sugar of lead, which is very poisonous; they do not keep their lustre or colour, and the tone is much less brilliant than that obtained from tin. In order to harden lead pipes, antimony is sometimes mixed with the metal, but this causes them to be brittle, so that they split when being tuned with a cone, and, in the case of inverted conical-shaped pipes, they sometimes snap right off.

For very large pipes, such as those required in the pedal organ, zinc has been used of late years with very satisfactory results. It is very light, is not much affected by a moist atmosphere, keeps well in tune, and gives a very fair tone. The speaking parts of these pipes should, however, be made of pipe metal, let into and soldered to the zinc. Zinc is very cheap, and will stand hard knocks, so that for show pipes it is very useful, but it does not give good results if used for pipes under 4 feet long.

Now, as I have said, tin is the best metal to use, but it is very expensive, and, under these circumstances, is not used without adding a certain proportion of lead, unless in the highest class of instruments.

The show pipes of the great organ at the Albert Hall are composed of nearly pure tin (90 per cent.); the internal pipes are five-ninths tin and four-ninths lead.

Common pipes contain five times as much lead as there is tin, but about the most useful proportion is

two-thirds lead to one-third tin, which makes what is termed "spotted metal." These spots rise to the surface when the metal is cooling, and when the pipes are polished up they look as though they were marked all over with inkstains which have been partially cleaned off. If a little more tin is added, say five parts of lead to three parts of tin, the spots run closer together; indeed, spotted metal proclaims its quality by its appearance. If the spots are very widely separated the quantity of tin is small, but if they are numerous and close together the proportion of tin is large. Such pipes give good round tones, and are very satisfactory for all except stops which are required to give a piercing quality of tone, in which case the more tin there is in their composition the better.

Having decided upon the quality of our metal, we place the requisite proportions of each in an iron melting pot. The proportions are taken by weight, and as regards the lead, it may be useful if I say that the lead linings of grocers' tea-chests, being very soft metal, are very applicable for the purpose, and grocers are often glad to dispose of this stuff at a very cheap rate. Put a little Russian tallow and a small piece of resin into the melting pot, to keep the metal nice and clear, and when the metal is thoroughly melted, ladle a sufficient quantity out into an iron saucepan—which should previously be greased and made warm—sufficient to cast a sheet of metal of the size required. The sliding front of the casting box should be raised by adjusting the screws, so that the aperture at the bottom is rather wider than the thickness of the sheet of metal to be cast. Thus, if we require a sheet $\frac{1}{16}$ inch finished thickness, we must make the aperture rather more than $\frac{1}{16}$ inch wide, as the rough upper surface of the

sheet will have to be planed down before the metal is made up into a pipe. Having adjusted this to our satisfaction we fix the casting box in position with the wires, as before described. A double sheet of brown paper must be laid on each end of the bench, so that, while the casting box is at rest, the molten metal therein may not burn the ticking.

But, before going further, I would strongly recommend the inexperienced amateur to refrain from attempting too large a job at first. Commence by casting only a small sheet of metal, practise planing and cutting up; then try to solder pieces together by following the directions which I shall give. After that a small pipe, say 1-foot C, may be attempted, and when the requisite skill has been obtained you may commence work in earnest.

When your metal is poured into the saucepan it must be kept well stirred and a little more grease thrown in to keep the surface clear, and before putting it into the casting box the heat must be tested, as it will not do to use it too hot. Accordingly have ready a few strips of stout white cartridge paper, a few inches long and about an inch wide. Plunge one of these strips into the molten metal, and if the paper only turns brown the metal is ready to use, but if the paper smokes up and consumes at once, the heat is too great. All scum and dross must be removed.

When the right temperature is obtained, stir the metal well up and pour into the casting box, pull out the wires which secure the box to the bench, and then with a firm and uniform pressure draw the box back to the further end of the bench, and the sheet of metal will be left behind, or rather in front of the box. It will be advisable to have help in this matter, so that there may

be one person on each side of the bench to draw the box along. The sheet of metal will be sufficiently cool in a few minutes to be removed, and another one can then be cast, but any metal remaining in the box must be taken out and put into the melting pot before pouring any more in. A shallow trough with a sloping bottom should be hung on to the front end of the bench to catch any metal that may run over, as shown in Fig. 35.

The sheet of metal must next be planed to make it smooth, and in order to do this it must be tacked down at one end on a level bench, and planed *away* from the point where it is so secured. If it is attempted to plane towards the fixed end, as in planing a board, the metal will ruck up and be spoilt. Care must also be taken to plane the sheet to a uniform thickness, and not to make it thinner in some parts than in others, the tendency being to run it off thin at the edges. The plane used is like an ordinary carpenter's jack-plane, only the iron is set more upright. After planing the surface and scraping down on both sides with a flat steel scraper till it is smooth and of the requisite thickness, the edges must be trued up. The thickness of the metal will, of course, vary with the size of the pipe and the nature of the stop. Speaking generally, a tenor C pipe should be about $\frac{1}{16}$ inch thick, and the smallest only about as thick as an ordinary playing card. Pipes required to give a full round tone are made of stout metal, while those required to give sharp and piercing tones are generally of thinner and closer metal; that is, metal containing a large proportion of tin.

Before finishing off the metal it should be cut to the sizes required for the pipes. I think it will be useful if I give a method by which the exact sizes and shapes

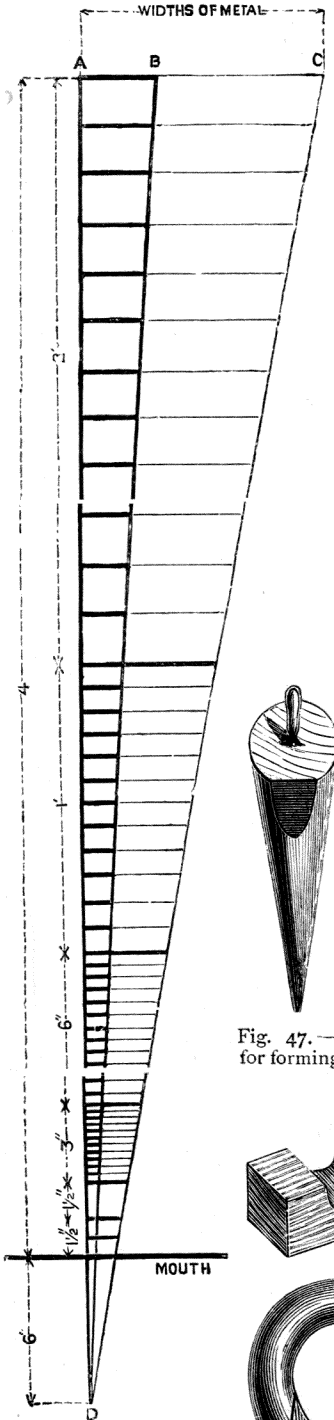


Fig. 36.—Scale of Pipes and size of Metal required to make them.

Fig. 47.—Cone for forming Lips.

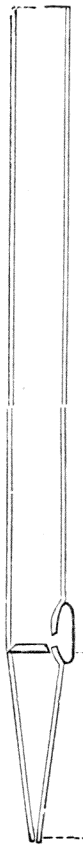


Fig. 41.—Section of Complete Pipe.

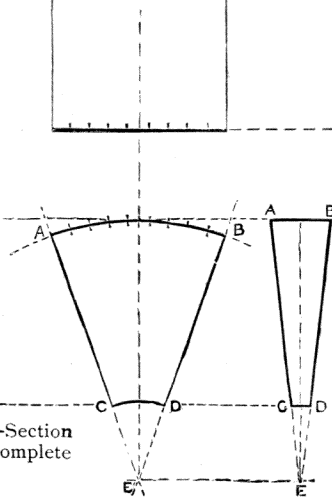


Fig. 38. Fig. 37.
Method of obtaining Correct Size and Shape of Pipe Foot.

Fig. 40.—Sheet of Metal Cut to Size of Pipe.





Fig. 43.—Cylinder and Foot ready to Solder together.

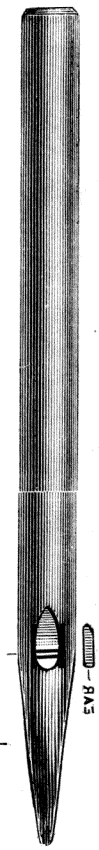


Fig. 44.—Pipe Complete.

Fig. 42. Block to Support Pipes.

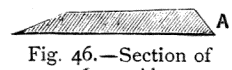


Fig. 46.—Section of Languid.

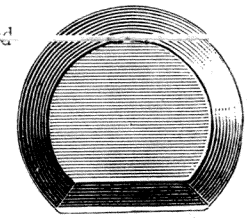


Fig. 45.—Languid.

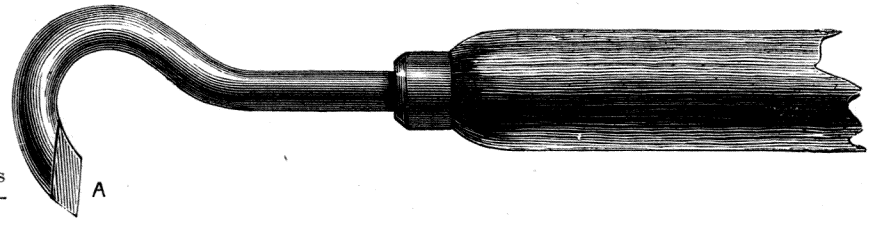


Fig. 39.—Cutter or Shave-Hook.

Folding Plate No. 4, containing Figs. 36—47, to face page 53.

can be obtained for any kind of pipe. The metal pipes are round, and the distance round a pipe, or the circumference of any circle, is within a shade of $3\frac{1}{7}$ times its diameter. For instance, suppose we want to make a pipe whose diameter is $2\frac{5}{8}$ inches, we shall require a sheet of metal which is $8\frac{1}{4}$ inches wide, which we may reckon up thus—3 times $2\frac{5}{8}$ inches make 7^7 inches, and $\frac{1}{7}$ of $2\frac{5}{8}$ inches is $\frac{3}{8}$ inch, which added together give $8\frac{1}{4}$ inches as the distance round the pipe. No doubt to many these instructions, and those which immediately follow, will seem superfluous, but I must beg of them to bear with me, as I know from previous experience that many amateurs are likely to be in great difficulty in this matter. Now if the amateur wishes to find the size of the sheet of metal for any pipe, he has only to make a scale like that in Fig. 36. This scale takes all pipes up to 4 feet long. First draw a line on a board 4 feet 6 inches long from B to D, and at a distance of 6 inches from the bottom draw a thick line across and mark it with the word *mouth*. Now divide the line above this into two equal parts, being of course 2 feet each. At the top draw a line across and make it just as long as the diameter of the longest, or tenor C pipe, of your open diapason, or whatever stop you intend to make.

If for open diapason this diameter will be about $2\frac{5}{8}$ inches for a chamber organ, and this distance is that marked A B on the sketch. From the point B draw a sloping line down to the point D, which is 6 inches below the mouth. The lower 2 feet of the long line is now divided into 2 lengths of 1 foot each, and a cross line drawn, marked C^2, or 1-foot C. The lower length of this is again divided into two lengths of 6 inches, and the line marked C^3, or 6-inch C; the lower length

thus obtained is subdivided again into 3-inch lengths, and so on, dividing each in half, and the cross lines at those divisions are all C pipe diameters. Now if each of these portions are divided into twelve equal parts by lines running across, we obtain the diameters of all the pipes in each octave by simply measuring the length of the cross lines at the places marked for the required pipes, while the distance from the line marked mouth up to the line of any pipe diameter will give the length of the straight tube, or cylinder for that pipe. Thus far we have an ordinary pipe scale, but if we extend the cross line at the top to the point E, and make it $3\frac{1}{7}$ times as long, that is, $8\frac{1}{4}$ inches long from A to C, that line gives us the width of the metal required to make a tenor C pipe $2\frac{5}{8}$ inch diameter. Draw a sloping line from the point E down to the point D, and extend each of the cross lines till they touch that sloping line, and it is obvious that measuring any of those lines across from the outer line A to the outer line C, the distance is just $3\frac{1}{7}$ times as much as the same line measured only from A to B, and consequently from this scale we can get the size of any pipe in the stop, and the size of the metal required to make the tube for that pipe. For pipes extending to 8 feet long the scale must be made 4 feet longer at the top, and that space be divided into twelve equal parts, the same as each of the others already described.

The feet of the pipes are conical, and I have been asked by many how to obtain the correct size and shape of these. Here again the matter is very simple. Suppose we want to make the foot of our tenor C pipe, and we wish it to be 12 inches long, with an opening at the bottom 1 inch in diameter; we draw a section of the pipe-foot as at A, B, C, D, Fig. 37, first

setting up the centre line, and drawing the diameter A B $2\frac{5}{8}$ at the top, and 12 inches down, drawing the diameter, C, D, of 1 inch from the bottom. From the points A and B draw lines down through the points C and D, and extend them until they meet in the centre line, which will be at the point E. This completes the section. Now look at Fig. 38, and making a centre line, take the distance E to A, or E to B from the section, with a pair of compasses strike an arc of a circle, as at A, B, on Fig. 38, sticking one point of the compasses in the point E. Now we must take the arc or curve thus obtained exactly the same length as the distance round the pipe, viz., $8\frac{1}{4}$ inches, and in order to do this correctly we must take a small distance in our compasses, say 1 inch, and step it round, eight times, and then add the $\frac{1}{4}$ inch to complete the distance. We have thus obtained the points A and B, and if we join these points to E by a sloping line, and then with the compasses placed at E we strike another arc, with the distance E to D, as in Fig. 37, we shall obtain the exact shape of the sheet metal required to make a pipe-foot, fulfilling the conditions laid down. This sheet is that enclosed within the lines A, B, C, and D, on Fig. 38. If this sheet is cut out and turned up, as will presently be described, it will form a cone, perfectly flat or square, as it is termed, at the top and bottom.

It takes a long time and space to describe this setting out, but the actual work can be done very quickly when you have once grasped the method.

In workshops where many stops of pipes of the same scales are constantly being made, patterns cut out of sheet iron or some similar material are kept in stock, so that for a particular pipe-foot all that is required is to lay the pattern on the metal and cut

round it with the cutting-tool. An ordinary amateur will not need to go to this expense, and can, therefore, either make a set of patterns out of stout paper or card-board, or simply set each one out on the metal itself.

For cutting up the metal, unless it is very stout, a shoemaker's or saddler's knife will be found sufficiently strong, but a couple of tools similar to that shown in Fig. 39 will be found very handy. They can be made out of an odd piece of steel, and fixed in a handle. The part A is ground to an acute wedge shape, and the bottom is brought to a sharp point. One of these tools should be made about the same size as the figure for small work; and another about three or four times as large for large work.

Having cut the metal into the required shape and form, and planed the edges true—for which purpose one of the little iron American planes will be found very handy—the pieces must be thoroughly cleaned on both sides. This is done with whiting and water, with a little soft soap mixed with it, rubbing it on with a soft pad till the metal appears clean and bright; leave it to dry, and then finish off with wash leather. *Soda* must not be used in the water.

The metal is now bright like silver, but before turning it up into shape it must be prepared for soldering; that is, it must be protected from the heat of the iron. Take an old, clean saucepan and pour into it some thin glue boiling hot, and then mix a little whiting and water and pour it into the glue, so as to make a mixture like thin whitewash. With a paint brush give the metal a coat of this mixture nearly an inch wide on both sides of the metal where the soldered joint is to come, let it dry, and then give another coat.

In order to turn the metal up it has to be rolled round a mandrel or roller, and these can be made in the same manner as described in Chapter I.; that is, by rolling several thicknesses of paper round a long roller of wood, until the requisite size is obtained.

To bring it round the roller slip the sheet so that it laps over the edge of the table about half-an-inch, and slip under the edge a lath of wood cut feather edged, and as long or longer, than the sheet of metal; place the mandrel on top of the sheet of metal, and with the thumbs placed under the slip of wood, gently bring the metal round the roller. This operation requires great care, as it is very easy to thoroughly spoil the sheet of metal if it is clumsily done; but those of my readers who have experimented in making paper pipes will have acquired the knack necessary to bring the paper or the metal straight and smooth over the mandrel. Before folding down close to the mandrel the edges of the metal to be soldered together must be first gone over with the little iron plane, so as to take off any of the whiting that may have run on to them, and they must be planed so that they only touch on the under side, forming really a V-shaped groove for the solder to run in, as shown in sketch, Fig. 48. It must specially be noted that these edges must not be scraped or filed, but be made clean and smooth with the plane or shave-hook, otherwise you will assuredly fail to make a joint with the solder. The little iron planes will be found the best tools to use, and they can be purchased for about 1*s.* each at almost any tool shop. Having got this matter all right, the edges of the metal must be brought together and pressed closely down to the mandrel by gently pressing a slip of wood on them. This slip should be shaped somewhat like a paper-

knife, and may be about 10 inches long, 2 inches wide, and $\frac{3}{4}$ inch thick, without any sharp edges, as the metal must not be dented or wrinkled in any way. If the glue sizing has chipped off at all, it must be replaced with fresh, and allowed to dry before proceeding to solder. In order to keep the edges of the metal together for soldering the amateur may find it con-



Fig. 48.—Section of Pipe Cylinder Ready for Soldering up.

venient to bind it round here and there with a piece of broad tape. A few blocks like Fig. 49, with semicircular hollows of different sizes, will be handy for supporting the pipes, both for this and succeeding operations. The soldering-iron used is really an iron, and not a copper bit. It is shaped as shown in Fig. 49, and the square part is made of well-hammered iron, 4 or 5 inches long and 1 inch square, with a rather thin tang, which slips

into the wooden handle, but is not permanently fixed therein. The handle is made in two pieces, which are merely held together by being bound round with wire, as shown, at the end furthest from the iron, so that it can be slipped on and off the iron, as required. Rub a piece of tallow candle all along both edges of the metal where it is to be soldered, make your iron hot, put a piece of solder in the hollow part of a clean brick, add some resin, and *tin* the iron, as it is termed, by rubbing the sloping part in the solder and resin, so as to give it a coating of solder. To a beginner this tinning of the iron is a troublesome job; but until it is accomplished it is impossible to take up the solder on the iron, so as to make a joint. The iron must be clean, and hot enough to melt the solder readily, but not so hot as to perish it; practice alone can enable any one to judge of the temperature required.



Fig. 49.—Soldering Iron.

A little piece of composite candle will be found of great assistance to enable the solder to be taken up on it. This should be placed along with the solder in a hollow block of wood, and whenever you require more solder, touch the iron on the candle first and then take up the solder. First tack the pipe together by dots of solder about 3 inches apart, then take up more solder and connect the dots to one another. Finally, with the iron tolerably hot, run down the whole length of the joint, so as to make the solder flow in a clear bright line. If the iron is too cold this joint will look rough and botchy, but with a nice hot iron the joint is smooth

and workmanlike. Fig. 48 shows the pipe turned up ready for soldering, the thick lines indicating the glue sizing, and the black dot on top a dot of solder for tacking.

Having soldered up the tube or cylinder, we may proceed to perform the same operation with the conical foot, which must be turned up on a mandrel of the requisite shape. The directions given in my first chapter for making the mandrels for the feet of the paper pipes will apply here, but the mandrels must be made rather more substantial than is needed for turning paper on. The paper mandrels can be much more quickly made than wood ones, are cheaper, and can be increased in size as required for larger pipes by merely gluing more thicknesses of paper round them. The feet of the pipes, especially large ones, should be cut out of thicker metal than the tubes, so as to be strong enough to support the weight of the pipes without doubling up. When the feet are soldered up the mouth must be cut in the tube and the lips formed.

The width of the mouth for the open diapason will be $\frac{2}{9}$ of the diameter of the pipe, and its height will be $\frac{1}{4}$ of its width. In order to cut the mouth, a metal or hard wood cone is inserted in the pipe, and a cut made at each side of the mouth to the depth required, and then another cut is made across to join the two cuts, thus taking the piece right out. The small size tool (Fig. 39) is used for this purpose. One side of the metal or hard wood cone is squared off, as shown in Fig. 50, and this flat part is now brought under the portion of the pipe immediately over the mouth, and the lip is then formed by gently rubbing the metal down with a burnisher, so

that it assumes the form required. In pipes which are outside the case the bay leaf, as the ornamental upper lip of the pipe is termed, is formed before the pipe is turned up, by marking out the shape on the inside, and rubbing a burnisher round the line, thus causing a ridge to show on the outside of the pipe.

In large pipes the bay leaf is formed separately and soldered in. The same process is repeated on the top of the foot to form the lower lip, only it must be remembered that the lower lip is not made so deep as the top one, and that it must not take so much off the diameter of the foot, as a windway is to be allowed for. The pipe may now be cleaned off inside and out with a wet sponge and a little whiting, which will get off all the sizing; a little mop, like that used for paper pipe painting, being used to clean the inside of the metal pipes.

The languids may now be formed and put on. They are simply pieces of thick metal cut to fit on to the top of the pipe-feet, and shaped as shown in Fig. 45, and in the sections Figs. 46 and 50. For a tenor C open diapason, they may be a full $\frac{1}{4}$ inch thick, while for the smallest pipe in that stop, they may be about $\frac{1}{10}$ inch thick. It will be observed that they are sloped off all round the curved part to a very thin edge, so that when placed on the top of the pipe foot, and the tube on top of all, the joint is scarcely seen. The angle of the slope of the languid at the mouth should be about that shown in the section Fig. 50, but some makers slope it further back. Now, polish the languid up, size it round with glue and whiting, serve the top of the pipe-foot the same, trim off to form a slight V groove for the solder, place the languid on the foot, and solder it by dots, and then join

all round the curved part, leaving the straight part open for the wind to pass. The under side of the languid should be just level with the top of the lower lip. These processes may now be repeated, and the tube joined on to the foot, taking great care that the mouth comes in its proper position, and that the foot and the tube are perpendicular to each other, as, unless this is the case, the pipes will lean in all directions when planted on the sound-board, looking very unsightly, and occupying an unnecessary amount of space.

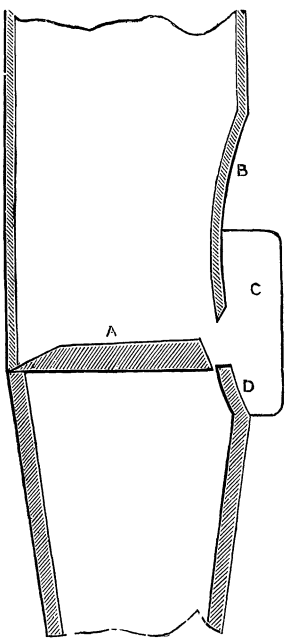


Fig. 50.—Enlarged Section of Mouth or Speaking Part.

The ears are now to be cut out and soldered on, taking care to size with glue and whiting as before described. The ears are merely small pieces of metal shaped as shown in Fig. 50, and placed one on each side of the mouth to prevent the wind, which should impinge on the upper lip, being wasted. In this figure A is the languid, B the upper lip, C the ear, and D the lower lip. It must be remembered that the seam or joint should be at the centre of the back of the pipe and foot. It now only remains to chamfer off the edge of the upper lip, and to cone in the hole at the bottom of the foot. The chamfering may be done with a small shave-hook or a sharp penknife, and the

foot is coned by means of a hollow metal or hard wood cone being struck and worked round it until the hole is reduced to its proper size. The directions and dimensions given in Chapter I. will apply generally to metal pipes, and instructions in voicing and tuning, etc., are given later on.

CHAPTER IV.

REED PIPES.

IN the previous chapter I gave my reasons for supposing that the generality of amateurs would not gain much by trying their hands at metal pipe making. These reasons apply with tenfold force in the case of reed pipes, in which the speaking part requires such delicate work and entails so much patient perseverance to secure satisfactory results, that I am afraid many who attempt the task will fail. Moreover, it is very difficult to give written instructions as to this most important branch of the work; but, so far as is in my power, I will endeavour to make the matter clear. In order to give the amateur every facility I have carefully drawn the accompanying sketches on a large scale, and I trust that a careful study of the drawings and instructions will supply all that is required to enable the amateur to understand what is to be done.

It must first of all be pointed out that the reed pipes have no mouths like flue pipes, and that the pipes themselves play quite a secondary part in deciding the tone of the note given. The real speaking part is a metal tongue somewhat like a tongue in a concertina or harmonium reed. This tongue, if properly adjusted, and wind forced against it, vibrates in or against an

opening cut in a small brass tube called a reed: the length of the vibrating portion being regulated by means of a bent wire which presses the tongue against the reed. The lengthening or shortening of this vibrating part decreases or increases the number of vibrations, and accordingly the note obtained is proportionately

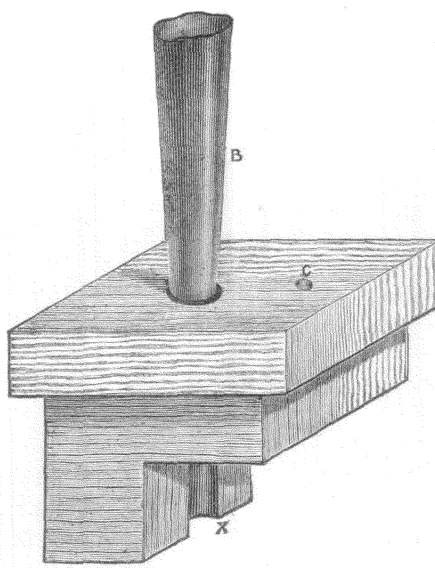


Fig. 51.—View of Wood Reed-Block.

lower or higher in pitch. The reed and tongue are fixed in a hole in a block of wood or metal, and the whole affair is enclosed in a sort of pipe-foot which is termed a *boot*.

If we now place a short pipe over the hole above the reed, and test the sound, we shall find that the note obtained is of the same pitch as without the pipe, but that the tone is different. So, according to the length,

scale, and shape of the pipe, we may obtain a variety of tones from the same reed; but the tone can also be modified by manipulating the tongue of the reed.

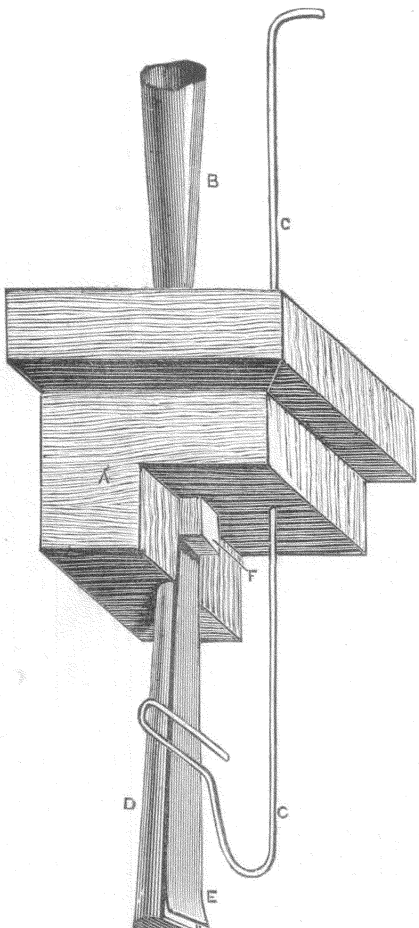


Fig. 52.—View of Wood Reed-Block, with Reed, etc., complete.

Having thus in a measure cleared the way, I will proceed to describe the several parts of the reed pipes. Fig. 51 is a view of a wood block, and it will be seen that it is merely a square piece of wood, the lower portion cut smaller than the upper, so that it will fit into the boot, and a portion of this lower part is cut right away. A hole is bored through it the size of the reed, but it will be observed that this hole is made nearer to the back of the block than to the front.

Another much smaller hole is bored through near the front through which the tuning-wire will pass. In Fig. 52 the block is shown so that we may obtain a view of its under side, and the reed and tongue are shown in position. A is the block, B the lower portion of the pipe fitted into the hole in the lower part of which is D the reed, and E the tongue. The tongue and reed are kept firmly in their place by means of a wedge F, which fits into a notch cut at the side of the hole in which the reed is placed. The tuning-wire C is also shown. Passing on to Fig. 53 we have a section of the wood boot with the reed block fitted into it. G is the boot, and H is a small wooden foot or tube through which the wind passes into the boot. This boot is merely a square box of thin wood and may be about 6 or 7 inches long, but the width will of course vary with the size of the block. Figs. 54 and 55 give respectively a view and section of the metal block, and

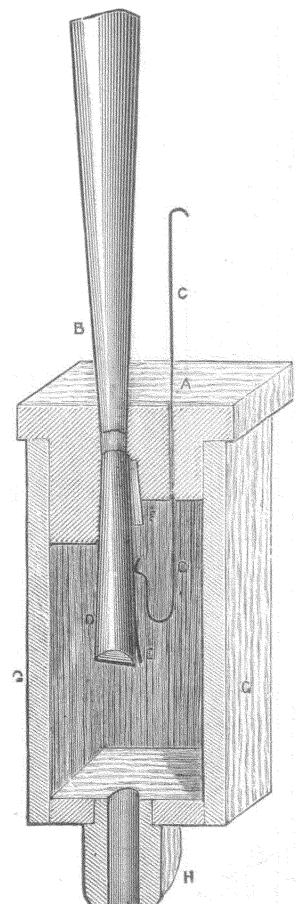


Fig. 53.—Section of Wood Reed-Block and Boot.

the upper part of the boot. Metal is generally used now, but formerly wood was almost exclusively the material for blocks and boots of reed pipes. Amateurs will probably be likely to succeed best if they make these parts of wood, as metal blocks must be cast, but the pipes may, nevertheless, be of metal if desired. In order to avoid confusion I have lettered the sketches so that the same parts are indicated in each sketch by the same letter.

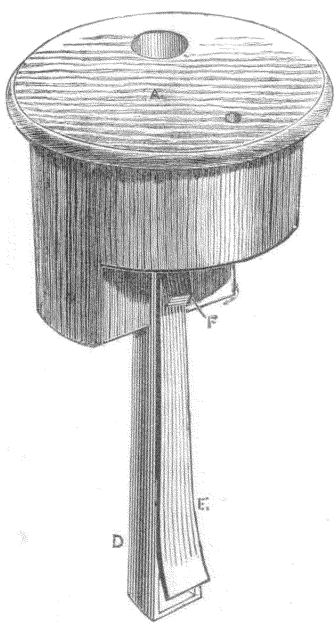


Fig. 54.—View of Metal Reed-Block and Reed.

There are two kinds of reeds used in organ-pipes, and they are shown in Figs. 56 and 57. The first is termed the OPEN reed, and the second is called the CLOSED reed. They both consist of a tapered brass tube, open at the top or small end, but closed at the bottom or large end by means of a piece of brass soldered on, and this bottom piece, as will be seen by the section (Fig. 55) is usually sloped so that it is rather higher at the back than at the front. In the open reed the entire front is filed away as shown in Fig. 56, and the edges must be perfectly smooth, straight, and true. In the closed reed only the lower portion is so filed

away, so that a conical opening is made as seen in Fig. 57. The exact size of these openings depends on the particular stop for which the reed is intended, and also on the individual taste or caprice of the maker, but the edges MUST BE TRUE.

No definite rule can be laid down for the exact sizes of any of the speaking parts of reed pipes, as nearly every builder uses his own scales, the only thing necessary is that whatever scale you decide to adopt should be strictly adhered to throughout the several stops. For loud and full-toned stops the opening in the closed reed should be longer and wider than for quiet thin-toned stops; and, of course, if an open reed is used, the width of the opening is regulated in the same way.

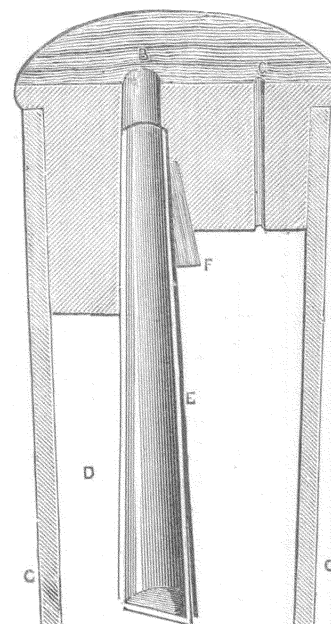


Fig. 55.—Section of Metal Reed-Block in Boot, with straight tongue.

The length of the reed is generally computed at $\frac{1}{2}$ inch for each foot in the *tone length* of the pipe. Thus for a 4-feet pipe the reed will be 2 inches long, for a 3-feet pipe $1\frac{1}{2}$ inch, and for an 8-feet pipe it will be 4 inches. This refers to the speaking length of the reed, or more properly to the part of the reed visible below the block. Consequently we must allow an addition to the length

of the reed according to the size of it, so as to admit of its being firmly held in its place in the block. For a CC reed we may allow about $\frac{3}{4}$ inch extra length, while for the smallest (top G) we may allow about $\frac{5}{16}$ inch, the total length of these two reeds will be $4\frac{3}{4}$ inches for CC, and about $\frac{3}{4}$ inch for top G. Now as regards the diameter of the reeds, CC may be about $\frac{6}{16}$ inch at the top or small end, and half as large again at the bottom or large end, viz., $\frac{9}{16}$ inch. The top G is $\frac{2}{16}$ inch at the top, and half as large again, viz., $\frac{3}{16}$ inch, at the bottom. These reeds are shown in the sketches the actual size; Fig. 57, showing the closed reed, with an opening one-third of the speaking length, the dotted lines showing what would be the size if made two-thirds long, which is the length often used for trumpet and cornopean stops. The shaded part marked A in the top part of the reeds shows the portion which is to be inserted in the block. It is usual to make the

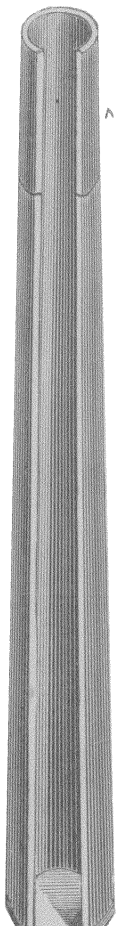


Fig. 56.—CC Open Reed. Full Size.

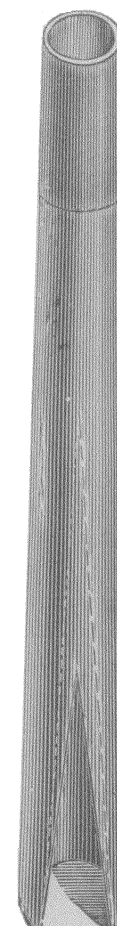


Fig. 57.—Closed Reed. Full Size.

reeds the same length and scale for all stops, any difference required being simply in the size of the opening where the tongue comes; but if amateurs like to take the extra trouble there is no objection to their having different scales for the reeds of different stops. A scale showing the length and the two diameters of each reed can easily be made by following the same system as in making a scale showing the length and two diameters of a wood pipe, using, of course, the dimensions given in the present article.

We now have to deal with the tongues, the vibrations of which, in or against the reed, produce the sound. They are simply strips of very thin well-hammered brass cut nearly as long as the reed, and the making of these is a very delicate piece of work. Reeds subdivide themselves into two classes, viz., free reeds and striking reeds. Free reeds are so termed because in vibrating the tongues pass right into the opening of the reed, whilst in the striking reed the tongues strike on the edges of the opening, but do not pass into it. The surface of the reed where the tongues strike is generally covered with leather in order to prevent harshness of tone. This is managed by fastening the leather all round the reed, and then carefully cutting it away over the opening. Care must also be taken to get the edges perfectly flat and true. It will, therefore, be understood that the length and width of the tongue are affected by the conditions above referred to.

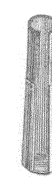


Fig. 58.—Smallest Reed. Full Size.

To make the tongues, procure a sheet of thin well-hammered or rolled brass, and with the cutting tool mentioned in the last chapter, cut out a piece sufficiently wide to make the longest tongue, and long enough to

cut a good many tongues side by side. In order to economise material, and save useless labour, they should be marked out so that the wide part of one comes at the top of the strip, and the wide part of the next one comes at the bottom, in exactly the same way as I have shown in the sketch on page 30 (Chapter I.), for cutting out the wooden lips of paper pipes, only the tongues will, of course, have but very little tapering.

It must be clearly understood that the tongues must not be cut out with shears, as it would cause them to roll up, or kink, and thus render them utterly useless. We, therefore, after marking out the size of the tongues in the manner described, take our shave-hook, and placing a straight-edge against each line, firmly draw the point of the hook along the line, until the metal is almost cut through. Now look at Fig. 59, which is a portrait of a little home-made vice, which will be very useful in many ways. The sides are made of beech, or other hard wood, and the jaws are each lined with a piece of ebony planed perfectly true. The short side is hinged to the long one by means of a piece of stout leather, and a block is fixed to the lower portion of the long side as shown, so as to keep sides parallel. The vice is opened or closed by means of the thumbscrew. If it is intended to make reed pipes longer than 4 feet tone the vice should have two thumbscrews side by side, as it will have to be nearly 6 inches wide; but if the vice is not required more than 3 inches wide one screw will suffice. This little vice may be secured in the chops of an ordinary bench vice, or screwed to the side of the bench, or dovetailed into the top or side of it.

Now for its use. Having scored out a tongue, screw the strip of metal in the vice so that the scored line is just level with the top of the vice, then carefully break

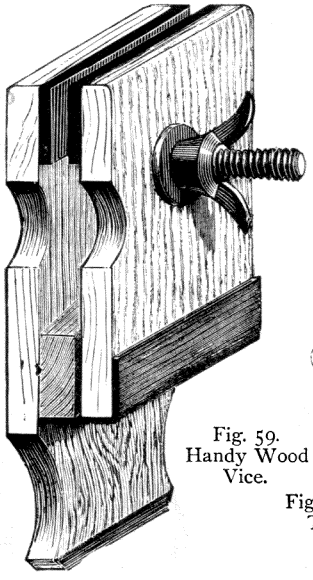


Fig. 59.
Handy Wood
Vice.

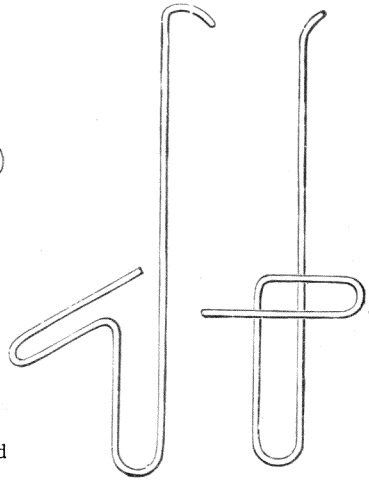


Fig. 60.—View of Tuning Wire.

Fig. 61.—Another with Alternative Bend.

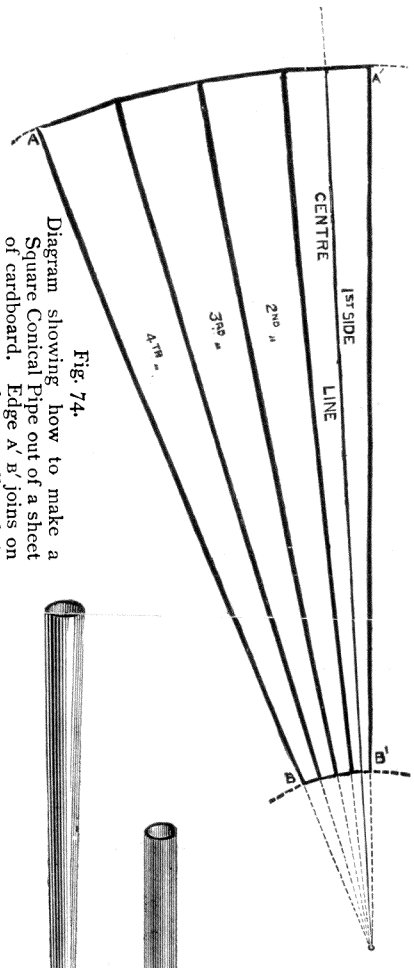


Fig. 74.
Diagram showing how to make a Square Conical Pipe out of a sheet of cardboard. Edge A' B' joins on to edge A B when cardboard is folded up.

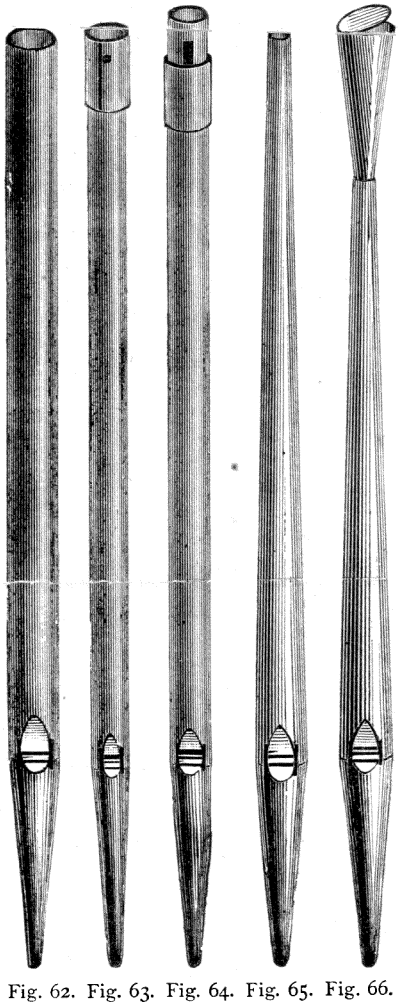


Fig. 62. Fig. 63. Fig. 64. Fig. 65. Fig. 66.

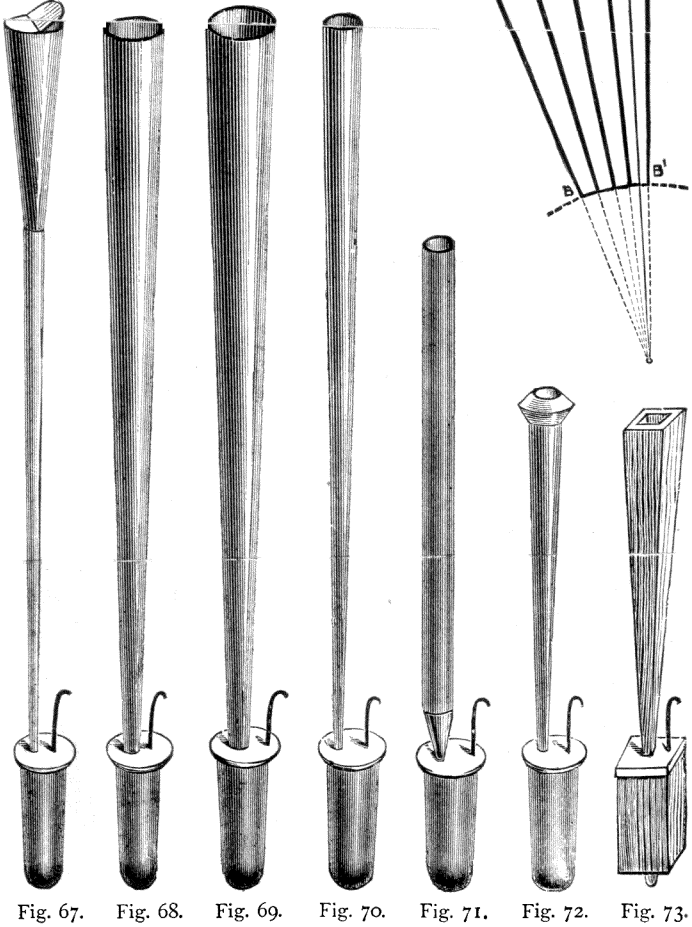


Fig. 67. Fig. 68. Fig. 69. Fig. 70. Fig. 71. Fig. 72. Fig. 73.

Figs. 62-73.—Sketches showing comparative Scales of Pipes to sound the same note.

Folding Plate No. 5, containing Figs. 59—74, to face page 73.

or crack the metal, and you will thus be able to separate each tongue from the sheet without bending or wrinkling it in any way. Having thus roughly shaped a lot of tongues, you proceed to finish them off. Screw each one up in the vice again, and with a little iron plane carefully plane the edges true, and make the tongue the width required. Then very carefully file each tongue down to its proper thickness, where again the matter of taste comes in. For heavy-winded pipes required to give a loud full round tone, the tongues must be rather thick and broad, but for light-winded pipes to give a thin penetrating tone, the tongues must be thin and narrow. The tongue must be *perfectly true* on the side *next* the reed, but on the outside it slopes, being made thicker at the top than at the bottom or free end. Some makers have the tongue flat on both sides and very thin, but this is a plan that cannot be recommended as the tone is not satisfactory.

I do not think I can give amateurs better advice than to urge them to procure one or two complete pipes of each stop which they propose to make, and endeavour to imitate them in every part, and also in tone. If you obtain from a dealer or builder a large, a medium, and a small pipe of each stop, you will have a clear guide before you as to the size, scale, and thickness of every portion, and above all will know how your pipes ought to sound when completed. These specimen pipes need not necessarily be new ones, but, of course, they must be in good working order. One word of caution however, on no account give way to the impulse to blow a reed pipe with your mouth, as it will most probably ruin the pipe. Always test for tone by placing the pipe on a sound-board or on a voicing machine.

When filing the tongues down let them be laid on a block of smooth hard wood, and to finish them off use an emery wheel or a piece of the finest glass-paper stretched on a flat piece of cork. When proceeding to fit and voice the reeds we must fix the tongues, flat side down on the block of smooth hard wood by means of a small screw clamp at the extremity of the thickest end. Then take a round burnisher such as is used for sharpening steel scrapers, or, better still, a round piece of steel with a handle at both ends (this steel should be about as thick as a stout straw and about 6 inches long), and, holding a handle in each hand, gently work it up and down the tongues, so as to make the thin ends curl upwards from the block of wood on which they are laying. The curve must commence about *half way* down the tongue, and must extend right to the tip of the free end in one continuous curve. The pressure must be applied gently so as to obtain this result, and so that the curve may be perfectly true and not tending more to one edge of the tongue than to the other. The tongue must be taken off and carefully fixed in its place and tested so as to see whether it answers, as it must not be curved too much. It is a prime necessity that reeds should speak promptly, and if this result is once obtained the question of tone can be settled by manipulation. Assuming that you have fixed on the particular tone or quality to be obtained from the pipe you must test it in a variety of ways until that quality is satisfactorily gained. The tuning-wire will require shifting up, or down, and probably the pipe itself will want a little trimming down, but this must be cautiously done and only a little taken off at a time.

The requisites for good and prompt speech are that the outside face of the reed tongue should be graduated

in thickness from the fixed end off to nothing at the free end, whilst, before curving, the under side must be perfectly flat and true. The curving must be neither too great nor too little, but, as it is impossible to state the exact amount required, it must be settled by actual experiment. It must not be twisted or kinked in any way or the tongue will be irretrievably damaged. The tongue must also fit the reed most accurately, and must not overhang at any of the edges. If the pipe refuses to speak at all (a very probable result of a first attempt) it may arise either from the tongue being too thick, too much or too little curved, not properly fitting the reed, being bent or twisted, or the wedge not being properly adjusted. If it speaks, but squeaks, grunts, or rattles, it may be caused by the tongue being too thin, not curved enough, or from its not being properly adjusted or tightly wedged up. Dust or filings will often cause dumbness, or make the pipe sound a fifth above its proper note. If you get a good note then the tuning is accomplished by shifting the tuning-wire up or down, or by cutting the tube down. All straight tubes may have a sliding piece at the top as described for paper pipes, and inverted conical pipes may be regulated by shades like the wood pipes.

Having obtained a satisfactory note from one pipe, all the others in the same stop must be made to give exactly the same quality of tone. The reed tongues will of course be smaller and thinner as the pipes run smaller. I may remark that they can be purchased unvoiced at most places where organ requisites are sold.

This voicing and tuning of reeds is a work requiring unwearying patience, and a certain knack which can only be acquired by long practice. The amateur will,

however, meet with no difficulty that the ordinary tradesman does not also have to encounter and conquer, for there is no royal road to tuning these or any other descriptions of organ pipes. Now, presuming that the amateur has made his reed-block, reed, etc., and fitted the latter into the block, it must be firmly secured by means of a little wedge made of hard wood. The wedge must fit well throughout its length, and must be allowed to project below the block so that it can be taken out easily when required to do anything to the tongue, etc.

Next, we must make the tuning-wire, and in Figs. 60 and 61 you will see sketches of the wire from two different points of view. It is rather difficult to show exactly how this wire is to be bent, but if it is borne in mind that it is only the loop which touches the tongue while all the rest of the wire is kept beyond reach of the vibrating tongue, you will have no difficulty in making it. Fig. 60 is a side view, and Fig. 61 is a view looking direct on that portion of the wire which presses on the tongue. The latter figure also shows an alternative method of forming the loop. The wire should fit easily but not loosely into a hole in the block, and the top of it should be curved over a little, so that the tuning-knife can be hooked under it when required to shift the wire.

The pipe is fitted tightly into the hole above the reed, and the size of the hole in the bottom of the pipe is therefore in a measure regulated by the size of the reed, but the hole in the pipe may often be required to be smaller than the reed. In the case of small metal reed pipes the pipe is often soldered into the block, but in the case of large pipes a short pipe or socket is soldered into the block, and the pipe itself merely drops into the socket.

The pipes are in most cases of a conical shape, the largest section being at the top and the smallest at the bottom. They may be made of either metal, wood, or paper. If they are to be metal the amateur must first make a scale in exactly the same way as for an ordinary metal pipe, showing the length and diameter of each pipe in the stop, and also the width of the metal required to make it, proceeding as directed in setting out a pipe-foot, as they will be merely like elongated feet. If the pipes are to be of wood they are made square in section but conical in elevation (see Fig. 73), and the wood need not be more than $\frac{3}{4}$ inch thick for an 8-feet pipe. If they are made of paper they will require to be rolled on a mandrel of the requisite shape, but it might perhaps be convenient to the amateur to make them square as for a wood pipe, in which case they could be cut out of a single piece of stout cardboard, and each angle partly cut through with a knife, so as to facilitate folding up into shape (see Fig. 74). The only joint would then be along one angle, and this could be covered with a strip of paper to make it secure and strong. The pipe could then be further strengthened by covering it with two or three layers of stout paper, so that it would look, and also really be, as practically without a joint as a circular paper pipe. Do not forget that when gluing the layers of paper a minute or two must be allowed for the glue to soak in and for the paper to stretch, before rolling it round the pipe. Well rub down with a paper-knife or a round stick so as to get a smooth unwrinkled surface. Pipes made in this style would only require a few mandrels, as the smaller ones could be made without them. I might add that if the stoutest Willesden waterproof paper is used to form the pipe, and a thinner variety of the same

paper used for the outside layers, the pipes would not require painting or varnishing, and would at the same time present a nice appearance. One advantage of using wood or paper is that there is no danger of the pipes crushing up or breaking off with their own weight as is often the case with metal. If the metal is too soft they crush up, if it is too hard the pipes are brittle and easily break off.

As I daresay many of my readers would like to have a hint as to the scales of reed pipes, I have furnished a set of sketches showing their length and scale for a tenor C pipe, *as compared with a tenor C open diapason.*

The pipes shown are as follows :—

Flue Pipes.—

Fig. 62. Tenor C, Open Diapason.

Fig. 63. Tenor C, Keraulophon, 6 scales smaller.

Fig. 64. Tenor C, Slotted Gamba, 6 scales smaller.

Fig. 65. Tenor C, Gemshorn, diameter at mouth 1 scale less than Open Diapason, diameter at top $\frac{1}{3}$ diameter at mouth.

Fig. 66. Tenor C, Viol-di-Gamba, diameter at mouth 2 scales less than Open Diapason. Diameter at top the same. Diameter at smallest part (which is $\frac{1}{5}$ the length down from the top) $\frac{1}{3}$ of the diameter at mouth.

Reed Pipes.— .

Fig. 67. Tenor C, Oboe. Diameter at top of widest part same as Open Diapason, diameter at joint of inverted cone (which is $\frac{1}{4}$ the length of the pipe) $\frac{1}{3}$ of top diameter. Tongue thin and narrow, and may be straight, or very slightly curved.

Fig. 68. Tenor C, Trumpet, about 2 scales larger at the top than Open Diapason, tongue slightly curved.

Fig. 69. Tenor C, Cornopean. 5 or 6 scales larger at top than Open Diapason. Broad tongue, nearly straight, but does not lay close to the reed.

Fig. 70. Tenor C, Bassoon. 8 to 12 scales smaller than Open Diapason. Tongue thin and narrow, very slightly curved, and close to reed.

Fig. 71. Clarinet. Tubes only $\frac{2}{3}$ the length of Open Diapason, and 12 scales smaller in diameter. Tongue thin and narrow, nearly straight, and close to reed.

Fig. 72. Vox Humana. Only $\frac{1}{2}$ the length of Open Diapason, diameter of largest part of top piece the same as top of Open Diapason.

These pipes are sometimes made the same shape as the Clarinet, and of stout metal.

CHAPTER V.

SOUND-BOARD, WIND-CHEST, PALLETS, ETC.

WE now commence on what appears, from a casual glance at the sheet of details accompanying this article, a rather formidable undertaking, but it will not be found to present any great difficulties or to occupy a very long time. The chief requisites are good materials, the ability to plane a board true, and the exercise of a little care and patience.

The sound-board of an organ—the term is a misnomer, for it is in no sense of the word a sound-board—is merely a flat board, termed the "table," which is divided by wooden partitions, on the underside, into as many channels as there are keys in the compass of the instrument. The wind is admitted into these channels by means of valves, called pallets, from a box underneath, termed the wind-chest. On the top of the table are flat slips of wood called sliders, running between other flat and fixed slips, termed bearers; over these are thick boards, termed the upper boards. Holes are bored down through the upper boards, sliders, and table into the grooves, the pipes being planted over these holes, and if the slides are open the wind passes from the wind-chest into the channels and from thence into the pipes. When the sliders are closed no wind can pass into the pipes.

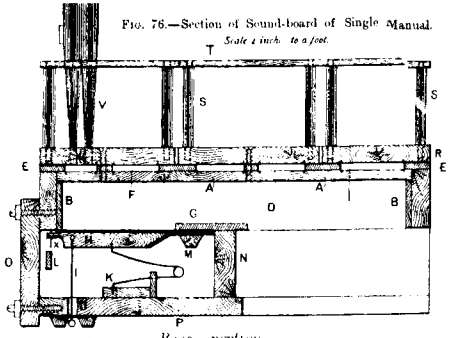


FIG. 76.—Section of Sound-board of Single Manual.
Scale 1 inch to a foot.

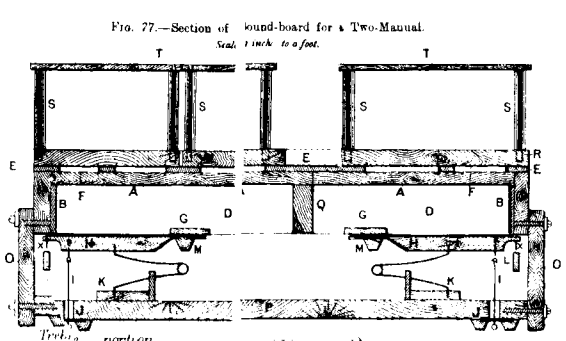


FIG. 77.—Section of Sound-board for a Two-Manual.
Scale 1 inch to a foot.

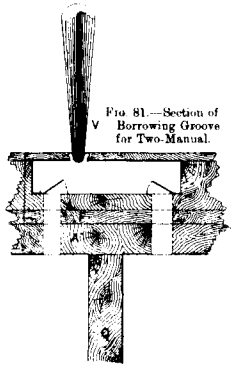


FIG. 81.—Section of Borrowing Groove for Two-Manual.

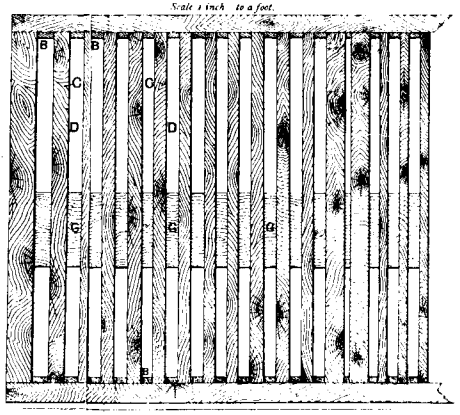


FIG. 78.—Plan of Sound-board Bars, showing filling-in pieces, &c.
Scale 1 inch to a foot.

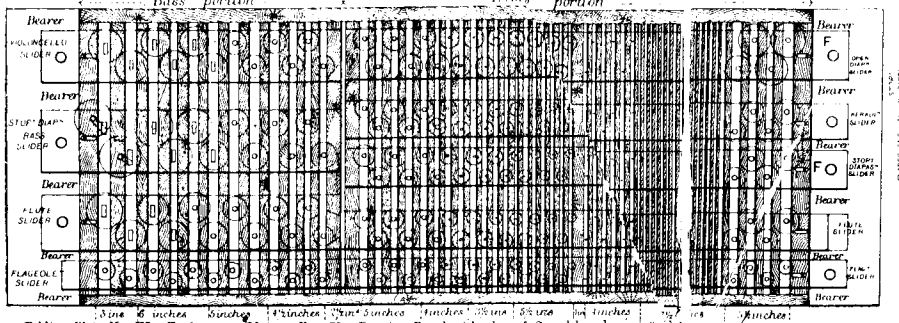


FIG. 75.—Drawing Board with plan of Sound-board.
Scale 1 inch to a foot.

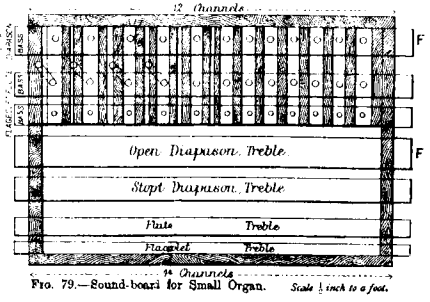


FIG. 79.—Sound-board for Small Organ. *Scale 1 inch to a foot.*

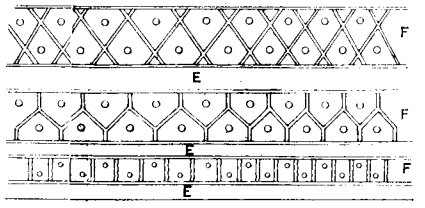


FIG. 80.—Grooving for waste Wind on Table and upper Boards.

Details of Sound-Board, Wind Chest, &c.

DRAWN BY MARK WICKS.

The Reference Letters refer to the same portions in each Figure

- **A.** Table of Sound-board.
- **B.** Filling-in pieces at ends of Channels
- **C.** Channel Bars
- **D** Channels
- **E.** Bearers
- **F.** Sliders.
- **G.** Filling-in pieces at tail end of Pallets.
- **H.** Pallets.
- **I.** Pulldowns.
- **J.** Brass Plate through which the Pulldowns pass.
- **K.** Spring Rail.
- **L.** Thumping Rail.
- **M.** Fillet of wood over Pallet hinge.
- **N.** Back of Wind Chest (Wind Bar)
- **O.** Front of Wind Chest.
- **P.** Bottom board of Wind Chest
- **Q.** Division between great and swell Wind Chests.
- **R.** Upper Boards
- **S** Rack Pillars
- **T.** Rack Boards.
- **U.** Conveyance Tubes
- **V.** Pipe Feet.
- **W.** Levers for opening and closing Sliders
- **X.** Guide Pins for Pallets.
- **Y.** Section of Violoncello Pipe.

Folding Plate No. VI.—To face page 80

The first thing necessary is to make a drawing-board, for without this you would be liable to spoil all your work. So prepare a board of ½ inch pine, 6 feet long, and 2 feet or more wide, and on it set out, to full size, the plan shown in Fig. 75, on the sheet of details. This is for the organ described in Specification 1 in Chapter I.

The outside measurements are 5 feet long by 2 feet wide, so mark these lines first, and then draw another at each end 1½ inch in, to show the thickness of the end bars or cheeks: the front and back cheeks are each 1 inch thick. Now draw the two thick bars dividing the treble from the bass, the centre of these divisions being 21¼ inches from the bass end. These bars may be about an inch thick with a space between them, or the division may be one solid bar 2½ inches thick. The bass portion is now to be divided into twelve channels, and eleven partitions, or bars, in the following manner:—The first two channels and one division occupy 3 inches, the next three channels and four divisions take 6 inches, the next three channels and three divisions take 5 inches, the remaining 4½ inches being divided into four channels and three divisions. The channels in the bass may be slightly wider than the bars. Commencing now on the treble side of the thick bars, we have four channels and four divisions in a space of 5 inches; then four channels and four divisions in 4 inches; next four channels and four divisions in 3½ inches, then seven spaces and six divisions in 5½ inches. Now mark a bar 1 inch thick, and on the other side of it six spaces and six divisions in 4 inches, and then fifteen spaces and fourteen divisions in 7½ inches. The remaining 5½ inches is occupied by four spaces and four divisions, these

really being for the first four notes of the tenor octave, which are placed at this end of the sound-board for reasons which will presently be explained. In the treble portion of the sound-board the divisions, especially the very thin ones, should be wider than the spaces, in order to allow a firm seating for the pallets. Having marked out all these lines carefully, score over all the bars and the cheeks in order to prevent any mistakes being made hereafter.

It must, however, be specially noted that if couplers are to be attached to the organ the sound-board should contain 68 channels. The twelve extra channels will be at the treble end of the board, and will not require to be more than $\frac{3}{16}$ inch wide, and the divisions will each be $\frac{1}{4}$ inch thick. By making the larger divisions a little thinner and the channels a mere trifle smaller, these 12 extra ones can be got in without increasing the length of the sound-board.

We may now proceed to mark out the sliders and bearers. The two outside bearers are each $1\frac{1}{2}$ inch wide (measuring from the outside edges of the cheeks) and these may be drawn from end to end of the sound-board. Then, commencing from the back of the treble portion, set off a width of 4 inches for the width of the open diapason slider, and draw the line for it, allowing it to run $3\frac{1}{2}$ inches over the end of the board. Now mark a bearer 2 inches wide, a slider 3 inches wide for the keraulophon, then a bearer 1 inch wide, and a slider 3 inches wide for the stopt diapason. Draw another bearer 2 inches wide, then a slider 3 inches wide for the flute, the lower line of which you can carry right through the bass also. Now set off a bearer $\frac{3}{4}$ inch wide, and a slider $2\frac{1}{4}$ inch wide for the flageolet, continuing these lines also through the bass,

and thus, with the outside bearer already drawn, completing the width of the sound-board.

On the bass end, now set out, after the outside bearer at back, a spare slider $4\frac{1}{4}$ inches wide which may be used for a stop termed the "Violoncello," which will shortly be described, then a bearer 2 inches wide, next a slider for the stopt diapason-bass $4\frac{1}{4}$ inches wide, a bearer 2 inches wide, and a slider $4\frac{1}{2}$ inches wide for the flute bass, the lines for the next bearer and slider have already been drawn through from the treble. This completes the setting out so far, and we have now to show the positions of the several pipes. The pipes stand in double rows over each alternate channel, as shown in the sketch, the larger pipes being placed back to back, but should not touch each other. With the smaller pipes there will be no trouble whatever, as they will all stand over their proper channels; but as the pipes get larger they become more crowded, and it may become necessary to groove some of them off a few inches, so that they may have speaking room. This is especially the case with wood pipes, as they take up more room than either paper or metal ones. It is therefore necessary to set them all out on this board and mark the name of each note, and you will then see where every pipe will stand in the organ. It will only occupy a few hours, and the work will amply repay you in time and trouble that it will save afterwards. To set out the paper pipes all you have to do is to strike a circle with the compasses, the same diameter as the outside measure of the pipes including the tuning piece. Commence with the smallest pipe and work up to the largest and you will then see just how to place them.

In the case of wood pipes you will have to cut out a paper pattern of the outside size of the pipes, and

laying it on the drawing-board, draw a pencil line round it, and mark the name of the note in the square thus drawn.

We now arrive at the reasons for placing some of the larger pipes at the treble end of the sounding board. The object is to save space, and keep down the height of the organ. The usual method is to transfer each alternate pipe in the bass to the treble end, but the plan I propose possesses several advantages over this. The usual plan is open to several objections, viz., it is the tenor octave that is the most crowded and the most difficult to deal with, not the bass; transferring the bass pipes only does not keep down the height, as the open diapason and the keraulophon both run to 4 feet long in the tenor. It also becomes necessary to waste space by having another very thick bar in the treble, and the sliders require to be made so that one portion is at the bass end, and the other at the treble, thus making a very awkward piece of work. My method avoids all these difficulties, and by transferring the first four or six notes of the tenor octave to the treble end, you are enabled to plant three or four of the longest pipes in the bass of each stop off the sound-board, and three or four of the tenor octave of the open diapason and keraulophon can be planted off at the treble end; thus your longest pipe on the sound-board itself, is only 3 feet 4 inches (approximate) speaking length. You also obviate all crowding of the pipes and simplify the arrangement of the sliders, as the bass sliders, instead of running all through the length of the sound-board, are only the length of the bass portion, and thus, may be wide enough to accommodate all the pipes, and yet not be too hard to open and close. The flageolet slider runs right through, and the flute

can be made to draw in two parts or as a single slide. If it is intended to adopt the latter plan, which will save a stop-knob and connections, the slider can still be made in two portions and dovetailed together over the thick bars, as shown in Fig. 75. It is shown to draw from the bass end, but could just as easily be drawn from the treble by cutting a little piece out of slider or bearer, just over the thick bar. I may, however, state that in a small organ there is but little objection to having the channels arranged for pipes in regular consecutive order from the lowest to the highest note. It simplifies the action somewhat, for no roller action is required, but the plan of transferring some of the larger tenor pipes to the treble end has the advantages which I have pointed out, and which appear to me to counterbalance the advantage gained by the simplicity of action in the latter plan.

If you adopt the plan of planting the largest pipes off the sound-board, you will require to do so by conducting tubes, as shown in Fig. 82; and as I have made the sounding-board of such a size as to obviate as far as possible the necessity for grooving, you will require little, if any, for the wood pipes, and none at all for the paper ones.

Having completed the drawing-board, hang it up in your workshop, so as to be convenient for reference whenever you may require it.

We now proceed to the actual construction of the sound-board, of which the setting-out of the drawing-board will have already given you a pretty good idea. First prepare a board of $\frac{3}{4}$ inch Honduras mahogany, 5 feet long and 1 foot 10 inches wide, finished measurement; plane it perfectly true, and square the sides and ends. If you are unable to get a thoroughly good

piece of mahogany, straight grained, free from knots, and well seasoned, use yellow pine of the best quality; for though mahogany is the best, good pine is better than bad mahogany.

Now set off on a rod all the bars and spaces marked on the drawing-board and transfer them to the table, and square them right across the board with a T square, scoring all the divisions as shown in the drawing-board, and from another rod mark the positions of the sliders and bearers.

Prepare the bars and divisions from perfectly sound well seasoned yellow pine, making them of the requisite thickness, and as long as the table is wide, that is 1 foot 10 inches, and they must all be exactly the same depth, viz., not less than 3 inches. If you cut them from a board 11 inches wide, divide it into three, and after sawing, plane them all up to the size of the one that happens to be the narrowest. Should there be the least knot or shake in any of these bars, throw it aside and prepare another one; for it must be borne in mind that if the wind is allowed to pass from one channel to another it will probably be necessary to pull the sound-board to pieces in order to remedy the defect. The pieces thrown aside will not be wasted, as they can be cut up to form the fillings-in hereafter described, and the knots and bad places need then be the only parts absolutely rejected. When you have prepared all the partitions, etc., the grooves should be made in the underside of the sound-board to receive the two 1½ inch bars forming the ends, and also for the three thick divisions in the bass and treble portion, as described a little later on. Then take the two 1½ inch bars forming the ends, and having made sure that the edges are planed perfectly level and square, screw

them on to the top of the table at each end (not on to the side which you have grooved out, which is the underside), the screws being inserted through the centre line of the *bearers*, not through the sliders. Then screw on over their proper positions the thick bars dividing the bass from the treble, and also the thick bar which comes in the centre of the treble portion. These bars are only fixed here temporarily, in order to keep the table rigid and flat during our next operations, but it is very important that it should be done. Then screw on to both ends of these bars a longitudinal piece of the same depth, and as long as the sound-board. The whole affair will then have the appearance of a frame placed edgewise and secured to the sound-board table. One or two small screws may be driven through the sound-board into these longitudinal pieces to firmly secure it to the board.

Without some such means being adopted to keep the board rigid, the large quantity of hot glue used in fixing the channel bars would cause the board to warp and twist, and thus entirely spoil it. Turn the board over again, and go to work on the under side, and groove out all the scored bars to a depth of $\frac{1}{8}$ inch, using either a grooving plane or a chisel. You can cut the groove at each side with a sharp-pointed knife, or a tenon saw, using a straight-edge to guide it, and after taking out the intervening wood, smooth the bottom of the grooves with the tool called an "old woman's tooth," and you will then secure a uniform depth also. Now plane the bars and divisions so that they just fit nicely into their proper grooves, but not so tightly as to require forcing in, and be sure that they all bed flat down into their places. Give every division a coat of very thin hot glue on both sides to stop

all the pores, and set them up to dry. When dry you may proceed to glue them into their respective grooves, working them backwards and forwards a little to secure a good joint. I need hardly say that the grooves and the edges of bars should both be glued. For all the work connected with the organ use only the best French or Russian glue, which is of a very light colour. Thick black-looking glue, that is sold at about 4*d.* or 6*d.* a pound, is useless for any work that is intended to last. The glue should be broken up and soaked in cold water for ten or twelve hours, then placed in a proper glue pot, and boiled down. It should be used fresh, and boiling hot, as glue that has often been remelted, or that has become cool, will not hold well.

After all the other bars have been glued in and allowed to get dry—twenty-four hours at least should be allowed—you can take off the top pieces and glue them into their proper grooves; then cut up a lot of pieces of pine for filling-in pieces, and glue in a piece about $\frac{3}{8}$ inch thick between the ends of every bar, so as to entirely fill up each end of the channels, as shown at B in Figs. 76, 77, and 78. At a distance of $7\frac{1}{2}$ inches from the front edge of the table fill in a piece of $\frac{3}{8}$ inch pine to receive the pallet hinges; these pieces may be about 4 inches long. Remember you are working on the under side of the board, and that, therefore, if the bass portion is on your left hand, the front of the board is the edge farthest from you. These fillings-in are shown at G on the diagrams.

While this is drying plane up two pieces of sound pine 1 inch thick, and the total depth of the channels including the thickness of the table, which will make them about $3\frac{3}{4}$ or 4 inches wide, and as long as the table. These pieces are for the front and back cheeks,

and when glued on as I shall describe, will make the sound-board 2 feet wide. The gluing of the fillings-in should be allowed at least two days to dry, and then you may plane up both edges of the sound-board perfectly true, and place the cheeks in position so that their top edges are flush with the top of the table, and the bottom edges flush with the edges of the divisions. With a stock and bit drill two holes through the cheeks into the ends of each of the thick bars, to receive a screw 3 or 4 inches long. Take the cheeks off and brush a copious supply of glue over the ends of the bars and fillings-in and also over the cheeks, working the glue well in. Then place the cheeks in position, and work them well down into their places the same as you did in gluing in the divisions, insert the long screws and screw them tightly up. When quite dry take these screws out, and in their places drive in a long peg of hard wood well glued, and the cheeks will then hold on as long as the sound-board will last.

Prepare the ends of the wind-chest, making them of 1 inch pine, the exact width of the sound-board, viz., 2 feet, and $4\frac{1}{2}$ inches deep, and then plane up the back of the wind-chest, or wind-bar, as it is termed, making it 4 feet $10\frac{1}{2}$ inches long, $4\frac{1}{2}$ inches deep, and at least $1\frac{1}{4}$ inch thick. In the centre of it cut a hole 12 inches long and 2 inches wide to admit the wind from the bellows, and near each end cut a similar hole, 5 inches long and 2 inches wide, for the pedal wind trunks, if you intend having a separate pedal organ; or these holes may be made one in each end of the wind-chest. The sound-board should then be stood aside for two or three days to get thoroughly dry.

Assuming that all the gluing is quite dry, you may now plane down the whole of the under surface of the

channel bars and cheeks, testing it very carefully to ensure its being perfectly true, then glue and screw on the ends of the wind-chest so that they come flush with the outside ends of the sound-board, thus leaving $\frac{1}{2}$ inch of the thick end bars on the inside to allow the pallets to bed on them. Tack some thin boards all over the under surface to protect it from injury during our subsequent operations, and then turn the sound-board over so that the top is uppermost. Take the smoothing plane and plane down the table till it is as true and level as the surface of a mirror, and then with your rod set out on it the positions of the sliders and bearers. Plane up some $\frac{3}{8}$ inch mahogany of superfine quality and possessing the straightest possible grain, cut it to the sizes of the several sliders and bearers, and shoot all the edges perfectly true. The sliders must be long enough to project about 3 inches beyond the ends of the sound-board to allow for the stop action. Screw the bearers down in their places with thin $\frac{5}{8}$ inch screws, sinking the heads of the screws below the surface, but do not place these screws over the thick bars. Place the sliders in position so that they fit tightly between the bearers, then plane up some good $1\frac{1}{4}$ inch pine for the upper boards, of which you will require three for the treble side, the one over the flageolet side may run right through the bass, and two short ones for the bass portion. They are made of such a width that they just come to the centres of the wide bearers, as shown in the sections, Figs. 76 and 77. Plane up some good $\frac{3}{8}$ inch or $\frac{1}{2}$ inch pine for the rack boards, making them exactly the same sizes as the respective upper boards. To avoid confusion I have only shown the rack boards at the back in Fig. 82, but it will be understood that

they cover the whole top of the sound-board. Lay these flat on the upper boards and screw them tightly down on to the table, the screws passing through the bearers and table into the several thick bars which are made for the purpose of receiving them.

Now mark right across the top of the rack board the centre line of every channel, then draw lines showing the two rows of pipes over each slider, and where these lines intersect the cross lines will be the centre of each hole for the pipes to stand in. With centre bits of the requisite size bore the holes right through all these boards into the channels. Most amateurs bore a little slanting, so the best way to manage is to bore the holes partly through from one side of the board, and then go round to the other side and finish them, and you will thus neutralise this tendency. The sizes of the holes are of course regulated by the sizes of the pipe feet, and they will be about $\frac{7}{8}$ inch for CC, $\frac{5}{8}$ inch for tenor C, and $\frac{3}{16}$ inch for top G in the stopt diapason. Open diapason the same size for the same notes. The flute will be about $\frac{5}{8}$ inch for CC, $\frac{3}{8}$ inch for tenor C, and $\frac{3}{16}$ inch for top G. Keraulophon the same as the flute for the same notes. Flageolet CC, $\frac{5}{16}$ inch, tenor C, $\frac{3}{16}$ inch, top G, $\frac{1}{8}$ inch.

The six lowest notes of the largest pipes should be made by boring two holes side by side, and then taking out the intervening wood, thus forming one oblong hole, as shown on the plan in Fig. 75. A piece of $\frac{1}{4}$ inch mahogany is then glued over each of these holes on the top of the upper board, and a hole is bored through it to receive the foot of the pipe, or for the conveyance tube, as the case may be.

It will be noticed that I have placed an extra slider

at the back of the bass in continuation of the open diapason. This space being there you may, if you please, place a stop of twelve pipes upon it, as it will give you more power and variety in the bass, which will be very useful, especially if you do not have a 16-feet pedal stop. The stop I recommend is termed the Violoncello, and is made like a stopt diapason, with a straight upper lip. It is shown in section on the left-hand side of Fig. 82, and you will observe that there is a diagonal line passing from the level of the top edge of the bottom lip to the outside of the ears; this represents a piece of thin wood, which just fits in between the ears, and is glued in that position. Make these twelve pipes exactly the same size as the tenor octave of the open diapason, the mouth to be cut up one-third the diameter, and the top of the pipes to be covered with a cap the same as in the stopt diapason. The size of the holes through the feet, and of the holes to be bored through the sound-board, will be the same as for the tenor octave of the open diapason; and the six lower holes to be enlarged as described for the other bass stops. When all the holes have been bored for the pipes, do those for the rack pillars—boring them in any convenient position where they will not interfere with the screws—carrying them about three parts through the upper boards. You may then take off the rack boards and enlarge the holes in them, so that the pipe feet will fit them at the required height; and also enlarge the holes over the screws, so that a screwdriver can be let down to ease or tighten the screws as may be required, in consequence of change of temperature causing the sliders to stick or run loose, as the case may be.

The next proceeding will be to scorch all the holes through the sound-board with a red-hot iron rod, to

clear out all roughness. The tops of the holes in the upper boards should also be slightly countersunk, so that the pipe feet may fit in perfectly airtight.

Take off the upper boards, sliders, and bearers, and test the surface of the table to see that it is quite true; if not, make it so. Now look at Fig. 80, and you will notice that three different sorts of grooves are there shown as existing between all the holes. These are the various methods adopted for preventing the accumulation of waste wind between the table and the sliders, or between the sliders and the upper boards, which would otherwise cause a ciphering of the pipes.

You may adopt either or all of these methods, but your first proceeding will be the same for each, viz., to mark on the ends of the table and upper boards the position of each slider, draw the lines along the under side of the upper board, and then make a little channel $\frac{1}{10}$ inch wide, and the same depth along each side, where the edges of the sliders would come, and between every hole run channels crosswise into the long ones. This grooving may be done with a V tool, or a chisel, or even with a red-hot wire. All waste wind will be carried off by these little channels, and conducted to the outside of the sound-board. The same thing must be done on the table, under every slider. Now take the block of wood with the cork on it, mentioned in Chapter I., and stretch a piece of fine glass-paper over the cork, then carefully rub down the burrs raised in making the channels on the table and the under side of the upper bar boards. Fix the sliders and bearers in the proper places by means of a small brad at each end, punching the head of the brad below the surface, and then plane down the slides and bearers perfectly level. Take them off again carefully, and draw out the brads,

and cut a slot in each slider, as shown, over the thick end bar, to allow the proper distance for the movement of them. The bass may be drawn out an inch, and the treble sliders $\frac{3}{4}$ inch each. Drive a stout wire pin into the end bars through each slot level with the top of the sliders, and that will prevent them being drawn any further, but they may be lifted off when required. A piece of thin mahogany, cross-way of the grain, should now be glued on the underside of each slider at the end where it is to draw, and a square or round hole made through to receive the ends of the levers, which are shown in Fig. 82, but will be described in a subsequent chapter. Give the sliders, the top of the table under them, and the under side of the upper boards over them, a good dressing with the very best black lead, to make the sliders work smoothly. Cut a strip of thick cartridge paper and glue it smoothly on the top of each bearer, and that will allow just sufficient play for the sliders.

If there is any grooving off of the pipes, that should be the next operation. Suppose you find there is not room for a pipe to stand in its proper hole over the channel, you place it as near to it as you conveniently can, and cut a deep groove in the upper board from the hole to where the pipe stands; the grooves should be at least an inch wide and made quite smooth. The inside should be coated with thin glue to prevent shakes opening, etc., and then a piece of $\frac{1}{4}$ inch mahogany should be glued over the top of the groove to close it in, and a hole made in it for the foot of the pipe, where it is intended that it should stand. By this method the wind can be conveyed to any portion of the sound-board where it may be desired to place the pipes; the only rules to be observed are that the grooves should be

large enough to convey plenty of wind, and that there should be no sharp turns, but if the groove is deflected from the straight line, it should be by a curve.

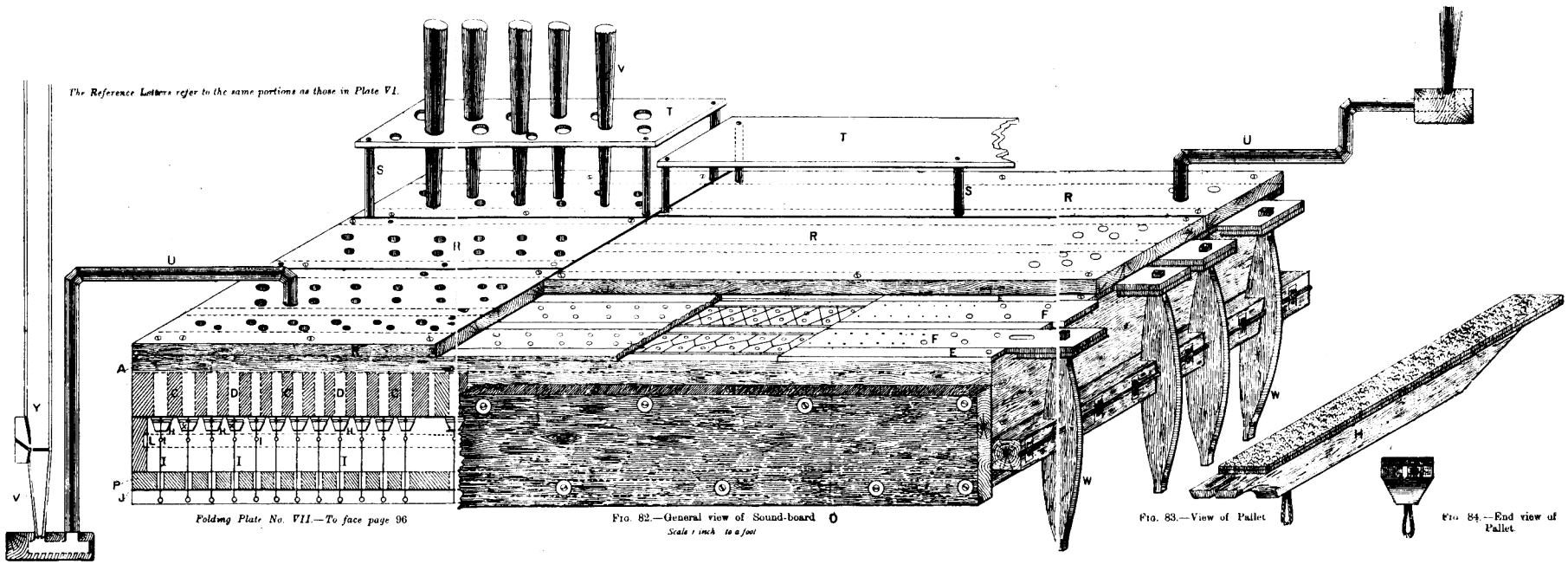
Another kind of grooving is shown in Fig. 81, and is termed a "borrowing groove." This would be required in the small two-manual organ, mentioned in Chapter I., as the compass of the swell organ only extends down to tenor C, and the bass of the great organ has to do duty for both the great and the swell. This is a proceeding which has nothing whatever to recommend it, when viewed from a strictly musical standpoint, as it follows that the bass, which should be nearly equal in power to the treble, is really very much weaker; but the plan is often adopted in small organs simply to save expense and to keep down the height of the instrument. The stopt diapason slider should be placed at the back of the great sound-board, and the upper board should extend over it and also over the slider in the swell organ, as is shown by the dotted line in Fig. 77. A groove is then made in the upper board, connecting each bass channel in the swell with the corresponding channel in the great, and a hole is bored through at each end into the channels just the same as though a pipe stood at each end of the groove. It will thus be understood that, although there are no bass pipes in the swell, the sound-board is made with fifty-six channels exactly corresponding with those of the great sound-board. Over the holes at each end of the grooves a leather valve is placed, which opens upwards into the groove. These valves are made by gluing two thicknesses of soft white sheepskin together, with the soft side outwards, allowing a single thickness only to form the hinge. Cover the top of the groove with thin mahogany in the usual

way, and bore the hole through it to receive the foot of the pipe in any convenient place, so long as it does not come immediately over either of the valves. Now on pressing a key in the bass of the swell organ, the little valve flies open and the air is admitted into the groove and passes out through the pipe. The little valve at the other end keeps closed, and thus prevents the wind passing down into the channel of the great and causing all the pipes to sound for which stops might be drawn. The converse would be the case on pressing a key on the great organ.

Where grooves cannot be used, tubes are convenient for conveying wind to pipes when they are planted off the sound-board, whether at the sides, back, or front of the organ. These tubes are generally made of metal, and are costly; but the amateur, profiting by his experience in making paper pipes, can make these tubes in just the same way, painting them inside and out to preserve them. There should be no sharp angles, but all turns must have a double joint, as shown in Fig. 82, where one pipe is shown at a higher level, and the other at a lower level than the sound-board. The wind is conveyed to all speaking fronts in this way. The conveyance tubes should always be as large as possible, never less than 1 inch internal diameter. The pipes can be stood on a board and the tubes can enter the board at any convenient part. The rack pillars should be 4 or 5 inches long in the bass, and about 3 inches for the treble, and may be made either round or square; the top and bottom portions should fit tightly into their respective holes (which may be made in any convenient position), and should be black leaded, so as to be easy to remove at any time that may be required.

Having completed the upper portion of the sound-

The Reference Letters refer to the same portions as those in Plate VI.



Folding Plate No. VII.—To face page 96

FIG. 82.—General view of Sound-board 0
Scale 1 inch to a foot

FIG. 83.—View of Pallet

FIG. 84.—End view of Pallet.

board, turn it over again and take off the thin boards which were bradded on to protect the under side. Shake and blow out all the chips and dust from the channels, and after seeing that the surface is quite true, glue a sheet of stout cartridge paper, allow it to stretch, and then fasten it down over the entire surface of the channel bars, rubbing it well to ensure its perfect adhesion everywhere and be very careful to see that there is no inequality in the surface, however slight, as it would prevent the pallets closing properly. When dry, cut out the paper where the pallets are to come, using a sharp penknife.

The pallets must now be made by jointing up a board of sound yellow pine 4 feet 10 inches long and rather over 8 inches wide, the grain running *across* the board; plane it perfectly true on one side, and on the other side plane it so that it is $\frac{5}{8}$ inch thick at one end, and only $\frac{3}{8}$ inch at the other. Lay it over the pallet holes, the thick end at the bass, mark the centre of every channel bar on the board, square the lines over, and then saw it up into separate pallets. When jointing it up, see that the joint comes over a bar, and not over a channel, and before sawing it, run a rebate $\frac{3}{4}$ inch wide all along the front edge, so as to leave the thin piece on the level side. If this rebated edge is French polished it will give the pallets a very neat appearance. After separating the pallets plane them to shape, slope off the tail end, and make a cut in the front end with a tenon saw, to a depth of about $\frac{3}{8}$ inch, as shown in Figs. 83 and 84. At $\frac{3}{4}$ inch from the front bore a small hole right through the pallet, and enlarge it on the upper side, pass a loop of thin whipcord through this and gently drive a glued wedge in between the two ends of the cord to hold it firmly, and then trim it off nice and

level with the top of the pallet. The pallets, when finished, should be wide enough to lay at least $\frac{1}{8}$ inch on each channel bar. Now get a piece of strong, but very common, calico that has been washed, and glue the pallets on to it side by side, allowing the calico to project 3 inches at the tail end. Cut them apart when dry, and then glue them on to a strip of stout felt in just the same way, but not allowing any felt to project at the tail. Cut apart again, and then glue them on to a piece of the best sheepskin leather, allowing 3 inches extra for the hinge, the same as with the calico, which should be neatly glued down against the end of the felt and over the leather. Some use two thicknesses of leather instead of felt and leather, and if this is done, both pieces of leather should overhang at the tail end as shown in Fig. 83. The grain surface of the leather must be well roughened with glass-paper, or the glue will not hold. When dry, cut the pallets apart with a sharp knife, and then sprinkle some whiting on a sheet of glass-paper, and gently rub the soft leather surface of the pallet on it until the whiting is worked into it. The pallets may now be glued in their places on the channel bars. The tail or hinge piece is glued, and the glue allowed to touch about a $\frac{1}{4}$ inch of the end of the pallet, and it is then rubbed down on the filling-in piece at the back of the pallet-hole. Be careful to get the fronts in a straight line, and then give each pallet a tap with a hammer to bed it on the channel bar so as to make it fit quite air-tight. Now drive a stout pin or wire into the front cheek through the little saw cut in the front of each pallet. This is the guide pin, and it prevents the pallet from shifting sideways, but allows it to move easily downwards. The guide pins may project a little

more than an inch from the channel bars. In many organs a guide pin is put on each side of the pallet, but it is obvious that, whilst it does no more than the front pin in preventing lateral movement, it gives two chances of the pallet sticking, in consequence of dampness, or from the pins getting bent. Cut strips of leather 4 or 5 inches long, and glue one over the hinge of each pallet, carrying it right up to the top of the sloping tail of the pallet.

We now come to a disputed point in organ building, viz., whether or not a fillet of wood should be screwed tightly down over the leather hinge of the pallet, as shown in the sketches. I have shown a fillet there, that it may be adopted or not, but I myself prefer its absence to its presence.

The springs of the pallets are made of No. 18 or 19 steel wire, as shown in the sketch, and the method is as follows: Drive two pieces of stout wire into a board about 5 inches apart, and forming the apex of an equilateral triangle with the wires, insert a peg of hard wood about $\frac{3}{4}$ inch in diameter. Now take a piece of spring wire, place it against the first wire peg, then carry it up to the wood peg, and twist it twice round and continue the wire down to the next wire peg, and bend it against it. Cut it off with the nippers at the points where it bends round the wire pegs, slip the spring off, and make both the arms of it curve a little inwards, and it is finished. Make all your springs on the same pegs and they will all be alike. Now make a slip of wood rather longer than the length of the interior of the wind-chest, 3 inches wide and about $\frac{1}{2}$ inch thick, on the back edge of this glue a slip of $\frac{1}{4}$ inch mahogany $1\frac{1}{2}$ inch wide, and immediately under the centre line of each of the pallets make a tenon saw cut $\frac{3}{4}$ inch deep in this

mahogany slip. Place the springs in these saw cuts, and bore a little hole in the pallet $4\frac{3}{8}$ inch from the front edge, and a similar hole in the pine slip, and insert the bent ends of the springs in the holes. The spring rail may now be fastened in its place by screws or buttons. The thumping rail is made of a slip of wood $\frac{3}{4}$ inch thick, and $1\frac{1}{4}$ inch deep. It is nearly as long as the sound-board, and is let into a groove in each end of the wind-chest, at about 1 inch below the fronts of the pallets, so that it prevents them being pulled down more than an inch. It should be covered with leather or cloth on the top edge, and should be fastened in position by a button or screw, so as to be easily taken out, if required, to get at the pallets.

Now dovetail the back of the wind-chest into the ends, so as to make a good joint of it, and screw it down tightly on to the edges of the channel bars, but do not glue it to them. In order to make it air-tight, you may glue a piece of paper all over the joint at the back.

Now get some tinned iron wire (No. 19 gauge) and cut 56 pieces, and make a neat little hook at one end of each piece with a pair of round-nosed pliers, so that it will hook on to the whipcord loop of the pallet and hang down rather more than an inch below the under side of the bottom board of the wind-chest. This bottom board is merely a piece of inch pine, the size of the wind-chest, to which it should be tightly screwed when in position. Immediately under each of the loops bore a hole in the bottom board fully $\frac{1}{4}$ inch in diameter, for the pull down wires to pass through. Now procure a strip of stout sheet brass 5 feet long and $1\frac{1}{2}$ inch wide, and drill a very small hole in it over the centre of each of the holes in the bottom board. Enlarge these

holes with a fine rymer, very carefully, so as to make them just large enough for the pull down wires to pass through without any wind escaping round them. This plate of brass is now fastened down on to the bottom of the wind-chest by a fillet of wood being screwed on each side of it, as shown at J, in Figs. 75 and 76. Unhook all the pull-downs, make a little loop at the bottom end where it hangs below the brass plate, and then hook them up again.

It now only remains to make the front of the wind-chest, which is merely a $\frac{3}{4}$ board of pine or mahogany. See that the front edges of the wind-chest are quite level all round with the front cheek of the sound-board, and then glue a strip of soft leather all round where the front will come on. Screw the front on with long, thin round-headed screws, with brass washers or shields, to prevent the heads drawing into the wood, and be sure that no air escapes round the joints.

The method I have described for making the sound-board is the one I adopt myself and recommend, but some builders merely glue the edges of the bars on to the table without grooving them in. This plan, however, is not so strong, and increases the danger of leakage from one channel to another, especially in sound-boards of amateur construction, and as it takes longer in gluing, it does not really save much time. Another method is to put the sides and ends together first, and then groove the bars into the sides, putting the table on last, which is a rather difficult job. This plan also requires extreme accuracy in planing, but if a good board cannot be procured, the table may be formed by gluing slips of $\frac{3}{4}$ inch pine in between each channel bar, and thus forming a solid top.

The 2-manual sound-board may be made in two

distinct boards, and then glued together, or may be made all in one, and divided by filling in pieces, as shown at Q, in Fig. 77. One wind-chest will supply both sound-boards, as it extends under the whole surface of them. The great pallets open at the front and the swell pallets at the back. The holes for the wind-trunks must be made in the ends of the wind-chest. The general instructions for making the single manual will apply to the two-manual.

For a small organ, containing from 1 to not more than 4 stops, a very compact arrangement is to make the sound-board double, as shown in Fig. 79. The front portion contains 44 channels, thus taking all the pipes down to tenor C. The back portion has only 12 channels for the 12 bass pipes in each stop, and the pipes will thus stand in a single row over each bass slider. The divisions should be made double in the bass sound-board, in order that the channels may not be too large, about $1\frac{1}{4}$ inch being wide enough for the largest channel, and $\frac{7}{8}$ inch for the smallest. The width of the slider for the flute bass and also the width of the bass portion of the sound-board may be considerably reduced by grooving off the flute pipes so that they stand opposite the space between each of the stopt diapason pipes, as indicated in Fig. 79, and it would only involve 2 or 3 inches of grooving for each of these 12 pipes. The length of the sound-boards may be from 3 feet 3 inches to 3 feet 9 inches, or longer if you like, as the more room there is, the better the pipes will sound. The bass pallets will open at the back and the treble ones at the front, and the wind-chest will extend under the two sound-boards in exactly the same way as is shown in the section of the two-manual in Fig. 77. The action will be described in due course. For a

1-stop organ, the treble and bass sound-boards should be each about 5 inches in width (clear length of channels), the channels being 2 inches deep. The dimensions already given for widths of bearers and sliders, depths of channels, etc., will apply to any organ having more than one stop.

CHAPTER VI.

THE BELLOWS.

WE now take up the construction of the bellows, upon the action of which depends in a great measure whether the organ shall or shall not be a pleasure to play upon. If the bellows are too small, or the valves imperfect in action, or the leather joints too tight, so as to cause squeaking, they would be a never-ending source of annoyance both to the performer and the audience. By carefully following the instructions which will be given herein, the amateur will, I hope, be enabled to construct a perfectly reliable article.

A glance at Fig. 101 will give an idea of the general appearance of a reservoir with two feeders, as seen from the back. The upper portion consists of two distinct folds or sets of ribs, the upper set folding outwards and the lower set folding inwards. These ribs are fastened to framings, or boards—the top one marked A, being called the top board; B, the floating frame; C, the middle board, and D, the trunk-band. The feeder boards are marked E. In Fig. 102 you have a section of the bellows across the feeder, and this view being on a large scale, shows every detail of the construction, both inside and out. You will notice that there is a set of valves on the top of the

feeder board, and another set on the top of the middle board, both sets opening upwards. In its normal position, the feeder would hang down, so that it would be open to its fullest extent, and filled with air. On pressing the blower down, the feeder would be closed, and the air within it driven into the reservoir, and, on allowing the feeder again to descend, the valves in the reservoir would close and prevent the return of the air, whilst, at the same time, the valves of the feeder would open and admit the air into it, to be driven into the reservoir at the next upstroke of the feeder.

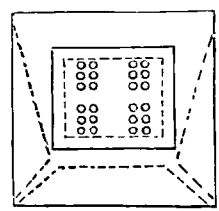


Fig. 86.—Plan of Feeder. Scale, ½ inch to 1 foot.

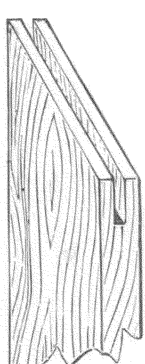


Fig. 87.—Method of Making Joints.

In the top board of the reservoir a safety-valve is placed, which, on the folds rising to a certain height, is opened by a string, and the surplus air escaping at this valve, thus prevents any danger of the bellows bursting from too much air being forced into them. Weights are placed on this top board, and these give the necessary pressure to drive the air out of the reservoir, through the wind-trunks into the wind-chest of the sound-board. The folds of the bellows working opposite ways cause this pressure to be equal, no matter whether the bellows are wide open or nearly closed. If the folds were both inside or both outside folds, the pressure would be constantly varying. With this brief introduction, I now go on with my instructions for making the bellows.

First, then, prepare some ¾ inch and 1¼ inch pine for the framings, and cut it up into pieces about 5 inches wide. The top frame is 4 feet 6 inches long, and 2 feet wide, and 1¼ inch thick; the next, or floating, frame is exactly the same size, but this latter frame

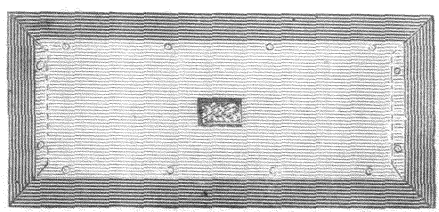


Fig. 88.—Plan of Upper Board. Scale, ½ inch to 1 foot.

need be only ¾ inch stuff. The middle board frame is 4 feet 9 inches long, and 2 feet 3 inches wide, and should be made of 1¼ inch stuff, as it bears all the

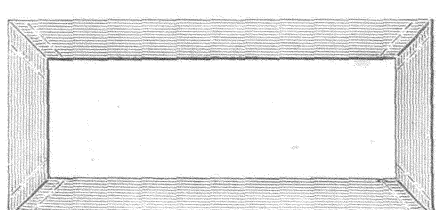


Fig. 89.—Plan of Floating Frame. Scale, ½ inch to 1 foot.

weight of the bellows. This frame has a bar of the same thickness, and 4½ inches wide, across the centre (mortised and tenoned in), as there are to be two valve-boards.

All these frames are to be put together by mitring the corners, and then cutting a groove in each, as shown in Fig. 87. They are then glued together with

a tongue of oak or mahogany, *cross way* of the grain, in the grooves, and cramped tightly up, thus forming a strong and air-tight joint. The tongues are shown by the dotted lines at the corners of Fig. 89. Ordinary mortise and tenon joints will not do, as they are not sufficiently strong, and if the wood shrinks at all, they are not air-tight.

Having completed these framings, now make the trunk-band, which is made of 1 inch pine $3\frac{1}{2}$ inches wide, and forms a sort of tray when glued and screwed in its place on the middle board. The outside measure

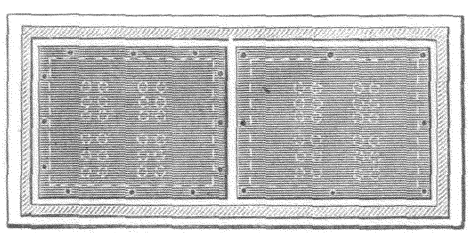


Fig. 90.—Plan of Valve Boards.

of this band is 4 feet 6 inches long and 2 feet wide, being exactly the same size as the floating frame. It should be carefully dovetailed together at the corners, the holes for the wind-trunks being cut in the back of it before it is put together. The hole for the wind-trunk for the sound-board is shown in the centre, and those for the pedal wind-trunks on each side of it. It must, however, be borne in mind that the wind-trunks may be placed either at the back or at the ends of the instrument, as may be most convenient.

In a two-manual instrument having separate wind-trunks, the wind-trunk for the great sound-board is at one end, and that for the swell sound-board at the

other. Only one trunk is, however, needed, if one wind-chest supplies both sound-boards. Now prepare two valve-boards 2 feet long, 1 foot 7 inches wide, and ¾ inch thick, plane them very true, and then bore four sets of six holes in each, as shown in Fig. 90. The

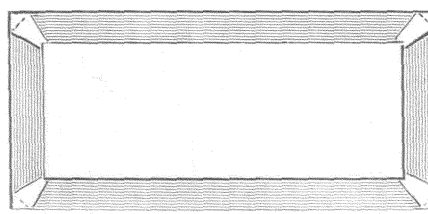


Fig. 91.—Plan of Ribs for Upper Fold. Scale, ½ inch to 1 foot.

holes may be about 1¼ inch diameter, and should be made with a centre bit. The floating frame is left just as it is, for it is nothing but a frame. The top

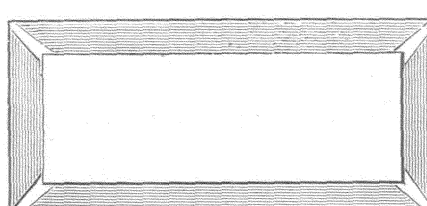


Fig. 92.—Plan of Ribs for Lower Fold. Scale, ½ inch to 1 foot.

frame should have an inch board prepared for it about 4 feet long, and 1 foot 7 inches wide, with a hole about 5 inches by 3 inches cut through the centre of it, for the safety valve. These boards will be screwed down perfectly air-tight on to their respective frames, but should not be fixed until the bellows is all complete, as it is so much easier to glue the ribs into their places when the framings only are there.

Now prepare sixteen pieces of pine $\frac{1}{2}$ inch or $\frac{3}{8}$ inch thick and $3\frac{1}{2}$ inches wide, for the ribs. You will require eight long ones and eight short ones: those for the top fold are shown in Fig. 93, and those for the lower fold in Fig. 94, from which you will also get the length required. Be careful in cutting the angles to the slopes shown, or they will cut through the leather gussets when in use.

When you have cut all the ribs bevel off the edges of them as shown in the cross sections, Figs. 95 and 96.

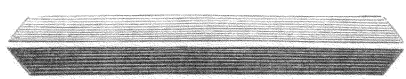


Fig. 93.—Ribs for Upper Fold. Scale, $\frac{1}{2}$ inch to 1 foot.

We will now go on with the leathering, etc., of the reservoir, leaving the feeders till this is finished. It must be understood that each joint in the ribs is made by a strip of linen, or, what is better still, of Venetian



Fig. 94.—Ribs for Lower Fold. Scale, $\frac{1}{2}$ inch to 1 foot.

blind tape on the inside and a strip of leather on the outside. You will commence by laying each pair of ribs together on a board, or on top of your bench, as shown in Figs. 93, 94, and 95, leaving a space of $\frac{1}{8}$ inch between them, and fasten them down with a small French nail at each end, so that they cannot shift. Now glue a strip of blind-tape over the two ribs of each set in the upper fold, and a strip of leather over each set in the lower fold, for one will be the inside and the other the outside. The glue must be used thin and

boiling hot, and the leather should be half-strained white sheepskin, cut into strips about 1½ inch wide, and pared down at each edge on the soft side, so that when the strips are glued down there will be no perceptible ridges at the edges, and therefore little risk of anything catching against the leather and tearing it off. A very useful tool for rubbing the strips down so as to squeeze out all superfluous glue can be made by fitting a piece of thin ivory—such as is used for covering the manual keys—into a saw cut in the end of a piece of wood, about 6 inches long and 2 inches wide. The other end may be formed into a

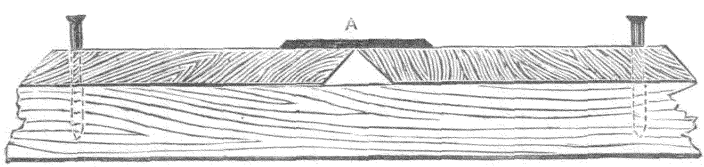


Fig. 95.—Ribs Fastened on Board for Leathering or Taping. Half full size.

convenient handle. A bowl or can of nearly boiling water should be kept at hand, and all superfluous glue and smears wiped off the leather with a sponge.

The leather must be glued on the soft side, and should have two or three coats. When you have glued each pair of ribs together with the strips of tape and leather, and they are quite dry, fold them together as shown in Fig. 96 (which is an endwise section), so that the tape or leather comes inside the fold. It is a good plan to place a strip of wood or cardboard about ⅛ inch thick between the lower edges of the ribs at c, to keep them that distance apart while the next operation is performed. Now glue a strip of leather over the bevelled edges of all those that are already taped,

and *rub it well down* on to the tape; and glue a strip of tape in a similar way on to the ribs that have been leathered. This leathering and taping is shown by the black line on the top of the bevels in Fig. 96. You have now each pair of ribs joined all along the centre by a piece of leather on the outside, and a piece of tape on the inside, and as the two ribs are $\frac{1}{8}$ inch apart the hinge works very easily. Now see that the inside edges of the top frame and of the floating frame exactly correspond, then take some strips of leather and fold them lengthways down the centre, and glue the top half of them on to the under side of the top frame, close to the inner edge, all round, so that the other half of the strips hang down, and proceed in the same way with the top side of the floating frame, but leaving the *upper* half of the leather sticking up. Do exactly the same with the under side of the floating frame, and close to the outer edge, and also on the top of the trunk-band, but using tape instead of leather for these. When this is dry, fix the ribs into their places by gluing the other halves of these strips of leather on to the outside top and bottom edges of the upper folds, and the halves of the tape strips on to the inside top and bottom edges of the lower folds. Allow these to dry, and then glue a strip of tape over the inside of the top frame and the inner edge of the top ribs, and the same with the bottom edge of the top ribs and the inner edge of the floating frame. Proceed in a similar way with the outer edges of the lower fold, only of course using leather instead of tape.

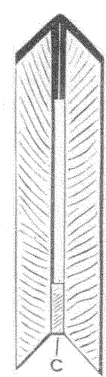


Fig. 96.—Method of Joining the Ribs. Half full size.

The section, Fig. 102, shows the positions of the tape and leather for every joint, so I think a little study of the diagram will make clear to the amateur, what it is rather difficult to describe in writing. Care must be taken not to let the edges of the ribs grind against the woodwork of the frame, but the leather and tape should touch each other about $\frac{1}{8}$ inch. Leaving the reservoir for the present, we will now take up the feeders.

The bottom board of each feeder is formed by a framing the same as the other boards, and each measures 2 feet 2 inches in length, and 2 feet in width. The back piece is 6 inches wide, the front piece 8 inches, and each side is 6 inches wide; thus leaving an opening 14 inches long and 10 inches wide, which is covered by a valve board 17 inches long and 13 inches wide, to be screwed on when all is complete in the same manner as the other boards are. Each valve board to have four sets of six holes $1\frac{1}{4}$ inch diameter, to be covered by valves as described hereafter. The ribs of the feeders are to be made of $\frac{1}{2}$ inch pine, the end ones being as shown in Fig. 97, 2 feet long on the longest side, and 1 foot long on the shortest, and are all $5\frac{1}{4}$ inches wide. The side ribs are triangular, and rather more difficult to set out; they are shown in Fig. 98. First draw on a board two parallel lines, about 2 feet long and 5 inches apart. From a point at one end, set off a length of 1 foot $7\frac{1}{2}$ inches on the top line, now measure a length of 1 foot 11 inches from the same point down to the lower line, and draw a line joining the two points: thus obtaining the sloping side. Join the 1 foot $7\frac{1}{2}$ inch point to the 1 foot 11 inch point, and your shape will then be complete. Make four ribs like this for each feeder, and then cut off about 3 inches from the pointed ends, for these

ribs must not extend right to the hinges of the feeders. Proceed with the leathering and taping of each pair of ribs in just the same way as you did with those for

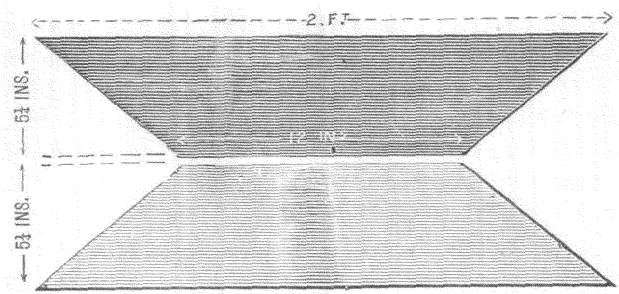


Fig. 97.—End Ribs of Feeders. Scale, 1½ inch to 1 foot.

the reservoir. Now plane up two strips of ¾ inch pine 2½ inches wide, and bevel them off, and glue and screw them on to the inside of the feeder boards where the

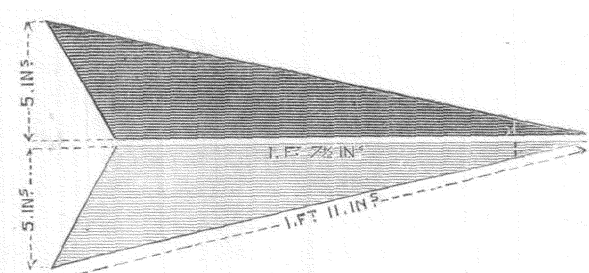


Fig. 98.—Side Ribs of Feeders. Scale 1½ inch to 1 foot.

hinges are to come, and fix similar pieces on to the middle board immediately over them. The feeder boards may now be hinged on to the middle board by four strips of stout webbing to each. Fasten the strips with glue and tacks, the ends to be one inside and the

other outside, in exactly the same way as the webbing hinges are put on a clothes horse. Or you may bore some holes through the feeder frame and middle board, and draw some stout sash-line through and fray out the ends and glue them down, driving wedges into the holes to make a good strong job of it. In either form of hinge it is necessary to glue a strip of leather both inside and outside, along the edge of the feeder board. The ribs may now be glued into their places with strips of tape and leather, as described for the reservoir. Fig. 102 will show exactly how the joints are arranged.

The next thing to be done is to close up the corners of all the ribs by means of gusset pieces, both in the reservoir and the feeders. To get the sizes and shapes of the gussets, open the bellows until the holes at the corners show their greatest possible size, both in height and width, and cut a paper pattern to requisite shape, which is of a diamond form, allowing it to be large enough to lay on the wood at least an inch all round. Having satisfied yourself that your pattern is the right shape, cut out the requisite number of pieces in soft leather and pare down the edges all round. Glue them on very carefully, using boiling hot glue, or it will not hold. Rub them well down with the ivory tool, and sponge off the superfluous glue. Where the folds come in the centres of the ribs you will have to pinch up a piece of the gussets between your fingers, and when the glue is dry cut the pinched-up pieces off with a pair of sharp scissors. Then cut some strips of leather 4 inches long, pare the edges, and glue them over the centre lines of the ribs, so as to cover the part of the gusset that has been cut. Proceed in the same way with the gussets of the feeders. This gluing on of the gussets needs much patience, for it is a most troublesome job,

especially for the inexperienced. Cut out four small triangular shaped pieces and glue in one on each side of the feeder ribs over the gap at the hinge end, and the leathering will now be complete.

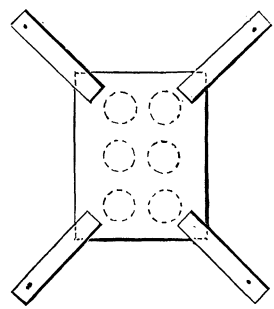


Fig. 99.—Method of Forming Valve.

Now to form the valves, take a good sized piece of sheepskin leather, and glue another piece on to it, so that the soft sides are both outside. You must not forget to scratch the grain side of the leather with glass-paper before gluing, or the glue will not hold. Pass a warm iron over this and place it between two flat boards to dry. When dry rub it well on both sides with a round stick to take out the stiffness, and then cut it up into pieces just large enough to cover a set of six holes with an overlap of $\frac{3}{4}$ inch all round. Now cut some narrow strips of leather and glue on to each corner of the valve, and then tack the other corner tightly down on to the valve-board, allowing the valve just the least play. This valve is shown in Fig. 99, and it is my opinion the most efficient valve in use, and it never curls up, for it is held down at each corner. The ordinary puff valve is shown in Fig. 100, and is made in much the same way of two thicknesses of leather, but the upper thickness does not cover the portion marked F, which forms the hinge. This hinge is glued down

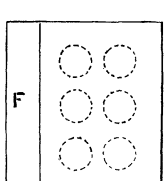


Fig. 100.—Puff Valve.
Scale, 1½ ins. to 1 ft.

on to the valve-board, and a strip of thin wood is bradded over it to prevent the valve from blowing right over. This is a good valve, but it sometimes curls up, and I much prefer that first described. Before fixing the valves glue a nice smooth sheet of stout writing-paper over the valve holes, and when dry cut the holes through with a knife, and you will then have a good smooth bed for the valves to lay on.

The valve-boards may now be screwed into their respective places, using round-headed straight screws with washers, and placing a strip of leather between the joints to make all air-tight.

The safety valve is a piece of $\frac{5}{8}$ inch pine $\frac{3}{4}$ inch larger all round than the hole which it covers, and it should be lined with a double thickness of leather. The leather should extend an inch or two over at the back to form the hinge, which is glued down on to the under side of the top board, and a fillet of wood bradded over it. The valve is kept closed by a wire spring as shown in Fig. 102, and is opened by means of a string, which is fastened to a staple in the middle board, and brought through the safety valve and knotted outside. If you allow the bellows to rise 8 or 9 inches it will be ample.

You will now see that in consequence of the way in which the bellows is made you have only to take out a few screws in order to get at any part of the interior should anything go wrong. In the old style of bellows with solid boards instead of framings the only way to get at the valves was by ripping up the bellows, and I well remember my disgust when I had to perform that awful operation on the first bellows which I made, and the waste of time and material in repairing the damage thus caused.

The only thing necessary to complete the interior of

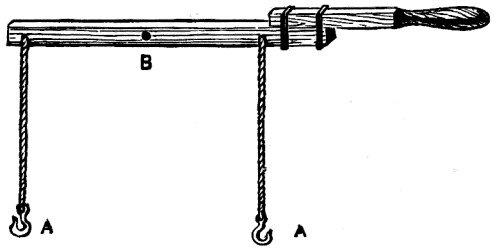


Fig. 104.—Hand Blower.

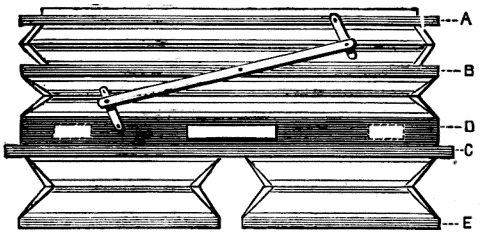


Fig. 101.—Back Elevation of Bellows.
Scale, ½ inch to 1 foot.

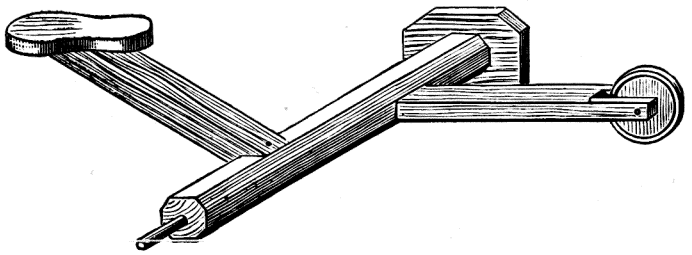


Fig. 103.—View of Foot Blower.

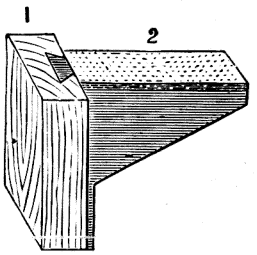


Fig. 105.—Movable Support for Ribs.

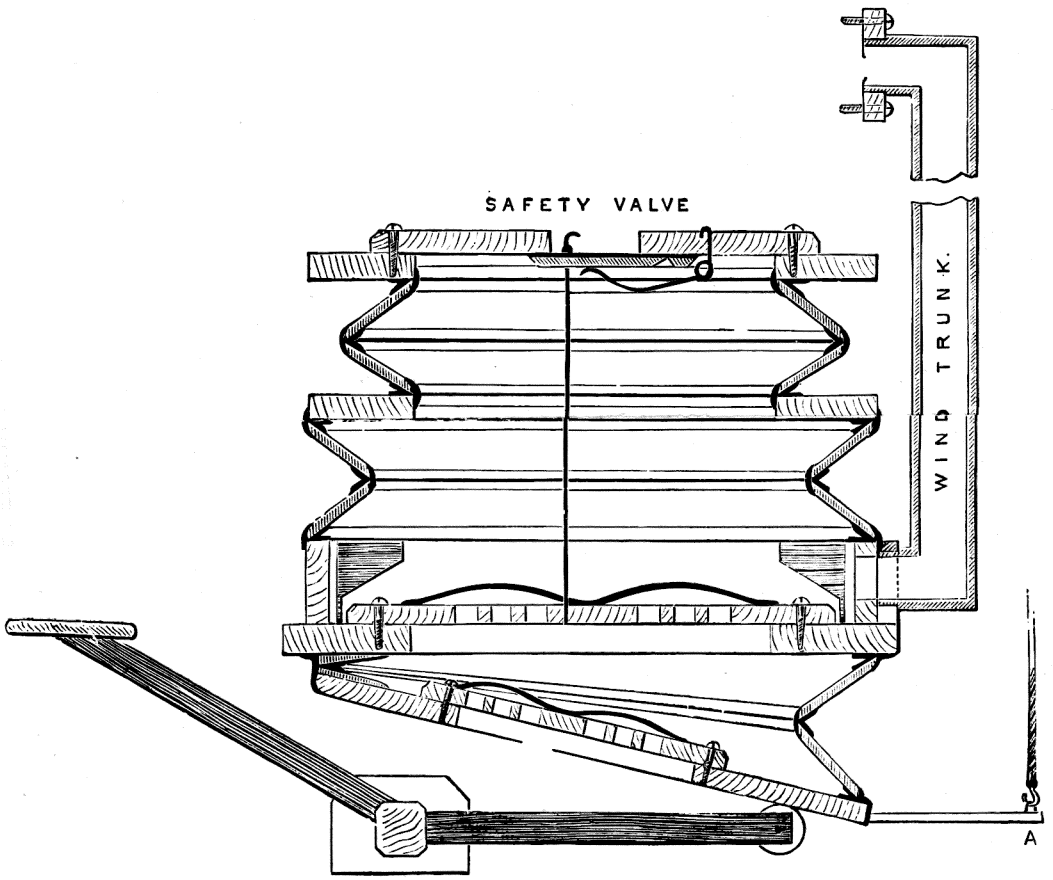


Fig. 102.—Section of Bellows, with Blower. Scale, 1½ inches to 1 foot.

Folding Plate No. 8, containing Figs. 101—105, to face page 117.

the bellows is to put in six supports for the ribs. These are simply pieces of wood shaped as in Fig. 105, covered on the top with two thicknesses of leather, and fixed to the inside of the trunk-band, two on each side and one in the centre of each end.

In order to enable you to take out the valve-boards when necessary, you must make some of these supports movable, which will be easily accomplished by making them in two parts; the portion marked 1 in Fig. 105 to be fixed to the trunk-band, and the part marked 2 to be dovetailed into it, so that it can be slipped in or out as required.

The wind-trunks are square, or rather oblong-shaped tubes made of $\frac{1}{2}$ inch pine, and mitred at the bends. They are connected to the wind-chest or trunk-band by means of a flange plate, which is a flat piece of mahogany, about 3 inches longer at each end than the length of the opening, and about $\frac{3}{4}$ inch wider on each side than the width of it, and an opening the size of the interior of the wind-trunk is cut in the flange plate. Thus, if the outside size of the wind-trunk is 13 inches by $2\frac{3}{4}$ inches, the flange plate would be about 19 inches by $4\frac{1}{4}$ inches. The wind-trunk is halved into the flange plate, as shown in Fig. 102. The plate is screwed to the wind-chest or trunk-band, as the case may be, and a thickness of leather placed between the joints.

In order to secure the equal and parallel opening of the bellows a pair of regulators will be required. One of these is shown in Fig. 101, and it consists of three pieces of thin flat wood, or metal, jointed together. The long piece is centred on the floating frames, the top short piece on to the top frame, and the lower short piece on to the trunk-band. All the centres work loosely. The other regulator is placed at the front of

the bellows, but the long piece slopes in the opposite direction.

The bellows, if a small one, may be made with only one feeder, if preferred, extending the whole length of the bellows, and hinged either at the front as described, or at one end. For the two-manual it would be better to make the bellows as wide as the combined width of the sound-boards, as the larger they are the better. The instructions already given will apply just the same, the only alteration being in the dimensions.

The weighting for the bellows should, if possible, be flat metal weighting, done up in flannel to prevent damage to the woodwork.

Two views of a foot-blower are given in Figs. 102 and 103. It consists of a roller working on a pivot, centred at each end into brackets, which may be fixed to the building frame or screwed to the floor. An arm, with a little wheel at the end of it, extends from the back of the roller in such a position that the wheel comes directly under the centre line of the feeder. The wheel may be covered with an india-rubber tyre to cause it to work silently, and a strip of brass should be screwed on to the underside of the feeder frame for the wheel to work on. On the front of the roller another arm projects, sloping upwards, and it has a flat piece of wood, shaped to receive the foot, on top of it. This arm should be placed in the most convenient position for pressing with the foot. When the foot is pressed on this the other arm rises and closes the feeder, and when the pressure is withdrawn the feeder falls again. It is obvious that by altering the position of the arms the blower can be made to work either right or left of the performer.

Fig. 104 shows a hand-blower, which is required

where pedals are used. It is simply a flat bar of wood or metal, centred on the building frame or other convenient place, and cords hang down at equal distances from the centre, and are hooked into staples projecting from the centre of the feeder frame.

One end of the bar is extended and formed into a convenient handle, or the handle may be made separate and slipped into a pair of staples on the top of the bar when in use, and unshipped when not required. The cords should be of such a length that when one feeder is up the other is down.

Carefully test the bellows to see that there is no escape of wind, and remedy any defects that may show themselves.

When complete the woodwork of the bellows may be painted or covered with fancy paper, according to taste, but the leather work should be left as it is.

CHAPTER VII.

THE BUILDING FRAME AND MANUAL ACTION.

BY the building frame is meant the framework which supports the sound-board and pipes, the key-board, bellows, etc., and as these portions of the instrument are of great weight, it is very necessary that the building frame should be well and substantially constructed. A glance at Fig. 106 will show that no great ingenuity is required in the construction of this framework, as it consists merely of two posts and two cross rails at each end, joined together by two longitudinal rails or bars, on which rest two boards. The exact position of these bars and rails is a matter of considerable importance, and will vary according to the style of the instrument. The building frame shown in the sketch is for the organ described in Chapter I., Scheme 1, but the general method of construction will be the same for all the schemes I have mentioned, the only alterations being in the dimensions.

First prepare the four upright posts of yellow deal or pine, 4 feet 3 inches long, $3\frac{1}{2}$ inches, or more, wide, and not less than $1\frac{1}{2}$ inch thick. If wood or metal pipes are largely used, the posts should be 2 inches thick at least. The cross rails are the same thickness as the posts, and 6 inches deep, and should be tenoned

right through the posts, so that, when finished, the outside width of the frames measures 2 feet 2 inches,

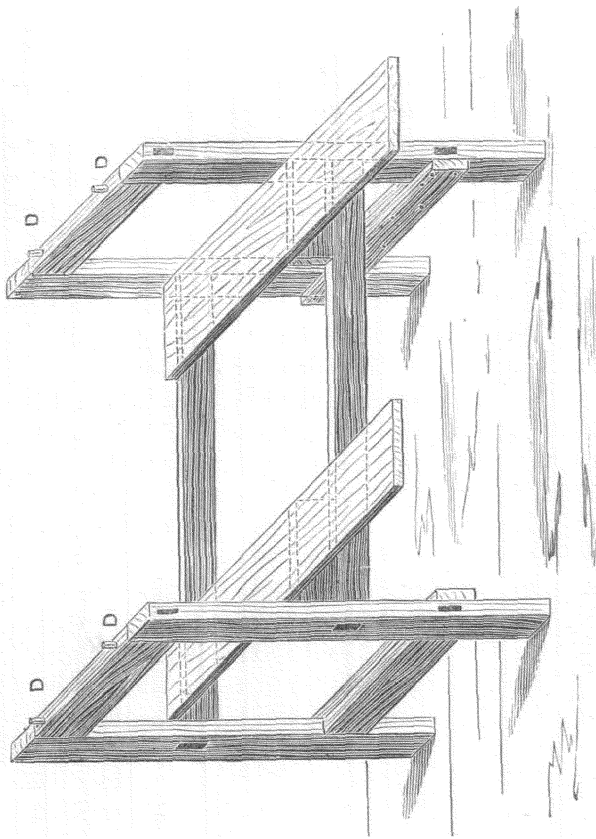


Fig. 106.—The Building Frame. Scale, ½ inch to a foot.

thus being a little wider than the sound-board. The top rails are placed so that the top edges of them are just level with the top of the posts. The top edges of the lower rails should be just 14 inches from the

ground. On the inside of these lower rails another rail, exactly the same size, and 1¼ inch thick, should be strongly glued and screwed. On these inner rails the ends of the middle board of the bellows will rest; and if there are no wind-trunks at the ends of the bellows, a similar rail 3 or 4 inches wide may be screwed at a distance above the others, equal to the thickness of the bellows-board, thus forming a groove into which that board will just slide without allowing any upward play. But if there should be a wind-trunk at either end, this upper rail must be omitted, as it would come in the way of such wind-trunk.

Having made the two end framings exactly similar in every respect, they must now be joined together by the two longitudinal rails which should each be 5 feet long, 4½ inches wide, and 1¼ inch thick. The back rail is tenoned into the back posts so that the top edge of it is 2 feet 8 inches from the ground; the front one is tenoned into the front posts so that its top edge is 2 feet 3 inches from the ground. This is on the assumption that pedals are so attached. If these are not required the rails will all be placed 4 or 5 inches lower. The distance between the end frames should be 4 feet 9 inches, so that it just allows the middle board of the bellows to slide in between them and rest on the rails screwed on to support it. Now get out two pieces of deal 5 inches wide, 1 foot 1¼ inch long and 1¼ thick, and glue them edgewise on to the top of the front rail at each end, thus making the rail exactly the same height as the top of the back rail, and leaving an open space 2 feet 6½ inches wide. Now prepare two boards of ¾ inch pine, 1 foot 1¼ inch wide and about 3 feet 3 inches long, and screw them down on to the front and back rails so that the front edges over-

hang. On these boards the sides or cheeks of the key-board will rest, and the keys themselves will have a clear space under them for the necessary action to be placed in connection with the pedals. The ends of these two boards should be left square until the case of the instrument is decided upon, when they may be cut off to any shape or size that may be required, or as suggested in the sketch by the dotted lines.

The sound-board will rest on the top of the posts, and cross rails, and all that will be required to keep it in its place will be two little dowells, or pegs of hard wood, at each end as shown at D in Fig. 106. These dowells fit into holes in the under side of the wind-chest and cheeks of the sound-board, and the weight of it, especially when loaded with pipes, will keep it down firmly.

Fig. 107 shows the building frame complete with the sound-board, key-board, bellows, etc., in position. The middle board of the bellows must be secured to the rails by screws or buttons, as the case may require.

Two coats of paint would make the frame look all the nicer and preserve it from damage by damp, etc.

We must now consider what alterations would be necessary in order to make a building frame suitable for any of the other schemes which I have described. For either of the two-manual organs the only difference will be that it must be made 2 inches wider than the total width of the two sound-boards, and about 4 inches extra height allowed for the posts above the level of the boards supporting the key-board if octave couplers are to be used.

If no octave couplers are to be placed in any of these organs, either single or two-manual, 9 or 10 inches will be sufficient for the height of the under side

of the wind-chest above the top of the key-board; but if couplers are to be used, the height must not be less

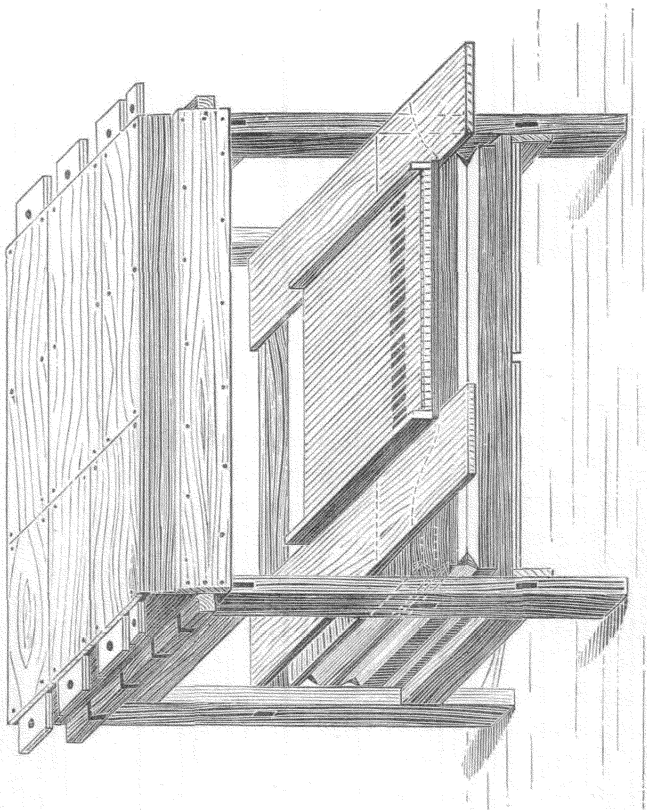


Fig. 107.—Building Frame, with Bellows, Sound-Board, etc., in Position. Scale, ½ inch to 1 foot.

than 15 inches, and for a two-manual this height must be measured above the upper key-board.

In order to make these matters quite clear, I now give a summary of the chief points to be attended to in constructing a building frame for any small organ :—

1. The outside measurement of it should be the same length as the sound-board, and slightly wider.

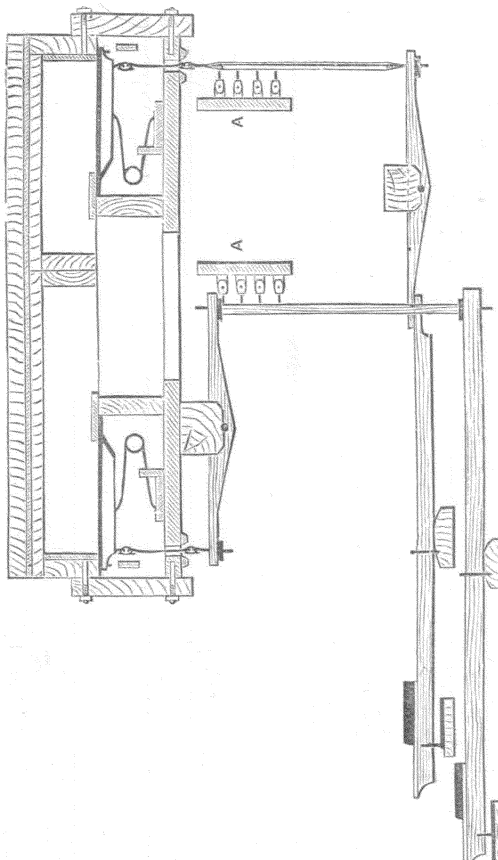


Fig. 108.—Action for Two-Manual Organ. Scale, 1 inch to 1 foot.

2. The top of the key-board should be about 28 inches from the floor *or above the pedals, if any,* and the under side of it would thus be about 25 inches from either of these points.

3. The middle board of the bellows should rest on rails not less than 11 inches above the floor, or above the pedal action, if any.

4. The key-board should project about 10 inches from the front of the under case or panelling, and the length of the projection of the boards supporting the key-board will depend on the existence or non-existence of a swell-box.

5. If an octave coupler is required, the height of the under side of the wind-chest above the key-board should be 15 inches at least; but if there is no octave

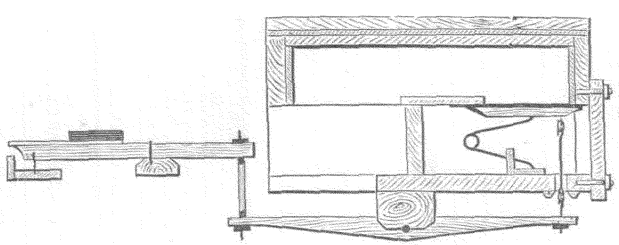


Fig. 109.—Action Below the Keyboard.

coupler, 9 or 10 inches will be sufficient. *Note.*—This height may be reduced in extreme cases, where the height of the room really demands it, but it renders it difficult to get at the action.

6. In a two-manual this height should be taken from the top of the upper key-board.

Where, however, the room is very low, or, for some other reason, it is required to keep down the height of the instrument as much as possible, the action can be made to pass below the level of the key-board, as shown in Fig. 109. The key-board may in this case be 2 or 3 inches higher from the ground. The building

frame would be very low, and thus effect a considerable saving.

Where pipes are planted off, they may be supported on a board placed on brackets screwed to the end posts.

We must now direct our attention to the manual action, which is the mechanism by which, when a key is depressed, the valve or pallet in the wind-chest

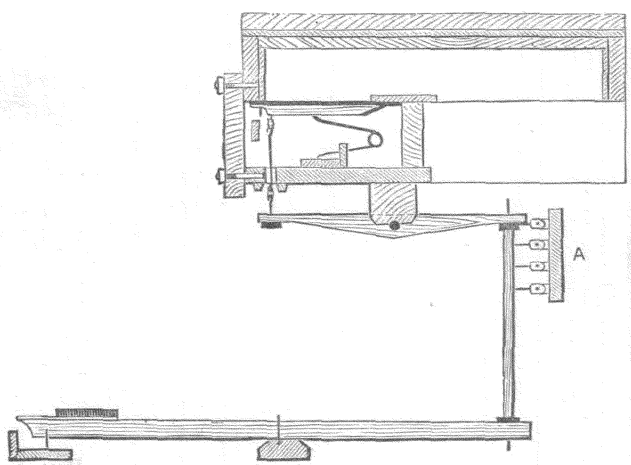


Fig. 110.—Action for Single Manual Organ. Scale, 1 inch to 1 foot.

belonging to that note is opened, and all the pipes over that channel, for which stops are drawn, caused to sound. Many are the ways in which this is accomplished, but we need only concern ourselves with two of them, namely, the fan-frame action, pure and simple, and the fan-frame modified by the introduction of a few rollers.

Fig. 110 shows a side view of both these actions, the roller board being marked A. It will be seen that

on the end of the key-tail is an upright rod of thin wood, termed a sticker, with a wire in each end of it, the lower wire passing through the key-tail and the upper one passing through the end of a thin piece of wood termed a backfall. This backfall works on a centre wire, and in a groove cut in a square balk of wood termed a backfall rail, or bridge, and the other end of it is connected by a tapped wire with the pull-down of the pallet. Thus, when the front of the key is pressed down, the tail of it is raised, and with it the sticker and the back end of the backfall. The front end of the backfall consequently descends, and brings with it the tapped wire and the pull-down, and thus opens the pallet. When the

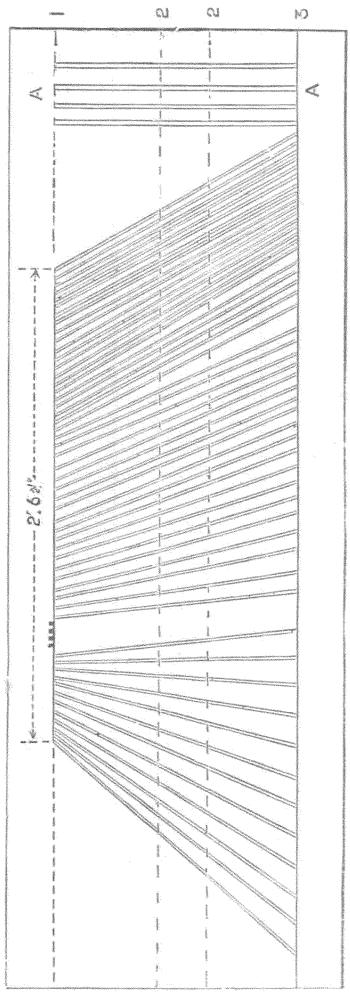


Fig. 111.—Plan of Backfalls.

pressure on the key is taken off, the action returns to its original position. A set of these is required for every note on the key-board, and, as the back ends of the backfalls are immediately over the key-tails, and the front ends are immediately under their respective valves, it follows that, as the sound-board is longer than the key-board, the backfalls spread out in the form of a fan, thus giving rise to the term fan-frame action. A plan showing the radiation of the backfalls is given in Fig. 111. The action of the roller will be better understood if described later on.

First make the stickers, which may be either square or round. If square they may be cut off a plank of good sound pine $\frac{3}{8}$ inch thick, either with a saw or a cutting gauge, and finished off with glass-paper, so that they are rather less than $\frac{3}{8}$ inch square. They may be made in long pieces and cut up to the required lengths afterwards. If round stickers are required, take a $\frac{3}{8}$ inch bead plane and run a bead all along one edge of the $\frac{3}{8}$ inch plank, turn the board over and run a bead along the outer edge of the same side, as the two quirks will nearly meet the bead will easily crack off, and present the form of a round stick, which will only require finishing off with glass-paper to make it present a neat appearance.

When the stickers are cut to the required length insert a piece of tolerably stout tinned iron, or phosphor bronze, wire in each end, allowing it to project $1\frac{1}{4}$ inch. See Fig. 112.

The backfall rail should be next got out, it should be nearly as long as the sound-board, and about $2\frac{1}{2}$ or 3 inches square. It may be made of oak, mahogany, or pine, but whatever material is used should be sound and dry. The backfalls themselves should be $1\frac{1}{2}$ inch

wide and rather over $\frac{1}{4}$ inch thick, mahogany being the best material to use for them.

They should be cut to the shape shown in the sketches, and the lengths will depend on the lengths of the keys and the extent of the radiation. In order to find the lengths of the backfalls and the exact position of the grooves in the backfall rail in which they are to work you must now proceed to set out to full size the plan indicated in Fig. 111. Take a piece of smooth oard just long enough to slide in between the posts of the building frame, and wide enough to extend back an inch or two beyond the key-tails, while the front edge is an inch or two in front of the line of the pull-downs of the pallets. Now draw on it the line marked 1 1, immediately over the holes for the sticker wires in the key-tails, and mark on this line the exact position of every such hole, which is really in the centre line of each key. Keeping the board carefully in the same position draw the line 3 3 exactly under the line of the pull-down wires, and mark on it the position of every pull-down. These positions may be marked off on a rod and then transferred to the line on the board. Now join the points on the back line to the points on the front line, and this will give you the exact length of every backfall from the hole where the sticker wire goes through to the hole where the pull-

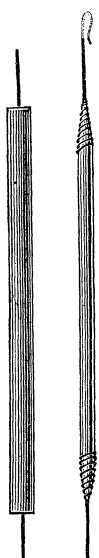


Fig. 112.—Sticker. Fig. 113.—Tracker.

down wire passes through, so you may cut them all about an inch longer. In joining these points do not forget that if the four tenor channels are transferred to the treble end of the sound-board, you pass over the 13th, 14th, 15th, and 16th points over the key-tail line and join the 17th point to the 13th point on the pull-down line, and so on, as the backfalls for the transferred channels are immediately under those channels and run square across the board, as shown at A A on the plan, Fig. 111. Now take the backfall rail and make a deep gauge mark all along the centre line of it, and make this mark correspond with the centre line of the backfalls as marked on the board. Lay the backfall rail in this position—with the gauge mark downwards—on the board, as shown by the two lines on the plan marked 2 2, and mark on both sides of it the position of the backfall lines, take the rail up and join these points, and you will then have the centre line of every groove for the backfalls to work in. With a fine tenon saw carefully saw down the grooves to a depth of 1¼ inch, allowing them to be just wide enough for the backfalls to work freely in them; take out the intervening wood with a ¼ inch chisel, and smooth the sides of the grooves with a flat file or a piece of glass-paper placed over a thin flat piece of wood.

The backfalls are inserted in their proper position, a stout wire run through the centres, and fastened down in the gauge mark on the backfall rail by means of narrow pieces of thin hard wood, or sheet brass being screwed over it with small screws. This plan is better than using staples, which are apt to split the rail, and cannot easily be withdrawn if required.

The centre wire should only run through those backfalls which run in a tolerably direct line across the

rail, but, where they radiate much, a separate centre wire should be used for each one, and fastened down as before described, as it does not do to let the axis pass obliquely through the backfalls.

The holes in the backfalls should all be made with a drill, and the centre ones must be bushed; that is, lined with cloth, in order to secure silent action. As this bushing of holes is necessary for many portions of the actions, it will be convenient to describe it now. And though it may seem rather a difficult and tedious operation to line with cloth a hole $\frac{1}{8}$ inch in diameter, it will not be found so in practice. Cut some strips of old woollen cloth—a piece of any old garment will do—about $\frac{3}{8}$ inch wide, and cut into lengths of $1\frac{1}{2}$ inch. Cut them into a point at one end, and pass this point through the hole to be bushed, draw the cloth a little way through, and glue the outside of it and draw that into the hole; pass a bradawl or a wire through the cloth to press it well down to the sides of the hole, and when dry, trim off the cloth close to the wood on each side.

Having completed the backfalls, the stickers may be put into their places by passing the top and bottom wires through their proper holes, previously, however, slipping a little disc of cloth or soft leather over the wires, so that the ends of the sticker may not rattle against the key-tail or backfall.

These cloths may be purchased for *6d.* or *8d.* a hundred, or if you prefer to make them yourself, you can do so with a $\frac{3}{8}$ inch hollow punch, and then make a hole in the centre of each for the wire to pass through. The cloths are shown in the several sketches by the thick line at the top and bottom of each sticker, but are drawn rather larger than the real size in order to make them conspicuous enough.

The front ends of the backfalls should come so that the holes through them are directly under the pull-down wires. A short length of wire tapped with a very coarse thread at the lower end, and having a small hook at the top end, is passed through the hole in the end of the backfall and hooked, in the manner which will be described, on to the pull-down of the pallet, and a leather button is screwed on to the tapped wire close up to the under side of the backfall. These leather buttons can be purchased very cheaply, or made by the amateur in the same way as described for the cloths. The hooked end of the wire does not hook on to the pull-down wire itself, but on to a small disc or oval of soft leather, as shown in Figs. 114 and 115, and the leather is then hooked on to the pull-down, thus securing silent action. This is most essential, as nothing is more annoying, when playing on the instrument, than to hear grating and rattling of the mechanism. The hooks of the handblower of the bellows should be hooked into a stout leather looped on the staple in a similar way, otherwise the hooks would be apt to slip out on the descent of the feeder, besides being noisy. Or you may use wood connections instead of rope.



Fig. 114.—Leather Connection.



Fig. 115.—Pull-Downs Hooked into Leather Connection.

The next thing will be the roller board for those

channels which are transferred to the treble end of the sound-board.

This may be made of $\frac{3}{4}$ inch mahogany about 3 feet 6 inches long and 6 inches wide; the rollers themselves are of mahogany, and must be thoroughly seasoned. They are made about an inch wide and $\frac{3}{4}$ or $\frac{7}{8}$ inch

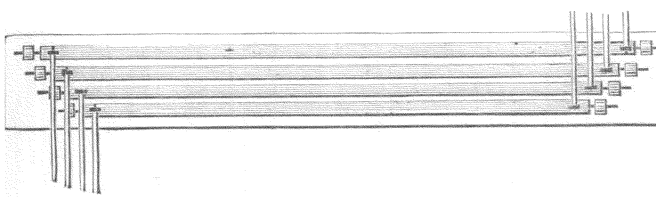


Fig. 116.—Front View of Roller Board. Scale, 1 inch to 1 foot.

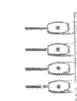


Fig. 117.—End View of Roller Board.

thick, rounded off on the top and bottom edges. They work on a centre wire which is driven into each end, and passes through a stud tenoned into the board, and these wires should project an inch beyond the studs,

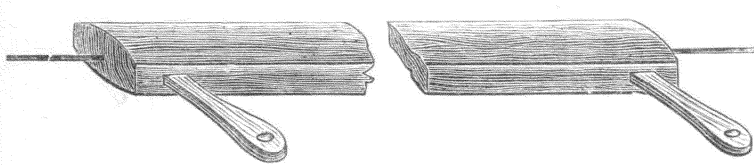


Fig. 118.— Enlarged View of Roller

to allow them to be drawn out by means of a pair of pliers if it should be required.

The rollers are shown in Figs. 116 to 119. Fig. 120 shows the studs, which can be expeditiously made in the following manner:—Cut a piece about $1\frac{3}{4}$ inch wide off the end of a $\frac{3}{4}$ inch board of mahogany; run a rebate along the top and bottom edges to form the tenon, and then round off the front edges. Drill a hole right

through, then cut the slip into separate studs about ¾ inch thick, bush the holes in which the centre wires of the rollers are to work, and then smooth all off with glass-paper. We have now only to make the roller arms, which may be either of metal or wood. If of metal, make them of stout wire flattened out at one end, and having a hole drilled in it as shown in Figs.

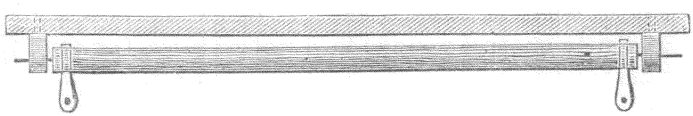


Fig. 119.—Plan of Roller Board. Scale, 1 inch to 1 foot.

118 and 119. Bore a hole in the roller slightly smaller than the wire of the arms, and then drive them into their proper places. The roller arms should project about 1½ inch from the roller, and the holes in them must be bushed. There are only four of these rollers, so, if you like, you may make them all the same length; and a strip of wood with four holes in it might be screwed on to each end of the roller board to receive the centre wires, instead of having separate studs. This method, however, would not do where many rollers were required, as it would so greatly increase the weight and bulk of the roller board. In some actions there is a roller for every key. Rollers may also be made of ⅜ inch iron gas piping by cutting it to the requisite length and inserting a wood plug in each end to receive the centre wires and the arms. A hole is drilled through, and the arm is then driven through

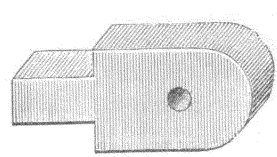


Fig. 120.—Roller Stud.

and riveted at the back. These iron rollers and arms should be painted over with Brunswick black to prevent rust. As it is very necessary that the rollers should be placed close together and occupy as little space as possible, the gas piping is preferable to wood, and besides does not warp. The exact positions of the roller arms must be obtained by actual measurement, the left-hand arm being immediately over the tail of the key to which it belongs, and the right-hand arm immediately under the end of its own backfall. The four transferred backfalls are shown at AA in Fig. 111, and the action of the roller is as follows: When the key is pressed down it pushes up a sticker as in the ordinary action, the top wire of the sticker, however, passes through the left-hand arm of the roller, instead of through a backfall. The right-hand arm of the roller is connected to the back end of its own backfall by means of a short sticker, and consequently that end is pushed up and the front end brought down as in the ordinary action. It is thus evident that, when a roller is used, the action can be transferred to any position right or left of the key pressed down.

For a two-manual instrument the lower manual is for the great organ and the upper manual for the swell, though the respective positions of the manuals are sometimes reversed. The great organ action is exactly similar to that described above, the stickers pass behind the swell keys, which is much better than making them pass through a mortise in those keys, as it then becomes impossible to alter one manual without interfering with the other. The backfalls of the swell organ rest at the front ends on the tails of the keys and should be thinned down where the stickers of the great organ pass between them (see Fig. 108). The key-tails of the swell manual

should have a disc of leather glued on them, where the backfalls touch, to prevent noise.

Sometimes a tapped wire is passed through the ends of the backfalls and key-tails, but this is not absolutely necessary. The valves of the swell sound-board pull down from the back, and instead of using a sticker for that purpose as for a thrust or push action, we use what is termed a tracker, which is always adopted where a pull action is required. These trackers are made either round or flat; if flat they are about $\frac{3}{16}$ inch thick, and $\frac{3}{8}$ inch wide; if round they are $\frac{1}{4}$ inch in diameter, and made with a bead plane the same as stickers. In either case the ends are cut pointed and a groove cut in them with a tenon saw. In this groove a tapped wire is placed, with the lower end bent and passed through a hole at the bottom of the groove (see Fig. 121); a piece of thin twine is then bound tightly round the ends of the trackers to hold the wire firmly, and is afterwards coated with thin glue. The wires are formed into a hook at the other end when required to hook on to a pull-down, or other connection. The backfalls are placed on a backfall rail the same as in the great organ, and the positions of the grooves in it are obtained in the same way as described for that one.

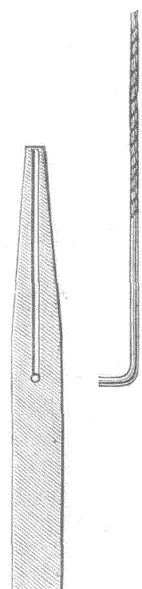


Fig. 121.—Top of Tracker and Tapped Wire.

If any channels are transferred on the great sound-board the same must be done on the swell, and a roller board made in exactly the same way.

In the small organ with the twelve channels for the bass placed at the back a roller board may be used for most of those channels. It is, however, quite possible to use long radiating backfalls, fixed at a slightly lower level than the treble backfalls, so as to pass beneath them, and in this case each backfall in the bass must be separately centred.

The action of the organ with the sound-board below the key-board (shown in Fig. 109) is simply a tracker

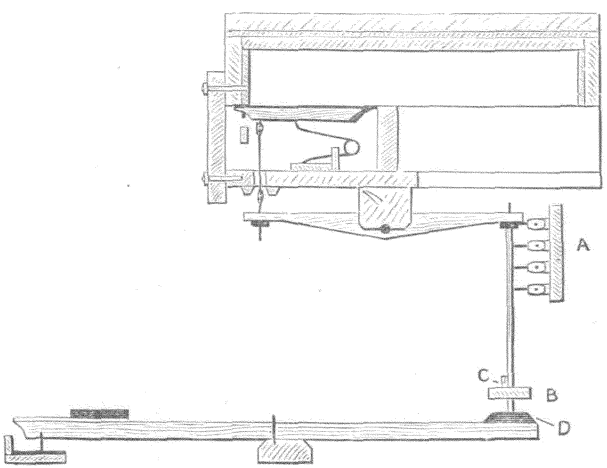


Fig. 122.—Sliding Key-Board.

and backfall action, the pallets being at the back instead of at the front, and needs no further description. The backfall rails of either of the organs are screwed on to the underside of the wind-chest, or to pieces connected with the building frame, according to the position required.

Fig. 122 shows an action for a single manual with a sliding key-board. In this case there is no wire at the

bottom of the sticker, but the stickers rest on a sloping ridge about $\frac{3}{4}$ inch high, which is made on the top of the key-tail and covered with soft leather. The stickers pass through holes in a rail, which is called a register, and are prevented from falling too low when the key-board is pushed in by having a little piece of wood glued on them. This arrangement permits the key-board to slide in like a drawer when not in use, and so prevents waste of space in the apartment. In Fig. 122 B is the register, C the piece of wood glued on to the sticker, and D the sloping piece on the key-tail.

A sliding key-board is also shown in Fig. 125, page 143.

CHAPTER VIII.

THE KEY-BOARD.

THE delicately-poised and accurately-constructed keys in a modern instrument present a great contrast to those in organs built in the Middle Ages, the keys of which were several inches wide, and so heavy that they required beating with the fist in order to move them, from which circumstance a performer on the instrument was termed an organ-beater. The physical exertions required to play on such a key-board must almost have equalled those of Gulliver when entertaining the court of Brobdignag with a musical performance, and of which he remarks that "it was the most violent exercise I ever underwent." The description of an ancient key-board may have furnished Dean Swift with his idea in this case.

In the key-board at present in use the natural notes of the chromatic scale are generally shown by white keys, while the sharps and flats are indicated by raised black ones. Even this is a reversal of the ancient practice, for the natural notes were black, and the sharps and flats were white. In some instruments of the present day, especially in those of Gothic design, the old order of the colours has been revived. I may

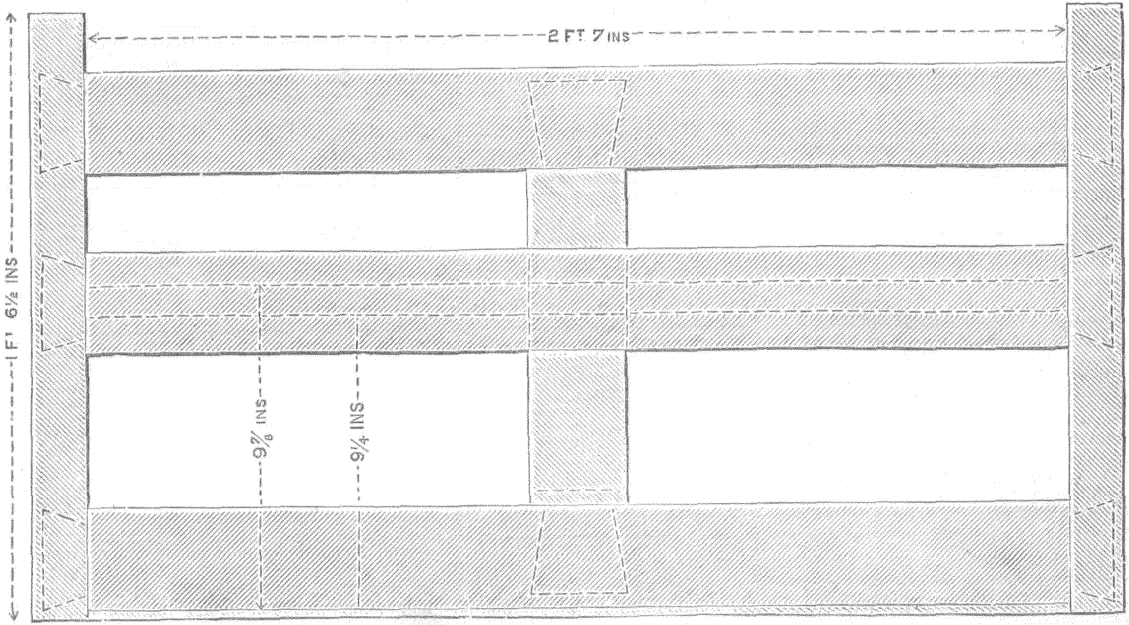


Fig. 123.—Plan of Frame of Organ Key-board, showing Cheeks, Front, Middle, and Back Rails, and Cross Rail, on scale of 2 inches to 1 foot.

mention that in the fine old organ at Exeter the old key-board is still preserved.

Many amateurs who are engaged in building the small organ described in these pages would no doubt wish to be supplied with instructions for making the key-board, so that the instrument may be truly described as being "all their own work." To enable them to gratify this laudable ambition, I will now endeavour to explain how the key-board can be satisfactorily made;

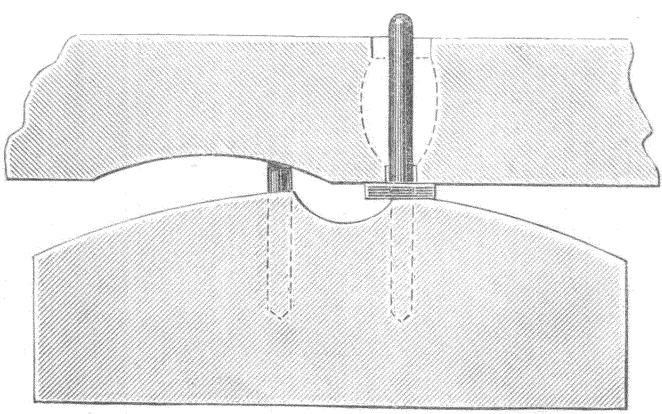


Fig. 124.—Full-size Section of Mid-rail, showing the shape of the Mortise.

but I must here impress upon all who intend to attempt this task, that every part of the work must be most accurately and carefully executed, or the keys will be a source of annoyance instead of pleasure.

To those who do not intend to make their own key-board, but who are not blessed with a long purse, I may hint that the key-board of an old piano may often be obtained for a few shillings, and can be easily converted into a suitable manual for the organ.

Before starting on the keys themselves, it is necessary

to construct the frame, of which a general idea will at once be gained on an inspection of the plan in Fig. 123. It consists of two sides, called the cheeks, and three rails, termed the front, middle, and back rails respectively, and a cross rail in the centre, to add strength. All the wood to be either oak or mahogany.

First prepare the cheeks, which are 1 foot $6\frac{1}{2}$ inches long, $3\frac{1}{2}$ inches high, and $1\frac{1}{2}$ inch thick. The front and back rails are 2 feet $9\frac{1}{2}$ inches long, $3\frac{1}{4}$ inches wide, and $\frac{3}{4}$ inch thick. The middle rail is the same length and width, but is $1\frac{1}{8}$ inch finished thickness, worked to

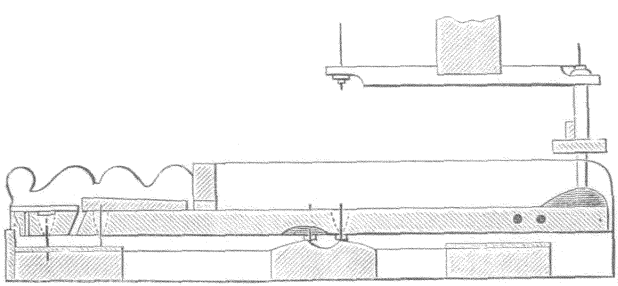


Fig. 125.—Section of Key-Frame and Keys, on scale of 2 ins. to 1 ft.

the shape shown in the section, Fig. 124, and the top of it stands $\frac{3}{8}$ inch higher than the top of the front or back rails. The cross rail is $\frac{3}{4}$ inch thick, and supports the other three. All the rails are dovetailed together and secured with screws, this plan being better suited for the purpose than mortises and tenons. The cheeks are 2 feet 7 inches apart in the clear.

The front and back rails should now be covered on the top with thick green baize, to secure silent action. The appearance of the key-board will be much improved if the front portion of the cheeks is cut out, as shown in Fig. 125, and the front edge should project

$\frac{1}{4}$ inch beyond the front rail to receive the bead, which runs along the front of the keys, to hide the gap between them and the key-rail. This bead should be $1\frac{1}{4}$ inch high, and $\frac{1}{4}$ inch thick. Having now completed the key-frame, the keys themselves should be commenced. They may be made of good mahogany or lime. Good yellow pine may be used, provided the mortises hereafter to be described are cut in hard wood, and let into the keys at the proper places. Joint up a board of $\frac{7}{8}$ inch stuff—mahogany, lime, or pine, whichever you intend to use—with the grain running across it, plane both sides very truly, and square all the edges. The finished size of it is to be 2 feet 7 inches long, and 1 foot 6 inches wide. With a compass, pencil, and T-square, set out the keys, as shown in Fig. 126. First draw the lines A, B, C, D, E, and F, at the following distances from the front edge of the board:—A, $\frac{3}{8}$ inch; B, $1\frac{5}{8}$ inch; C, $2\frac{1}{8}$ inches; D, $5\frac{1}{8}$ inches; E, 9 inches; and F, $9\frac{5}{8}$ inches. The lines A and C show the position of the front pins in the white and black keys, E and F the mid pins, and B and D the front and back edges of the combs or raised black keys. After drawing these lines, set out the white key lines, each of which is exactly $\frac{15}{16}$ inch apart. The compass of this key-board is to be from C C to G in the alto, but if a smaller or larger compass is required, the board must be proportionately reduced or extended in length. There are thirty-three white keys, and the size above given allows $\frac{1}{16}$ inch to spare. Then mark out the black keys, taking notice that they do not come in the centre of the white ones, but to the left or right of the centre as required, the object being to get as much room as possible on the white keys between each black one. The blacks are arranged in alternate groups of two and

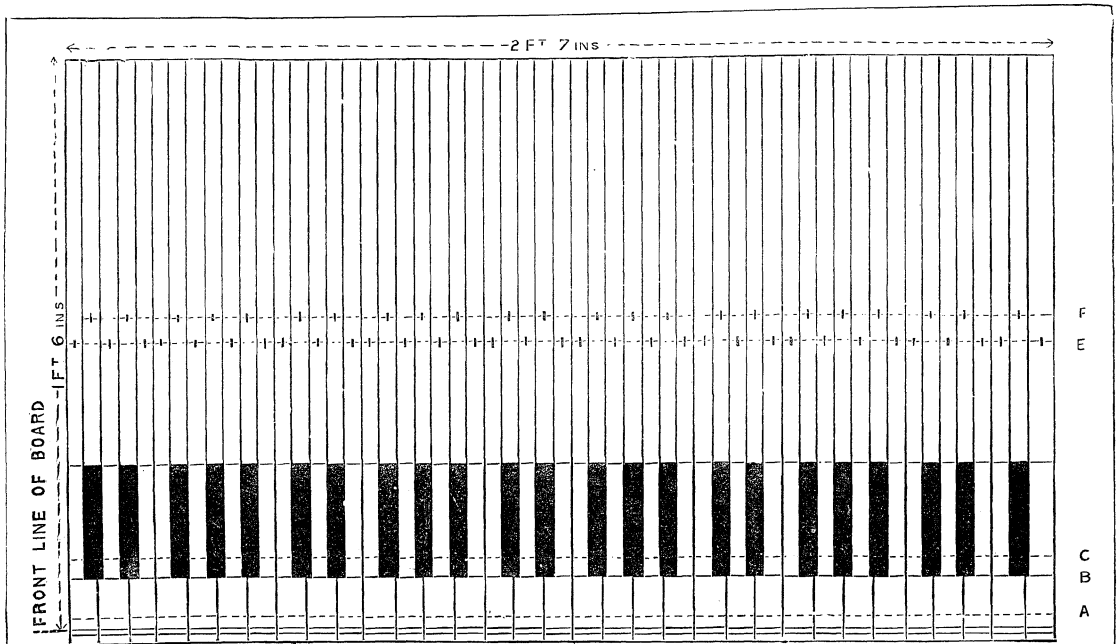


Fig. 126.—Diagram showing Method of Setting out Key-board, on scale of 2 inches to 1 foot.

three. Fig. 127 shows more plainly how the groups of three black keys are arranged with regard to the white ones. It will be as well to score across the black keys with a lead pencil, to distinguish them, or you may make a mistake in boring the pin mortises. When you have marked this all out, glue a slip of the

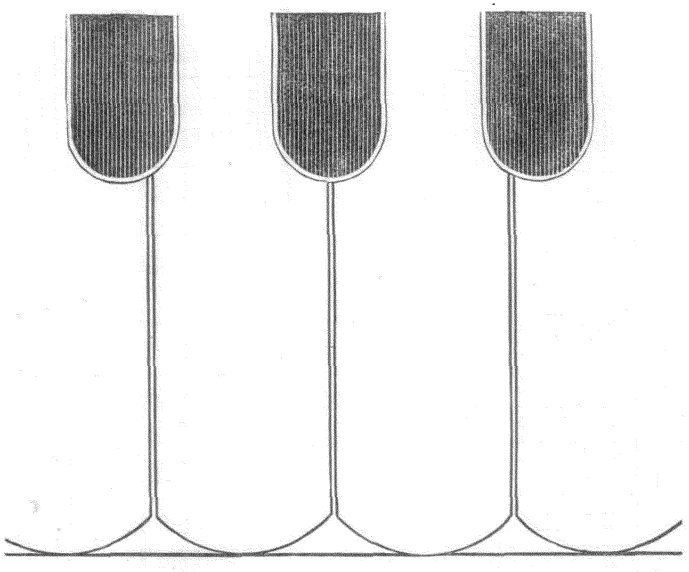


Fig. 127.—Full-size plan of front portion of Keys.

same wood as the board all along the front edge. This slip need only be $\frac{1}{8}$ inch thick, and it should be secured to the end of each key, as marked out, with two little pins or brads as well as with glue. Over this slip glue another of chestnut $\frac{1}{4}$ inch thick, and if you intend to have the fronts of the keys moulded, run the moulding on this slip (see Fig. 128). This moulding, though not

much used at the present time, forms an easy way of finishing the key fronts, is cheaper than ivory, and looks better than plain flat wood.

The board now being prepared, fasten it down on the key-frame, with its front edge level with the edge of the front rail, and with a centre-bit the exact size of the key-pins, bore the holes for the key-pins right through each key into the rails of the frame. You will thus have no difficulty in getting the pins exactly in

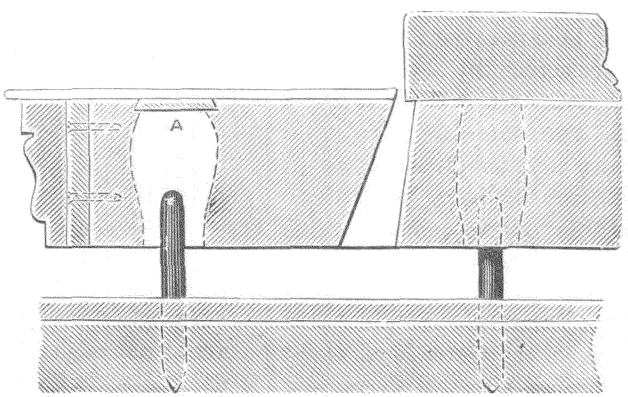


Fig. 128.—Full-size Section of front end of Keys.

their right places. Take the board off again, and cut the mortises, which should be done with a proper tool, viz., a chisel punch. If you cannot get this, use a small mortise chisel, the same width as the key-pins. The under side of the holes for the mid pins should be left untouched, but the top part is formed into a mortise, or slot, about $\frac{1}{3}$ inch long, and the width of the key-pin, the pin being in the centre. The mortises must then be cleared with the clearing tool if you can possibly get one, or if not, you must do the best you can with the mortise chisel. The clearing tool—a

small centre-bit, the centre of which is as thick as the key-pin—is inserted through the top mortise, and, on turning it, the wood is cleared away all except about $\frac{1}{8}$ inch at the top and bottom. The shape of the hole, when finished, is shown in Fig. 124. The object of this internal enlargement is to prevent unnecessary friction of the key on the pin, and the liability of sticking. The holes for the front pins have the slot or mortise at the bottom, and the top is bored out with a centre-bit, about $\frac{5}{16}$ diameter. In the white keys this hole is covered with a slip of thin wood which runs right across the key, and is let into it, as shown at A in Fig. 128. The black keys will not require this slip as the holes are covered by the thick ebony. Having completed the mortises, go over the tops of the keys (where the ivory platings are to come) with a fine toothing plane, and then give them a coat of size and flake white, to prevent the wood showing dark through the ivory. Lay out your ivory platings, match the fronts and tails, and number them, keeping the whitest ones for the treble keys, and then shoot the edges for the joints with a finely-set steel plane. Glue the fronts in their places with white Russian glue, and when they are all on, clamp a strip of heated hard wood over them, and leave them to dry. The tail-pieces are what is termed sprung on, which is done as follows: drive a small French nail into the key, just a little within the distance to which the back of the ivory would reach, and you will have to slightly bend the ivory plating to get into its place when gluing it on. Be careful not to let any glue get into the joint between the two ivories, or it will show as a dark line, but if the joint is properly made, it should be scarcely visible. Rub the ivory well down, and clamp a strip of wood on it

the same as with the front pieces. When you draw out the nails, fill in the holes with some stopping coloured to match the wood. If you intend to face the nosings of the keys with ivory veneer, instead of having a moulding, that should now be done, but if you have circular nosings, as shown in Fig. 127, they must be formed after the keys are cut apart.

When the glue is thoroughly dry and hard, you may scrape the key platings with a steel scraper, taking care to keep the scraper in a diagonal position across the keys to prevent the joints working up. Rub them down with fine worn glass-paper, and then polish them well with a damp linen pad and finely-powdered pumice stone, and finish off with whiting and water, which may be placed on a flat felt pad and the keys held flat on it, rubbing lightly. This finishing off may be done after the keys are separated. Take great pains with this part of the work, or the keys will not look nice. The keys may be separated by sawing down the lines with a thin fine toothed saw, and the black keys may be cut from the white with a stout fret saw, or a thin mortise chisel. The white keys must be sloped back where they butt on the end of the black ones, as shown in Fig. 128, and the black keys are hollowed out on the under side where they cross the mid-rail. The sides of the keys may then be gone over with a fine set plane to take just the roughness of the saw marks off, finishing off with the scraper, and fine glass-paper, but be careful to take off no more than absolutely necessary. Now drive your key-pins into the holes already bored for them in the rails of the key-frame, and be careful to have them upright; the sections will show how high they project above the rails. The mid-pins should have a small disc of soft leather, or felt, fitted on to them for the keys to rest on,

in order that wood may not rattle against wood. Place the keys in position, and fit on the ebonies so as to leave the least possible gap between them and the white keys. The ebonies are generally sloped at the sides and front edge, but the latest improvement is to make them quite square at the sides, and circular on plan at the front. The extra width at the top is a great acquisition, and there is less liability to catch the finger-tip against the end of the black key when playing rapid passages of music.

The upper row of keys in a two-manual instrument is now generally made to overhang the front row as much as possible without interfering with free access to every key. The two rows are also placed as close together as is consistent with free action and removal of keys for repairs, etc.

Each key in the upper row must come exactly over the same key in the lower row.

Should the keys require any loading to balance them properly, a hole should be bored through the side of the key with a centre-bit, and the lead forced into it, as shown by the round dots near the tail end of key in Fig. 125. Lead for the purpose may be purchased in small round sticks.

Immediately behind the combs or ebonies there is placed a bar of hard heavy wood, about $\frac{3}{4}$ inch thick, lined at the bottom with a piece of thick red baize. This bar, which is called the thumper, rests on the keys, and runs loosely in a vertical groove in the key cheeks at each end. Its use is to prevent the keys rebounding, and so causing a ciphering of the notes when playing rapid chords.

The section, Fig. 125, shows the connection with the key action where the key-board is made to slide in.

This is a convenient arrangement, as the key-board can be shut up like a drawer when not in use, thus keeping it out of harm's way, as well as giving more room in the apartment. A disc of thick cloth is glued on the end of the key-tail, and over this is glued a piece of soft leather, thus forming a circular lump, highest in the centre. On this the lower end of the sticker rests, the sticker being prevented from shifting laterally by being cut oblong in shape, and passed through a hole in a rail termed a register. The rail, or register, need not be more than $\frac{3}{8}$ inch thick, and $1\frac{1}{2}$ inch wide, and the sticker is prevented from dropping any lower when the key-board is pushed in, by a piece of wood glued on it. The top of the register should be covered with soft leather to prevent noise.

I have endeavoured to make these instructions as clear as possible, but an inspection of a key-board would be a great assistance to the amateur.

CHAPTER IX.

THE STOP ACTION AND COUPLERS.

THE next requisite for our organ will be the mechanism by which the sliders of the various stops are shifted in or out as may be required. This mechanism is of an extremely simple character, as will be seen by an inspection of Fig. 129, which is a plan, or view looking directly down, of the action known as the wooden trundle stop-action; and in Fig. 130 we have an isometrical elevation of this action, showing its connection with the slider. The most convenient arrangement for the stop knobs is, in the majority of cases, to place the bass stops on the left-hand side of the key-board, and the treble stops on the right-hand side of it. It is this kind of arrangement that the stop action now being described is especially adapted for. The letters marked on the diagrams refer to the same portions of both plan and elevation. A is the draw stop, the knob of which projects on the outside of the case of the instrument, and the other end of this stop rod is, for the sake of economy, generally mortised into a square rod of commoner wood, as shown at B. An upright roller, or trundle as it is termed, marked D, having an arm C, to which B is connected by a centre-pin, and another similar arm E at

right angles to the first one, is connected in the same manner to the trace F, in the lower end of which the lever G is fixed, and the upper end of the lever passes through a square or round hole in the end of the slider. The trundle D works on centres in a strip of wood both top and bottom, as more clearly shown in Figs. 131 and 132. When the stop knob is drawn out the arm C is pulled backwards, which thus causes the trundle to turn partly round; the arm E is drawn backwards and carries with it the trace and the lower end of the lever G; the

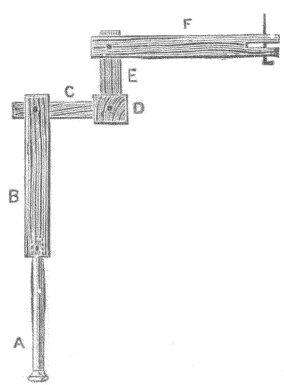


Fig. 129.—Plan of Stop Action (Wooden Trundle).

upper end of the lever thus moves to the right and draws out the slider. When the stop knob is pushed in this action is, of course, reversed, and the slider closed.

The rod A is of $\frac{7}{8}$ inch round mahogany; B, D, and F are about $1\frac{1}{2}$ inch square, and may be of any hard wood that will not warp. The rollers, or trundles, D, are about 8 inches long, and placed in a direct line one behind the other, about 6 inches apart, as shown in Fig. 131 and 132. The arm C and E are each about 4 inches long and $\frac{1}{2}$ inch thick, thinned down at the ends where

they are connected to the stop rod, or trace, as the case may be. The arm C is placed exactly opposite to the stop knob, but the arm E is generally nearer to the top

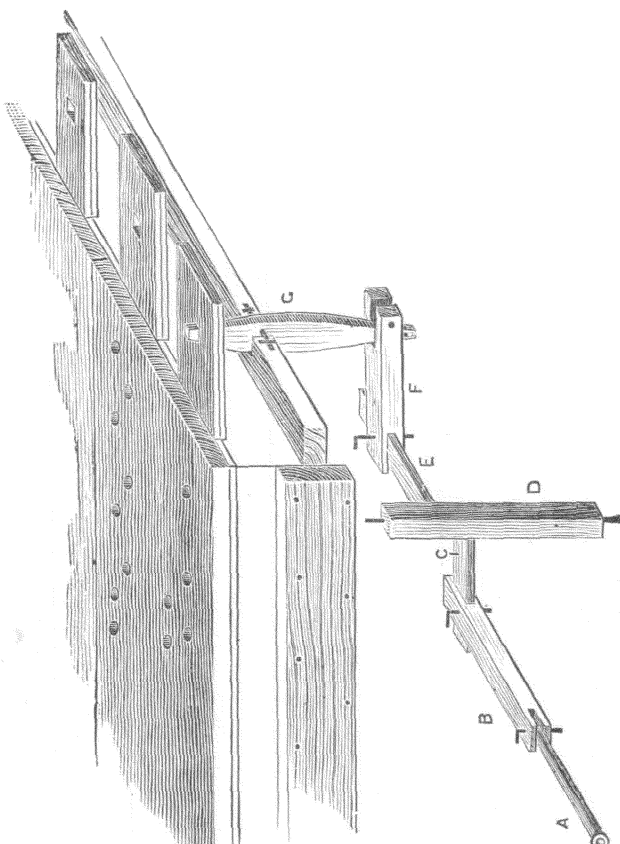


Fig. 130.—Stop Action (Wooden Trundle).

of the trundle, but its exact position depends on the length of the lever G. If the rollers are made very short in consequence of the height above the key-board being less than 15 inches, the arms E may be much

lower down, as it is obvious that it may be in any position in the length of the trundle that may be most convenient. The arms are both tenoned into the trundles, and the pins on which the trundles work should be stout and strong, and driven tightly in. The strip of hard wood, H, in which the top centres work may be about 3 inches wide and $\frac{3}{4}$ inch thick, and

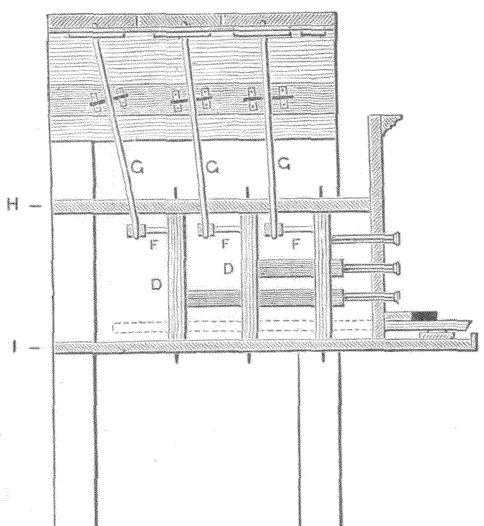


Fig. 131.—End view of Wind Chest and Stop Action. Two-manual.

should be firmly secured to the framework of the instrument. A similar strip may be placed for the bottom pins to work in, or they may work in holes bored through the board on which the key-board rests. All these pivot holes must be bushed with woollen cloth to secure silent action. The trace F must be long enough to reach from the arm E to the lever when the stop is pushed in, and will, of course, vary in length according

to the length of the sound-board of the instrument. The lever G is $2\frac{1}{2}$ inches wide and $\frac{5}{8}$ inch thick, made of hard wood and shaped as shown in Fig. 130. The upper end of the lever works in the slot in the end of the slider, and the lower end passes through a mortise in the end of the trace, and is secured by wire pins.

A still better way is round the lower end of the lever

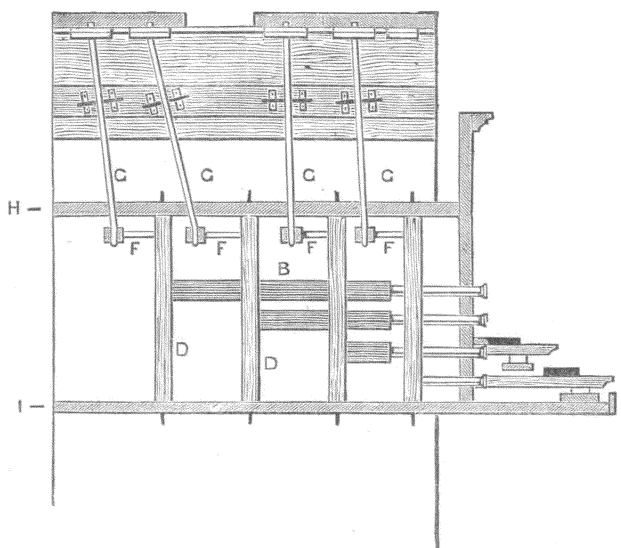


Fig. 132.—End view of Wind-Chest and Stop Action. Two-manual.

and pass it through a *round* hole in the trace, and drive a pin through the lever *below* the trace to prevent it slipping out, but allowing it to turn when the arm is drawn back. A rail two or three inches square is screwed on to the end of the sound-board, and grooves cut in it, the same as in a backfall rail, to receive the levers which are centred on a stout wire similar to backfalls.

The levers may be sloped forwards as shown in Figs. 131 and 132, or they may all be perpendicular, according to the space you have at your disposal. The levers are generally centred so that the lower part is twice as long as the upper part; thus, if the stop knob is made to draw about $1\frac{1}{2}$ inch, the slider will move $\frac{3}{4}$ inch, which will be a very convenient length for both movements. The stop knobs are turned something like drawer knobs, and generally have a plate of porcelain or ivory let into them with the name of the stop on it. These can be purchased for a small sum, but if you prefer to make your own and save the expense, you can make the labels of paper and print the names on them, and glue them on to the stop knobs, giving them a coat of varnish to protect them from dirt. The label should show both the name of the stop and also its foot-tone, thus "Open Diapason, 8 feet," "Flute, 4 feet," etc.

Fig. 131 shows the stop action at the bass end of the single manual for scheme 1, the top knob being for the principal, the next for the stopt diapason, and the lower one for the violoncello. The order of the stops at the treble end would be—reckoning from the top downwards—as follows: 1. Flageolet, 2. Stopt Diapason, 3. Keraulophon, 4. Open Diapason. In order to show that it does not matter whether the upper or lower knob is connected to the furthest slider, I have given, in Fig. 132, a view of the bass end of the two-manual with stops arranged in the opposite way to those in Fig. 131. Here the top stop draws the Lieblich Gedacht on the swell organ, the next the keraulophon, the third one the stopt diapason bass of the great organ, and fourth the flageolet. The keraulophon might be made tc draw from the treble end if you so desire.

The iron trundle action is still simpler than the

wooden trundle just described. The trundle D, Fig. 133, works on a pivot at the lower end and in a collar at the upper end. The arm C is connected to the stop knob rod as in the other action, and a bent arm at the top of the trundle forms both the trace and lever. The trundle may be made of a piece of inch gas tubing, and the arms may be made of $\frac{3}{8}$ inch iron rod passed through holes drilled in the trundle, and riveted at the back, the front end of the arm C being flattened out, and

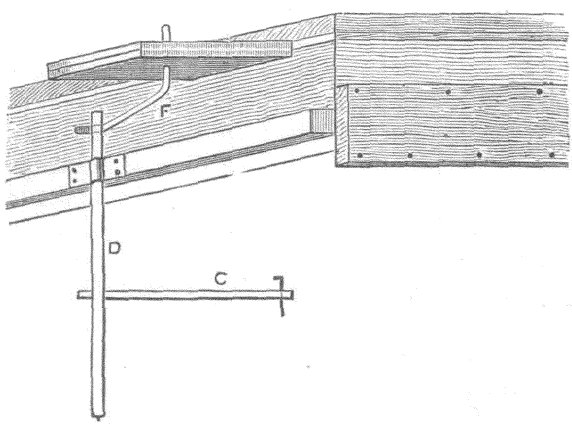


Fig. 133.—Stop Action (Iron Trundle).

having a hole drilled through for the centre wire to pass. A piece of hard wood should be driven into the bottom of the tubing, and the iron pivot fixed firmly into it. If the trundle is made of solid iron, the top arm is merely a continuation of it, being bent over to the requisite shape.

Another style of stop action, which is well suited for a small single manual organ with few stops—and especially where there is not sufficient height above the key-board for a trundle action—is shown in Fig. 134.

A board about the same length as the sound-board, and nearly as wide, is placed just above the key-board, leaving just sufficient room for the keys to work. The draw stops are placed in a horizontal line over the key-

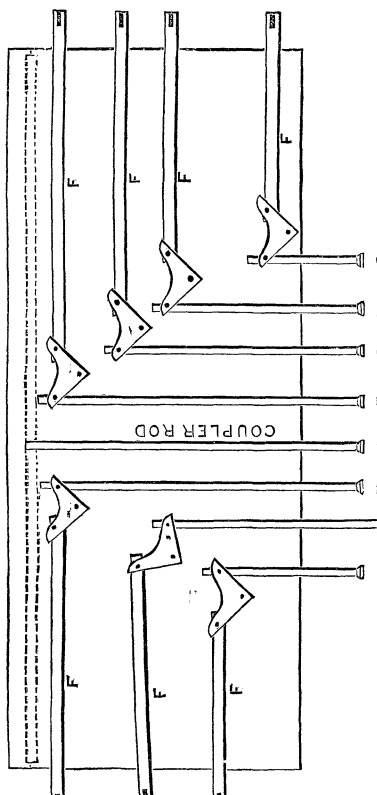


Fig. 134.—Plan of Stop Action in a Single Row.

board, and are connected at the back end to what is termed a square. This square, see Fig. 135, is made of $\frac{3}{8}$ inch mahogany, mitred together as shown in the sketch, so that the grain runs parallel with both edges;

a saw cut is made in the thickness of it—starting from the sharp corner—down as far as the dotted line, and a piece of veneer is then glued into it, thus making the joint very strong. If the square were cut out of a single piece, it would be very liable to break when in use. A centre hole is made near the sharp corner and bushed with cloth, and a small hole is made through near each of the other angles. The sides of the square are each about 4 inches long, the article, when complete, answering the same purpose, and being also very similar to a bell crank. Large bell cranks might, indeed, be used instead of wood squares. The cranks are screwed down to the board by a screw passing through the bushed hole, and through a little block of wood placed underneath the square to raise it the requisite height, and to prevent unnecessary friction. The rods marked F are the traces, which are connected at one end to the levers just the same as in the trundle action, the other end being connected by a screw or pin to the vacant corner of the square belonging to its proper stop rod. The stops shown are those for Scheme I., the principal being drawn out. In all these stop actions, the holes in the case through which the stop knobs pass should be lined with scarlet or some other coloured cloth, and a washer of the same material should be slipped over the stop rod close up to the back of the knob.



Fig. 135.—Square.

The centre wires shown for the different joints in the trundle actions, should be screwed at one end, and a leather button put on to prevent the wires falling out. All parts that rub together should be well black-leaded so that they may work smoothly.

The effect of an octave coupler is practically to

largely increase the number of stops. Thus, with the coupler, an open diapason would sound like an open diapason and a principal drawn together. The principal would sound like a principal and fifteenth, and so on with every stop. With two or three couplers an almost endless variety can be obtained from a comparatively small number of pipes.

The octave coupler, or diaocton, as it is sometimes termed, is shown in Fig. 136, and consists of a bridge with a set of backfalls and stickers immediately under

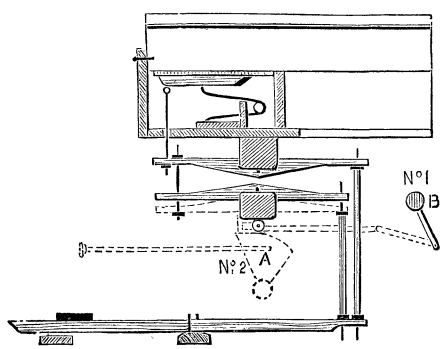


Fig. 136.—Octave Coupler out of Action.

the manual backfalls. The stickers of the coupler are placed as close to the manual stickers as they can be, without interfering with their action. The back ends of the coupler backfalls rest on these stickers directly over their own keys, but it must be distinctly understood that though in the diagram the front end of this backfall appear to be connected to the front end of the manual backfalls of the same key, it is not so in reality, but it is connected to the front end of the thirteenth backfall higher up the scale. Thus, if we assume the key shown to be the CC note, the back end of the coupler backfall will be connected to its own sticker on

that key, but the front end of it will be connected by the tapped wire shown to the front end of *tenor C* backfall of the manual action, and when the CC key is pressed down, and the coupler is in action, it will cause the CC note and the tenor C note to sound together. So on all through, the coupler backfalls, each being connected to the note an octave higher up the scale than that over which the tail end rests. The coupler backfalls will therefore slope to the right hand, whilst the bass backfalls of the manual will slope to the left. If a roller board is used to transfer the first four notes of the tenor octave on the manual to the treble side, a similar roller board must be used to transfer the first four notes in the bass of the coupler to those four notes in the tenor at the treble end. This roller board will be placed before the front ends of the backfalls.

As mentioned in a previous chapter, the organ will undoubtedly be much more perfect if there are twelve extra channels in the treble portion of the sound-board, so that the octave coupler can be carried right up to the top G in treble. It is obvious that without this arrangement, the highest octave in the treble would not be coupled to any other notes, so that when using the coupler, it would be limited to the first $3\frac{2}{3}$ octaves on the key-board. If these additional channels are made, however, it will add six inches to the length of the sound-board, and necessitate the carrying of each stop in the treble, an octave higher, that is twelve more pipes will be required for each of those stops. These pipes will, of course, only be brought into use when the octave coupler is in action. Amateurs, therefore, must decide for themselves whether they will go to the trouble of making sixty tiny pipes, with the necessary channels, pallets, etc., for use with the octave coupler

only. Very many organs are constructed without them; but I think it only right to mention it again here when treating on the coupler action, so that those amateurs who wish their organs to be as perfect as possible, may be able to carry out their wishes.

The coupler is shown in the sketch as being out of action. When the stop knob is drawn out it causes the coupler bridge with its backfalls to drop about

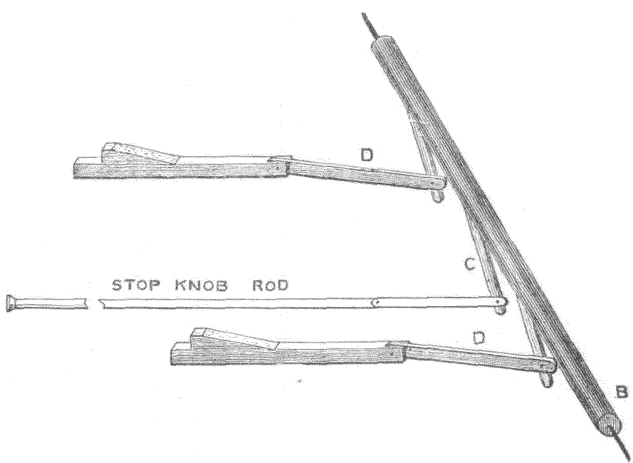


Fig. 137.—Coupler Movement, No. 1.

½ inch, and it will then be in the position shown by the dotted lines, the front end of the backfall resting on the leather nut which is screwed on the lower end of the tapped wire, and the back end resting on the top of its own sticker. The holes in these backfalls are made rather elongated so as to allow them to slip up and down on the wires of the stickers, and the tapped wires connecting them to the manual backfalls. The manner in which the draw stop accomplishes the

requisite movement is as follows, viz., the back end of the stop rod is connected to the arm c, on the under side of a long roller running the whole length of the

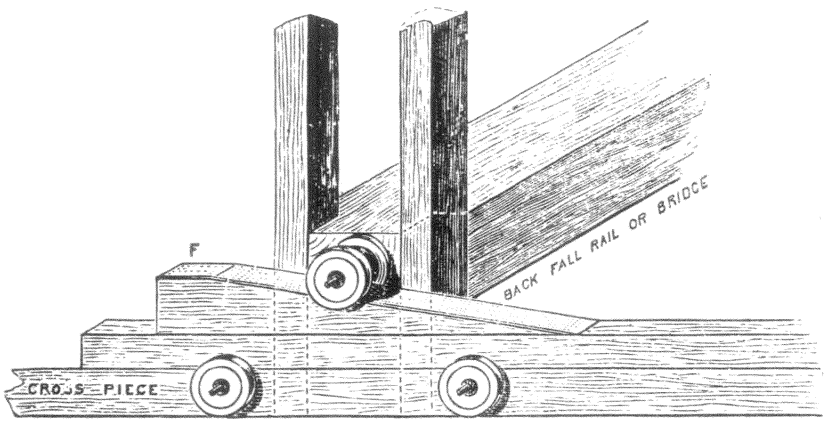


Fig. 138.—Enlarged View of Octave Coupler Movement.

sound-board (see Fig. 137). Opposite each end of the coupler bridge there is another arm on this roller or trundle, which is connected to a jointed rod carrying a little inclined plane passing under a wheel on the end

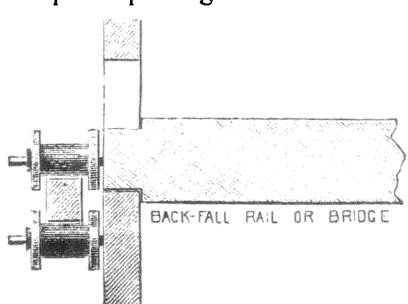


Fig. 138A.—Section of Octave Coupler Movement.

of the backfall rail. Fig. 138 gives a view of one end

of the backfall rail or bridge belonging to the coupler. It will be observed that it is cut to a shoulder, and runs between two upright pieces of wood. The wheel projects from the end, and two similar wheels are fixed to the cross piece underneath, and on these wheels the rod carrying the inclined plane works. When the stop is pushed in the inclined planes are drawn backwards, thus causing both ends of the bridge to rise at the same time, and the wheels then rest on the little squares at the ends of the inclines. The coupler is then out of action, as the coupler backfalls are out of gear with the stickers and nuts on the tapped wires. On pulling out the stop, the inclined planes are pushed forward, and the bridge itself then rests firmly on the cross pieces at each end, and the coupler can be brought into use. The position in which the coupler trundle is placed, is shown on Fig. 136 at B, and it would thus be just behind the roller board, and quite out of the way of any part of the action. The upright guides for the ends of the bridge, and the pieces in which the centres of the trundle work can be fixed to the building frame where required. The arm connected with the stop rod may be placed in any portion of the under side of the trundle, so that it is exactly opposite the stop knob.

The roller or trundle must be stout and strong, but need not necessarily be round. If of wood it should be about 1½ inch diameter, and of well-seasoned material, the arms being mortised into it. If made of iron, ¾ inch gas tubing would do very well, making them up in a similar way to the iron rollers for the roller board. The arm or connecting rod, which passes between the stickers, must be of very thin hard wood, or stout sheet brass. This arm is marked D on Fig. 137. The rods carrying the inclined planes should be

tolerably stout so as not to bend at all, and should run between flat pieces of wood in order to keep them horizontal. The wheels may be of hard wood turned specially for the purpose, or may be formed of stout reels, such as those on which sewing-machine cotton has been wound, and should be covered with leather to secure silent action. The holes through the centres should be bushed with cloth; the centre wires must be very strong, and the ends tapped to admit of a nut being screwed on to keep the wheels in position.

The inclined planes may be 2 inches or 3 inches long, and should rise about ½ inch, being just sufficient to allow the action to be out of gear when the coupler stop is closed. These inclined planes should also be covered with soft leather, and all parts well black-leaded where they rub.

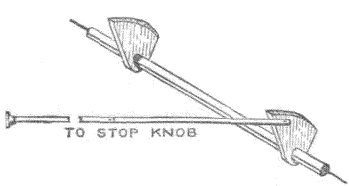


Fig. 139.—Coupler Movement, No. 2.

If this action is made to work the reverse way—that is, as it would appear if you hold the page up to the light, and look through the paper at the drawing, or as it would be seen reflected if held before a mirror—it could be placed under the backfalls instead of behind the stickers, which, however, I consider the best place for it.

Another kind of movement for effecting the shifting up and down of the coupler bridge is shown in Fig. 139. This is merely a roller with two cams on it which is fixed directly under the bridge (see No. 2, Fig. 136), the cams working against two little wheels fixed on the under side of the bridge. The cams can easily be made as follows:—Take a piece of ¾ inch mahogany, and with the compasses strike two segments

with a radius of 4 inches each, and about 1½ inch below the centre cut a hole in each for the roller to pass through, and then cut the segment out as shown in the enla ged view, Fig. 140. The top left hand corner should be flat, as this part supports the bridge when the coupler is out of action, and the whole of the top edge should be covered with soft leather. The cams should be securely fixed on to the trundle, and the draw-stop rod may be fixed either to the further side of one of the cams or to a separate arm according as it may be most convenient. The cams being fixed to a trundle at a point below their centre causes the front ends to be higher than the back ends are when brought to the same position by drawing out the stop knob, and this causes the bridge to rise or fall according as the stop knob is pushed in or drawn out. It will be understood that the ends of the bridge rest firmly on the cross pieces when the coupler is in action, but when it is out of action the bridge is supported by the little wheels resting on the square part of the inclined planes, or of the cams, as the case may be.

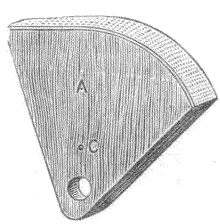


Fig. 140.—Cam.

The directions for the octave coupler apply to either a single or two-manual instrument, but the coupler now to be described will only be applicable to instruments of the latter class. It is called "the swell to great unison coupler," because when it is in action it couples the swell organ to the great organ, so that both organs can then be played from the great organ key-board, and when you press a key on the great organ it pushes up the tail end of the same key on the swell. This coupler is shown in position at A, Fig. 141, and an enlarged

view of it with the action also connected with it is given in Fig. 142. A bar, or rail, of wood, see Fig. 143, is placed between the two rows of keys, near the tail end, and the ends of the rail run in a slot in each cheek of the key-board. A short round sticker, termed a tumbler, see Fig. 144, runs loosely in a hole directly under the centre of each swell key. A groove is cut in each key, both upper and lower, as shown in the sketch, and when the coupler is in action the tumbler is in the position shown in Fig. 142. A tapped wire, with a wooden or thick leather nut covered with soft leather on the under side, runs through every swell key in the position shown, and by screwing this wire up or down

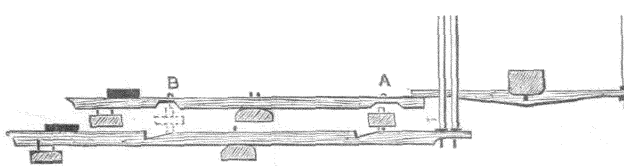


Fig. 141.—Swell to Great and Great to Swell Coupler.

the action of each tumbler may be regulated to the utmost nicety. When the tumbler is out of action it is in the position shown by the dotted lines, and is out of gear with the keys. If the coupler were placed as shown at B on Fig. 141, it would couple the great organ to the swell, so that both the organs would be played from the upper manual, and it would then be called "the great to swell unison coupler." There are many different couplers in use, but these are the simplest; others are described later on in this chapter. The tumbler rail should be of oak or mahogany $2\frac{1}{2}$ inches or 3 inches wide, and about $1\frac{1}{4}$ inch thick. It is shown in Fig. 143, and you will observe that a shoulder, or tenon, is formed at each end of it; the length of the

rail up to these shoulders being the exact width between the two cheeks of the key-board, which will be about 2 feet $6\frac{1}{2}$ inches. The tenons work in a mortise, or slot, in the key cheeks, which slots must be made about 5 inches long so as to allow sufficient travel for the rail. Bore a hole about $\frac{1}{4}$ inch diameter directly over the centre line of each key on the great organ, the positions of the holes being obtained by removing the upper row of keys and marking in pencil over the centre of each one of the lower row. Carefully bush

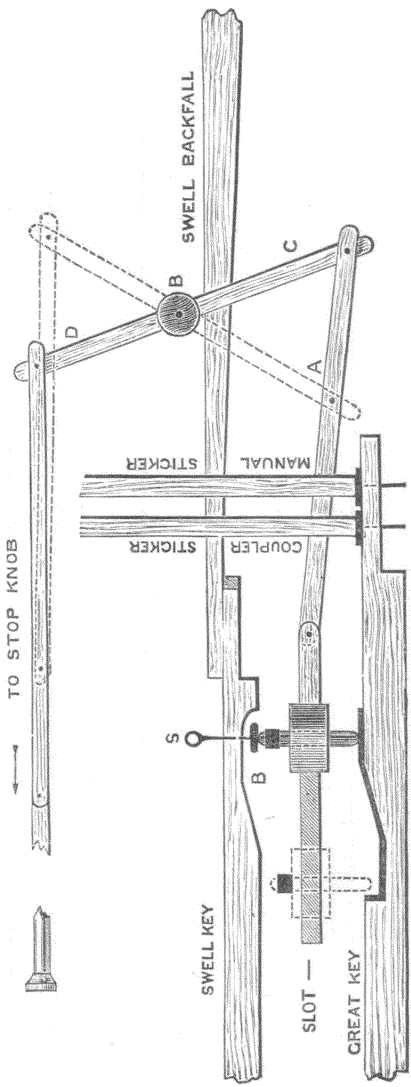


Fig. 142.—Swell to Great Coupler. Enlarged View.

all these holes with soft woollen cloth; and then, wiht a small bead plane, strike off sufficient lengths of mahogany beading to make the tumblers, and cut them to the requisite length, viz., the exact distance between the upper flat surface of the great keys and the flat underside of the swell keys. Smooth the tumblers well so that they slide easily in the bushed holes prepared to receive them, then round them at each end with a piece of glass-paper; but be careful not to make them too short, and cut a strip of soft leather and glue a piece of it round each tumbler near the top, as shown, in order to prevent it slipping too low when out of action, see Fig. 144. A small pin may be driven through the lower portion when the tumbler is in position. The surface of the grooves in the lower manual keys must also be covered with leather, black-leaded, so that the tumblers will glide easily up the incline when drawn back by the stop action.

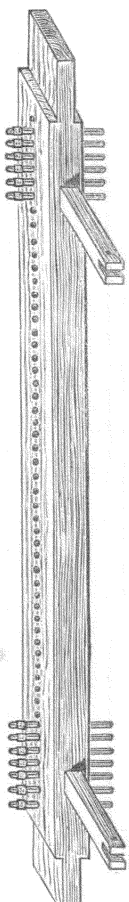


Fig. 143.—Tumbler Rail for Swell to Great Coupler (Back View).

The draw-stop action for the swell to great coupler is very similar to that belonging to the octave coupler. A roller, or trundle, B, shown in section on Fig. 142, is made exactly similar to that shown in Fig. 137, with two arms on the under side, and a flat rod, C, connecting each arm to the short arms shown on the back of the tumbler rail in Fig. 143. The arm, D, connecting it to the stop rod, is, however, on the upper

side of the roller, and, as will be seen, the angle at which it inclines is the same as that of the lower arms. The movement is shown in action, but when the stop is pushed in the arms will be in the position shown by dotted lines. The arms, C, and the connecting rods, A, must be thin so as to allow them respectively to pass between the swell backfalls or the stickers on the great organ keys.



Fig. 144. Tumbler.

Great care must be taken in fixing the trundles for any of these coupler actions, in order to secure their perfectly level and parallel working. The octave coupler swell to great will be easily understood from the instructions given with regard to the other couplers. It would be connected with the tails of the keys on the great organ by means of backfalls and stickers the same as the octave on the great organ, but

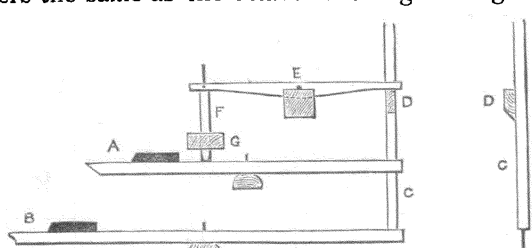


Fig. 145.—Swell to Great Unison Coupler.
The small cut to right shows front view of Sticker.
A, Swell Key; B, Great Key; C, Great Sticker; D, Block on Great Sticker, E, Coupler Backfall; F, Coupler Sticker; G, Coupler Sticker Register.

the other end of each backfall would pull down a valve in the swell sound-board an octave higher up than that on the great organ. This is a very useful coupler.

In Fig. 145 will be found another mode of coupling the swell to the great organ in unison; and its con-

struction is as follows :—A little block of wood, covered with leather on the top, is glued on to the side of the great sticker, as shown in the sketch, and when in action, the coupler backfalls rests on this block. A sticker connects the front end of this backfall with the swell key, and presses on the key just behind the comb. These stickers are kept in their places by passing through holes in a strip of wood, or register, as it is termed, marked G in the sketch. To put the coupler out of action, raise the bridge of the backfalls about $\frac{3}{8}$ inch.

Fig. 146 shows a coupler that may be useful to some of my readers who wish to couple an upper manual to

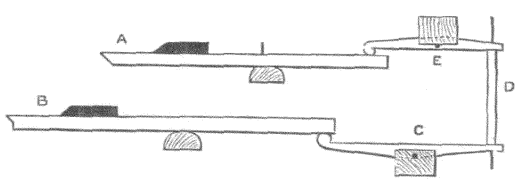


Fig. 146.—Great to Swell Coupler.

a lower one, as for instance, great to swell, or, if as is sometimes the case, the great organ manual forms the upper row of keys it would become the swell to great coupler. This action can be applied to keys of any length, and it does not matter which overhangs. The tail of the swell key A raises the front end of the top backfall E, and presses down the back end and the sticker D. The lower end of the sticker consequently presses down the back end of the lower backfall, the front end of which then raises the key-tail on the great manual, B. To put the coupler out of action either raise the top bridge with its backfalls, or lower the under one, but the former is the best mode.

CHAPTER X.

THE PEDAL ORGAN: SOUND-BOARD, AND PEDAL KEY-BOARD.

WE now approach the consideration of a portion of the instrument which, in many works purporting to instruct the amateur, is either treated in a vague manner or omitted altogether. I allude to the arrangement of the pedal organ and the action connected therewith; and I trust that the instructions that I now give, and the copious illustrations with which they are accompanied, will enable amateurs to select the arrangement that happens to be best suited to the means and space at their disposal, and that they may be enabled, by the help of instructions and illustrations combined, to carry out the work in a satisfactory manner.

The first point to be considered, is, how do we wish the pedal pipes to be arranged? In many cases the answer to this question must depend on the space at the disposal of the amateur. It may be that we have plenty of room to spare both at the sides and at the back of the organ; and, if so, we may very effectively bring the six largest pedal pipes to the front, and arrange three on each side of the key-board, and the remainder would be placed at the sides, and, also, at

the back of the organ, if necessary, as shown in Fig. 147. In the case of the two-manual instrument none would need to be placed at the back, as there would be plenty of room at the sides. In Fig. 148 all the larger pipes are shown arranged at the back, and the smaller ones at the sides, none being brought to the front, thus saving a little in the depth of the instrument. Fig. 149 shows all the pipes arranged on a single sound-board at the back of the organ; and, as I anticipate that this plan

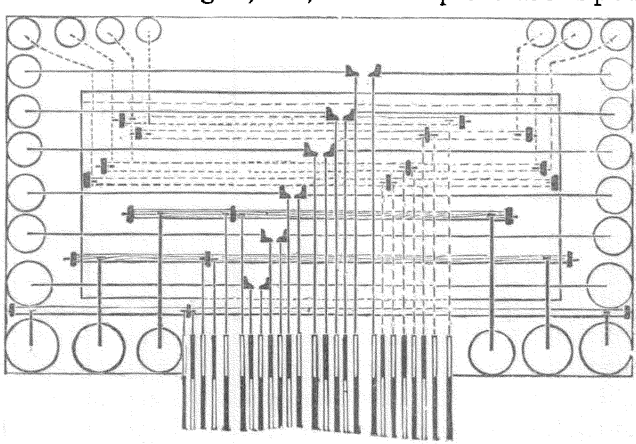


Fig. 147.—Plan of Pedal Action, No. 1. Scale, $\frac{1}{2}$ inch to 1 foot.

will be adopted by many of my readers on account of its compactness and simplicity of action, I have set it out on a larger scale, so that a study of this plan will also enable the amateur to more readily understand the other systems mentioned. Another good arrangement which, moreover, is so simple that I have not thought it necessary to give an illustration of it, is to suppose this last sound-board to be cut in half, crosswise, placing one-half on each side of the organ, having twelve pipes on one side and thirteen pipes on the other.

This arrangement, as will be readily seen by any one who will take the trouble to put it on paper, is a very good one for the two-manual, as the depth of the organ is sufficient to allow the pipes to be all placed at the sides.

The pedal sound-boards are made much in the same way as the manual sound-boards, but are much simpler, as in our small organs there will be only one stop on the pedals; consequently no sliders, or upper-boards will

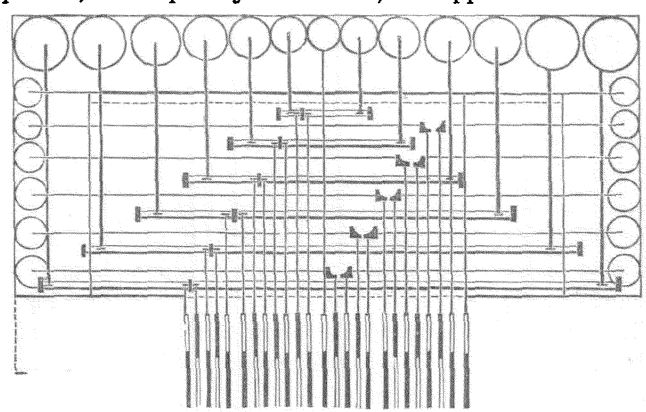


Fig. 148.—Plan of Pedal Action, No. 2. Scale, ½ inch to 1 foot.

be required. Fig. 150 shows the ordinary style of pedal sound-board, the channels being made 6 or 7 inches long in the clear, and 2 inches deep. The widths of the channels vary from about 1½ inch for CCC, to about ⅞ inch for C. The wind-chest should be 4 inches deep. The top board, or table of the sound-board, should be about an inch thick, if no grooves are required, but if any of the pipes are grooved off, either a separate grooving-board must be used, or the table must be made thicker, in order that the grooves may be cut deep enough to convey the requisite supply of wind. As a

rule separate grooving-boards are the best for this purpose. The amateur organ-builder must bear in mind that one of the sides of the wind-chest must be made movable in the same manner as in the manual sound-board, in order to get at the pallets if required. The pallets should be made exactly the same as the others, but a rather stouter spring should be used, and the pull-downs should pass through holes in a strip of brass.

The holes for the pipes to stand over should be bored in the same way as described for the bass pipes, viz., by boring two holes side by side, and cutting away the intervening wood to form one oblong hole. The pipe feet do not stand in these holes, but in a speaking block, which is merely a circular piece of wood about 1½ or 2 inches thick, having a circular hole at the top to receive the pipe foot, the hole being sloped out on the under side to correspond with the shape of the hole in the sound-board; this block should be glued on to the table. The action works under the wind-chest, so care must be taken that the sound-board be raised sufficiently from the floor to admit of this.

Another method of making the sound-board is shown in Fig. 151, which is very much the same as the preceding one turned on its side. This sound-board stands on the floor, and thus saves a few inches in the height of the instrument, and, as either side of it may be turned towards the action, a pull or a push action may be used, according to the movement that may be required. In the plan, Fig. 147, the sound-boards are shown as being returned both at the back and at the front; but this is not really necessary, as they may be simply straight sound-boards extending the whole depth of the sides, and those pipes which are placed at the back and

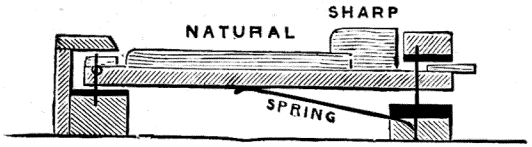


Fig. 154.—Section of Pedal Key-Board.
Scale, 1 inch to 1 foot.

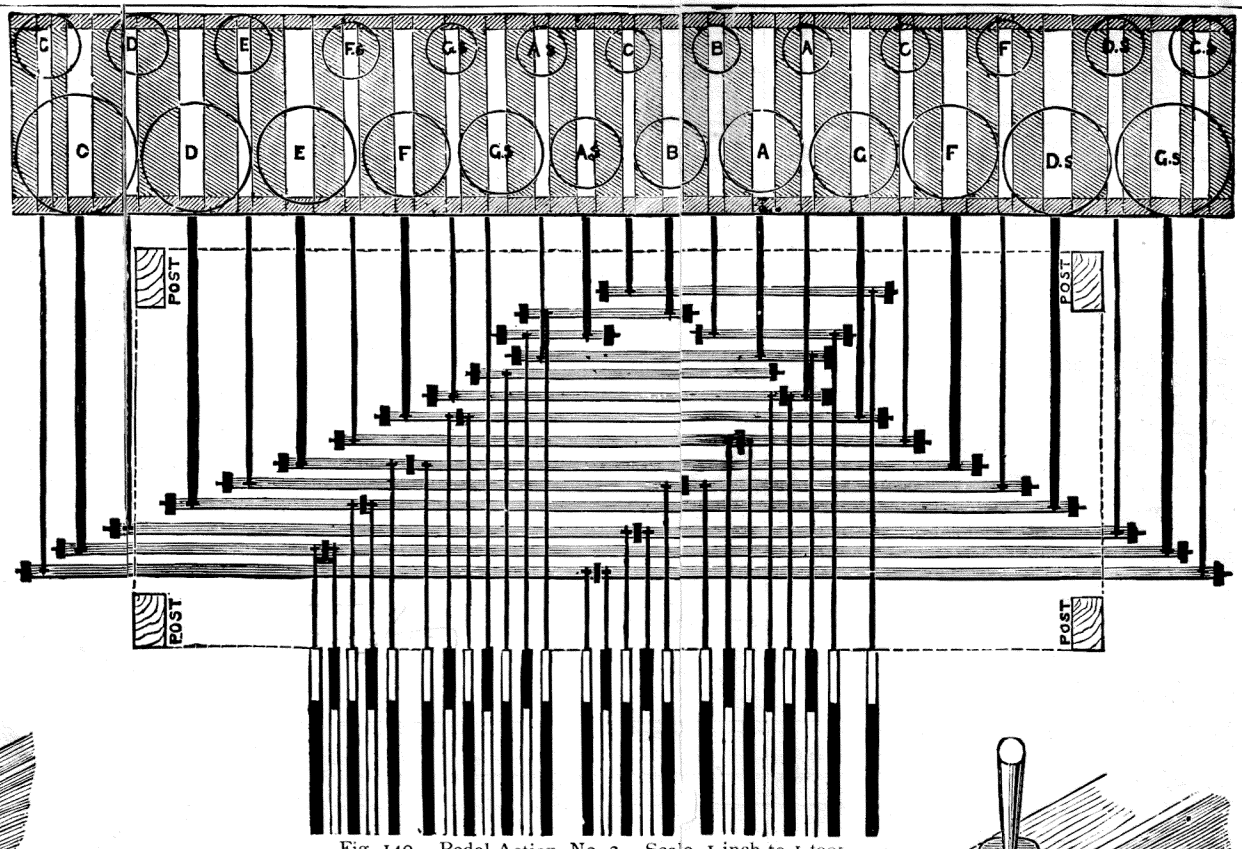
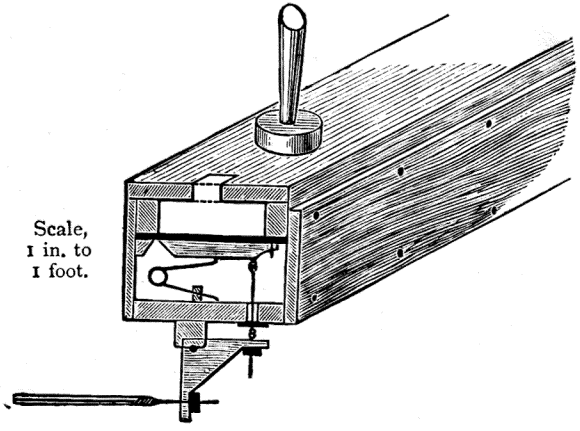


Fig. 149.—Pedal Action, No. 3. Scale, 1 inch to 1 foot.



Scale,
1 in. to
1 foot.

Fig. 150.—Pedal Wind-Chest and Sound-Board.



Fig. 152.—Natural Pedal Key. Scale, 1 in. to 1 foot.



Fig. 153.—Sharp Pedal Key. Scale 1 in. to 1 foot.

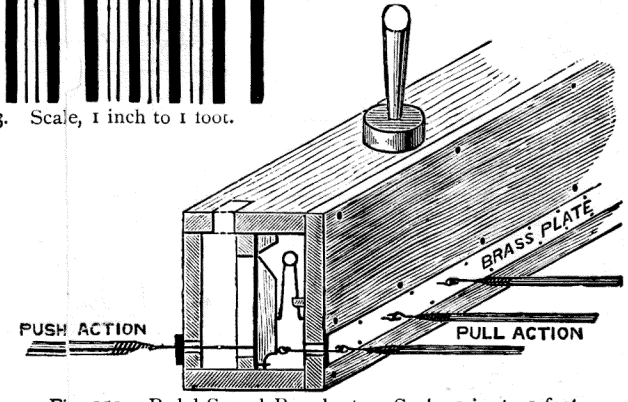


Fig. 151.—Pedal Sound-Board, etc. Scale, 1 in. to 1 foot.

Folding Plate No. 9, containing Figs. 149—154, to face page 177.

front may stand on a grooving-board instead of being exactly over their channels. If this method is adopted the sound-boards will be much easier to make, and the action will be much simpler, as only one kind would be required. The same course might be followed in carrying out the arrangements shown in Fig. 148, where the sound-board might extend only along the back, the pipes at the sides being planted off. The sound-board would then be divided into twenty-five channels, as in Fig. 149, or thirty channels if a full pedal organ is required (the largest pipes being placed near to the back edge, and the front part left clear for the grooves, or conveyance tubes. I may say that if this plan be not adopted it will still be necessary to put double divisions to all the channels unless very thick wood is used for the purpose, which is not by any means advisable, so that in reality there would be no extra labour involved by making use of the channels thus formed.

I have allowed fully for the size of the pipes on these sound-boards, but it is very probable, especially in the case of the style in Fig. 149, that you may not require them quite so long. The pipes may be placed so that the sides come close together, but should not touch each other. Make your pipes before you make the sound-board, and, if they are circular pipes, all you will have to do will be to strike circles the size of the extreme outside diameter of the pipes, and mark them on the sound-board table side by side, and you will then see exactly how much space you require for them to stand in. With wood pipes you should cut out a square of paper or card the exact size of each pipe, and place it on the sound-board table, and mark round it in pencil. The sound-board in Fig. 149 should be 12

inches wide, and I have shown it 6 feet 3 inches long; but, as stated above, it may not be necessary to make it quite so long. If the pipes are placed near the edges, as I have shown in the illustration, and with the mouths of the two rows facing towards each other, there will be plenty of speaking room, as there will be no danger of the wind from the pipes in one row impinging on the lips of those in the other row.

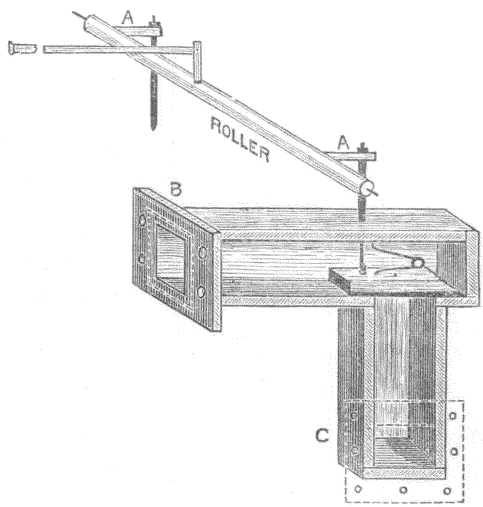


Fig. 155.—Pedal Wind-Trunk.

Having completed the sound-boards, the wind-trunks may be next prepared; they should be of $\frac{1}{2}$ inch stuff, and measure about 5 inches by $2\frac{1}{2}$ inches internal diameter. As stated in a previous chapter, they may be placed either at the ends or at the back of the bellows, as may be most convenient; but in most instruments the best plan is to place them at the back, and to allow the wind to enter the pedal wind-chest at the extreme end. A section of the wind-trunk is given

in Fig 155, from which it will be seen that the wind enters from the bellows at the upper part B, and passes into the wind-chest at the lower part C, a flange plate being used at either end to connect the wind-trunk to the bellows and to the wind-chest.

In order to save unnecessary labour in blowing when the pedals are not required, it is usual to have a valve, worked by a stop-knob, to shut off the wind from the pedal wind-chest. This valve is shown in the section, and is opened or closed by the stop-knob acting on the upper arm of the roller—the arms marked A at each end being connected by a tracker to the pallet or valve in the wind-trunks, if there are two; but, of course, if there is only one wind-trunk, only one arm and tracker will be required.

Now to construct the pedal key-board. First prepare the front and back sills, each 3 feet long and $3\frac{1}{2}$ inches wide; the front one $2\frac{1}{4}$ inches thick, and the back one $1\frac{1}{2}$ inch thick. These may be of oak or pine; the sides may be of $\frac{3}{4}$ inch pine, 2 feet long and 5 inches deep, cut out as shown in Fig. 156, the sills being firmly mortised into them. Draw a line, or gauge mark, along the centre of the whole length of each sill, and divide each line into thirty equal parts with the compasses, starting from the outside edge of the frame, thus making each division rather more than $1\frac{5}{16}$ inch. Some prefer the divisions to be rather more than this, so if you like, you may make the sills a trifle over 3 feet long, and divide accordingly. Now draw a line across the sills through each point, and drive a stout wire pin into all the points except the 6th, 14th, 20th and 28th. These blank spaces are those shown between E and F and between B and C in each octave, there being no sharp keys between those notes. The

front row of pins should show 1¼ inch above the sill, and the back row 4 inches. I may say that I term the sill farthest from the organ the front, and that which

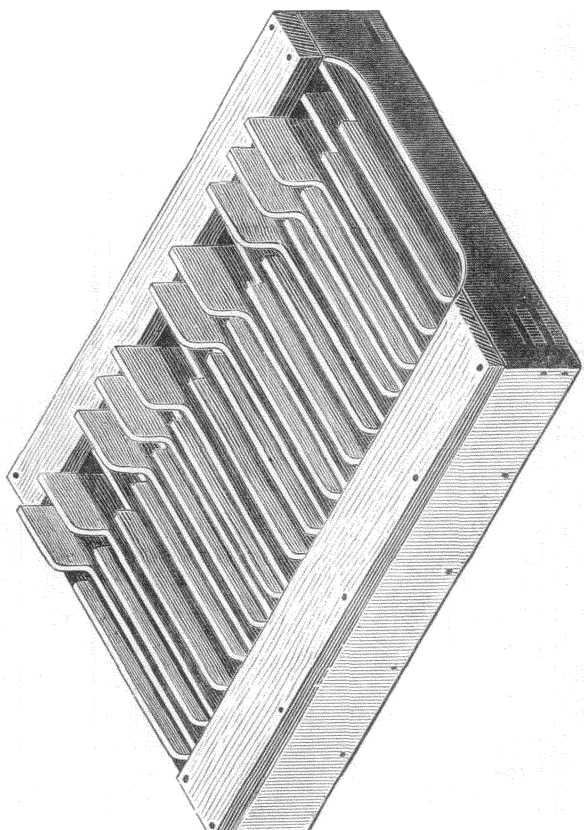


Fig. 156.—View of Straight Pedal Key-board. Complete.

is nearest the casing the back one, as I think this nomenclature is less likely to confuse the amateur than the ordinary one, in which the order is reversed.

Now get out twenty-five pieces of good sound pine, fully 1 inch deep, about $\frac{7}{8}$ inch thick, and 2 feet long, for the pedal keys. Bore a vertical hole carefully through one end of each bar, so that it will just slip easily on to the front row of pins, and mark where the back pin comes, and bore holes in the bars for them, elongating them on the under side; these holes must be bushed with cloth. Now get out twenty-five pieces of mahogany or birch about $1\frac{1}{2}$ inch long and $\frac{3}{4}$ inch thick, and glue and screw one over the front hole in each bar, as shown at A in Figs. 152 and 153. When dry, bore a hole $\frac{3}{8}$ inch diameter through the side of the key, so that it passes through the vertical hole, and the top of it just touching the under side of the piece A; the object being to prevent unnecessary friction on the pin. The pin may pass right through the piece A, the hole being elongated to about $\frac{3}{8}$ inch to allow the necessary movement, or the key may be supported by the piece A resting on the top of the pin. Next prepare fifteen pieces of mahogany or birch 14 inches long, 1 inch deep, and $\frac{7}{8}$ inch thick, and glue one on to each natural key, as shown at B in Fig. 152, slightly rounding them on the top and front edge. Next prepare ten pieces of similar wood, $4\frac{1}{2}$ inches long, 3 inches deep, and $\frac{3}{4}$ inch thick, and glue them on to the sharp keys, as shown at D in Fig. 153, slightly rounding them on the top and front edge. Some prefer these pieces to slope upwards a little from the front to the back. You may now insert a wire spring under each pedal, as shown in the illustration, in Fig. 154, fixing one end into the back sill, and allowing the other to run free in a groove mark on the under side of the keys.

The front board may then be prepared of 1 inch

stuff, 5 inches high, and screwed on to the front sill. The front cover board, or heel rest, may be of the same thickness, and screwed on to the top of the board' as shown. The back cover board may also be of 1 inch stuff, and should have holes bored through for the tops of the pins to pass through, but the pins should not fit tightly into these holes, as the cover board may have to be removed at some future time to get at the pedal keys. The top of the sills, and also the under

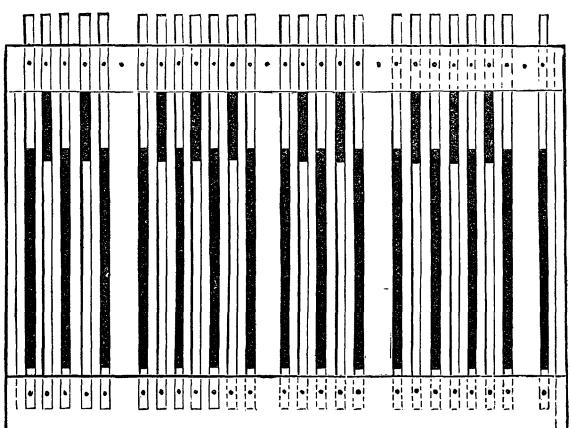


Fig. 157.—Plan of Straight Pedals. Scale, 1 inch to 1 foot.

side of the back cover board should be lined with three or four thicknesses of carpet felt to secure perfectly silent action.

This completes the pedal-board as shown in Figs. 156 and 157. If, however, it is desired to make a radiating concave pedal key-board, you proceed according to the plan shown in Fig. 158. The back sill will be 3 feet long, or rather more, and the front one 2 feet 6 inches long, each one being divided into thirty spaces, as described for the straight key-board. The

pedal keys at the sides are slightly longer than the inside ones, in order to bring them level at the ends, and the raised slips of the natural and sharp keys are arranged so that the front ends form a concave curve, and the front and back cover boards follow the lines of these curves, as shown by the dotted lines in the plan given in Fig. 158.

Instead of making the keys to work on a pin at the back end, as previously described, they *may* be made

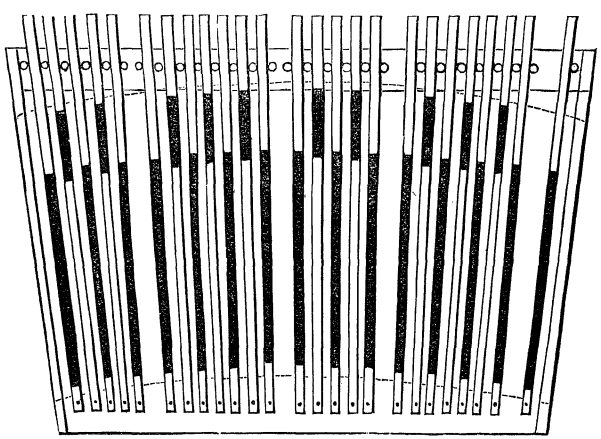


Fig. 158.—Plan of Radiating Pedals. Scale, 1 inch to 1 foot.

to pass through a sort of rack formed by fixing a stout pin of oak in the back sill between each key, as shown by the small circles marked on the drawing. The oak pins must be covered with cloth to prevent rattling. Of course this plan is equally applicable to either kind of key-board, but I consider the pin movement better than the rack.

I must leave it to the amateur to decide for himself whether he will have a straight or a radiating key-board, as there is much difference of opinion among musicians

as to the relative merits of the two varieties. The keys in modern radiating key-boards, however, do not spread out so much as those made years ago.

In my next chapter the action connecting the pedal keys with the pallets will be described, and the mysteries of the rollers, etc., shown in the drawing accompanying this chapter will be explained.

CHAPTER XI.

PEDAL ACTION: COUPLER GREAT TO PEDALS.



N considering the question of the mechanism necessary to connect the pedal keys with the valves of the sound-board, we shall find that different arrangements of rollers, squares, trackers, or stickers, will furnish us with the means of transmitting the motion of the keys in any direction that may be required.

Rollers are needed in the pedal action for the same reasons that they are needed on the manual—viz., in consequence of the pipes being arranged alternately on each side of the organ, and being situated beyond the range of the key-board, and in some cases brought in front of it. It may be asked, "Why should we place the pipes alternately at the sides; why not have them in consecutive order and have a backfall fan frame action as for the ordinary manual action?" The answer is that the organ is better balanced by placing the pipes in alternate order, and that it prevents the speech of the pipes being interfered with by what is termed sympathy, which large pipes are specially subject to when placed in chromatic order.

The rollers are fixed on a board laid flat, which, in such case is termed a roller frame, not a roller board.

This board should be framed at the ends to prevent it warping; the rollers themselves should be of $\frac{3}{4}$ inch gas tubing, and made exactly as described in the chapter on the manual action. In order to prevent

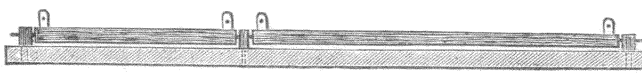


Fig. 159.—Section of Roller Frame.

confusion, I have drawn the rollers much wider apart than they need actually be placed, for if they are $\frac{1}{4}$ inch apart, it will allow ample room for working, so they may be arranged on a board much narrower than that shown. They are arranged in pairs as in Fig. 159, and work in studs as previously described: the arms need not be more than $\frac{3}{4}$ inch above the rollers, so that the total height occupied by the roller frame is less than 3 inches. The holes in the roller studs and arms should be bushed with cloth to prevent rattling noises when in action.

Squares are required somewhat similar to those used in the stop action in Fig. 134; but in order to get the necessary depth of action without taking up too much height, we make them with one arm about twice as long as the other, as in Fig. 160, and according to the way the long arm is placed, so the action which is transmitted by the square is increased or reduced in extent. These squares may be made of $\frac{5}{8}$ inch mahogany in two separate pieces which are mitred together, as shown; a saw cut being made from the angle down to the dotted line, and a piece of thin veneer glued into this cut, thus making a strong joint. The long arm

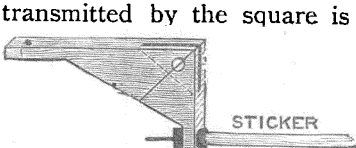


Fig. 160.—Square with Long Top.

may be about 5 inches long, and the short one $2\frac{1}{2}$ inches. The hole for the centre to work on should be bushed with cloth; and holes must also be bored through near the end of each arm for the wires to pass through. The ordinary equal sided square which will be required in some portions of the actions is shown in Fig. 161, and is made in a similar manner to the others.

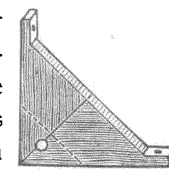


Fig. 161.—Square.

We will assume that we are going to adopt the sticker and roller action shown in Figs. 149 and 162.

The squares are arranged in grooves cut in a balk of timber similar to a backfall rail, so that the ends of the long arms come under the respective pedal keys. A sticker runs from the short arm to the roller arm, and another sticker runs from the arm on the other end of

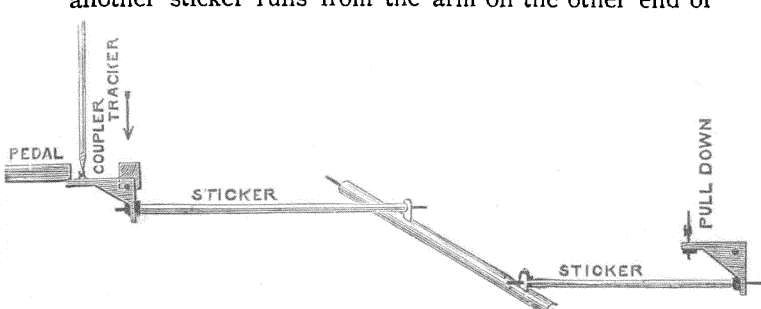


Fig. 162.—Pedal Movement (Sticker) Working to the Right.

the roller to a square placed under the valve of the proper channel in the pedal wind-chest, the pull-down being connected to the long top arm of this square. The action will thus be that when the pedal key is pressed down, the lower arm of the front square is pushed forward, and carries the sticker with it, and the other end of the sticker presses against the roller

arm and causes the roller to partially revolve on its axis. This, of course, presses the other arm against the back sticker, the further end of which pushes the lower arm of the back square, bringing down the top arm, and with it the pull-down and valve. Fig. 163 shows the same action working towards the left, instead

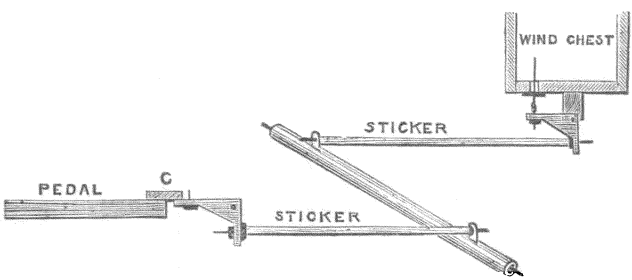


Fig. 163.—Pedal Movement (Sticker) Working to the Left.

of to the right, of the pedal key. In order to prevent any waste in the height of the pedal key-board, a piece of hard wood marked c in the several figures is glued

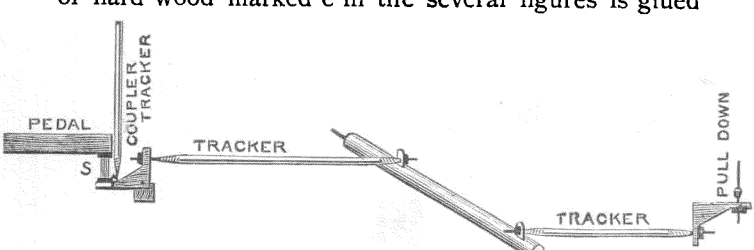


Fig. 164.—Pedal Movement (Tracker) Working to the Right.

and screwed on to the top of the end of each key. This piece presses on the long arm of the front square, and thus saves rather more than an inch in the height of the key-board, which is a great acquisition.

If a pull action is required, the front square is inverted, and a short sticker glued on the long arm as

shown at s in Figs. 164, 165, and 166, so that it comes under the end of the pedal key, which would not in this case require the piece c. A tracker instead of a sticker would extend from this square to the roller arm, and

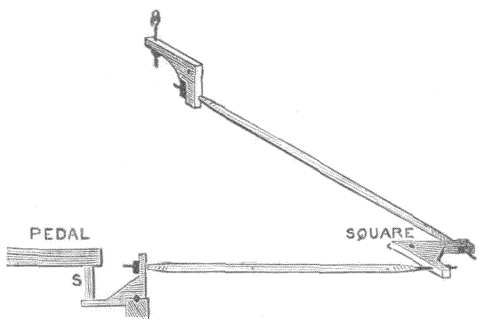


Fig. 165.—Pedal Movement (Square) Working at Right Angles.

a similar tracker would connect the other arm of the roller to the back square, which is turned in the opposite direction to that in the previous action. The trackers must be secured in their places by means of

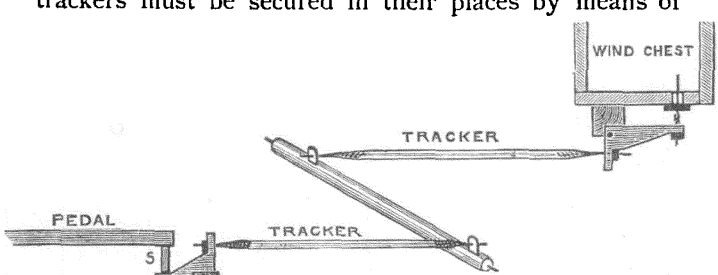


Fig. 166.—Pedal Movement (Tracker) Working to the Left.

leather nuts screwed on to the tapped wires on the ends. Thus it will be seen that for a push action we use stickers, and for a pull action we use trackers, and either of these may be adopted as the action for Fig. 149 arrangement. In order to bring the action

out clearly, I have shown on these plans all the stickers or trackers in the first octave by thick lines, and those in the second octave by thinner ones.

If the sound-board shown in Fig. 151 is adopted, the back square is not needed, as the wire in the sticker passes through a hole in a brass plate, and pushes the valve open; or if a pull action is required, the sound-board faces the other way, and the hooks on the end of the trackers would be hooked on to the pulls of the valves.

In the arrangement shown in Fig. 147 we have three different actions—viz., the direct sticker or tracker actions just described; a backward action for the pipes which are brought to the front on each side of the key-

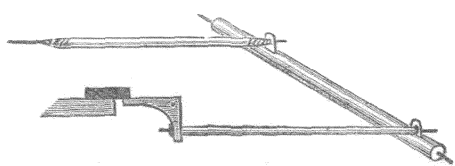


Fig. 167.—Pedal Movement Working Backwards.

board; and the right-angled action for the pipes at the sides of the organ. The second of these actions is shown in Fig. 167, and will be readily understood. A tracker or a sticker connects the square with the roller, and a sticker or a tracker connects the other arm of the roller to the square under the pull-down if the first style of sound-board is used, or is connected directly to the valve if the second style is adopted. If a pull action is required, the sticker would be first and the tracker second; if a push action, then the tracker would be first and the sticker second, and the front square would, of course, be inverted.

The right-angled or square action is shown in Fig. 165, and requires only squares with stickers or

trackers according as to whether a push or a pull action is required. It will, of course, be understood that this action will work either to the right or to the left, according to the way the central square, which lays flat, is placed; and, like the other actions, it may be used for either style of sound-board. Where it is used in conjunction with the roller action, the front square should be inverted as shown in Fig. 165, in order that the trackers may pass above the rollers and not interfere with them. The roller action and the square action is arranged alternately in Fig. 147; the rollers at the back, which are shown by dotted lines, would not be required if the back pipes were only planted off from the side sound-boards, as the square action would then be used for those notes. In fact, if, as I have before suggested, the sound-boards were not returned either at the front or back, a square action would be the only kind required for all the pipes as arranged in Fig. 147. If the side pipes in Fig. 148 were only planted off on a grooving board, a roller action would be all that would be required for that arrangement. In the case of any channel that comes opposite to its own pedal key, the action may be carried direct across to it without the intervention of a roller, and where it is not very much out of the direct line, the wires of the stickers or trackers may be slightly bent so as to admit of their being carried direct across in a similar manner. A case in point is shown in the GGG sharp in Fig. 149, and it also occurs in the other arrangements.

I have now described several different methods of connecting the pedal keys to their proper valves or channels, and a careful study of the instructions and accompanying diagrams will, I think, enable the amateur

to select or devise an action suitable for any position required. When the main ideas are once thoroughly grasped and understood, it is easy to make modifications to suit any requirement.

We have now only to make the coupler action connecting the great organ manual keys to the pedals, so that when the pedal keys are pressed down, their action is transmitted to the manual as well as to the pedals. This is an extremely simple piece of mechanism, and is shown in the general view in Fig. 168. A set of backfalls marked B is placed just under the keyboard of the manual. A small sticker marked S connects the back end of the backfall to the manual key-tail, and a tracker connects the front end of the backfall to the front square under the pedal key-tail. This tracker is hooked on to a small loop of whipcord fixed into the square. This loop must be only just large enough for the wire to pass through. The coupler may be made either as an octave coupler or unison coupler; thus, if the CCC pedal key is connected to the CC manual key, and so on all through, the effect of the coupler will be to bring on to the pedals as many stops as may be drawn on the manual, the 8-feet stops would sound an octave above the pedal bourdon, the 4-feet 2 octaves, and the 2-feet stop 3 octaves above the same. If, however, the CC pedal key is connected to the CC manual key, and so on from that note up to the top C in the pedals, the notes of the pedals and the manual would be in unison.

The coupler is shown in Fig. 168 as being in action, and the stop knob is drawn out. When the stop is pushed in, it causes the backfall rail or bridge of the coupler to drop about $\frac{3}{4}$ inch, and thus puts the backfalls B and the sticker S out of gear with the keys.

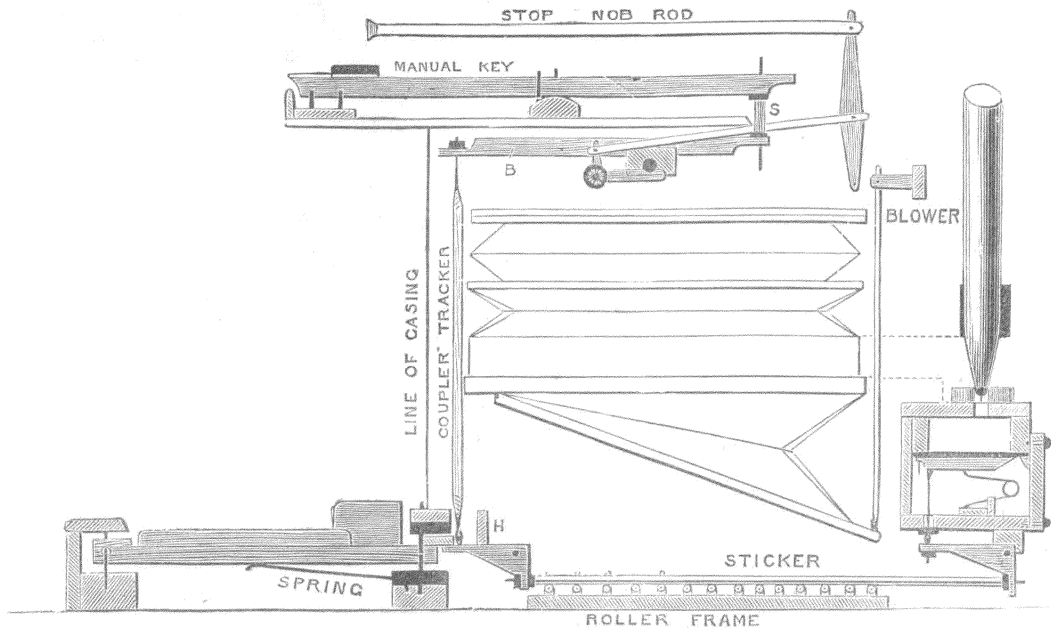


Fig. 168.—General View in Section of Pedal Action. Scale, 1 inch to 1 foot.

The wires of the trackers and stickers are made long enough to allow of this drop, and the holes which they pass through in backfalls and key-tails are elongated so that the wires may work freely when the bridge is raised or depressed.

Fig. 169 shows more clearly the manner in which

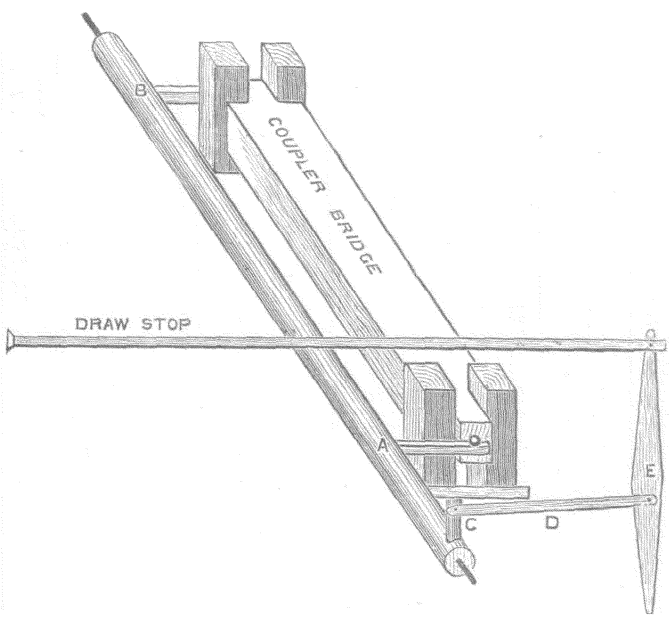


Fig. 169.—Shifting Action Coupler Great to Pedal.

the stop action raises or depresses the coupler bridge and backfalls. The ends of the bridge are cut to form a shoulder or tenon, which runs between two uprights in the same manner as described for the bridge of the manual couplers. A pivot or wheel is fastened on the end of the bridge, and a roller having two arms, marked A and B, raises or depresses the bridge by acting on

these wheels according as the stop is pulled out or pushed in. The stop knob rod is connected to a lever E, which works on a pivot at the bottom, and a rod D is connected to the lever and the upright arm of the roller. This sketch also shows the stop knob drawn out; when pushed in, it would, of course, push the lever E backwards, drawing with it the arm C, thus causing the arms A and B to be lowered, and the backfall rail is thus allowed to sink down until it rests on the cross pieces at the bottom of the uprights. The roller must of course be placed sufficiently low to allow of the movement of the backfalls.

A coupler from the swell organ manual to the pedals would be made in just the same way, and, if in addition to the one just described, it would be placed below it. Of course, if the swell to pedal coupler is required, additional height must be allowed between the floor and the manual keys.

Another mode of coupling the pedals to the manuals is by means of a tumbler action similar to that shown in Fig. 143, for swell to great coupler. Instead of being made to slide, the tumbler rail is placed near the ends of the key-tails, with a centre wire at each end, so that it will turn round. It is made to give a quarter of a revolution when the stop knob is drawn out, which then brings the tumbler vertically in connection with the backfalls and key-tails. When the stop knob is pushed in, the tumblers are inclined at an angle, and consequently do not act on the keys.

The backfalls must be centred so that the back ends which push up the stickers do not rise more than $\frac{3}{8}$ inch when in action, or they will force the manual keys too high. If the centre pins pass through a point about $\frac{3}{5}$ from the front ends, they will be about right. The

depth of the pedal action is $\frac{3}{4}$ inch as before intimated, and that of the manuals only $\frac{3}{8}$ inch, hence the necessity for the pins of the coupler backfalls being placed out of the centre.

If full compass pedals of thirty notes are required (running up to F instead of only to C) they may of course, be made by allowing a proportionate increase in the width of the pedal key-board, but two octaves will be found quite sufficient for all ordinary purposes and they do not take up so much room.

It is, of course, quite possible to have pedals without having a separate pedal organ, by merely making the pedal key-board and the coupler backfalls, so that the pedal keys act on the manual keys only. This arrangement, whilst taking up less room and being less expensive than the other, still enables the performer to have the advantage of pedal practice, and he can use both hands on the upper part of the manual whilst playing the bass with the pedals.

The pedal key-board is placed so that the centre C key is immediately under the middle C′ of the manual, consequently the pedal board is slightly to the left of the centre of the instrument. It need not be fixed in any way to the instrument, as the pedal keys may readily be placed so that they rest on the arms of their proper squares. A small mark or mortise on the front of the case would indicate the exact position which the key-board should occupy, and thus, when not in use, or when the housemaid's services are called into requisition, it could be removed and placed out of the way.

A small bar of wood fixed above the front squares, and lined with cloth or baize on the under side which touches the top of them, would prevent any tendency to rising, and keep all squares in their proper place

when the pedal key-board is removed (see H, in Fig 168).

It will, of course, be understood that the stickers and trackers in the pedal action should be made rather stouter than those in the manual action.

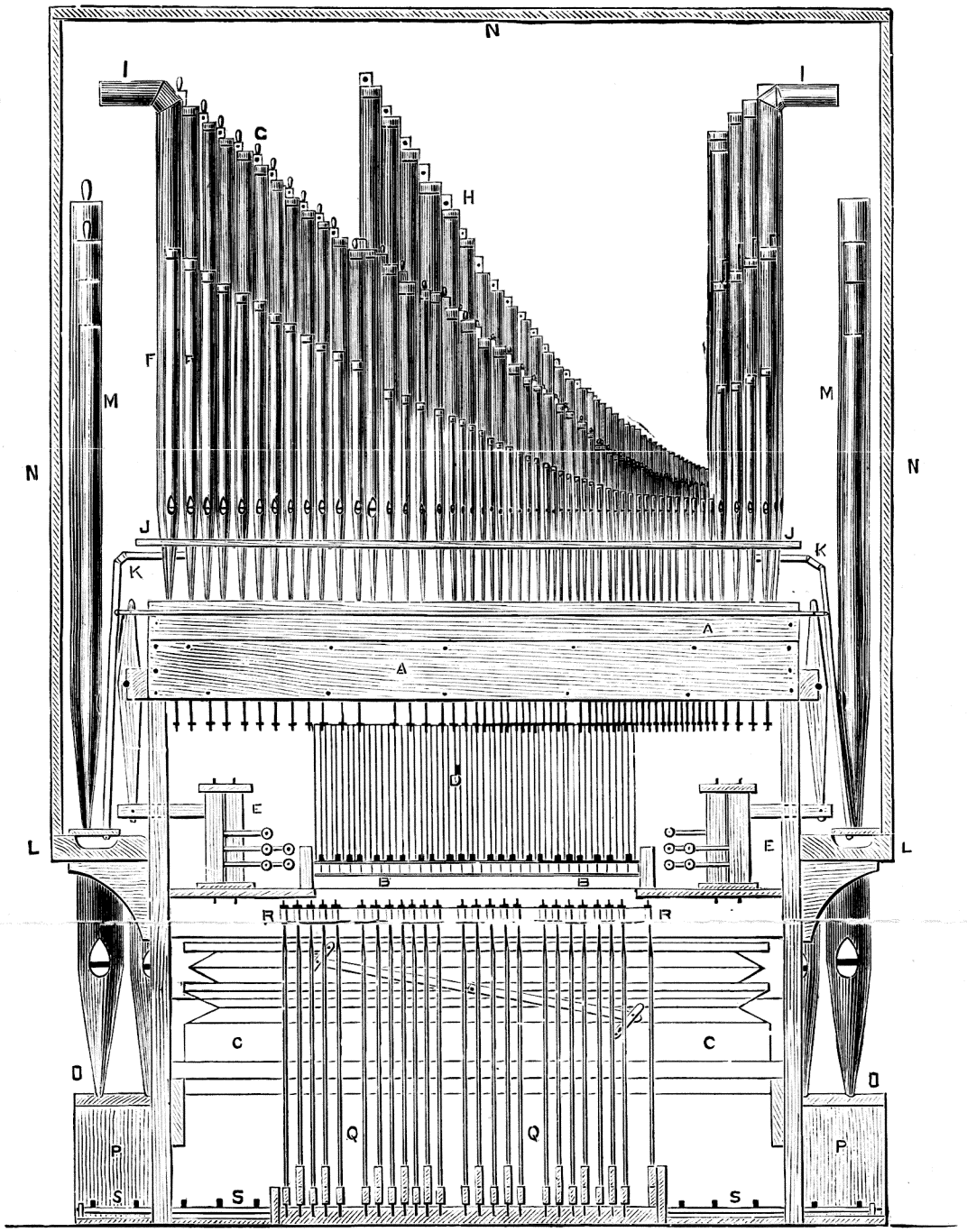
If any of my readers propose placing more than one stop on the pedal sound-board, it will be necessary for them to use sliders and upper boards similar to those on the manual sound-board, and to allow the channels to be sufficiently long to supply all the stops, thus the width of the pedal sound-board would be increased. One stop on the pedals would give sufficient bass for any of the organs for which I have given specifications, but some amateurs might build organs of larger scope than those, in which cases an additional pedal stop would be an improvement.

CHAPTER XII.

THE SWELL, ETC.—VENETIAN SWELL—GRIDIRON SWELL—BOX SWELL—TREMULANT.

ACCOMPANYING this chapter are two sections of organs, from a study of which the amateur will obtain some idea of the general arrangement of the several parts. Fig. 170 is a longitudinal section of the one-manual organ described in Scheme I., and is really a view of the instrument as it would appear without a front casing. Of course, it will be understood that, as the pipes of the several stops are arranged in rows one behind the other, it is not possible, in a sectional view, to show all the pipes, as those in front hide those which are behind them. As the two-manual instrument would present a nearly identical appearance when looked at from the front, I have in Fig. 171 given a transverse section of it instead, as that will also give an idea of the appearance of the single manual when viewed from the side. In the two-manual, the swell shutters and swell box enclose only the pipes on the back sound-board, but in a single manual they would enclose all the manual pipes, and the shutters would therefore be placed immediately behind the show pipes in the front of the organ.

Fig. 170.—Longitudinal Section of Organ. Scale, ¾ inch to 1 foot.



A, Sound Board; B, Keyboard; C, Bellows; D, Stickers; E, Stop Action; F, Flageolet Pipes; G, Flute and Stopt Diapason Pipes; H, Open Diapason and Keraulophon Pipes; I, Mitred Pipes; J, Rack Board; K, Conveyance Tubes; L, Board for Large Pipes; M, Large Pipes planted off; N, Swell Box; O, Pedal Pipes at Back; P, Pedal Sound Board; Q, Pedal Trackers to Coupler; R, Pedal Coupler; S, Pedal Rollers.

Folding Plate No. 10, containing Fig. 170, to face page 199.

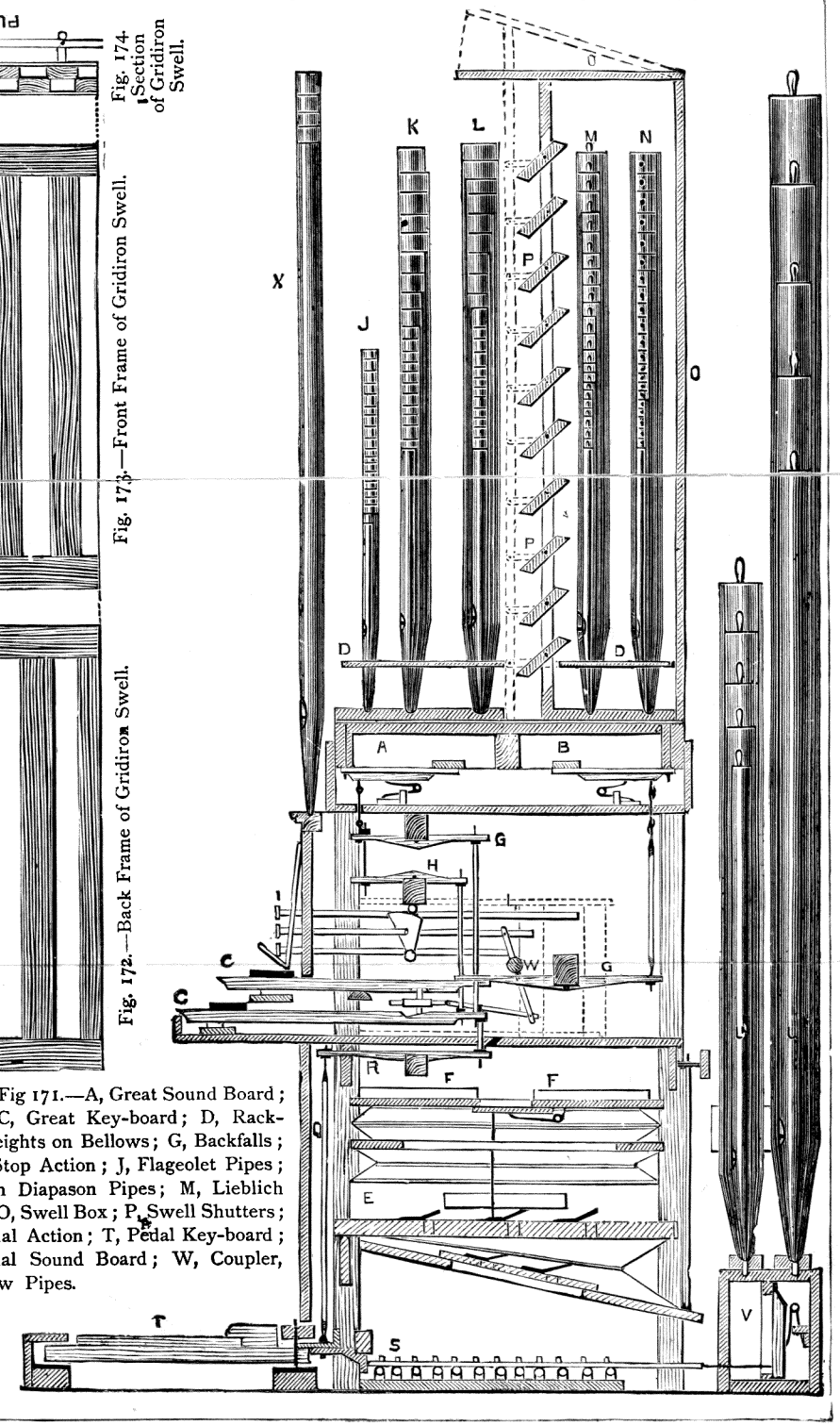
It will, of course, be understood that the pedal pipes are not enclosed in the swell box. They may stand either behind it or at the sides of it, according to the desire of the amateur; their position being determined in a great measure by the space at his disposal. I may also say that if you wish some of the manual pipes to be brought to the front or sides, so as to form show pipes, they should only be some of the lowest notes of the stopt pipes, unless you place the whole stop outside the swell box, which may be done. Thus it would not do to place the largest pipes of the open diapason outside the swell box, and leave the remainder of that stop inside, as, when you were playing, one note would sound loud and clear, whilst the next one might be soft and subdued. But in the case of the lower notes of the stopt pipes, as they form the base of the open diapason, they might with advantage be placed outside the swell, so that their full power might be available, and the break in the power would not be very marked.

The swell forms a most valuable addition to any organ—even when the instrument has only one stop of pipes—as it is almost the only method available for obtaining expression. By the aid of a properly constructed swell, we may play so softly that, notwithstanding the fact that several stops may be in use, the musical sounds proceeding from them can scarcely be heard, but by gradually opening the swell shutters, we can cause those sounds to gradually increase in power, until at last the harmonious thunders of the full organ peal forth in all their grandeur, and the majestic volume of sound may then be caused to gradually diminish or die away into the merest whisper. What a difference there is between playing

all the notes of a movement at full power, and in playing the same notes with varying powers, according to the sense of the words accompanying the music! I cannot but join issue on this point with a recent writer, when he deprecates the introduction of the swell in small organs, whether used for private entertainment or for public worship. Surely the fact that novices are given to using the swell unnecessarily is no reason why a valuable accessory should be excluded from the instrument. Practice, we are told, makes perfect; but if, as is often the case, the organ in a village church or schoolroom is the only instrument accessible to the youthful musician, and that be deficient in the matter of the swell, how is it possible for him to learn to use it? Again, many village organs are played by the sons or daughters of the neighbouring gentry who are fully acquainted with the use and musical value of the swell, and would be sorely disappointed if the instrument were without one. Under these circumstances, I would strongly advise the amateur not to omit this important and inexpensive accessory from his instrument. I say *inexpensive*, because if it is intended to have a case over the whole organ, so as to exclude dust, etc., all that will be necessary will be to add the shutters to the front of the casing, and a pedal to open and close the same, and your casing will be transformed into a swell box.

The sides and ends of the swell box are formed of framings of deal or pine *at least* an inch thick, and about 3 inches wide, and the end and back framings should be filled in with doors, so that ready access may be obtained to any portion of the interior. It is a great mistake to make the swell box of thin material,

Fig. 171.—Transverse Section of Organ. Scale, ¾ in. to 1 foot.



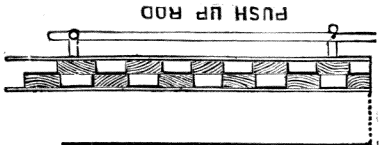


Fig. 174.—Section of Gridiron Swell.

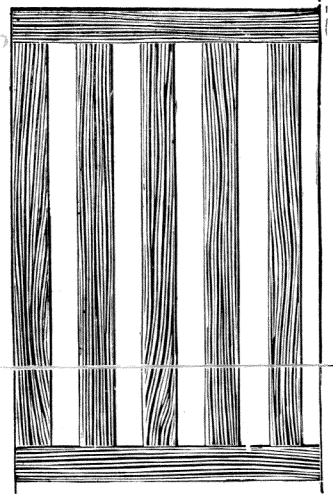


Fig. 173.—Front Frame of Gridiron Swell.

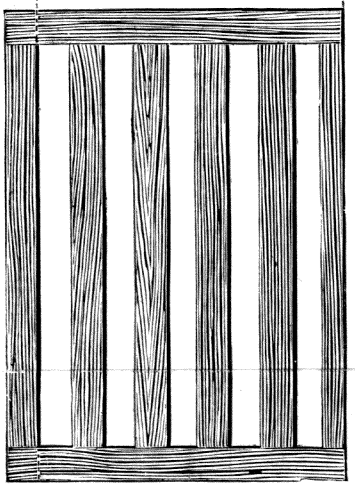


Fig. 172.—Back Frame of Gridiron Swell.

References to Letters in Fig 171.—A, Great Sound Board; B, Swell Sound Board; C, Great Key-board; D, Rack-board; E, Bellows; F, Weights on Bellows; G, Backfalls; H, Coupler (Octave); I, Stop Action; J, Flageolet Pipes; K, Flute Pipes; L, Open Diapason Pipes; M, Lieblich Gedact; N, Keraulophon; O, Swell Box; P, Swell Shutters; R, Pedal Coupler; S, Pedal Action; T, Pedal Key-board; U, Pedal Pipes; V, Pedal Sound Board; W, Coupler, Swell to Great; X, Show Pipes.

as is often done in the case of chamber organs, for a little consideration will demonstrate that it is necessary to have thicker material in a chamber organ than in a church organ. The church organ being situated at a considerable distance from the audience, the sound loses a portion of its fulness before it reaches their ears, but in a room the audience are necessarily close to the instrument, and the sound reaches them with undiminished power. A more efficient swell box is made by having two thicknesses of stout wood with a space between them filled in with sawdust, millboard, or coarse felt, or other non-conductor of sound. In any case the whole of the interior of the swell box should have two or three thicknesses of brown paper pasted over it, and then be given two or three coats of oil paint, and that will make it more impervious to the sound of the pipes. A coat of varnish over the inside will tend also to reflect the sound when the swell shutters are opened.

The directions for making the swell box will apply equally to either of the three kinds of swell which I shall describe. If for a single manual instrument with a general swell over the whole, the swell box should be made about the same width as the sound-board, so that it may be supported on the two outside bearers of it; or it may be to rest on the posts of the building frame by carrying the end frames of the swell box down sufficiently low. If any pipes are planted off the sound-board across the ends, as shown in the section, Fig. 170, the ends of swell box should be brought down so as to enclose these pipes also, as shown at c, c, on Fig. 175, so that all the pipes may be enclosed in the swell. A couple of strong wood brackets under the board on which these pipes stand

will be sufficient to give it the requisite strength to support the weight of the swell box, but the weight should be partly supported by the sound-board as well.

The same thing will be done under similar circumstances with the swell box of the two-manual organ; but of course the depth of the swell box will only be equal to the width of the swell sound-board. It would be supported in the front by the wide bearer between the two sound-boards—not on the upper boards—and at the back would rest on the outside bearer, or on the building frame in the manner before suggested.

The height of the swell box will depend on the height of your room and on the height of the longest pipe standing on the sound-board. As already stated in a former chapter, the height of the organ may be considerably reduced by planting some of the longest pipes off the sound-board, and by mitring some of those which are allowed to stand on it. The pipes may be planted off to any convenient position either at the back, ends, or front of the sound-board, and the wind conveyed to them with paper or metal tubes from $\frac{3}{4}$ inch to $1\frac{1}{4}$ inch diameter internally, according to the size of the pipes.

It must, however, be distinctly understood that there must, in all cases, be a space of *at least* 6 inches in height between the top of the longest pipe and the underside of the top of the swell box, otherwise you will not have room to lift your pipes out of the rack board when required. But if you have plenty of space to spare you should make this height above the top of your tallest pipe as much as two feet, if possible, and you will find that the pipes will sound very much better, being less muffled.

The Venetian Swell being the best and most effective, we will give it our first consideration. The box itself is made with framings and doors, as above described, and the front is filled in with louvres, or shutters, as shown in Figs. 171, 175, and 176. These shutters should be of 1 inch or $1\frac{1}{4}$ inch deal or pine, well seasoned. They are just long enough to fit in easily between the two end framings of the swell box, and are about 5 inches in width, and are splayed on the top and bottom edges, as shown in Fig. 177. The top edge of each shutter should be covered with two thicknesses of cloth, so that they do not rattle together when opened or closed, and the framings round the doors should, for a similar reason, be also lined with cloth. A stout "centre" wire is inserted at one end of each shutter about one-third down from the top; at the other end a groove is made leading up to a hole the same distance down as the first centre wire (see Fig. 177). This groove is to receive the other centre wire, which is fixed in the framing of the swell box instead of into the shutter itself, and the shutters can thus be lifted up and taken out if required. An arm of $\frac{3}{4}$ inch mahogany is then fixed on to each shutter. If the swell is for a two-manual with the two sound-boards in one, the arms on the swell shutter must be at one end, but if there is a space between the two sound-boards the arms may be in any convenient position. In the case of the single manual they may be directly over the swell pedal, as shown in Fig. 175.

A hole is made in the end of each arm to receive the wire pins fixed in the push-up rod. The push-up rod is made of inch stuff about $1\frac{1}{4}$ inch wide, and the pins are only just long enough to pass through the holes in shutter arms. The rod may be extended

so as to push up the top of the swell box like a lid, and you will then secure the fullest openness of tone possible. In Fig. 178, is shown the manner in which the swell shutters are opened and closed by means of the foot pedal, when the swell is situated at some distance from the front of the organ. The pedal A projects beyond the framing of the organ in a convenient position to be pressed by the foot, and is centred to a portion of the framing.

On the back end of this pedal is a rod B, or stout sticker, as it may be termed, connected to another rod C, placed at right angles to it, and centred to any convenient piece of wood. The further end of this rod pulls down the end of the rod D, which is centred like a backfall, and the tail end of it pushes up the rod connected to the arms of the shutters, and thus opens the swell, or pushes up the top of the swell box, if required. If the swell comes right to the front of the organ, you will only require the pedal A and the rod B, which latter will form the push-up rod opening the shutters. In order that you may be enabled to fix the shutters partially or wide open, the slit in the case through which the pedal projects is cut in step-like stages, so that by pressing the pedal slightly sideways it catches in one or other of these notches, and is thus held down, but can easily be released when required by merely pressing it back with the foot. As the combined weight of all the swell shutters is something considerable, it is desirable that a balance weight should be introduced to lessen it. This weight is shown at D on Fig. 176 and at F on Fig. 178, and it slides on a rod centred to a block under the swell box, and secured by a wire pin to the push-up rod. By shifting this weight along the rod you can arrange it so that it nearly balances the weight

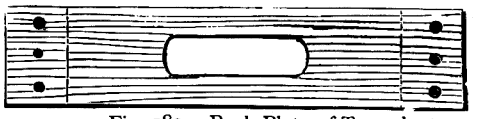


Fig. 180.—Back Plate of Tremulant.

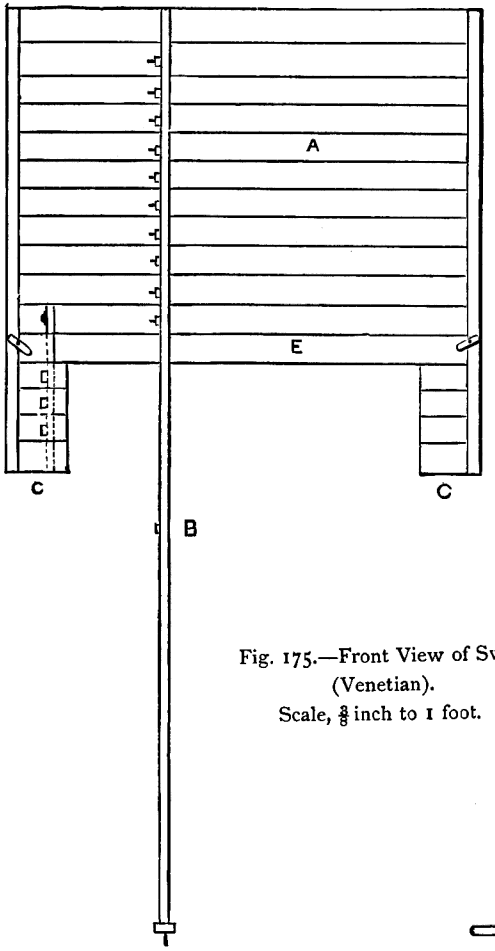


Fig. 175.—Front View of Swell (Venetian).
Scale, $\frac{3}{8}$ inch to 1 foot.

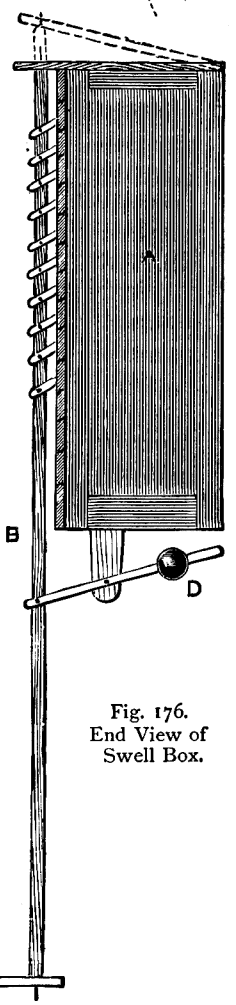


Fig. 176.
End View of Swell Box.

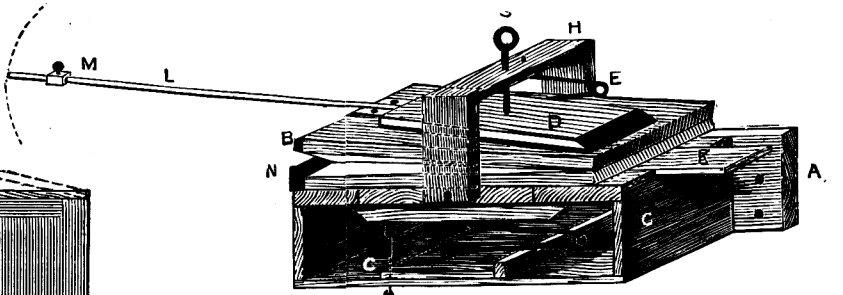


Fig. 179.—View of Tremulant.

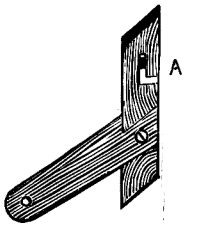


Fig. 177.—End View of Swell Shutter.

Fig. 178.—Box Swell Action, showing the Swell Pedal.

Folding Plate No. 12, containing Figs. 175—180, to face page 205.

of the shutters, leaving a little in their favour so as to secure that the shutters will close of their own accord. A spring may also be placed under the front end of the pedal, to cause it to return after being pressed down. You will find that this balance weight makes a very great difference in the pressure required on the pedal in order to open the swell.

Where there are reed pipes, the lower portion of the front of the swell box is made to open on hinges, in order to get at the tuning wire of the reeds, and this door can be secured by buttons when closed (see E in Fig. 175). You can, if you so desire, fill in the portions marked C on the same figure with small shutters, which will open themselves if a short rod is attached to them, and connected to an arm on the lowest long shutter, as shown at the left-hand side in the sketch. It is not really necessary to do this, as these portions of the swell box may be quite closed in, the tendency of sound being to find its way out at the nearest opening. In Fig. 171 the shutters are shown open, and it will be seen that they open similar to the laths of a Venetian blind, or like the louvres at a brewery or tannery. But when closed, they do not lap over at the edges like these, but form one unbroken surface as shown in Fig. 176.

You will now see that a very wide bearer is placed between the sliders of the great and swell sound-boards, to secure sufficient room for the swell shutters to open. It is much the best for them to open at the front of the box, but it is sometimes convenient to make them open at the back of it, in which case the extra 6 inches in the width of the sound-board will be saved.

Where space in depth is very limited, the swell

may be merely a box with the sides formed as doors, and the top of it opening like an ordinary box lid, as shown in Fig. 178. Where this is done, the lid or top should project over the front sufficient to allow it to still rest on the top of the push-up rod when open. A slit may be made in the lid, and a wire passed through it, and fixed into the top of the rod, which will then keep in position; but a round hole would not answer the purpose, as there is a lateral movement of the rod when the lid opens. Of course, it will be understood that this is at best but a make-shift swell, and not nearly equal to a Venetian swell, but it is certainly better than none, and can be added where the Venetian is excluded by reason of want of space. I may state that, instead of having a box lid, the top of the swell box might be fitted with horizontal Venetian shutters.

Another variety of swell—which only requires a space of about $2\frac{1}{2}$ inches to work in—is that termed the Gridiron Swell. It consists of a framing as shown at Fig. 172, which fills up the front of the swell box, and is, so to speak, a fixture, though it should be made so as to be readily taken out if required. A second frame, shown in Fig. 173, is made in such a manner that the bars in it correspond with the spaces in the other framing or "gridiron." This second framing is placed in front of the first one and secured up against it by means of a $\frac{3}{4}$ inch bead, similar to the manner in which ordinary window sashes are kept in their places. It further resembles a sash by its being capable of being lifted up, which is done by means of the rod and pedal. A reference to the section in Fig. 174, will show that when the swell is closed, the bars of the front frame cover the spaces in the back one; and

when open, the bars and spaces of both frames coincide with each other. The surfaces of the frames where they touch each other should be well black-leaded to secure easy and smooth action. The pedal movement for the several swells will be much the same as those described, according to whether the swells are situated at the front or at the back of the instrument.

We now come to a useful little apparatus termed a "Tremulant." When this is in operation it causes all the notes played to have a waver or trill, somewhat similar to the sound of the Voix Celeste stop. The same remark which I made with regard to the swell applies to the Tremulant—viz., that the indiscreet use made of it by novices is no argument for its exclusion from the instrument. When it is not overdone, but used with discretion, it gives beauty and variety of effect to certain passages in a movement, and I see no reason why it should not be introduced into small instruments as well as large ones. It consists, as shown in Fig. 179, of a wind-chest (marked C) having a hole cut through the top of it into a little bellows B. This hole is covered on the under side by a pallet or valve similar to those in the wind-chest of the manual sound-board, and is kept in its place by a guide pin and spring. On the top of the little bellows B, is a large hole covered by a pallet or valve D, which is kept from rising beyond a certain distance by means of the regulating screw wire S, which works through a strip of wood H, fixed on supports screwed to the side of the bellows. A spring E keeps the bellows closed. A slider K, with a hole through it the same size as the hole in the top of the wind-chest, by being drawn out, will regulate the size of that aperture as

required. On the top of the bellows is fixed a thin flat wire or steel spring about 8 or 10 inches long, with a sliding weight M on the end of it, which can be fixed at any point of the wire by means of an adjusting screw. The back of the wind-chest, which is shown in Fig. 180, has a hole about 2 inches long by 1 inch wide in the centre of it to admit the wind into the wind-chest. The front is supposed to be removed in the sketch, but it is merely a flat piece of wood closing the wind-chest right up.

The tremulant acts as follows: A hole corresponding in size to the hole in the back plate is made in any convenient position of the wind-trunk of the manual sound-board, or in the back of the sound-board wind-chest, and the tremulant screwed over it. A stop knob—or, what is better still, a pedal placed in a convenient position to be pressed by the foot or knee—is connected to the pull-down wire R of the tremulant; and on the pallet being opened the little bellows B is filled with compressed air, which forces the pallet D open, and the air escapes. The pallet D, however, rises but a little way before it is stopped by the screw S, whilst the spring E forces the bellows to close again. This causes the flat wire L, with the weight on it, to vibrate up and down, thus alternately opening and closing the bellows and pallet, and imparting a tremulous or wavy sound to the pipes. The quickness of the vibrations of the rod are regulated by means of the weight on the flat wire; the nearer it is placed to the bellows the quicker are the vibrations. A piece of stout felt is glued along the front edge of the bellows, as shown at N, to prevent it making a tapping noise. If the tremulant should make an unpleasant noise it may be prevented from being heard by enclosing the

whole affair in a box lined with thick felt; or it may be placed right away from the instrument, say in a cupboard in the next room, and if the wind is conveyed to it by a pipe about $1\frac{1}{2}$ inch diameter, it will act just as well as though it were attached to the instrument.

"Combination pedals" or "composition pedals" are arranged so as to operate on several stops at once, by merely pressing the foot on a pedal. This is managed by connecting the pedal rod with a roller having several arms each of which acts on a stop-slider, so that when the pedal is pressed it either opens or closes several sliders at the same time. These actions are generally connected to the opposite end of the sliders to that acted upon by the ordinary stop action, but by causing the roller arms to operate on a rod connected with the arm of the draw-stop action it can be fitted at that end. By means of these pedals a set of loud stops or soft stops can be brought into use as required by the necessities of the case.

CHAPTER XIII.

VOICING AND TONING—DEFECTS AND THEIR REMEDIES.



E have now completed the structural portion of the organ proper, as the case may be considered a separate matter, and may therefore proceed to prepare for the more delicate, and, I must admit, more tedious operation, of voicing and tuning the pipes. Before actually starting on this work, however, it will be advisable to give the constructive work a thorough inspection, with the view of ascertaining whether there are any defects which need removing. See that all the various parts are in their proper places, and act properly, and, above all, look to the building frame, and see if there is any indication that it is giving in any way, for the weight it has to support is something considerable, and any defect here would prove very disastrous. To make "assurance doubly sure," it would be as well if a longitudinal bar were screwed on near the top and bottom, both on the back and front of the frame, taking care that they come in such positions that they do not interfere with the working of any portion of the instrument, or with the means of access to it. If the work has been properly executed, these strengthening pieces

should not be needed, but amateurs often fail to make a strong mortise and tenon joint. The swell box should next be looked to, and care taken that it is properly secured to the building frame, or to whatever supports it, and that no rattling takes place when several large pipes are sounded at the same time.

We may then proceed to adjust the pressure of wind, and for this we shall require a little instrument, termed a wind-pressure gauge, or "anemometer." This can easily be made by the amateur for himself, and a glance at Fig. 181 will show how it is constructed. At the chemist's, or at a glass warehouse, procure a piece of glass tubing about 2 feet 6 inches or 3 feet long, and about $\frac{3}{8}$ inch bore, and bend it very gradually over the gas flame, or over the flame of a methylated spirit lamp, to the form shown in the sketch, making the arm that goes into the foot about 12 inches long, and each of the others about 8 inches long. Insert the bottom of the long arm into the foot of a wood pipe, or into a piece of wood similarly shaped, and fill in all round the top of the foot with red lead or putty, so that there may be no escape of wind, except through the tube. Then make a slip of wood about 10 inches long, and just wide enough to fit in between the two short arms of the tube, and slightly hollow out the

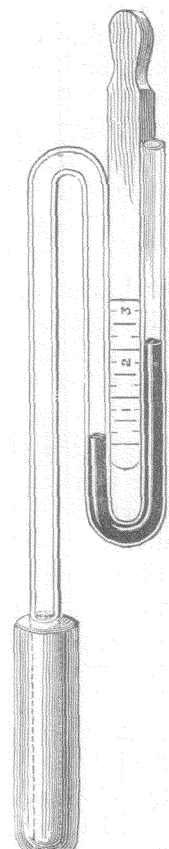


Fig. 181.
Pressure Gauge.

edges, so that it will keep in its position. Divide the lower portion of this slip into inches and parts of inches, as shown in the sketch, working from the bottom. Now colour a little water with a drop of red ink, aniline dye, or even tea, and with a small spouted jug or with a syringe, inject it into the top of the tube until it reaches 3 or $3\frac{1}{2}$ inches up both arms of it. If any bubbles of air appear in the tube, the water must be ejected by forcibly blowing through the foot, and the tube filled again.

Take one of your largest pipes off the sound-board, and, in its place, substitute the tube, taking care that the foot fits quite air-tight into the hole in the upper board, so that the air can only escape by passing up the tube. Place a little weight on the proper key to keep it down, then blow the bellows, and place weights on the top of it, until the water in the tube indicates the required pressure—2 inches is about the proper pressure for any of our organs, but it may be a little more or a little less, according to the volume of sound which you require to produce. Too high a pressure will produce a screamy sound from the pipes, which is very objectionable, but if it is too low the tone is weak and unsatisfactory. The pressure is indicated in the following manner:—The water in the two arms, when in its normal state, is perfectly level; but on blowing the bellows, the air presses on the top of the water in the middle arm, and thus causes it to rise in the third arm, and the distance between the two surfaces indicates the pressure in inches. This distance can be measured by adjusting the graduated slip of wood, so that the zero corresponds with the surface of the water in the middle arm. In the sketch a pressure of 2 inches is shown, and that is the pressure which I recommend my

readers to adopt. On large organs, some of the loud reed stops are placed on a pressure of 12, 15, or even 20 inches.

The weighting on the bellows should consist of pieces of flat iron, sheet lead, or stout slate, and, in any case, should be covered with two or three thicknesses of stout paper, or be wrapped up in baize, to prevent the top board of the bellows being dented by the sharp corners of the weighting.

Having now adjusted the pressure, we take the pipes in hand for voicing. I will deal with wood pipes first, as they are the simplest to voice. The voicing nicks are sloping nicks or grooves made on the face of the block of the pipe, deepest at the top, and dying away altogether before they reach the throat. For pipes required to give a full round tone the nicks are wide apart and rather coarse, but for fine and delicate toned pipes the nicks are close together and very fine. The nicks are made with tuning-files (shown in Fig. 182), which can be procured in several sizes ; two or three of the smaller sizes will be all that the amateur will require. They are very slightly rounded on one side, and rather more so on the other, and the edges are sharp. It is the edge which is used to make the nicks or grooves. For bevelling the edge of the block, cutting up the mouths and rounding the upper lips, a flat iron file will be required, or better still, make half-a-dozen of the handy little tools shown in the sketch, Fig. 183. They consist of slips of



Fig. 182.—Tuning File for Cutting Voicing Nicks. A, Section.

thin wood shaped as shown, one end being wider than the other, the end A being covered with very fine glass-paper, and the end B covered with glass-paper of rather a coarser nature, and covered in the same way on the under side, but reversing the order of the glass-paper. You have thus four tools in one, viz., two sizes and two degrees of fineness. The smallest ones should be simply veneer, and narrow enough to pass into the mouth of the smallest pipe.

I have often been asked whether I could give some rule for regulating the sizes and distance apart of the nicks according to the size of the pipe, and as this is a work which requires the utmost care and patience (for, in order to secure good results the nicks must be

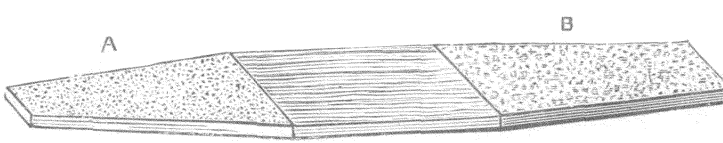


Fig. 183.—Home Made Tool for Bevelling, etc.

perfectly regular, gradually decreasing in width, depth, and distance apart as the pipes run smaller), I have thought it well to place at the disposal of the amateur a little mechanical appliance for the purpose. It is made in the following manner: Take a piece of thin card and draw on it a line corresponding in length to the width of the mouth of your largest pipe of the stop you wish to voice. Now divide this line into as many parts as you wish to have nicks; for the tenor C, open diapason wood pipes, the nicks should be rather less than $\frac{1}{8}$ inch apart from centre to centre. With your compasses, take the depth of the pipe and set it off immediately over the centre of the line showing width of the mouth (see Fig. 184). Up to this centre point

draw a line from each end of the mouth, thus forming a triangle, and then draw lines from each division up to the same point. If you wish to find the size of the nicking for any other pipe, all you have to do is to take the width of the mouth of that pipe in your compasses, and set it off on this triangle, so that the points of the compasses just touch the two outside lines of the

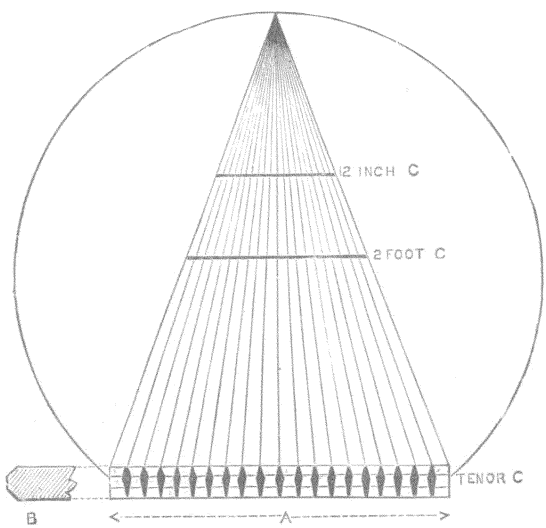


Fig. 184.—Method of Regulating Size of Voicing Nicks.

A, Front Edge of Tenor C Languid. Full Size. B, Section of Front Edge of Wood Languid.

triangle. Draw a horizontal line through these points, and you will find it divided equally into small divisions by the sloping lines running through it. In the sketch in Fig. 184 all this is set out (though it is there shown for a circular pipe), and the width of the mouths of the 2-foot C and 1-foot C are marked to show the application of the rule. If you draw this out on the card, as directed,

and by drawing horizontal lines at the proper places, show the widths of the mouths of every fourth pipe, you can then proceed to cut the card along the line of the largest pipe, and hold it against the top of the face of the block, and mark the position of the nicks with the point of a pencil. Cut the card down to the next line, and mark the pipe corresponding to it in a similar way, and so on until you reach the small pipes, in which the nicking will be merely scratches close together, requiring no setting out.

If you make one of these cards for each stop, I think you will have no difficulty in regulating your nicks. The depths of the nicks may be regulated by drawing a line on the top of the block the requisite distance in from the face of it. Of course, experienced workmen need no such mechanical aid as this, as they can regulate their nicking with the utmost accuracy by the aid of their eyes alone, and would probably look with great contempt upon any mechanical aid. I am not, however, writing for experienced hands, but for novices in the work, and this little appliance may save them spoiling many of their pipes. As the art of nicking nicely can only be acquired by practice, I recommend my readers to practise on spare pieces of wood before attempting to voice a pipe.

Fig. 185 shows the nicks full size on the block of the tenor C pipe of the wood open diapason stop. They are nearly $\frac{1}{8}$ inch apart and $\frac{1}{16}$ inch deep at the top, and die quite away before reaching the throat. Before making the nicks, see that the top edge of the block is perfectly square with the sides of the pipe, if not, make it so by chiselling; and, after nicking the block slightly chamfer the top edge of it, as shown in the sketch. This chamfer should be made without sharp edges, and

must be reduced as the pipes run smaller until in the top octave it merely takes the sharpness off the edge of the block.

The windway of the tenor C should be filed to about

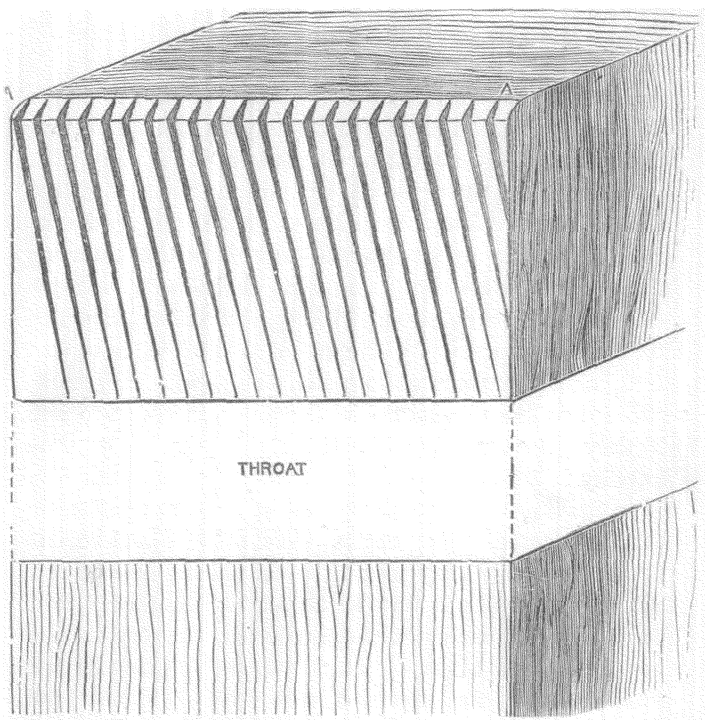


Fig. 185.—Block of Wood Tenor C Pipe, Open Diapason, showing Voicing Nicks. Full Size.

$\frac{1}{16}$ inch deep, and should be very gradually lessened in each successive pipe to top octave having a windway of only $\frac{1}{32}$ inch deep. The mouth should then be cut up to very slightly more than one-fourth of its diameter, and the edge of the upper lip should have the sharpness

just taken off with the glass-paper file. It will be remembered that the mouths of all the pipes were left slightly under the prescribed height in order to allow for finishing off when voicing and toning. I prefer using a file made of glass-paper, instead of a knife, for this purpose, as there is no danger of spoiling the lip with the file.

Having completed the voicing of the whole of the open diapason, and examined them to see that the voicing is clean, and no sawdust or chips remaining in any part, you may place the pipes in their proper position on the sound-board. They must fit well into the holes in the rack-board and upper-boards—especially the latter, as there must be no escape of wind there—or it will not only cause an unpleasant hissing, but will weaken the tone of the pipes. By the aid of a pitch-pipe, tuning fork, or an instrument in good tune, you may now proceed to test the sound of the pipes, in order to see if they give anything like the right note. The probability is that they will all sound very much too flat, as in making them we always allow them to run longer than the actual tone length. We must therefore cut them down until they sound the least bit too sharp, and this is done with a fine tenon saw, cutting very thin strips off until the right note is given. Be very careful not to cut too much off at a time, and begin with the middle octave, and you will soon be able to tell how much is required to be taken off in each pipe. Roughly speaking, each pipe from 4 feet to 2 feet long is 2 inches shorter than the preceding one; each one from 2 feet to 1 foot long, 1 inch shorter than the preceding; each one in the next octave $\frac{1}{2}$ inch shorter, and so on, the difference decreasing by half in each octave higher. This work being satisfactorily completed, we

next insert the tuning shades, which are simply lids of soft tin or zinc, bent and inserted in a saw-cut made in the thickness of the back-board of the pipe, as shown in Fig. 33, Chapter II. It should be the same width as the pipe, but about half an inch longer than the depth of it. Raising it sharpens the tone, and depressing flattens it, but the lid must never be quite closed. We must test the pipes to see if they are equal in timbre or loudness, and of the same character of tone. Some, perhaps, may sound too soft, others too loud, and this difference will most probably be caused by the difference in the amount of wind which they respectively receive. If too loud, insert a wedge or two of wood in the bottom of the foot, so as to make the hole smaller; if too soft, possibly, either the mouth is too low, or the windway too small, or the nicking not deep enough; so carefully inspect the pipe in order to determine where the defect is most likely to be, and file the upper lip a little higher, or enlarge the windway the least bit possible, or deepen the nicking, as the case may require; sometimes all three operations will have to be gone through with the same pipe. Above all things, do not be too impetuous in any of these operations, or you may spoil your pipes altogether; better do it two or three times over than have to remake a pipe. The top edge of the cap should be exactly level with the chamfer of the block; if it is not so it may cause weakness, or total absence of tone, in consequence of the wind not being directed properly on to the edge of the upper lip. The front edge of the upper lip of the open diapason pipes should have the sharp edge just taken of with a touch of the glass-paper file, but must not be actually rounded.

As to the means of regulating the thickness of the upper lips of all the wood pipes, I may mention that

the chamfer should be made as high as it is wide, and made so that if the lip were extended right down to the top of the block it would run off to a sharp edge. It will therefore follow, that the higher the mouth is cut up the thicker the lip will become, and this rule applies to all the pipes, unless it is especially stated that they are to have thin lips, and then the same rule may be made to answer by cutting a chamfer a little sharper. It must, however, be understood that when I refer to the upper lips being left *sharp* or *rather sharp*, I refer to the absence of any rounding on the front edge, not to the *thickness* of the edge. The edges of the upper lips are not left square, but very slightly chamfered upwards.

The *Principal* or *Flute* stop may now be treated in the same way as the open diapason, only making the nicks rather finer and closer together than in the pipes of the same length in that stop. This stop, viz., the *Flute*, has two caps, an inner and an outer one. The face of the inner one must be exactly level with the face of the pipe, and the top edge of it should just have the sharpness taken off. The mouth is cut up one-fifth of its diameter and the outside edge of the upper lip left square, as, being an inverted mouth the roundness and chamfer of the lip is on the inside. The windway is very slightly less than that of the open diapason, and the pipes must not sound quite so loud.

The *Gemshorn* is voiced in a similar manner to the flute, the windway being the same size. The mouth is cut up one-third of its diameter, and the edge of the upper lip left sharp. This stop is not quite so full toned as the flute, being rather more reedy.

The Flageolet is voiced still finer than the flute, and must not be so loud. The height of the mouth is only

slightly over one-sixth of its diameter, and the holes in the feet are very small, being made as directed in page 41, Chapter II.

Stopt Wood Pipes.

The Bourdon should have the top edge of the block or languid slightly bevelled and nicked rather lightly for the size of the pipe. These nicks may be rather over $\frac{1}{4}$ inch apart on the CCC, and $\frac{1}{8}$ inch apart on the smallest pipe, making them only the same depth as those of the first two octaves of the open diapason: upper lip of largest pipe $\frac{1}{6}$ inch thick. The windway should be $\frac{1}{10}$ inch wide for the largest, and rather over $\frac{1}{16}$ inch for the smallest. Do not expect too loud a sound when close to the pipe, as you hear this stop best at a distance.

The Stopt Diapason really requires no nicking if made with block shaped as I have described; but it can be nicked if you like, making it rather lighter than the open diapason. Mouth cut up one-third of the diameter, windway rather larger than the open diapason, and allow plenty of wind at the foot. Lips about $\frac{1}{10}$ inch thick for CC, and slightly rounded on front edge.

The Lieblich Gedacht is voiced similar to the open diapason of same size. Mouth cut up one-third of the diameter or rather less, the upper lip fully $\frac{1}{8}$ inch thick for CC pipe, and slightly rounded on front edge. The windway to be the same size as that of the stopt diapason, and the cap to be slightly below the top edge of the block—viz., about $\frac{1}{8}$ inch for largest pipe and about $\frac{1}{24}$ inch for smallest.

It is useless trying to get a loud tone from stopt pipes, as if blown too strongly and cut up too high the

tone is harsh and very disagreeable. The proper tone is soft, sweet, and moderately full and humming. The stoppers, or tompions, must fit perfectly, and must be perfectly square with the pipe.

Having all the pipes completed, so far as voicing is concerned, you now place them in position, and cut them to the proper length, slightly chamfering round the top to make them look neat (if they are very much longer than necessary the stopt pipes may be trimmed down a bit); then proceed to tone them as described for the open diapason. In order to enable you to overcome all difficulties it may be well that I should point out the defects to which wood pipes are liable, and the way to remedy them.

1. *Windiness.*—Where this defect exists the pipe appears to take all the wind you can give it, and yet it all seems wasted as it does not produce much tone. This is often caused by the wind not being properly directed on to the upper lip, and the location of the defect may be determined as follows: Blow the pipe and hold your hand close to the mouth of it, and if the tone is improved it shows that the wind is directed outside the lip; so to remedy this raise the cap slightly, and that will direct the wind more inwards. If, however, holding the hand over the mouth effects no improvement, but rather makes matters worse, it shows that the wind is directed inside the pipe, and to cure it we must lower the cap a little. If we require a full fluty tone, the wind is directed more inwards than outwards; if a thin or reedy tone, it must be directed more to the outside of the pipe. Windiness may also be caused by the windway being too wide, the nicks too deep, or by the pipes or conveyances not fitting properly into the holes in the sound-board. If the former is the

case plane down the inner face of the cap and so reduce the windway; if the nicking is very much too coarse the only remedy will be to face the block afresh with mahogany, but unless this is very carefully done it will not answer.

2. *Over-blowing, or Sounding the Octave,* caused by too much wind for the size of the mouth. Cut the mouth a little higher, or enlarge the windway if really needful; but the generality of cases will simply require some of the wind stopping off at the foot by means of wedges inserted in foot.

3. *Hollowness,* caused by the mouth having been cut too high. Try giving more wind, but if the pipe then sounds too loud, and the defect is so bad as to spoil your stop, the only remedy is to saw off the upper lip just above the chamfer and tenon a new lip on. This is an awkward piece of work, and very vexatious, so beware of overcutting.

4. *Weakness of Tone,* caused by too low mouth, too thin a lip, too narrow a windway, or shallow nicks. Try allowing more wind at the foot first, and if not successful, deepen the nicking very slightly, or deepen the windway. If the lip is too thin it must be cut up a little higher, which operation in the case of a weak-toned pipe generally necessitates more wind at the foot and a larger windway. Bourdon pipes sometimes require a foot with a larger bore to be inserted in place of the one already fixed.

5. *Chiffing or Barking.*—This is a scraping noise heard with the sound of the pipes, or an uncertain sound given by the pipe before the proper note is heard. It is caused by the nicking being too shallow, or by want of parallelism between the edges of lips, or between the lips and the block. The block should

be square with the sides of the pipe, the lower lip perfectly parallel both with the face and with the edge of the block, and the upper lip parallel with both. A very little dust on the mouth of a small pipe will often cause it to sound very strangely, or not at all, so see to this before altering a pipe in any way.

Paper Pipes.

Open Diapason.—In this stop both the upper and lower edges of the languid are slightly bevelled, the lower edge, however, but very slightly. The voicing nicks on the tenor C languid should be about twelve to the inch, and nearly $\frac{1}{16}$ inch deep, and so cut that they are widest near the top of the flat edge, and die away on both bevels. These voicing nicks may be cut quite perpendicular, or may be slightly converging inwards towards the centre of the upper lip, so that the tendency is to prevent the wind impinging on the sides of the mouth. The rule which I have referred to for regulating the distance apart of the voicing nicks in wood pipes applies equally well in the case of paper or metal pipes. To set the card out for either of these describe a circle the same diameter as the internal diameter of the largest pipe of each stop which you propose to voice, and set off the width of the mouth, whatever it may be, at the lower part of the circle, and then divide it into spaces equal to the distance apart from centre to centre of the nicking for that particular pipe, and draw sloping lines from each divison up to the centre of the top of the circle (see Fig. 184). The width of the mouth of any pipe of the stop being taken in the compasses and set off, so that the points of the compasses just touch the two outside sloping lines, draw a horizontal line through these points, and you

will find it divided in exactly the same proportion as the larger one, as already explained in regard to pipes made of wood.

It will be observed that the edge of the languid, when nicked, will resemble the edge of a thick saw with the points or teeth blunt, but as the pipes run smaller, the nicks get finer and closer together, and the teeth then become sharper. If the pipes are voiced



Fig. 186.—Penknife-Blade for Nicking Paper Pipes.

before they are put together, the nicks can be made with a fine tuning file; but if the voicing is left till the pipes are completed, the nicks will be made with the tools shown in Figs. 186 to 189, which are conveniently shaped for getting at the edge of the languid, notwithstanding the smallness of the windway. Fig. 186 is a penknife blade, ground very fine, and fixed in a straight thin handle, like a penholder. Fig. 187

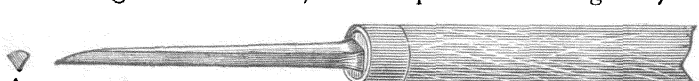


Fig. 187.—Bradawl Ground to Triangular Shape. A, Section.

is a bradawl ground to a triangular shape, and drawn to a point, the lower edge being sharp like a knife, and this tool is also fixed in a thin handle, and all of them are held in exactly the same way as one would hold a pen when writing. Fig. 188 is a triangular-shaped piece of steel, running off to a point, and having a sharp edge, which will be found very useful for the larger pipes. For the very small pipes, tools similar to Figs. 186 and 187, but ground very

much thinner at the point ends, will be necessary. Fig. 189 is a similar tool, but ground to a sharp edge on both sides of the sloping end. This last tool is used to make nicks on the inside edge of the lower

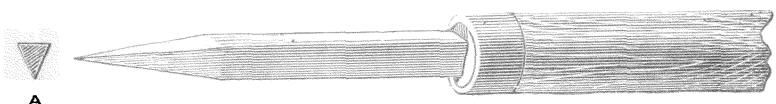


Fig. 188.—Pointed Triangular-Shaped Steel. A, Section.

lip of the pipes, corresponding to, but very much finer than, those on the edge of the languid. The upper octaves of the pipes will not require the lip nicked in this way, and it should not be done to any of the pipes until it has been ascertained that they sound properly, and that the wind is properly directed on to the upper lip, for if this is not the case, it may be necessary to take a little off the inner edge of the lip as described later on, when dealing with defects. In fact, this nicking of the lip should be the final operation, and should be done very lightly.

The mouth of the open diapason should be cut up one-fourth of its diameter, and the upper lip left rather sharp on its outside edge. Windway barely $\frac{1}{10}$ inch wide for tenor C, and decreasing to less than half this for the smallest pipe.

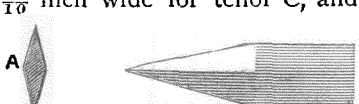


Fig. 189.—Nicking Tool for Inside of Lip. A, Section.

The Flute is voiced in exactly the same way as the previous stop (the nicks are rather finer and closer together), but rather softer than the open diapason. Mouth cut up one-fifth of its diameter, and the windway a scale or two smaller than the diapason, say tenor C of flute made the same size as the D of the open diapason.

Flageolet.--Nicks and windway still finer than those of the flute pipes of the same length. Mouth cut up rather more than one-sixth of the diameter; upper lip very slightly rounded on front edge. The holes in the feet should be coned very small. These pipes should be softer in sound than the flute, and care must be taken to secure this result, especially in the top octave, which always has a tendency to sound screamy.

Keraulophon.—The nicking and windway of this stop should be almost as fine as that of the flageolet, and the mouth cut up barely one-third of its diameter, the edge of the upper lip rather thin and not rounded on the outside edge. The holes through the sliding caps at the top of the pipes have already been referred to in a previous chapter. The proper tone of this stop is rather soft and stringy, and somewhat pungent.

Gemshorn.—Nicking and windway about the same as in the flute; mouth cut up about one-third of its diameter, and edge of upper lip left sharp and rather thin.

Stopt Diapason.—Nicking rather wider apart, but the same depth as in open diapason of same length, windway rather wider. Mouth cut up barely one-third of its diameter; upper lip thick and rounded on front edge, if a full round tone is required. If what is termed the quintaten or harmonic tone is preferred, the mouths should be cut up rather higher, and the lips made thinner and sharper on the outside edge. The upper lips of this stop are slightly arched, as described in instructions for making.

Lieblich Gedacht.—Very similar to the stopt diapason, but voiced rather softer. The mouth should be cut up barely one-third of its diameter; upper lip may be either straight or arched, according to taste, and slightly

rounded on front edge. A full supply of wind should be allowed. The original Lieblich Gedacht was made of metal with an arched opening for the mouth, and no flattening or *bay-leaf*, as it is termed, to form the upper lip.

Violoncello.—The nicking of this stop must be as fine as that of the flute, the mouth cut up barely one-third of the diameter, and the upper lip left rather sharp on the outside edge. The windway should be the same as that of the flute. This stop, as well as all stops intended to give a crisp stringy tone, should be coated with white hard varnish either over the oil paint, or used instead of it, both inside and outside the pipes. If paint only is used it gives the tone sweetness and fulness, but not crispness, which latter quality, in stops like the keraulophon and violoncello, is the great desideratum.

Paper pipes are subject to the same defects as other pipes, but the treatment for the cure of some of them will be rather different to that of wood pipes.

Windiness, caused by the wind not being properly directed on to the upper lip, may be detected in the same way as described for the wood pipes, viz., by holding the hand over the mouth of the pipe while it is sounding. If the wind is directed outside the pipe it may be cured by introducing a slip of fine glass-paper into the windway, and taking the least bit off the edge of the *languid* by gently working the glass-paper up and down two or three times. If, however, the wind is directed too much inside the pipe, introduce a very thin knife blade, or strip of thin metal, into the windway, so that merely by pressure the slope of the edge of the languid is slightly altered, and this will often be sufficient to cause the wind to be properly directed to

the edge of the upper lip. If this does not effect a cure, recourse must be had to the slip of glass-paper, and a little taken off the inside edge of the *lower lip*, so as to widen the windway. If a windway should happen to be too wide, it may often be remedied by simply pressing the lower lip a little inwards with a flat piece of wood, taking care to proceed very cautiously, so as to avoid cracking the foot of the pipe. If the upper lip projects too much, that may be pressed in in the same way, or if it does not project enough, the sides of the pipe may be gently pressed with the finger, so as to throw the lip forward, taking care not to damage the pipe. If the defects cannot be remedied by these means, the lip may be cut, or rather, prised off with a flat bladed knife; and if it is required to be further in, rub down the surface of the pipe with glass-paper, and then glue on a new lip, after testing it in its position on the pipe. If the lip is required to project more, cut a false lip of cardboard of the requisite thickness (cutting a V-shaped piece out of it), and glue it on to the pipe, and then glue on the wood lip over the card.

Overblowing may be prevented by coning in the hole in the foot so as to make it smaller; and this hole can be enlarged at any time by merely inserting the pointed end of a stick.

Weakness of Tone, Chiffing or Barking.—The remarks under these heads in the part dealing with voicing of wood pipes will apply to paper pipes. The tuning caps of the open pipes should fit moderately tight, so that, although they can easily be shifted by hand, they may have no tendency to shift of themselves when vibrating. The stopt caps of the stopt pipes must fit perfectly air-tight, and be square with the pipes, or you will not get a good tone; and the leather lining should be rubbed

with tallow or black-lead so as to ensure smoothness of action.

Metal Pipes.

Metal pipes are treated somewhat similarly to the paper ones in voicing, but are not voiced until they are completely put together. The purchase of metal pipes un-voiced will effect a saving of about 20 per cent. on the cost of each stop. The tuning nicks are cut on the thin sloping edge of the languid, so as to cause the edge to resemble the edge of a saw with the teeth rather blunt. The tools used are those shown in Figs. 186 to 189, and the inside of the lower lips must be nicked finely as described for paper pipes. The nicks in tenor C open diapason are $\frac{1}{32}$ inch deep and $\frac{1}{16}$ inch apart, and are reduced gradually as the pipes run smaller, until for the smallest pipes they become mere scratches. Follow the instructions given for the voicing of paper pipes as regards the relative sizes of the nicking of various stops as compared with the metal open diapason, the heights of the mouths and the cutting of the upper lips. As I recommended in the case of wood pipes that the amateur should practise nicking on spare pieces of wood, so I would even more strongly urge that the novice should practise on spare pieces of metal before attempting to voice a metal pipe. These pipes require very careful handling or they will soon be ruined. It would be advisabe to have a few small blocks of wood with semi-circular hollows cut in their upper surface, and of different sizes, so that two of them laid a little distance apart would form a firm support for a pipe when laid down for voicing, or for painting and decorating.

It very often happens that the lips of metal pipes

get pressed inwards, and if this is the case with any of your pipes the defect can be remedied by drawing the lip forward, by carefully inserting a flat strip of thin metal bent thus, ⌐. If at any time you require to press the lips inwards in order to reduce the windway, or to reduce the convexity of the upper lip, on no

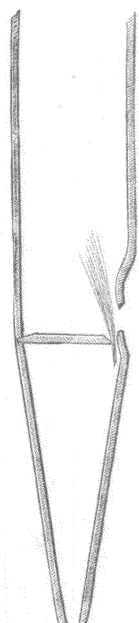


Fig. 190.
Pipe with Languid too Low.

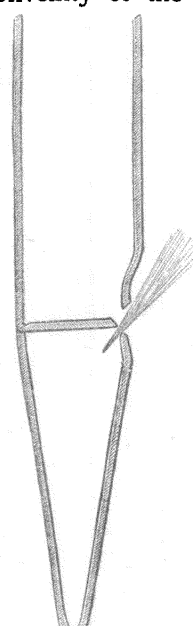


Fig. 191.
Pipe with Languid too High.

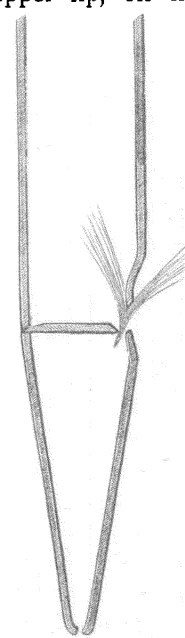


Fig. 192.
Pipe with Languid in Proper Position.

account give way to the impulse to do it by pressing your thumb on the lip, as the probability is that if you do the pipe may be spoilt. Take a flat piece of thin wood, or the flat blade of a table knife, and gently press the lip with that. Another common occurrence is that the languid is either too low or too high. Fig. 190

shows it too low, and it will be seen that the wind shoots into the pipe instead of on to the upper lip, and the pipe consequently does not sound or only in a very modified way. To remedy this, take a stout wire with a smooth and slightly rounded end to it, pass it up through the foot of the pipe, and gently press the languid upwards; taking care not to press it near the bevelled edge. If the languid is too high, as in Fig. 191, the wind is shot out of the pipe, and to cure this, gently press the languid downwards with the flat of a table knife, or thin flat piece of wood introduced at the mouth of the pipe. Fig. 192 shows the languid in its proper position, when the edge of the lower lip is exactly level with the notched edge of the languid. But it must be borne in mind that different stops require slightly different treatment as regards the height of the languid. For full fluty tones the languid should be rather low, so that the wind may be directed on to the inside edge of the upper lip, and shoot off up into the pipe, but for thin, reedy, or stringy tones it should be rather high so as to direct the wind more on to the outside edge of the upper lip.

For cutting up the mouths and making the very narrow bevel on the outside edge of the upper lip, a small penknife should be used ground to a flat edge—that is, there must be no bevel at the edge, as is often the case with penknives, but the blade should slope from the back right down to the cutting edge—and the knife itself should be held nearly flatwise.

For coning in the feet of metal pipes so as to reduce the windhole, stout metal or boxwood cups are used, and these are termed knocking-up cups.

The voicing and tuning of reed pipes have been dealt with in Chapter IV.

Pipes Generally.

It must be understood that all the pipes, when voiced and toned—that is, when they all give the requisite volume and character of tone throughout the respective stops—must be cut down to the length required to cause them to sound the proper note, as described for the open diapason wood pipes. Metal or paper pipes are trimmed down with a pair of scissors, which are more convenient for the purpose if made with cranked handles. The metal pipes are mostly tuned by means of a tuning cone, such as is shown in Fig. 193. The pipe having been trimmed down with the scissors so as to give almost the exact sound required, the cone is pressed on the top of it like putting an extinguisher on a candle, and then worked gently round. This causes the top edge of the pipe to be slightly coned inwards, which should be the normal condition of all open cylindrical metal pipes when in the organ. Pipes with the tops spreading outwards indicate bad workmanship. If it is required to flatten the tone of a pipe the cone is pressed on it a little as above described, but, to sharpen the note, the pointed end of the cone is inserted in the top of the pipe and the coning thus slightly lessened. Fig. 194 shows a *tuning horn*, which is merely a handle with a cone on each end in inverted order, so that it can be used either to open or close in a pipe, and being long it can be pushed down in among taller pipes when they are in their places on the sound-board. Care

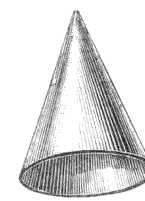


Fig. 193.
Tuning Cone.



Fig. 194.
Tuning Horn.

should be taken, when tuning, that the cones are not used in such a manner as to split the pipes.

Some metal pipes, such as the horn diapason, and all show pipes, are tuned by means of a tongue cut out near the top of the pipe. It is necessary that most show pipes should be much longer than the tone length, and in order that they may give the proper note a tongue is cut out at the proper place. This tongue is cut so that it is three or four times as long as it is wide, and is only attached to the pipe at its lower extremity. The free end is then curled backwards by means of a pair of round nosed pliers, and by curling it up tighter the slot is brought lower down and the tone is sharpened, but if it is uncurled a little



Fig. 195.—Tuning Knife for Reeds.

the lower end of the slot is closed a trifle, and the tone of the pipe is thus flattened. Paper pipes could be tuned in this way by cutting a slot clean out, say 3 inches long by $\frac{3}{4}$ inch wide for a 4-foot pipe, and inserting a tongue of soft tin or zinc in the bottom end of the slot. Paper pipes could also be tuned by shades in the same way as wood pipes, by making the bent part narrow and inserting it in the thickness of the pipe, but I prefer the sliding caps. Some delicate toned pipes are tuned by means of long ears at the sides of the mouths.

Fig. 195 is a tuning knife, which is used for tuning reed pipes. A little hooked wire projects from the top of the boot of the pipe, and if this wire is raised a little the tone is flattened, if depressed the tone is

sharpened, and this is done by hooking the sloping blade of the knife in the wire.

Fig. 196 shows a mop made of a bunch of wool tied on a wire handle, and is used when tuning *mixtures.* None of the organs which I have described possess a mixture, which consists of three or more rows of pipes on one slide; but some of my readers may have an organ in their possession in which there is such a stop. In order to tune these pipes it is necessary to silence all except the one that you are engaged on, and this may be done by inserting a mop in each of the other pipes affected by touching the same key.



Fig. 196. Tuning Mop.

It will be seen from the foregoing that voicing and toning, though not in itself very difficult, requires an immense stock of patience and tact, and it may be necessary to go over each stop many times before a satisfactory result is obtained. I would, however, urge the amateur not to be disheartened if he finds that some of his pipes prove very obstinate, for even with professional hands it is a tedious job to get all into order, and it is no uncommon thing for them to have to throw aside a pipe altogether, and substitute a fresh one.

CHAPTER XIV.

TUNING.

IT may be of service to many if I give a list of the several pipes in an organ which sound the musical note known as C, and also the lengths of those pipes. The lengths given are all for open pipes, and it must be understood that stopt pipes to sound the same notes would be only half as long. As I have little doubt that many of my readers are Solfaists, I have given the nomenclature of the pipes in the new notation also :—

Approximate or Tone Length of Pipe.	(Name of the note sounded.) New Notation.	Old Notation.
32 feet (longest made)	C_4	CCCC, or 4 C.
16 feet	C_3	CCC, or 3 C.
8 feet	C_2	CC, or 2 C.
4 feet	C_1	C, or Tenor C.
2 feet	C	C^1 Middle C.
1 foot	C^1	C^2 Treble C.
6 inches	C^2	C^3 Altissimo.
3 inches	C^3	C^4 ,,
$1\frac{1}{2}$ inch	C^4	C^5 ,,
$\frac{3}{4}$ inch	C^5	C^6 ,,
$\frac{3}{8}$ inch (shortest made)	C^6	C^7 ,,

The whole subject of the theory of tuning has often been fully discussed by other writers, and I therefore

do not propose to go into that matter, but will merely state that in order to tune any instrument having the ordinary key-board, so that music may sound agreeable whatever key it may be played in, it is necessary that the natural scale should be slightly altered. The natural scale, as sung by a good musician, consists of a series of tones and semitones at irregular intervals from each other; and this is not the only difficulty, for when we look at the chromatic scale, as accurately set out, we find that the sharp of one note is quite a different sound to the flat of the next note; but on key-board instruments we are obliged to make one sound do for both. If we gave all the notes in the natural or diatonic scale their correct sound there would still remain the difficulty in respect to the sharps and flats, and it is therefore necessary that instead of having irregular intervals we should split the chromatic scale up into twelve equal semitones, or, as it is termed, "*temper*" the scale. Until the method of tuning by equal temperament was introduced, it was impossible to play music in several of the keys which are now great favourites, as the discord was so great as to render those keys unbearable.

There are many methods by which tuning may be accomplished, but as I presume most of my readers are tyros in the art, I propose to describe the method of tuning by *ascending fifths* and *octaves*, that being the simplest method, and the one in which novices are most likely to succeed.

In Fig. 197 there is a musical scale set out, showing the order in which the several pipes or notes are tuned when *laying the bearings*, by which term is meant that the middle notes of the instrument are tuned so as to serve as a base or bearing from which to tune all

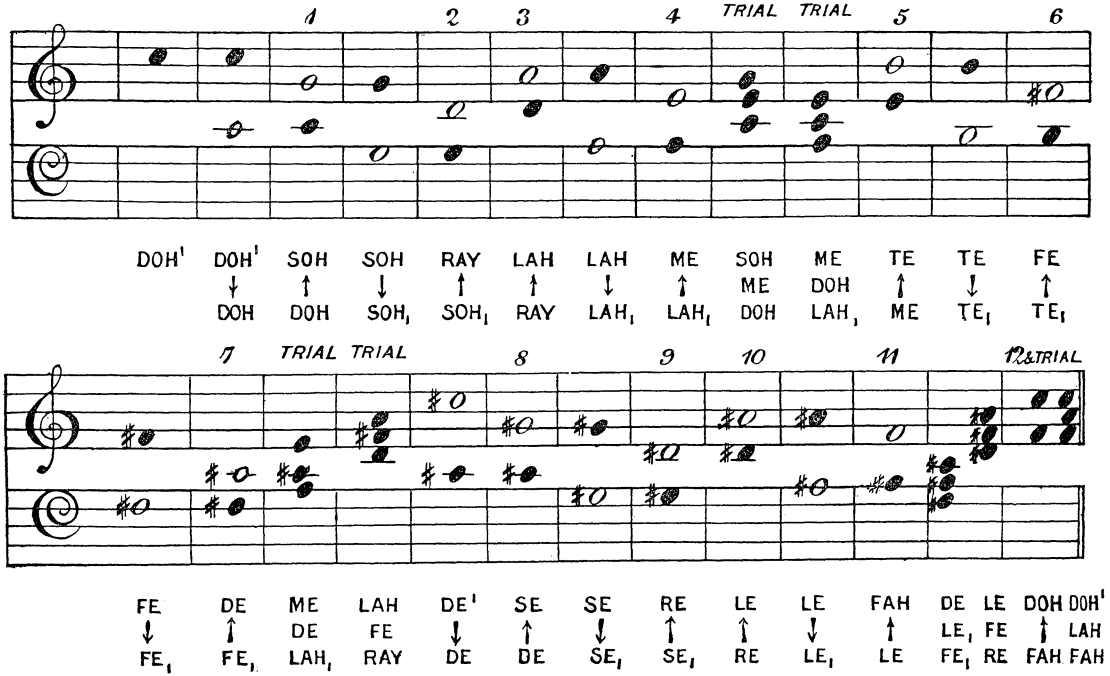


Fig. 197.—Tuning Scale in both Old and New Notations. The Figures show Successive Fifths.

the other notes, both above and below them. In this diagram all the black notes are supposed to be tuned and the open notes are the ones to be done, in the order in which they are shown. The Sol-fa names are also given.

It will be advisable that the novice should experiment a little first, in order to accustom his ear to the sounds desired to be obtained. Let him take two pipes which give exactly the same note, and shift the sliding-piece so that they no longer sound the same note. (I am assuming that they are paper pipes: if metal, sliding pieces made of paper should be put on for the purpose of this experiment. Wood pipes can be brought to the same pitch by raising or depressing the shades.) If the sliding piece or the shade of one of them is now gradually shifted—whilst both pipes are blown—and brought nearer and nearer to the same length or tone, it will be found that we can hear along with the sound of the pipes distinct beats, then waves, and that the nearer the sounds approach to unison, the longer are the beats or waves between each other, until, when perfect unison is obtained, we hear only continuous sound, as though only a single pipe were sounding. Exactly the same thing will be found to occur in tuning pipes giving notes a third or a fifth from each other. We first get quick, distinct beats, then slower and slower beats, then slight waves, and at last one clear, continuous note or chord. Now, the rule to be adopted in tuning for laying the bearing is to tune all notes an octave apart exactly perfect, so that they sound like one note. All notes a fifth apart are tuned so that they are two beats flat; that is, two beats are heard in a *second of time.* It may serve as a useful guide to amateurs if I mention that the small

American case-clocks, now found in most homes, generally tick about twice to a second, so that with one of these clocks near him, the novice will soon be able to determine the correct beat, as each beat should correspond with the tick of the clock. Having thus cleared the ground, we will now proceed with our tuning.

In tuning the organ, we *always* tune the *Principal* first; and, as in our little instruments the flute constitutes the principal, we commence with that stop. First take the 1-foot C pipe, and tune it so that it sounds exactly in unison with the sound of a C tuning-fork, and having made sure that it is absolutely correct—no beating or wavering being heard when the fork and the pipe are sounding together—you may then proceed to tune the C immediately below that pipe; this will be the 2-feet C, which must be made to give exactly the same sound—only, of course, it must be an octave lower in pitch. It will need some care to obtain perfect accuracy, as there is always a tendency to make one of the pipes rather sharper than the other. Having accomplished this satisfactorily, you will see that the next note on our scale which is to be tuned is the G pipe between these two C pipes; and this G is a fifth above the 2-foot C, so it must be tuned a perfect fifth first, and then lowered till it is two beats flat to the C pipe. The G being correct, we find from our scale that the next note to be tuned is the G an octave below it, and this is tuned perfect, and left so. We then ascend from this G a fifth, and tune the D two beats flat to the G. It will be understood that all notes which are to be flattened should be tuned perfect first and then flattened. From D we ascend to the next fifth, which is A, and tune it two

beats flat to the D, and then drop to the A below, which will, of course be tuned a perfect octave. From the A last tuned we ascend a fifth to E, and tune that note two beats flat to the A. Before proceeding further with our tuning, it will be well to try a chord or so in order to test the accuracy of the work already done. The chords indicated in the tuning scale are C, E, G, and A, C, E. If the result is satisfactory, the chords sounding neither too harsh nor too sweet, we proceed to tune the B, which is a fifth above the E last tuned, and make it two beats flat to the latter note. We then drop to the B below, and tune a perfect octave; and from that note ascend a fifth to F sharp, and tune that note two beats flat to the B. From F sharp we drop to the F sharp below, and tune a perfect octave, and from the lower F sharp we ascend a fifth to C sharp and tune it two beats flat. We now proceed to test by chords again, using the chords A, C sharp, E, and D, F sharp, A. These being found satisfactory, from the C sharp last tuned, ascend to the C sharp above, and tune a perfect octave; then from the lower C sharp ascend a fifth to G sharp, and tune it two beats flat to the lower note. From G sharp we then drop to G sharp below, and tune a perfect octave, and from that note ascend to the fifth above, which is D sharp, and tune it two beats flat; then from D sharp ascend a fifth to A sharp, and tune that two beats flat. From A sharp we drop to A sharp below, and tune a perfect octave, and then from the lower note ascend a fifth to F, and then try the chords F sharp, A sharp, C sharp, and, if you like, the F sharp above. Then try D sharp, F sharp, and A sharp. If all is right, the next fifth from F to C^1 should work in all right: if it does not do so, you may be sure there is something wrong in your

tempering of the notes. The chord F, A, C, may also be tried. Amateurs will hardly expect to get the bearings right at the first or even the second time of trying, as tuning is an operation which requires a considerable amount of practice to become at all proficient in. Accuracy in the bearings *must*, however, be obtained before proceeding to tune any other notes from them. I think it will be as well if I recapitulate the notes and the order of tuning in a condensed form: —C down to C; lower C up to G; G down to G; lower G up to D; D up to A; A down to A; lower A up to E (chords C, E, G, and A, C, E); E up to B; B down to B; lower B up to F sharp; F sharp down to F sharp; lower F sharp up to C sharp (chords A, C sharp, E; and D, F sharp, A); C sharp up to C sharp; lower C sharp up to G sharp; G sharp down to G sharp; lower G sharp up to D sharp; D sharp up to A sharp; A sharp down to A sharp; lower A sharp up to F (chords F sharp, A sharp, and C sharp; and D sharp, F sharp, and A sharp, and F, A, and C); F up to C.

Having completed the bearings satisfactorily, you will have tuned all the notes comprised in the $1\frac{1}{2}$ octaves, from F sharp up to C sharp, and may now proceed to tune all the rest of the notes, both above and below these bearings by octaves only, and afterwards test the whole compass by means of the same chords as those previously used, and by double octaves with the addition of any other which you may think fit. Test every note in the treble with its octave and fifteenth below, and every note in the bass by its octave and fifteenth above; the result in every case should be perfect unison. All major thirds should now sound slightly sharp; minor thirds slightly flat; fourths

slightly sharp, and fifths flat in the degree already mentioned.

Having got the principal thoroughly well tuned, tune each of the other stops perfect to the principal; taking notice, however, that the pipes of the 8-feet stops are tuned to sound an octave lower than the pipes of the principal, which stand over the same channels; and also that the flageolet, being a 2-feet stop, sounds an octave above the principal. The bourdon may, if you like, be tuned from the stopt diapason, as it sounds two octaves below the principal. The keraulophon also, being a delicate toned stop, should be tuned from either the stopt diapason or Lieblich Gedacht. It is best, when tuning, after laying the bearings, etc., to tune the stop furthest away from you, which, if you tune from the front of the organ, will be the open diapason; then tune the next stop to it, and so on, leaving the flageolet till the last. By following this plan you avoid having to reach over stops already tuned, a proceeding which might result in putting some of the pipes out of tune again.

As a final caution, I would warn the amateur not to handle the pipes more than necessary, as the warmth of the hands communicates itself to the pipes, and when they have cooled down, the notes will be found to have flattened considerably, although when left they may have been perfectly correct in pitch.

CHAPTER XV.

THE CASE—PIPE DECORATIONS.

THE amateur must now decide upon the style of the casing with which he intends to enclose his instrument; and with the view of assisting him in the matter, I have prepared three designs, with details, which will give some idea of what is requisite. If the organ is intended to stand in a recess it may not require much more than a front casing. A recess, however, considered from a musical point of view, is about the worst possible position in which to place the instrument, as the pipes, being so much enclosed, sound dull and muffled. In many houses it is simply Hobson's choice—a recess or nothing; but wherever room can be spared for the instrument to stand in such a position that there is a clear space at both sides as well as at the front, it should by all means be appropriated for the organ.

Design No. 1, Figs. 198 and 199, is for a case in the Tudor style, as it will work in harmoniously with the furniture of many modern houses; and it may be carried out either in oak, mahogany, American black walnut, or stained pine. In the matter of design, my own idea is, that an organ should look like what it is, and not be got up to imitate a cupboard or a bookcase

Fig. 199.—Side Elevation of Organ, Design No. 1.

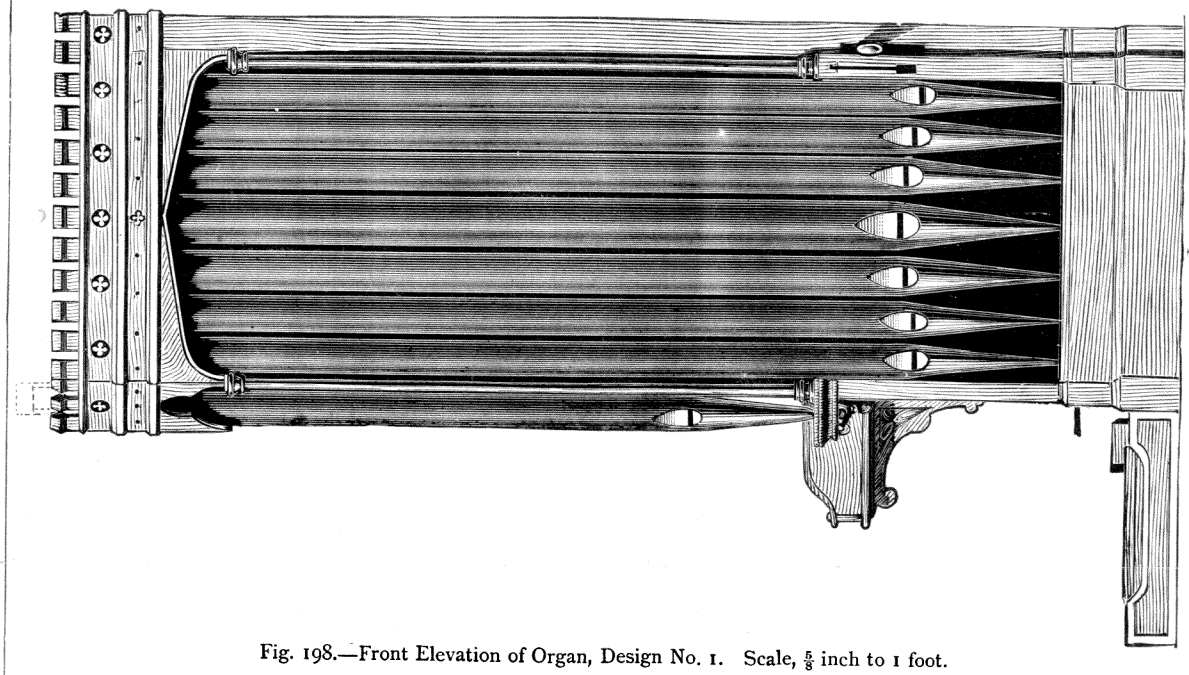
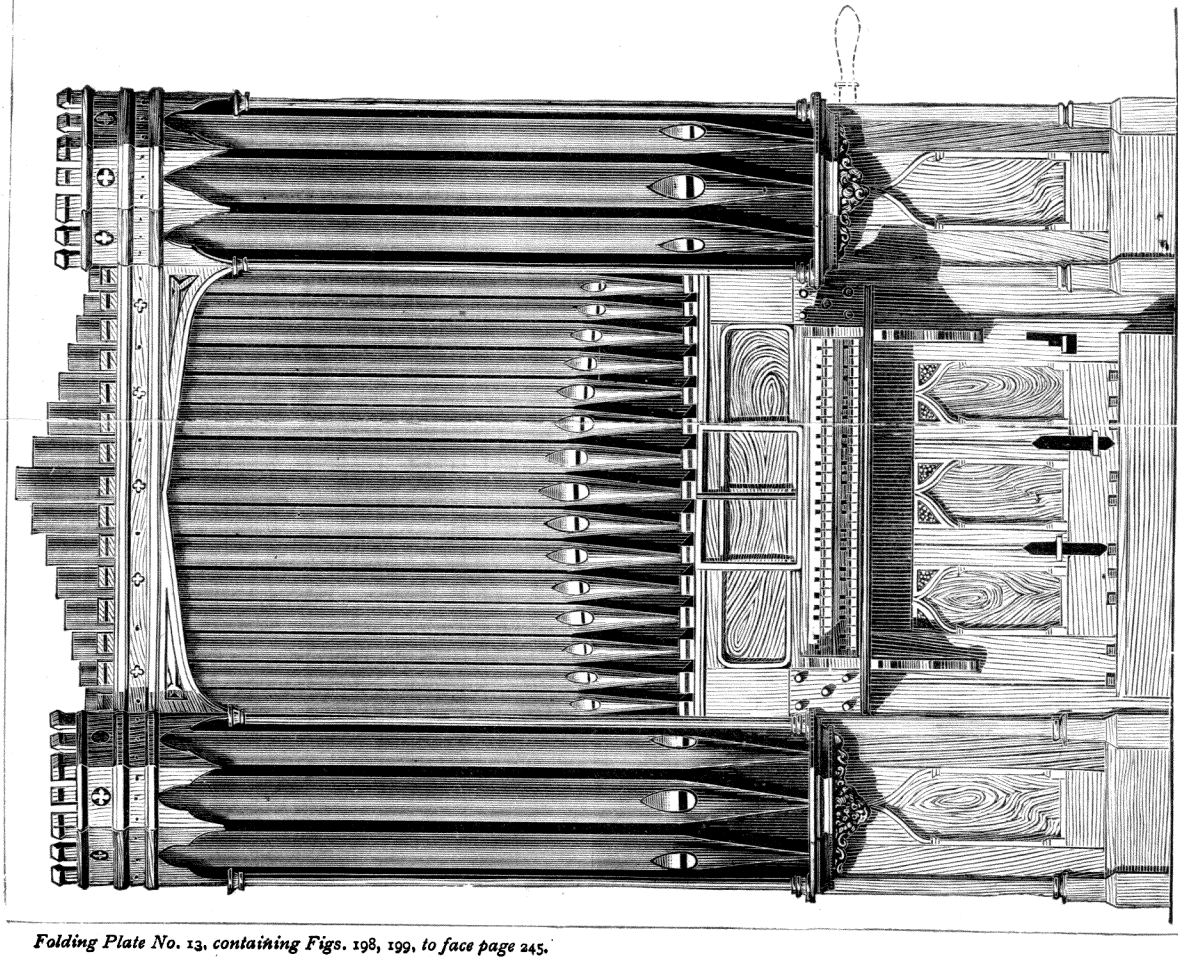


Fig. 198.—Front Elevation of Organ, Design No. 1. Scale, $\frac{5}{8}$ inch to 1 foot.



Folding Plate No. 13, containing Figs. 198, 199, to face page 245.

with all the pipes carefully concealed from view Therefore, in all my designs, it will be seen that the cases are arranged to show as many pipes as possible, and, although presenting a substantial appearance, do not involve a very large amount of work in their construction. Any one who is handy enough with his tools to turn out a good sound-board can make a case of this description. The show-pipes should, as far as practicable, be speaking-pipes, not dummies; not only because of the natural antipathy which cultured persons have towards anything that is a sham, but because of the amount of space and clearness of tone gained by bringing the pipes into the open. In Fig. 198 is given a front view of the casing, and Fig. 199 shows the ends or sides, both sides being alike. Although drawn as a two-manual instrument, about 6 feet 6 inches wide, and 10 feet 6 inches high, the design is of course equally applicable to single-manual organs much smaller in size, or for one of three or four manuals, much larger The only thing necessary is to keep to the same general proportions in the different parts. If for a narrow instrument, the case could be made with the towers placed corner-wise instead of facing to the front.

Fig. 200 gives a general view of the skeleton or framework of the casing, which consists of six upright posts nearly as high as the top of the casing, joined together by cross bracings where necessary for fixing the panels, etc. These posts may be of deal 3 inches or so deep, and $1\frac{1}{2}$ or 2 inches thick, and the front ones should be placed immediately behind the shafts or columns shown in the elevations; the position of these shafts being indicated at the left-hand side of Fig. 200.

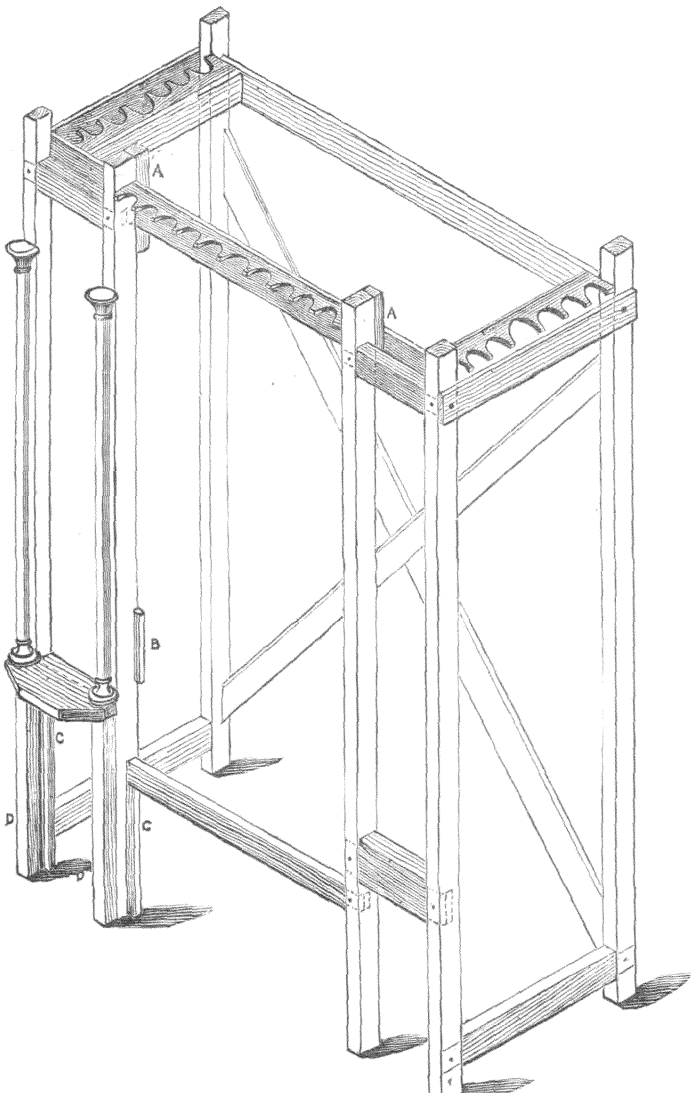


Fig. 200.—Sketch View of Framework of Casing. Scale $\frac{3}{8}$ inch to 1 foot.

Cross-pieces about 4 inches deep are tenoned into the front posts near the top, where they will be concealed by the ornamental canopies, and similar pieces are tenoned into the lower part at such a height that the supports of the large front pipes will rest on them, one of the supports in question being also indicated on the left-hand side of the sketch. The rail across the lower part of the centre portion should be placed in such a position that it does not prevent free access to the buttons or backfalls of the pedal coupler; but at the same time it must not be placed too low down, as it is intended to form a backing for the panelling to be screwed to. The back bracings may be placed diagonally as shown, but if the bellows is intended to draw out from the back, the bracings should be merely screwed on, or they may be simply longitudinal bars placed so as not to prevent the bellows being taken out. All the tenons may be merely secured in the mortises by means of hardwood pins driven tightly into holes drilled through both mortises and tenon, and the framing can then at any time be taken to pieces by merely punching the pins out again. In making a pinned mortise joint there is a proper method to be followed in order to secure a strong close joint. The tenons should fit tightly into the mortises, and care must be taken that they are not cut at all rounding at the shoulders, or a close fit at the posts will be impossible. Bore a hole through the side of the post, so that it passes centrally through the mortise and out at the other side; then insert the tenon, and drive it close up to the shoulder, and with your centre-bit just mark the position of the hole on the tenon. Withdraw the tenon and then drill the hole through it, but make the centre of it nearly $\frac{1}{16}$ inch *nearer to the shoulder* than it was marked. Reinsert

the tenon, and drive a tight-fitting slightly-tapered hardwood peg right through both mortise and tenon, and it will then draw the shoulder close up and make a good workmanlike job. The ends of the pins can be cut off afterwards close to the posts. All the holes must be bored through quite true and square with the sides of the posts.

Pieces marked A are to be screwed on to the back of the front posts, near the top, so as to receive the back of the rack-board and allow sufficient space for the pipes to stand between that board and the ornamental facing, and this space must, of course, be sufficient to allow room for the largest pipe which is to be placed there. A piece of $\frac{3}{4}$ inch stuff 4 or 5 inches deep, is screwed on to the pieces A, and forms the back of the rack-board. The rack-board itself, may be of $\frac{1}{2}$ inch stuff, cut out in semi-circles the diameter of the several pipes which it is to support, and may be glued or screwed edgewise on to the back-board, or secured on to the top edge of it. These boards are also shown in plan in Fig. 201. The arched pieces at the sides and centre of the front (Figs. 198 and 199) suffice to keep the pipes in their place, and these pieces may be screwed on with round-headed brass screws, or cup screws, as described for the panelling.

If the sides are made exactly as shown in Fig. 199, the front corner posts would only be carried up to the bases of the columns, and the side back-boards of the rack should therefore be dovetailed or otherwise strongly connected with the front back-board, and it would also be advisable to connect the posts to the swell box by slips of wood, in order to give sufficient strength. If, however, the posts are carried right up, the front edge of the side will present an exactly similar appearance to

the back edge, that is, it will have a style 4 inches or so wide.

The pilasters shown in the elevation as supporting the bases of the columns, etc., are formed by bradding on pieces of the requisite size and thickness, as shown at D in Fig. 200, and slips like B and C should also be screwed or bradded on to the sides of the posts, to form backings for the panels to be screwed to. The panelling in the lower part of the case is formed by framings and panels in the same way as an ordinary panel door, the Gothic heads being cut out of a thin piece of wood and fitted in afterwards, and a suitable moulding or beading bradded on the edges afterwards. The plinths round the base of the panels and pilasters are also formed of thin pieces of wood splayed on the top edge, and bradded on, all angle joints being mitred.

The two thick dark lines just above the pedal key-board on Fig. 198 are the openings through which the treadles of the foot blower protrude, and the step-shaped opening on the right is the opening for the swell pedal.

All the panel framings should be made movable, and should therefore be fixed by means of brass round-headed screws with shields, or by cup screws, the cups being sunk into a centre-bit hole which they just fit, and the screws can then do no damage to the surface of the framing.

The canopies of the towers from three sides of an octagon, as shown on the plan in Fig 201, and the mitred joints should be strengthened by gluing a block at the back of each as indicated in that sketch. The whole top of the casing is surmounted by a battlement which makes an effective and suitable finish. All mouldings, beads or bands, should be bradded on and nicely mitred at the angles. The ornaments may be

either sunk geometrical figures or may be Gothic roses or some similar ornament carved out of thin wood and glued on. The panels in the spandrel of the central arch should be cut right out with a pad or fret saw.

Perhaps the most difficult piece of work for an amateur would be the circular columns or shafts, but I would suggest that for these the mahogany cornice

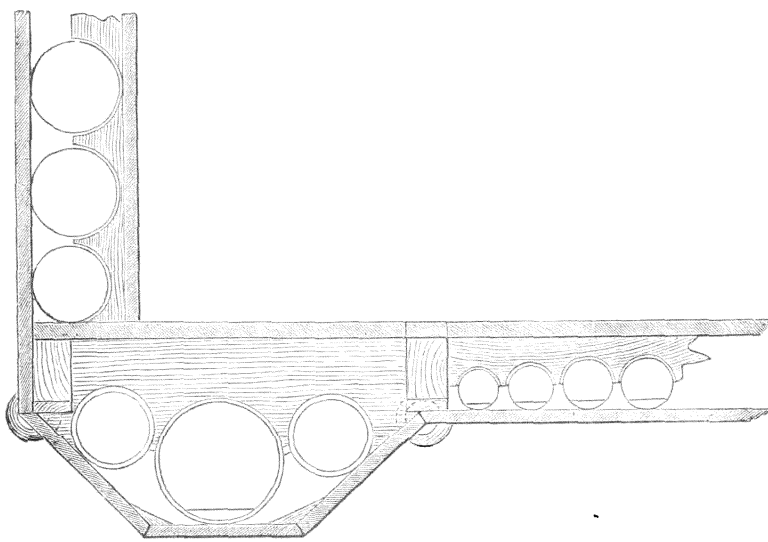


Fig. 201.—Plan of One Corner of Upper Part of Casing.
Scale, 1½ inch to 1 foot.

poles for curtains, which can be purchased in any length at the draper's or upholsterer's might be found very convenient. Second hand ones may often be bought for a trifle, but the purchaser must be careful to see that they are quite straight and not too stout.

If round shafts cannot be easily made or procured, octagonal ones may be made, and will be quite in keeping with the general design. Plane the wood

up square first, and then form it into an octagon by planing down the corners. The capitals and bases should be turned, and if the amateur can handle the carving tools, he might decorate the former with suitable foliage. The capitals and bases should be dowelled on to the shafts. The three-sided supports of the large pipes in front should have corbels placed under them either carved as indicated, or made out of a thick piece of wood of the same shape as the support, and diminished away almost to a point at the bottom. The brackets supporting the key-board should be fastened to the panelling only, so that when the panel framing is removed the brackets come along with it. The sides or ends of the key-board casing should be shaped somewhat in the style shown in Fig. 199, and, if possible, the cover or fall board should follow the same lines. If the amateur cannot make one he might possibly secure the cover board of an old piano and utilise that, otherwise he must either have a suitable one made, or make a cover board himself with a straight slope instead of a curve.

The panelling over the key-board needs no description, but it should be made movable, for ready access to the wind-chest, etc. The stop knobs may be arranged as shown or otherwise, according to taste, and the panels in which they are placed may, if thought desirable, project beyond the face of the other panels to about level with the front of the upper row of keys. The book-board may be of any style suitable to the general design of the instrument.

A hand-blower is shown in both elevations, and should be placed at the back of one end, as indicated in Fig. 199. The use of a hand-blower necessitates a tell-tale to indicate the amount of wind in the bellows.

The tell-tale consists merely of a small flat lead weight

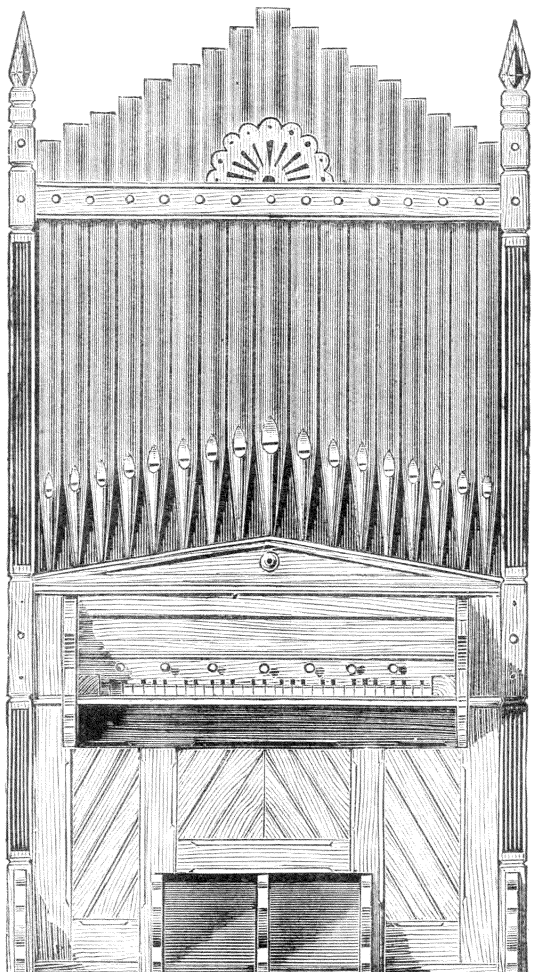


Fig. 202.—Design for Organ, No. 2. Front Elevation.
Scale, $\frac{5}{8}$ inch to 1 foot.

hung on to a piece of thin whip cord, the cord passes over

a little pulley in a small opening in the case, and the end of it is secured to the top board of the bellows. The cord should be of such a length that when the bellows is empty the weight is drawn nearly up to the pulley wheel, and a mark should be made on the case to indicate this position, and a similar mark should show where the weight descends to when the bellows is full. By watching this weight the blowist can always tell how much wind to give and thus prevent over-filling the bellows, or letting the supply of wind run short.

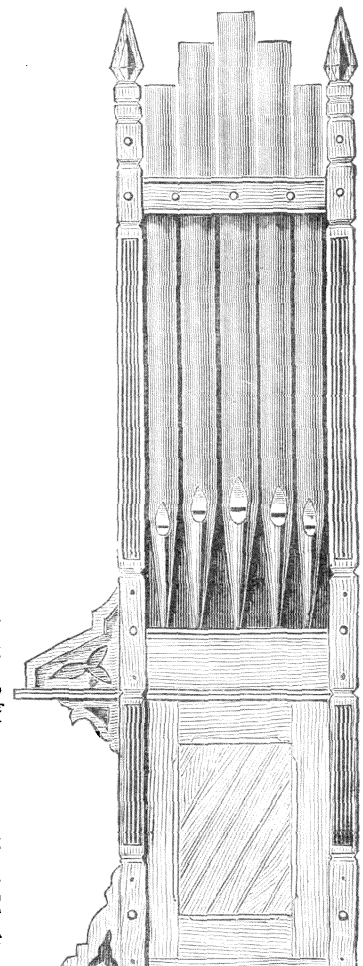


Fig. 203.—Design for Organ, No. 2. Side Elevation. Scale, $\frac{5}{8}$ inch to 1 foot.

Figs. 202 and 203, which form design No. 2, represent the front and side elevations, respectively, of a small organ, which may be carried out exactly to the size indicated by the scale, or which would be suitable for any sized organ, from 3 feet

up to 5 feet 6 inches wide, and from 6 feet up to 10 feet high. It will be observed that the design is a very simple one, consisting, as it does, of only four corner posts and a panel framing to fill in the lower portion of the case. It is shown as a single-manual instrument, without pedals, the bellows being blown in the same way as those of the harmonium, using foot-boards instead of a pedal. These foot-boards look very nice if covered with a piece of stout sheet brass, worked in a diaper or other pattern. This metal covering will last a lifetime, and always look neat, whilst carpet covering soon presents a deplorable appearance. Diapered indiarubber can now be obtained, and this will be found a great improvement on carpet for covering the foot-boards. Of course, the general design of this case would be equally applicable to a small two-manual organ with pedals, and it could be adapted to a larger instrument than indicated by the scale, by adding a wing on each side similar to those in design No. 3, only taking care

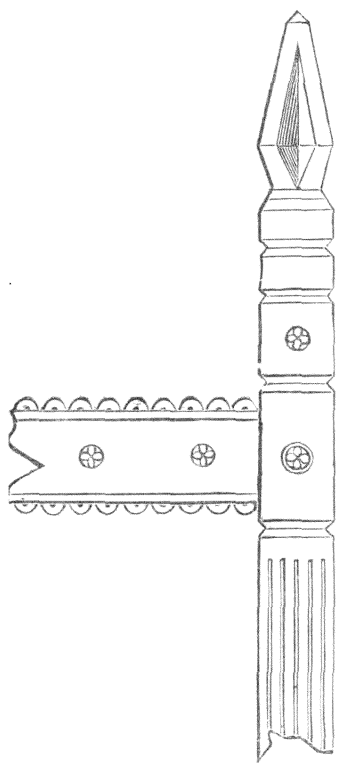


Fig. 204.—Detail of Upper Portion of Post. $\frac{1}{8}$th Full Size.

DESIGN FOR ORGAN, No. 3. Scale, ½ inch to 1 foot.

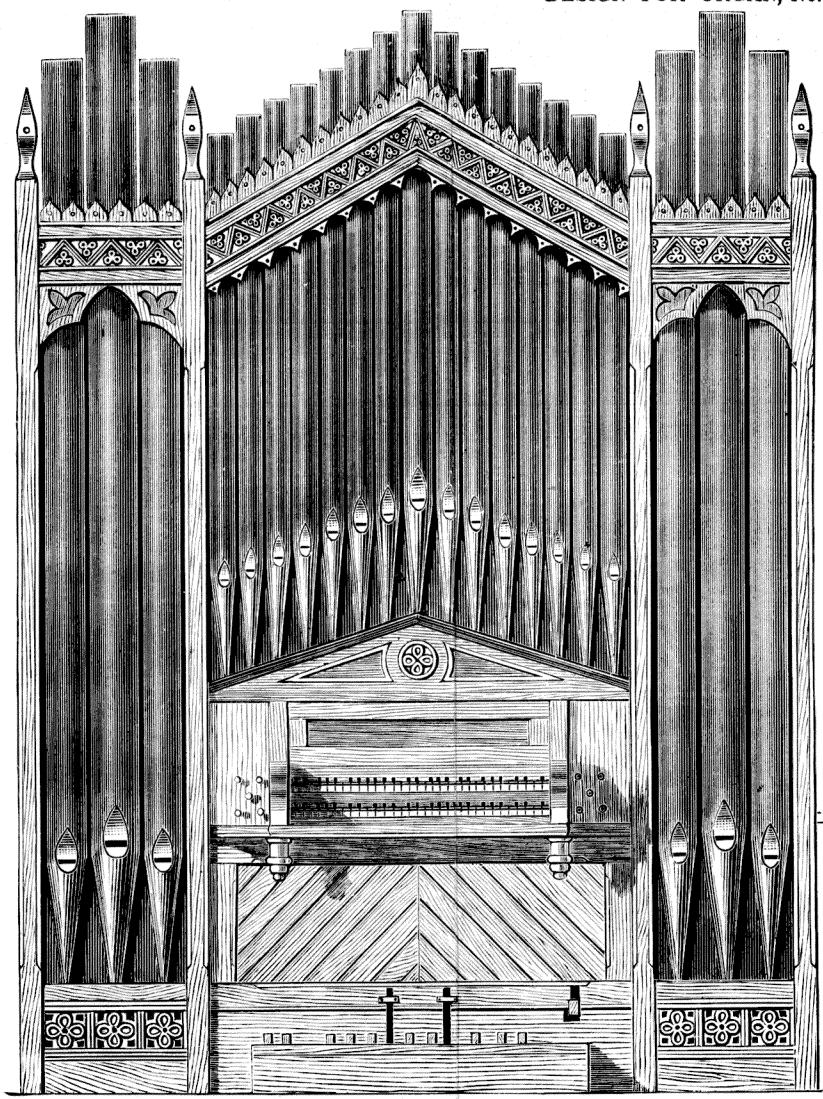


Fig. 205.—Front Elevation.

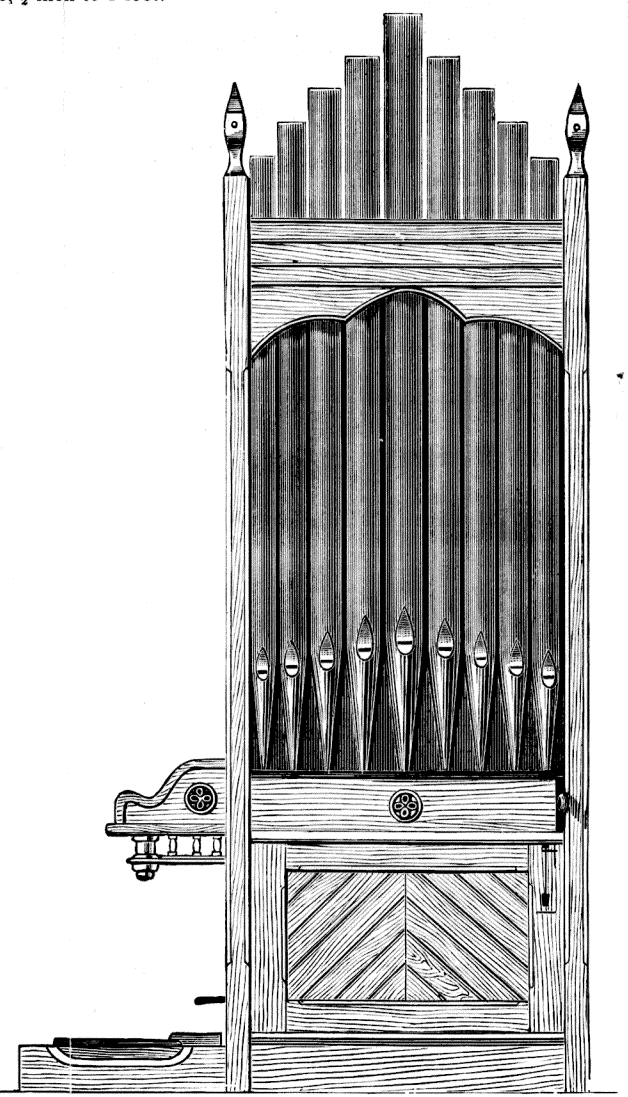


Fig. 206.—Side Elevation.

Folding Plate No. 14, containing Figs. 205, 206, to face page 255.

to make the wings to match the other portions of the case.

This case may be made of oak or of pine, either plain or stained, and it would also look well if it were executed in ebonised wood with the V joints, ornaments, etc., picked out in gold.

Fig. 204 is a view, on an enlarged scale, of the upper portion of the posts, with suggestion for ornaments. These posts may be about 3 inches square, and may either be of solid wood or built up of four pieces in the same way as a square wood organ pipe. Solid wood, if not well seasoned, is apt to split when kept in a warm room; hence it is often very advisable that, where exposed to view, posts should be built up as described.

The reeds or flutings in these posts should be formed with a suitable plane, but if such a tool cannot be easily procured, thin beadings, rounded at each end and bradded on, would form a pleasing ornament. If the posts are made hollow the finials should be cut out of the solid and fixed in position afterwards.

Fig. 205, or No. 3 design, shows a front suitable for a larger organ, which should not be less than 5 feet 6 inches wide and 9 feet 6 inches high; and a side view of the same is given in Fig. 206. The general instructions which accompany the first design will, I think, be sufficient to enable the amateur to understand the method of putting together either of the other two cases now described, and the thickness of the materials will be the same for all the panellings and framings. Of course, in the last two designs, there are no posts behind those seen in the diagrams, as no skeleton framing is required. The rack-boards for the show pipes will be similar to those already mentioned in the previous chapter.

The six posts required for design No. 3 may be from 3 inches to 5 inches square, according to the size of the instrument, and may be either solid or built up, as in the previous case. The ornamental trefoil panelling in the upper part, and the quarterfoil panelling in the lower part, is formed by boring holes in the required positions with a large centre bit, and then hollowing out the outer margin of the holes with a gouge. The divisions between each of these trefoils, etc., should be made of a thin beading, bradded on to a flat strip about $\frac{5}{8}$ inch wide, having a quadrant hollow on each edge, as shown in Fig. 207. When working the hollows, fasten the slips flat down on to the edge of a thin board with thin round wire nails, and then screw the board up in the bench and work the hollows with the plane made for the purpose. This being done, take the strip of the board, draw out the nails, which, as they are round, can be easily accomplished, and then fasten the bead in position by passing brads or wire nails through the back of the slip through the same holes. These beadings and slips should be made in long strips, and can then be cut up to the sizes required when complete. Mouldings similarly constructed could be used to ornament other portions of the case, affording an excellent effect at the cost of a small amount, comparatively speaking, of time and trouble, and rendering the instrument, in its simple decoration, as attractive to the eye as if the mouldings had been elaborately carved.

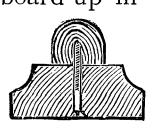


Fig. 207. Section of Beading for Divisions between Trefoil Panels.

This organ should be furnished with a hand-blower and tell-tale, as described for No. 1 design, and to this description I must refer my readers, for space would be

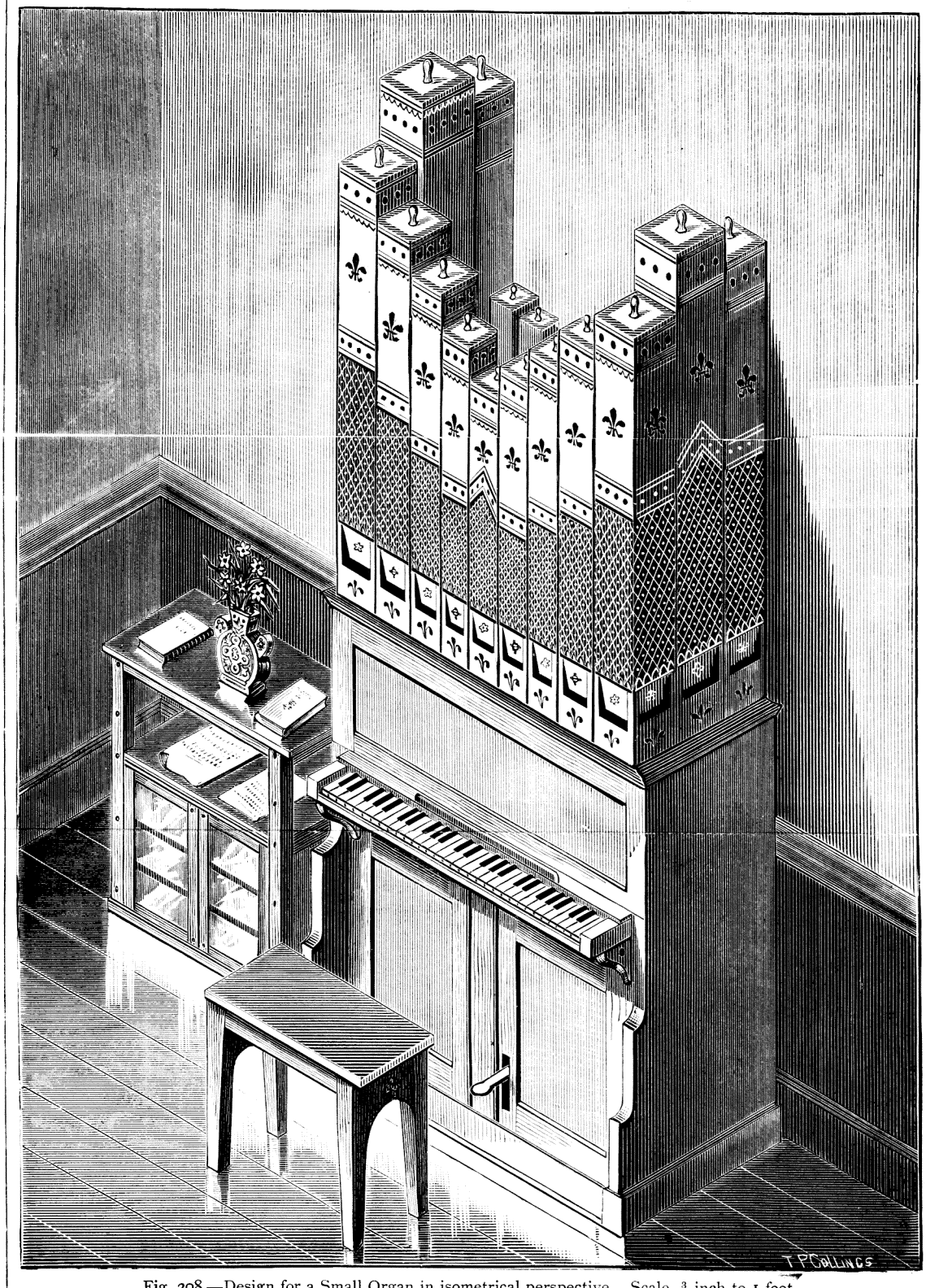


Fig. 208.—Design for a Small Organ in isometrical perspective. Scale, $\frac{3}{4}$ inch to 1 foot.

Folding Plate No. 15, containing Fig. 208 [illegible] *page 257.*

wasted, without any useful result, by repeating my instructions here.

Fig. 208 is a design for a small organ of one or two stops, with wood pipes brought into view and decorated. Of course it would be just as easy to arrange the pipes, if desired, so that the largest comes in the centre of the front, with the smaller ones sloping off as in the other designs, but this method is given to show the different modes in which the pipes can be arranged.

The designs which I have given will, I trust, enable the amateur to select something suitable for his purpose, and to adapt it to the necessities of his particular circumstances. Each and all of them will, I think, be found desirable for the purpose for which they are intended, and no one will find any difficulty in making such modifications, either in construction or ornamentation, as will render them better fitted for his particular requirements.

Decoration of Show Pipes.

Before deciding upon the style and amount of decoration for the show pipes, it will be necessary for the amateur to take into consideration the general surroundings of his instrument when placed in the position it is to occupy. It would not be advisable to lavish much colour or decoration on an instrument in a room almost devoid of colour, or the furniture of which is of a plain and severe type. But in a room handsomely furnished, with bright pictures on the walls and all other matters in keeping, any amount of colour may be used on the instrument without its appearing incongruous or overdone. At the present time many, if not most, people prefer to have the organ pipes of plain

metal or simply gilded, and it cannot but be admitted that pipes of spotted metal or burnished tin, or pipes wholly gilt, present a chaste simplicity of appearance which is very pleasing; and at the same time, such pipes are suitable for almost any surroundings and any style of case. But the use of either of these involves a large outlay which many amateurs would wish to avoid, whilst decorated pipes for a front may consist of wood, zinc, or paper, and will answer the purpose equally well, especially where the show pipes are only imitations. The great objection to decorated fronts arises from the fact that some unscrupulous persons take advantage of the paint to palm off on the unwary pipes of inferior material, whilst charging the full price of good metal; but this is a point with which amateurs will have no concern. I may say that wood pipes look wonderfully pretty when tastefully decorated, and it is surprising that they are not more often used as show pipes.

If zinc or metal pipes are to be painted, they must first be cleansed thoroughly with turpentine, or the paint will not adhere properly. The finished colours must also be dead or flat, that is they must have no gloss or lustre upon them when dry. In order to obtain this effect the groundwork should have two or three coats of oil paint (thinned entirely with oil) so as to look bright and glossy, and then be finished with a coat of paint which has been *entirely thinned with turpentine*. Or, instead of giving another coat of paint, you can take off the gloss by rubbing the painted surface all over with a sponge moistened with turps, and then allow it to dry on. For my own part I prefer the first method. Each coat of colour should be put on thin and allowed to dry before applying another coat.

The brighter the gloss of the oil paint the more flat and even will the surface appear when done over with the turpentine. For paper pipes a dead flat tint may be obtained by well mixing dry powdered colour with thin size, and applying while warm with a brush in the usual way, but be careful not to have it too thick, or the colour will look rough and patchy.

With the view of assisting the amateur to select the design to be followed in decorating his pipes, I have given in the frontispiece a set of six different designs in colours. These designs may be copied exactly, or modified according to taste. If but little ornamentation is required, the upper and lower lips might be gilded, and just a little sprig of rose, conventionally treated, placed over the top of the upper lip and a smaller one ust under the lower lip, all the rest of the pipes being left the plain ground tint. For case No. 1 the decoration designs No. 1 and No. 6 would be very suitable, as a diaper pattern is much used in Tudor architecture. These pipes might be diapered on the upper as well as the lower portion if preferred. The pipes in the centre bay of the case might be decorated in style No. 6, and the two wings in style No. 1, but the ground colour should be the same for both. It must also be understood that any of these designs might be executed on grounds of different tints to those shown. A vellum green is a very pretty ground colour, and may be made by mixing just a dash of green with a light cream or stone-coloured paint. Sage-green, either light or dark, is also a favourite colour for the ground work. No. 4 design would look very nice if a light sage-green were used for the ground tint, and the ivy leaves on the spiral band done in their natural colours. It may be useful if I mention that the spiral band may be readily

obtained by cutting a long strip of paper of the requisite width and twining it around the pipe in the required position, and then marking all round both edges of it with a chalk or pencil, so as to obtain the outline, and it would also be possible to obtain the pattern for the decoration of the band by drawing it on the back of the paper in chalk, and then placing it on the pipe and rubbing it so that the chalk is transferred to the pipe, or stencil patterns cut out of paper could be used.

All parts coloured yellow are intended to be gilded, using gold leaf and oil gold size, the oil-size being allowed to become almost dry before the gold leaf is applied. Gold paint looks very well when first done, but it soon turns black and causes much vexation, so I cannot recommend it. It is usual to outline all ornaments and gilt work in either white, red, or black, according to taste. All parts shown as red should be executed in vermilion.

For any arrangement where the pipes slope down from the centre towards each side, the designs No. 3 or No. 4 would look very nice, the centre pipe having a chevron ornament like design No. 5. The sides of the chevrons should correspond in position with the spiral bands on the adjoining pipes. The spiral band on the pipes to the left of the centre should slope in the direction of that on Fig. 3, and that on the pipes to the right in the direction of the band on Fig. 4.

The chevron designs No. 1 and No. 5 would be suitable for the pipes in the side wings of the cases, while straight band designs like No. 2 and No. 6 would be suitable for the centre bays of the same instruments. The pipes at the sides of the organ might be decorated in quite a different style and colour to those in the front. The chevron design No. 5 could be used alone

for the centre bays of either of the cases, care being taken to arrange the chevrons so that they slope downwards from the centre pipe towards each side, following the slope of the mouths of the respective pipes. Case No. 2 would look well if filled in with pipes decorated in this style. The same remark applies to the other designs, which should always be arranged on the pipes so as to follow the slope of the tops or of the mouths. It must be understood that in any instrument in which the tops of the pipes are not seen, the ornamental bands should be omitted from the tops of those pipes.

For case No. 3, designs No. 1 or No. 5 should be used for side wings, and No. 6 or No. 2 for the centre portion of the same.

The various bands and ornaments can be easily executed if stout cartridge paper stencil patterns are cut out, and the design then stencilled in with a proper brush. These stencil patterns should be made in three or four different sizes, as it would not do to paint an ornament on a slender pipe the same size as that on a stout pipe.

If case No. 2 is executed in black and gold, it would be best to have plain metal, or burnished tin, or gilt pipes. Zinc pipes scraped bright, burnished, rubbed with turps, and then varnished look very well, and being protected by the varnish, would preserve their lustre for a long time.

Those amateurs who are not skilful in painting small ornaments might adopt the plan recommended by me in another work, viz.:—to procure some good wall paper or "Lincrusta Walton" of suitable pattern and well gilded, and cut out such portions as are applicable, such as rosettes, dots, bands, fleurs-de-lis, trefoils, etc., and fasten them on to the pipes in the desired position

with thin glue, previously painting in the ground tint. If this is nicely done and the pieces stuck on neatly outlined in white, red or black paint, as taste may dictate, a very effective and creditable piece of work will be produced, which only very close inspection would enable one to detect from painted work. This plan is especially applicable to wood or paper pipes, and has the additional advantage of being very cheap.

A chalk line should be made down the centre of each pipe in order to secure the perfect placing of all the ornaments. Let me impress upon the amateur the extreme importance of executing the whole of the decoration of the pipes and the finishing off of the case with the greatest care and neatness, as any careless work will be patent to any one who sees the instrument, and cannot but be a reproach to the amateur himself.

CHAPTER XVI.

DEFECTS GENERALLY—LIST OF STOPS AND THEIR COMBINATIONS—ADDITIONAL SPECIFICATIONS.



UR organ being now complete, it will no doubt be useful if I give a few tests whereby we may know whether the various parts work satisfactorily, together with a description of a few of the defects which are common to most organs, and the way in which such defects may be remedied.

The most common defect, especially in instruments of amateur construction, is what is termed *cyphering*, by which is meant the sounding of pipes when they should be silent. This defect is caused by an escape of wind into the pipe from some illegitimate source, which may arise from many different causes. Perhaps the severest test for this defect to which an organ can be subjected is to *close all the stops*, and then, after filling the bellows, press down a series of full chords on the keys throughout the compass. Should there be no sounding of pipes, the instrument is probably free from runnings; but it should be further tested by drawing out the several stops one after the other and testing them individually and collectively by running up the keys in a series of major thirds right through

the compass. If the instrument is in proper tune, the runnings would demonstrate their presence by discords more or less pronounced. Cyphering may be caused by the keys having swelled or warped, in which case the faulty keys should be seen to and remedied as hereafter described. Keys will often stick in consequence of dampness, and when the air again becomes dry will resume their proper working. Dirt, crumbs, etc., dropped between the keys will cause sticking, so be careful to keep the fall-board down, and lock it when not in use, and look after the juveniles when it is open. A key being screwed up too high, or not enough, will also cause cyphering. Sometimes a *sticker* will justify its name by sticking in the hole of the backfall, and thus cause a cyphering, and this may arise from the wire getting rusty or the hole in the backfall closing slightly in consequence of the contraction of the wood by damp. *Backfalls* occasionally part company with their stickers, and, as hinted above, buttons screwed too high or too low will cause cyphering. Proceeding onward with the action we arrive at the *pull-downs*, which, if rusty or bent, will cause the defect referred to. A pallet *spring* may be too weak, or be broken, the pallet-*leather* uneven or wrinkled; the *pallet* itself may be warped; the *guidepin* bent or rusty; *dust*, particles of *fluff* off the leather; *chips*, or a *wedge* dropped from a reed may prevent the pallet bedding down properly;—all these things alone, or in combination, will produce cyphering. We now arrive at the *sound-board*, and here any bad workmanship would be almost certain to show itself. If the *channel-bars* were badly joined to the sound-board table, there would be escape of wind from one channel to the other, which might cause cyphering, or at least an unpleasant

hissing. This, however, is a defect which should be utterly impossible if the channel-bars are grooved into the table, as described in Chapter V. The remedies in all the above cases are too obvious to require mentioning; but as to the last, it might be well to suggest that, when the offending channel-bar has been discovered, a strip of linen or paper should be carefully glued all along the joint. If the services of the *sliders* or the table are not perfectly true, or if the *grooving* for waste wind is not sufficiently deep, cyphering will occur. These defects in the sound-board are most tiresome to remedy, involving, as they do, the entire removal of all the pipes and of the sound-board itself. If the *upper boards* are not screwed tightly down; and, lastly, to come to the *pipes* themselves, if they are so arranged that the wind from the mouth of one impinges on the lip of the mouth of another, it will cause cyphering. So see that where the pipes are close together they do not occupy the position referred to.

Faults or defects in the pipes have been very fully dealt with in the Chapter on Voicing; but it may not be out of place if I hint that *dust* is the root of a great many evils affecting the speech of pipes, especially with reed pipes. It may be removed from reeds by carefully passing a thin card between the tongue and the reed, but by all means deal tenderly with these pipes, as they are easily ruined. Dust will cause pipes to sound shaky, to give the octave, or to be quite silent, and the smaller the pipe the more liable it is to be affected. *Change of temperature* will, however, sometimes produce the same defects, so it will be well not to be too hasty in handling the pipes.

Robbing is a defect caused by channels being too narrow or too shallow, or the pallet holes too small.

It shows its presence by causing the pipes to sound weak or out of tune when several stops are drawn, the supply of wind not being sufficient for so many pipes. This is a structural defect scarcely open to remedy, but should not be present if my instructions have been adhered to.

As regards the *bellows*, change of temperature will affect the supply of wind, as the valves will curl slightly and the wood contract in hot weather, and thus cause a waste of wind. This defect will, however, generally cure itself as the weather becomes colder; but should it not then disappear the valves must be seen to, and here you will reap the benefit of having movable panels, which enable you to get at the valves without injuring the bellows. Should a gasping sound be heard at the bellows when the organ is in use, it shows that the valves are either too few in number, or too small to supply the requisite amount of wind for the pipes. This defect, as also if the whole reservoir is too small, or the wind-trunk too small or too long, or the regulators inefficient, will cause the pipes to sound jerky or shaky. Another little matter which, however, is very annoying to the player, is the creaking of the leather joints of the bellows; but this matter can be quickly rectified by applying a rag moistened slightly with sweet oil to the offending joints.

Defects at the Keys.—Irregularity in the height of the keys may be removed by screwing the buttons of the pull-downs in the direction required; thus, to raise a key, screw the button up; to lower the key, screw the button down. It may be noted that temperature affects the touch of the keys as well as the tone of the pipes. In hot weather the touch is more shallow than

in cold weather, and may necessitate an alteration of the position of the buttons of the pull-downs. Sometimes a key may be pressed down without the pipe sounding, in which case it is probable that there has been a breakage or severance in the connection of some portion of the action. If a button should have slipped off, put on a new one which fits tightly, but do not fall into the habit of *wetting* the buttons when you put them on as it causes the wires to rust, but grease the wires with good tallow, and screw on the button, if necessary, with a pair of pliers. If a key should stick, owing to warping, it should be taken out and pressed with a warm iron to bring it straight, but be careful not to force it, or it may break at the mortise. Slight warpings, or rubbings, may be remedied by scraping, black-leading, or chalking, as the case may require. If the sticking is caused by a pin being too tight, file the pin carefully, or slightly enlarge the mortise with a rat-tail file; but it is well to seek for the cause in other directions before tampering with either the pins or the mortises. See that the keys do not touch either the cheeks or the front beading, and that the ivory slips do not catch each other; if they do, use a very fine glass-paper file to take a minute portion off the edge.

Rattling of the keys may be caused by friction against each other, or against some portion of the framing, or in consequence of the mortises being too large for the pins. If the pins are oval ones, all that is necessary is to turn them partly round, but if they are round ones, they must either be replaced with thicker ones, or the mortises must be *wedged*. This wedging is done by making a small stab with the point of a penknife at each side of the mortise on the

underside of the key, and then gluing in a tiny wedge of wood, thus slightly closing the mortise. A match cut wedge shape at the point will make wedges for several keys, as the closing in of the mortise must be very slight. If keys thump when pressed sharply down, a greater thickness of felt or baize is required beneath them.

Weak rollers often cause defective touch in consequence of the rollers springing when the key is pressed, so that the pallet does not open till the key is quite down, when it does so with a sudden jerk which is very unpleasant. Iron rollers are not subject to this defect. All iron rollers, or roller arms, should be protected from rust by being painted with Brunswick black.

Faults in Draw-stop Action.—The draw-stops should work perfectly smooth without any jerk or springing, which defect is caused by weak rollers or arms. If on drawing out a stop-knob the slider does not act, the probability is that a wire connecting one of the arms has dropped out. If this is not the case, the defect must be traced up from the stop-knob to the slider until it has been discovered. The screws in the stock boards require to be tightened or loosened occasionally, according as change of temperature allows the sliders to work too easily, or causes them to run too hard.

If the swell shutters close noisily there is more cloth needed on them. The push-up rod should be rubbed with black-lead where it touches the shutter arms. Under ordinary circumstances the swell should be kept closed when not in use, to protect the instrument from dust, etc.; but the pedal which opens it should be fixed down for about an hour before the organ is to be played

upon, so that all the pipes may be subject to the same conditions and temperature.

As very many amateurs would not be content with the comparatively small chamber organs which I have described, I now give a list of the stops most generally in use. In connection with each stop, I have mentioned a few of the other stops with which it may be combined when playing the instrument.

Sixteen-feet Tone Stops.

The largest open pipes in use are 32 feet speaking length, and the largest stopt pipes which give the same note are 16 feet long, but as these will only be required on organs of the largest size, they need not be further refered to here; but we will pass on to the stops of 16-feet tone, which may legitimately find a place in a moderately large chamber organ. The first of these to be mentioned will naturally be the open diapason of 16-feet tone—sometimes termed the double diapason—which on most instruments is a pedal stop, but in large organs appears on the manual. This stop, when of wood, is about 11½ to 12½ inches deep, and 10 or 11 inches wide, the mouth being cut up one-third of the diameter.

The stop most generally useful for chamber work is the bourdon or double stopt diapason. The longest pipe is 8 feet in length, and sounds the note CCC, but the scale varies greatly according to the size of the instrument, the circumstances of the building, or the taste of the builder. For a large instrument the scale is frequently as large as that of the double open diapason, whilst for a small instrument they are sometimes made as little as 4½ inches deep by 3¼ inches wide. This stop appears both on the manuals and on the pedals. The mouth may be cut up from one-third

to one-half the diameter, according to circumstances. The lips should be thick and rounded on the outside edge. In large wood pipes the supply of wind is regulated by means of a disc of wood placed inside the foot of the pipe, and revolving on a peg which projects at the side of the foot. When the disc is horizontal the hole through the foot is nearly closed, but when the peg is turned so that the disc is perpendicular, the pipe receives its maximum amount of wind; thus it is possible to regulate the supply to a nicety.

The Violon is a small scaled stringy-toned stop, sometimes made straight, sometimes conical, the top being slightly wider than the bottom. The mouth is cut up from one-third to one-half for large instruments, but for small instruments slightly over one-fifth will be sufficient. Size of CCC about 6 inches by 7 inches. When of 8-feet tone it is called the violoncello, and the two combined—one on the manual and the other on the pedals—have a fine effect for light music. The lips are cut sharp, and the pipes are furnished with both ears and beard. They can be made in paper by following the directions given in the article for the violoncello.

Eight-feet Stops.

The pipes previously described may be omitted altogether from a chamber organ, but no organ would be presentable without 8-feet toned stops. Of these the chief is the open diapason, which is the foundation stop of all organs, and is properly a metal stop, but occasionally it is of wood, especially in the lower octave. Most of the other stops are regulated in scale from this one. The scale varies according to the size of the instrument, etc., the same as all others, but a good medium scale is 5 or $5\frac{1}{2}$ inches for CC.

Directions for voicing, etc., have already been given. Combines well with stopt diapason, or any fluty-toned stop, but should not be used with a stop of very reedy tone, as the two would clash.

Violin Diapason.—This, as its name implies, is a stringy-toned stop, and is therefore of small scale, being at least two scales smaller than the open diapason. Mouth cut up about one-third, and wind directed mostly on to the outside of the upper lip which is pressed inwards; edge of upper lip cut rather sharp. This is a metal stop, and is tuned by cutting out a tongue near the top of the pipe (one diameter down), and curling it backwards with a pair of round-nosed pliers, as described in my article on Voicing and Tuning. Fine nicking, wind hole rather less than $\frac{3}{8}$ inch for tenor C. Tone very reedy and resembling the Gamba, and the pipes should be quick of speech. Will combine with the same pipes as the Gamba described below.

Stopt Diapason and *Lieblich Gedacht* have already been described. They combine well with open diapasons and flutes, having a very filling effect. Also combine with soft solo stops of the Oboe and Clarinet class, and are very useful as soft solo stops.

Keraulophon, which has also been previously described, is another stringy-toned stop from four to six scales smaller than the open diapason, the peculiar tone being obtained by means of a sliding tube on the top, having a small round hole in it. Useful as a solo stop, and combines with others of a stringy or reedy tone, and with the Stopt Diapason and Hohl Flute (see Fig. 63).

Gamba (German).—A metal stop of small scale, five or six scales less than Open Diapason, and of very reedy and pungent tone. Mouth one-quarter

the circumference, and nearly one-third of its diameter in height. Nicking rather coarser than the Keraulophon; languid must be rather high, upper lip pressed inwards and cut sharp, as in Violin Diapason. This stop is generally made without ears, and is not so good in quality as the Pierced or Slotted Gamba, which is similar in scale, voicing, etc., but has a slot cut in the upper portion of the pipe, as described for the Violin Diapason. Tone stringy and penetrating, somewhat resembling the violin. Allow plenty of wind, and always put ears to the pipes, as they should be quick of speech. The Gambas combine well with Stopt Diapason, Lieblich Gedacht, Hohl Flute or Stopt Flute. A good violin effect can be obtained by combining it with open pedal stops (see Fig. 64).

Viol-di-Gamba.—This is rather a difficult stop to make, but well repays the trouble, as it has a very beautiful tone, being soft, sweet, and stringy. It is a metal stop, but can be made of paper by following the same directions. In shape it originally resembled the Gemshorn, or Spire Flute; but it is now generally made with a bell on the top of it. At the mouth, where it joins the foot, it is the same diameter as the Open Diapason, and it tapers off upwards to only one-third that diameter at four-fifths of the speaking length. The remaining fifth of the length is formed by the bell, or cone-shaped piece, which spreads out at the top to the same diameter as the pipe is where it joins the foot. The mouth is one-fifth of the circumference, and barely one-third of its diameter in height—some make it barely one-quarter—upper lip bevelled, but not too sharp, and should slightly overhang the windway. Nicking very fine and delicate, about the same as the Dulciana. Windway narrow and windhole small, not

exceeding $\frac{3}{16}$ inch at tenor C, below which it is not usual to carry this stop. The bell part must not be fixed until the pitch of the pipe has been set, allowing it to be a trifle sharp; then it may be fixed on with solder if metal, with glue if made of paper. This stop is tuned by means of long, flexible ears at each side of the mouth. This pipe is shown in Fig. 66.

Salicional.—A small scaled stop, 4 to 6 scales less than the Open Diapason. Mouth cut up rather more than one-fourth. Fine nicking; upper lip slightly sharp, and winding light. Tone very pleasing, being slightly reedy and penetrating.

Dulciana.—Same scale as Salicional, but the nicking is still finer, and winding very light. Mouth cut up rather more than one-fourth, and upper lip rather thick, so that the tone produced may be quiet and mellow. This stop has a great tendency to hesitate, which is one of its characteristics. It seldom extends below tenor C, being then grooved into the Stopt Diapason. Sometimes used in small organs as a substitute for the Open Diapason, especially in the swell. Useful for soft, bright solos. It is a good accompaniment for the Oboe, with which it produces a voice-like effect, and combines well with Stopt Diapason, and stops of a slightly reedy character.

Voix Celeste.—This is really formed by two Dulciana stops, one of which is tuned slightly sharper than the other, thus producing a wavering tone. This stop should always be in the swell.

Vox Angelica.—The smallest scaled stop made, and generally considered to be the sweetest. It is 8 to 12 scales smaller than the Open Diapason. Mouth cut up to the same height as the Salicional; nicking very fine and delicate; upper lip not too sharp. Tone

exceedingly soft and sweet, but the pipe is sometimes made with a slot or hole near the top, in which case the tone is more penetrating.

Gemshorn.—Has a conical-shaped pipe, one scale smaller than the Open Diapason at the languid; but only one-third of that diameter at the top. Already described in articles as a 4-feet stop, in which form it is more generally used (see Figs. 34 and 65).

Spitz Flote, or *Spire Flute.*—Similar in shape to the last, but the top is two-thirds of the diameter at the languid.

Stopt Flute.—Simply a Stopt Diapason, voiced fluty; generally a scale or so smaller than that stop.

Rohr Gedacht, Reed Flute, or *Flute à la Cheminée.*—This also is simply a Stopt Diapason with a small hole bored through the stopper, or if metal or paper, the cap has a small tube in it. Size of small tube about $\frac{3}{8}$ inch diameter for tenor C, and four inches long, decreasing to $\frac{1}{8}$ inch diameter and $\frac{1}{2}$ inch long on the smallest pipe. The mouth of the pipe is arched, as described for the Lieblich Gedacht. The tone is somewhat more open than that of the Stopt Diapason, but in many cases it is difficult to tell it from that stop. In scale and voicing it should be the same as the Open Diapason.

Clarinet Flute.—Made the same as the previous stop, but with the small tubes or reeds about twice the diameter there described. The stop sounds very reedy, and when a good one is a fair imitation of the clarinet; but it is very difficult to secure this imitative effect throughout the compass, or to get an even tone.

Harmonic Flute.—This, in common with all harmonic stops, has pipes twice the ordinary length. Thus, to secure an 8-feet tone we require a 16-feet pipe. The

pitch and tone are obtained by the pipes being overblown, and this is aided by boring small holes near the centre of the body of the pipe. These holes may be nearly $\frac{1}{16}$ inch diameter, and vary in number according to the length of the pipe; thus, for tenor C octave we should require three holes in each pipe; in middle C octave, two holes; and all above that, one hole. The mouth should be about one-fifth of the circumference and one-quarter of the diameter in height. Upper lip cut very arched, and a liberal supply of wind allowed to secure the overblown note. This stop is very successful in paper, and as a 4-feet stop with pipes two or three scales smaller than the open diapason, a beautiful silvery quality of tone is produced in the upper octaves. It is, perhaps, almost needless to say that the flutes combine with both open and stopt diapasons, and also with the 2-feet stops.

Clarabella.—A wood stop of open pipes, of the same scale as the stopt diapason of the *same length.* Height of mouth, barely one-fourth of the diameter. The block to be a straight one, similar to that shown for the open diapason in Fig. 27. Nicking rather fine. Rarely extends below tenor C, the stopt diapason forming the bass. Very useful for solo work, and where soft combinations are required.

FOUR-FEET STOPS.

Of these the chief is the *Principal,* which is simply an open diapason one or two scales smaller than that stop, and voiced rather lighter.

Flute Stops.—Oboe Flute is a wood flute of small scale, with a straight block and hollow cap. Mouth cut up from one-third to one-half of the diameter;

upper lip rather sharp; nicking fine, and strongly winded. Tone rather reedy.

Gemshorn, Spitz Flute, Stopt Flute, Clarabel Flute, and *Harmonic Flute,* are simply octaves of the 8-feet stops of the same name. As regards the Stopt Flute, I may add that it is not advisable to introduce this stop, unless there are at least two Open Flutes as well.

Hohl Flute.—Same scale as the Clarabella, but with the mouth made on the wide diameter of the pipe. Tone strong and hollow. Combines with Stopt Diapason, Gamba, Trumpet, Keraulophon, Clarinet, and most other reedy or stringy-toned stops.

Wald Flute (Forest Flute), is made with an inverted mouth, and of rather large scale. It is generally of wood, and seldom extends below tenor C. Tone clear and penetrating.

Suabe Flute is very similar in construction; but three or four scales smaller, and is of softer and sweeter tone.

Two-feet Stops.

Fifteenth.—This is simply the octave of the Principal, and is made one or two scales smaller than that stop, and is generally metal.

Piccolo.—Generally of wood, made similar to the Wald or Suabe Flutes, but smaller in scale.

Flageolet.—Already described; is not quite so shrill as the preceding stop, and is made with an inverted mouth.

Gemshorn Fifteenth is an octave higher than the 4-feet Gemshorn, and rather smaller in scale.

These stops should be carefully voiced to avoid an excess of shrillness. They combine with Open or Stopt Diapasons, and 4-feet stops where brightness

and fulness is required. For solo passages add the Stopt Diapason, or Stopt Diapason and Twelfth.

The *Twelfth* is a stop of $2\frac{2}{3}$ feet tone, and sounds the twelfth above the unison, and is consequently a fifth above the Principal. It can only be used when the 8-feet stops, Principal and Fifteenth, are drawn as well. Its use is to give fulness, but in very small organs it should be omitted.

Reed Stops.

In Reed Stops the sound producer is a metal tongue vibrating in or against a small tube termed a reed, which is fixed into a socket communicating with the pipe. The reed and tongue are enclosed in what resembles a short pipe-foot, which is termed a *boot*. There are no mouths to these pipes, and the pipes do not always correspond in length to the tone length.

Trumpet.—A powerful toned stop imitative of the instrument after which it is named. Reed generally closed, and the tongue curved outwards. The tube or pipe is conical, largest at the top (see Fig. 68). Combines with Open and Stopt Diapason, Hohl Flute, etc.

Clarinet, Cremona, or *Krumhorn.*—An 8-feet stop, giving an excellent imitation of a clarinet, and is suitable for small instruments. The tubes are very small, the CC being only about 3 feet long and $1\frac{1}{2}$ inch diameter, but it rarely extends below tenor C on small instruments. Combines with the same as those mentioned for the Trumpet.

Cornopean.—A full-toned imitative stop of 8 feet pitch, with a closed reed and straight tongue. Tube conical and largest at the top (see Fig. 69.)

Oboe.—This is a beautiful stop, and the most suitable reed for a small instrument. The tubes are very small

for two-thirds of their length, the top spreads out bell shaped, and is covered with a tin or metal lid soldered down half way round, so that the other half can be raised like the tin shades of open wood pipes. By raising or depressing this lid, the tone and power of the pipe can be regulated. Chiefly used on the swell manual. Combines with Hohl Flute and most stops of reedy tone, and if used with the Dulciana, with or without the Tremulant, produces the effect of a Vox Humana (see Fig. 67).

Bassoon is the bass octave of the Clarinet, with which it will combine, and also with other reedy stops (see Fig. 70).

Vox Humana.—When voiced by a master-hand this is a very beautiful stop, imitative of the human voice. The tubes are only half the tone length. As a general rule use Tremulant with this stop (see Fig. 72).

There are very many other reed stops, but few of them would find a place in an ordinary chamber organ.

In bringing this little work to a close, I think it as well that I should append the following specifications for organs of larger size and greater variety than those given in the first chapter, so that amateurs who have the means may gratify their ambition of possessing a really comprehensive instrument.

SPECIFICATIONS.

TWO-MANUAL ORGAN.

Great Organ.

	Feet.	Pipes.
1. Open Diapason	8	56
2. Stopt „ Bass	8	12
3. Clarabella to Tenor C	8	44
4. Dulciana	8	44
5 Principal	4	56
6. Piccolo or Gemshorn	2	56

Swell Organ.

	Feet.	Pipes.
7. Pierced Gamba to Tenor C	8	44
8. Lieblich Gedacht	8	56
9. Gemshorn Principal	4	56
10. Hohl Flute, or Wald Flute	4	56
11. Clarinet, Oboe, or Keraulophon	8	44

Pedals.

12. Bourdon	16	30
		554

Couplers.

1. Swell to Great, Unison.
2. Swell to Great Octave.
3. Great to Pedals.
4. Swell to Pedals.
5. Loud and Soft Combination Pedals may also be added.
6. Tremulant.

THREE-MANUAL ORGAN.

Great Organ.

	Feet.	Pipes.
1. Open Diapason	8	56
2. Gamba to Tenor C	8	44
3. Stopt Diapason	8	56
4. Dulciana to Tenor C	8	44
5. Harmonic Flute	4	44
6. Suabe Flute (Principal)	4	56
7. Piccolo, or Flageolet	2	56

Swell Organ.

8. Violin Diapason	8	44
9. Rohr Gedacht (Treble and Bass)	8	56
10. Hohl Flute	8	44
11. Keraulophon Principal	4	56
12. Oboe or Trumpet to Tenor C	8	44

Choir Organ.

	Feet.	Pipes.
13. Salicional to Tenor C	8	44
14. Lieblich Gedacht, Treble	8	44
15. „ „ Bass	8	12
16. Vox Angelica, or Viol-di-Gamba	8	44
17. Gemshorn, or Wald Flute	4	56
18. Clarinet	8	44

Pedal Organ.

19. Bourdon	16	30
20. Violoncello	8	30
		904

(Nos. 2, 4, and 5 may be enclosed in a separate swell, and a Voix Celeste or Vox Humana might be added in the Swell Organ).

Couplers, etc.

1. Swell to Great, Unison
2. Swell to Great Octave.
3. Swell to Pedals.
4. Choir to Great.
5. Great to Pedals.
6. Choir to Pedals.
7. Loud Combination Pedals.
8. Soft Combination Pedals.
9. Tremulant.

FINIS.

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