Part Two

I

Short Explanation of the Construction of an Organ

23. Much as to the nature of the mechanical structure of an organ must have been gathered from the historical sketch just given, but the following concise account will perhaps place the whole more clearly before the reader.

The most important fact to be first grasped is that an organ with independent pedals and two or more manuals is simply *several* organs of almost identical structure brought together so as to be conveniently under the control of one performer.

If then the mechanism from the key to the pipes is once explained, the same explanation will apply equally to each row of keys and to the separate pedal organ.

FROM KEY TO PALLET

24. Let us start from the manual keys, looking at Fig. 21 at each step.

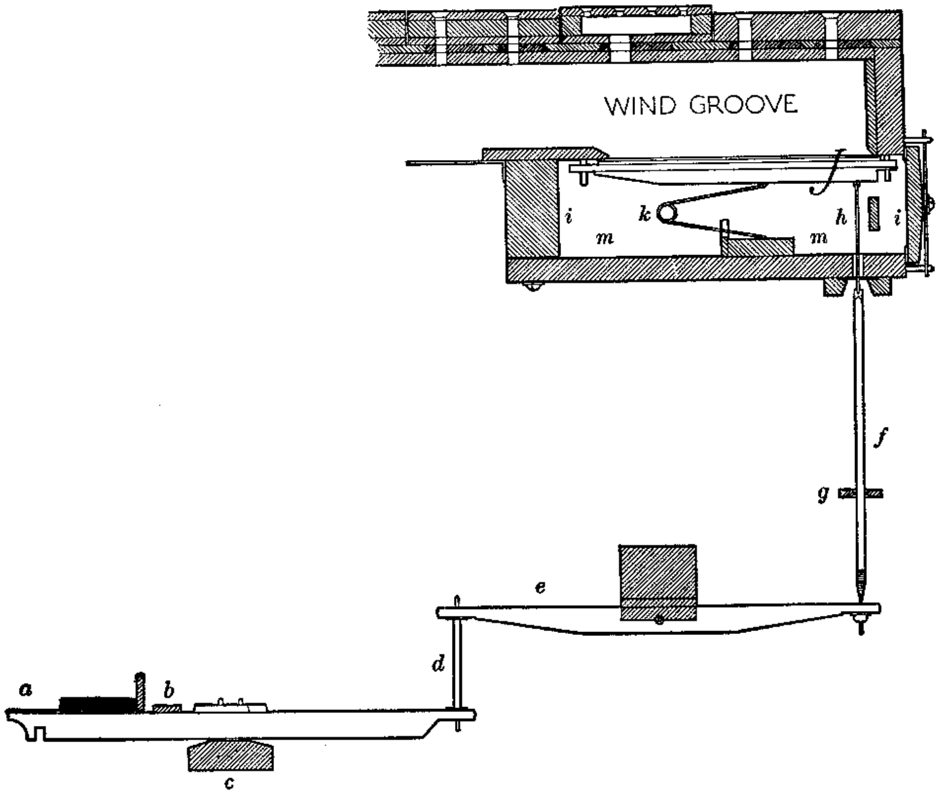

FIG. 21

A *key* is a lever, the front portion of which is exposed to view (*a*). Just behind the ornamental strip of wood forming a band between each manual is placed a weighted piece of wood lying on the whole length of keys from side to side, called the *thumping board* (*b*). Its duty is to keep the keys in position and resist any tendency they may have to rise unduly when released from pressure of the finger. Under the keys a series of pins are arranged on a piece of wood forming the *pin rail* (*c*). These pins fit easily into holes in the keys and prevent them from oscillating when moving up and down. On the end of the key, and kept in position by a little pin running into a hole in the key, is the *sticker* (*d*). The upper end of the sticker has also a little pin which passes into the end of a horizontally placed lever called a *backfall* (*e*). At the other end of the backfall is a hole through which passes the lower end of a *tracker* (*f*). Trackers may be of various lengths according to the size and position of the instrument. The little wire passing from the end of the tracker into the hole in the backfall is made like a screw, or *tapped*, as it is termed; so, where it appears below the backfall, a little leather *button* can be screwed on to it. Two purposes are answered by these buttons; they prevent the tracker from jumping out of position, and they enable the builder to *regulate* the length of the tracker by twisting the button to the right or left. If trackers are very long indeed, they are made to pass through one or more perforated pieces of wood, each tracker having one hole to pass through. These contrivances are called *registers* (*g*), and their object is to prevent the trackers from knocking against each other and making a rattling noise.

It will appear from the diagram that the upper end of the tracker is fastened to a *pull-down* (*h*) or piece of wire, one end of which passes out of a small hole in the *wind chest* (*i i*), while the other is fastened to the bottom of the *pallet* (*J*). This has been purposely done to give the younger reader a general idea that the key pushes sticker, sticker raises front of backfall, and at the same time forces down the further end of backfall, backfall pulls tracker, tracker pulls pull-down, pull-down pulls down (as its name implies) pallet, pallet allows wind to rush up to pipe.

25. But as a matter of fact the pipes are not arranged all of a row, beginning with the smallest on the right-hand side, ending with the largest at the left-hand side. If pipes were so arranged in large organs, not only would they present a very ugly appearance, but all the weight would rest on one side; and also, as large pipes take much more room of course than little ones, the left-hand side of an organ would have to be of much greater depth. And again, if this arrangement of pipes were followed, the resources of the box of air, or wind-chest, would be taxed to the utmost on the left side where the big pipes were standing, while the other end would only have to supply tiny pipes. All these considerations have led organ-builders to place pipes alternately on either side, beginning with the largest. Thus: —

C, D, E, F#, G#, A#, C, and so on, to the smallest; then back again, ending C#, B, A, G, F, D#, C#.
(Largest pipes on left-hand side.) (Largest pipes on right-hand side.)

One is called the "C side," the other the "C# side." This accounts for the very unpleasant musical scale heard when a tuner is at work, because he tunes in this order on one side: —

and in this order on the other: —

If the organ had a compass to 

or G^3, the little pipes in the centre would stand thus: —

. . . . . C, D, E, F# G, F, D#, C# . . . .

The note G would be produced by the smallest pipe, and the pipes would gradually increase in size up to the largest — on the left side to the C of lowest pitch, on the right to the C# of lowest pitch.

26. It is evident then that as the pipes do not stand in the same order as the keys, that is, by successive semitones, the action of the trackers will have to move sideways also in order to get under their respective pull-downs. This sideways movement is managed by what is called a *roller-board*. A peep at a roller-board in an organ will show its use and construction far better than any amount of verbal explanation. But it will be easily understood that if a series of little rollers (of wood or thin iron) be placed horizontally on an upright board, having at one end a jutting arm fastened to the tracker, and at the other end a similar jutting arm connected with the pull-down, when the tracker pulls one end of the roller the other end of the roller will move the pull-down, and the pallet under the foot of the pipe will thus be opened.

FROM BELLOWS TO PIPES

27. Having shown how the movement of a key acts upon various levers until the pallet is pulled open, our next step will be to trace the progress of the wind from the time it enters the bellows until it reaches the pipe. If the reader can understand these two processes, which always go on simultaneously, namely, leverage from a key and at the same time progress of wind from the bellows, he will have grasped the true principles of the construction of an organ.

The attention of the reader is now called to Fig. 22: —

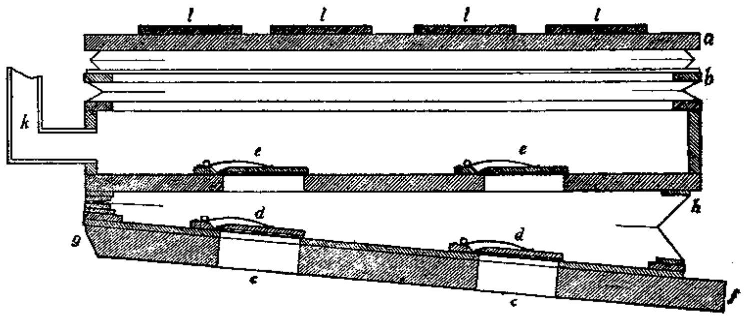

FIG. 22

The bellows-handle, or whatever lever is employed in its place, moves the *feeder* (*f g*). Feeders are the lowest portion of the bellows, and are perforated with large holes (*c c*), closed inside by light coverings of leather hinged at one end (*d d*). When a *feeder* is moved down, the air from outside raises these light *valves* (*d d*) and fills it; but as the return movement of the handle raises the *feeder*, the air cannot get outside again owing to the openings being covered up by which it entered; it therefore raises the valves in the *reservoir* (*e e*) above and enters in there. But the entry to the reservoir is closed by valves (*e e*) of similar construction to those which are placed in the bottom of the feeder; as soon, therefore, as the air has got into the reservoir and the feeder begins to go down for the second time, the valves in the reservoir fall over the opening and the wind is secured *inside the reservoir.* On the top of the reservoir are weights (*l l l l*) carefully adjusted, which make the air try to get out through the *trunk* (*k*) at the side. These trunks are sometimes of metal, more usually of wood, and convey the air into the *wind-chest.* The trunk guiding the wind from the bellows will be seen at *k* in Fig. 22. The following (Fig. 23) shows the action of *double feeders;* while one (*a*) is feeding the reservoir, the other (*b*) is being refilled: —

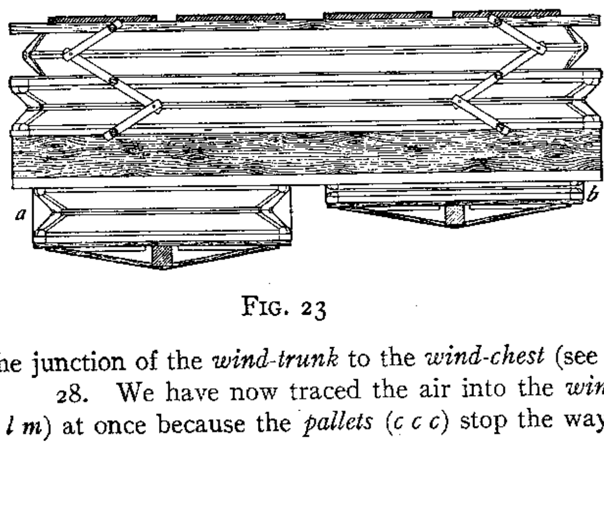

FIG. 23

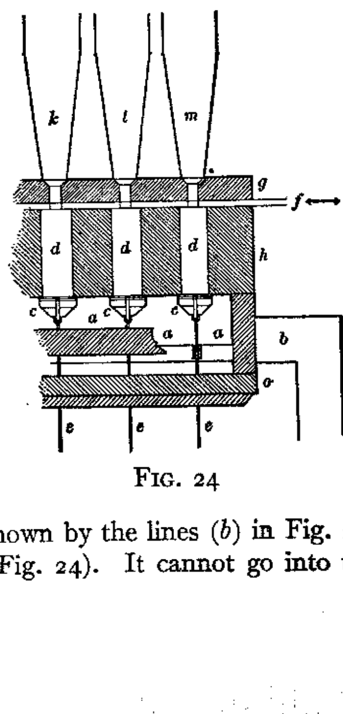

FIG. 24

The junction of the *wind-trunk* to the *wind-chest* (see *k* in Fig. 22) is shown by the lines (*b*) in Fig. 24.

28. We have now traced the air into the *wind-chest* (*a a a* in Fig. 24). It cannot go into the pipes (*k l m*) at once because the *pallets* (*c c c*) stop the way.

When the action of the keys (just described on page 8) pulls down the *pallets*, the air makes a rush to get into the pipes through the *grooves* (*d d d*); and it will succeed in getting into the pipes if the *slider* (*j*) is open. The slider is a flat strip of thin wood which moves from left to right or *vice versa*, lying between the top of the *wind-chest* (*h*) and the *soundboard* (*g*) in which the *pipes* (*k l m*) stand. The holes in the *slider* correspond exactly with the holes under the pipes. The *slider* (*j*) is acted upon by the *stop*. When the stop is *in*, the slider is out of position and the air is arrested in its progress to the pipes by finding no orifice in the slider. But when the stop is *out*, the holes in the slider are under the holes leading to the pipes (*k l m*), and the air rushes into them and makes them speak. When, however, the *key* is allowed to return up to its position of rest, the *pallet* closes sharply and no more air can get to the pipes whether the *stop* is in or out.

29. As it is often found difficult to explain the action of the *slider* to young persons, the following way of stating it may be of use. Take three strips of paper, two of white, one of black. Place the black strip between the two white, so that they coincide. Make a few holes through all of them (Fig. 25).

FIG. 25

Place them on a table. Then the lowest strip of paper represents the top of wind-chest, the black strip the slider, the top strip the soundboard and holes in which pipes stand. It will be evident that air could run through the holes in all the strips and enter the pipes if no further step be taken.

But now take hold of the black paper and give it a little pull to the right. The following (Fig. 26) will be now the appearance on the table:—

FIG. 26

It is very evident that, although there is an opening in the white papers, no pipe could now speak, because the black paper stops the progress of the air. This is exactly the nature and function of the slider. The stop when *out* makes all the holes coincide, as in Fig. 25; the stop when *in* makes the slider intervene, as in Fig. 26.

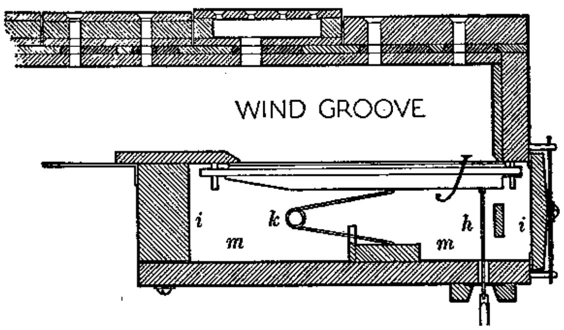

FIG. 27

In Fig. 24 (at *c c c*) the *pallet* was only shown from the front; it will make its function clearer if we show it sideways, as in Fig. 27. The pulling of the wire opens the *pallet* (*J*), which is hinged at *i*, the air rushes therefore from *m m* into the *wind groove*. On releasing the key, the spring (*k*) instantly closes the *pallet*.

The action which makes the stop-handle act on the *slider* is nothing more than a series of arms and levers; and as it is a portion of the mechanism most easily visible when looking inside the instrument, it is unnecessary to say more about it here.

COUPLERS

30. Couplers are of two kinds, *manual couplers* and *pedal couplers;* by the former, one of two rows of keys is so connected to another that when that one is being played, the other also is acted upon at the same time; by the latter, when the feet are playing on the pedals the lower notes of a manual are simultaneously acted upon. The most simple couplers are those which act upon one of two successive rows, such, for instance, as *Swell to Great*, which signifies that when this stop is drawn and the Great Organ is being played the Swell is simultaneously acted upon. The coupler formerly most commonly used can be thus explained. The backs of the keys are cut away — that of the upper set at the under side, that of the lower at the upper side (Figs.

28 and 29). A piece of wood is pierced with holes and made into a frame for the little flatheaded *stickers* shown at *a a*. When the coupler is *not* drawn out the stickers are all as in Fig. 28, where they cannot produce any effect; but when the coupler is drawn out, the *sliding register bar* (*b*) and all the stickers are thrown into position as in Fig. 29, and therefore upon pressing the front of the lower key the end rises and pushes up the back of the upper key. But *backfall* couplers, that is to say couplers formed by the use of levers (such as that represented by *e* in Fig. 21, page 8), are now most frequently met with.

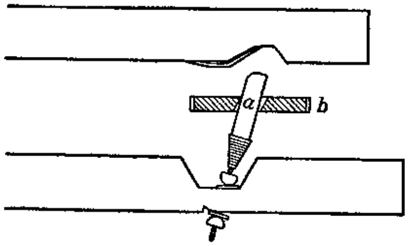

Fig. 28

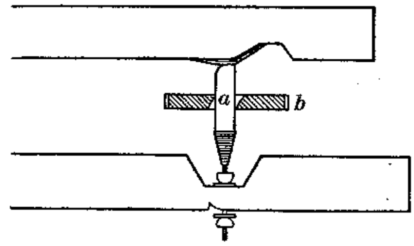

Fig. 29

Backfall couplers are placed out of gear (when the stop is *in*) by a displacement of the backfall frame in such a manner that the wire of the sticker moves up and down without acting on the backfall. Pedal couplers, owing to the extent of the pedal-board being greater than that portion of the manuals on which they act, are constructed by means of a *roller-board*, or a backfall called a *splay* backfall, because the arms are not parallel to each other.

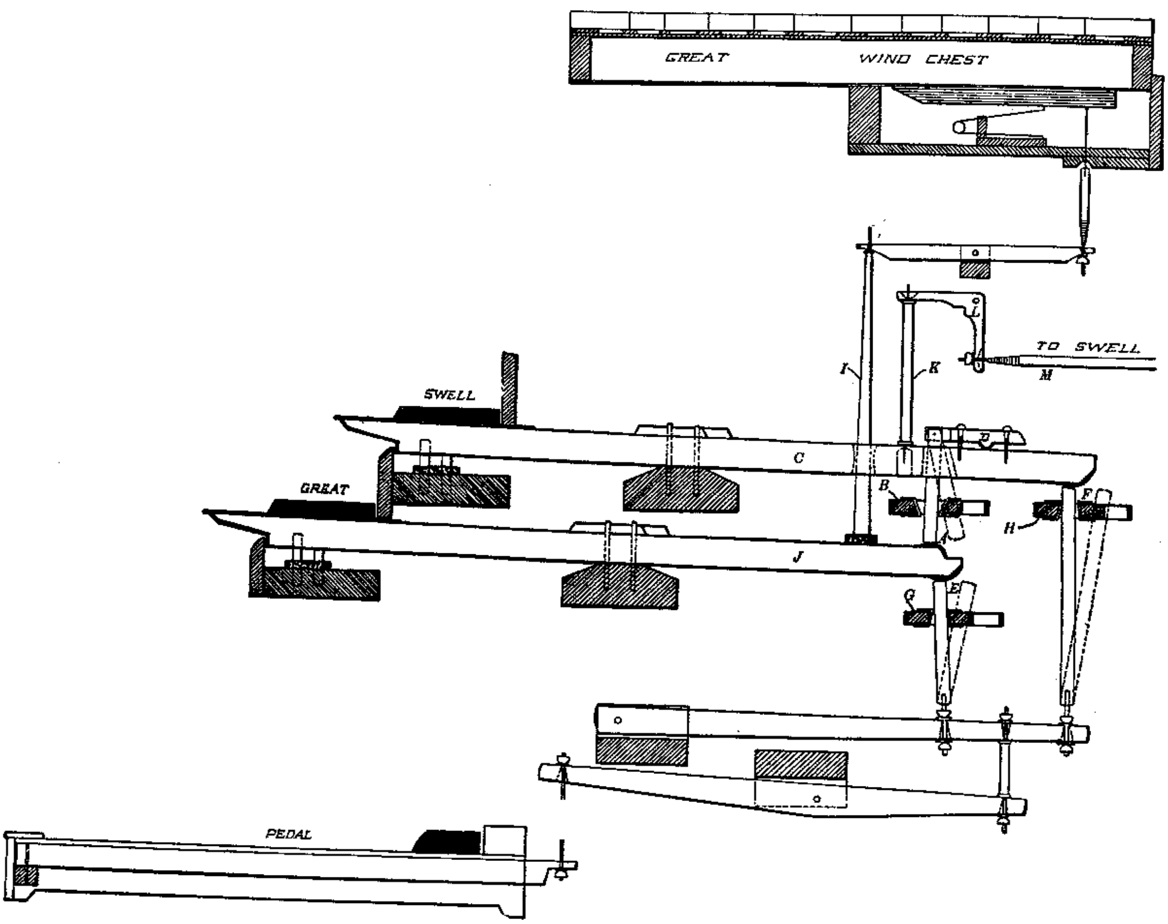

Fig. 30

The diagram (Fig. 30) shows both the manual and pedal couplers of a modern two-manual, *tracker-action* organ. Starting at the Great Organ clavier, the first Coupler to be considered is the *Swell to Great* shown at *A*; its flat stickers pass first through the *sliding register* (*B*), and thence through slots cut in the centre of the *Swell keys* (*C*), above which they are hinged to the rocking *adjusting-bars* (*D*) in the manner indicated.

The *rocking bars* are secured to the upper surface of the Swell keys by two screws each; and these screws, operating against each other, provide an easy and perfect adjustment of the coupler. The Great keys (on which the stickers glide and rest) are well buffed and blackleaded.

When the *Coupler* is out of action, register B is moved back, placing the stickers in the oblique position indicated by the dotted lines.

Great to Pedal (*E*) and *Swell to Pedal* (*F*) are operated in a like manner. *Register bars* (*B*, *G*, and *H*) extend the width of the keyboard, and are operated *On* and *Off* by the various coupler draw-knobs.

The Great Organ action is connected with the keys by the *flat stickers* (*I*) which rest on the upper surface of the *Great keys* (*J*) and pass through a slot in the *Swell keys* (*C*) as indicated by dotted lines. The *round stickers* (*K*) are connected to the Swell Organ wind-chest by *squares* and *trackers* (*L*) and (*M*).

31. When couplers are drawn, the touch of a large organ would be very heavy were it not for the *pneumatic lever*, for an explanation of which the reader is referred to Hopkins and Rimbault on THE ORGAN, the article *Organ* in Stainer and Barrett's DICTIONARY OF MUSICAL TERMS, or THE ART OF ORGAN BUILDING (2 vols.) by Audsley, and to section 35 of this book.

NOTE. — The so-called *tracker action*, described above, is now rarely used by the best organ-builders. Some of them do not make use of it at all, equipping even the smallest two-manual organs with a *pneumatic action*. Others still occasionally put the tracker action in very small instruments, but it seems to be only a question of a short time when it will be entirely superseded, on all new organs, by the more modern systems. Nevertheless, there are now thousands of organs in our churches built upon the tracker system; and it will be many years before these are all replaced by organs of newer construction. Hence, the organist who would have a working knowledge of the mechanism of any organ he may be called upon to play, will do well to study carefully the foregoing pages. — EDITOR.

32. The construction of all the *flue pipes* in an organ can be gathered from an examination of Figs. 31 and 32; for, although they differ in detail in a vast number of ways, the principle remains the same. The air enters the *foot* (*a*) or lowest portion, is arrested by a piece of wood or metal (*b*) called respectively the *block* or *languid* (a corruption of the Latin *lingua*), is forced to escape in such a way as to impinge upon the *lip* (*c*), and thus sets the column of air contained in the pipe into vibration.

33. It is not an easy matter to explain the construction of a *reed pipe* either by words or woodcuts. The student is recommended to ask an organ tuner to take a reed pipe to pieces and show how it is made. But to those who cannot thus see it with their own eyes, the easiest way to explain it is to ask them to imagine an ordinary clarinet with the reed end placed into a foot or boot so constructed that the bottom of the foot could be placed on an organ soundboard and the upper part should fit tightly round the portion of the instrument, just above the reed. On the admission of the air from the bellows, it would have to pass by the reed of the clarinet to escape; the reed would then by its elasticity beat against the orifice just behind it, and so be set into vibration.

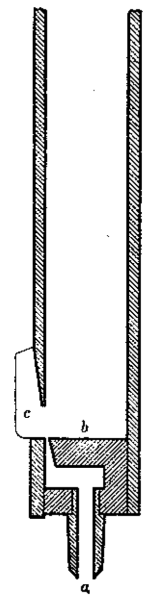

FIG. 31

FIG. 32

II

Modern Organ Construction

34. When an organ with *Tracker action*, operated entirely by the finger energy of the performer, contains more than about twenty speaking stops, the touch, especially with couplers drawn, becomes too heavy for the fingers to overcome, and rapid playing with full organ an impossibility. Supplemental power to remedy this has been found by employing pneumatic pressure and electricity, singly or combined.

TUBULAR-PNEUMATIC ACTION

35. By *Pneumatic action* is meant the mechanism used to overcome the resistance of keys, pallets, stops, or any other "Moving part" in organs, the motive power being compressed air, or atmospheric pressure.

The motor in every case is a *Pneumatic*, — that is, something inflatable or collapsible. It is not necessary that the pneumatic be of bellows pattern; it may be a mere bag of leather, or a groove or hole covered with leather, which is capable of being inflated or exhausted. So long as any surface is made to rise or fall, and this to move any adjacent part, it is termed a motor or pneumatic.

Pneumatic motors may be (a) near the keyboard, and transmitting power to the required quarter by a long tracker (*Pneumatic Lever*); or (b) they may be placed immediately adjacent to the part which has to be moved, and connected to the keys by small tubes of indefinite lengths. In this case, the transmission of power is by a tube, and not by a tracker as in the first instance, and the action is termed *Tubular-Pneumatic.*

Each key has its own tube, and no matter how great the distance to be covered between key and pallet, the mechanism cannot become more heavy or complicated; it is only necessary to provide a longer tube.

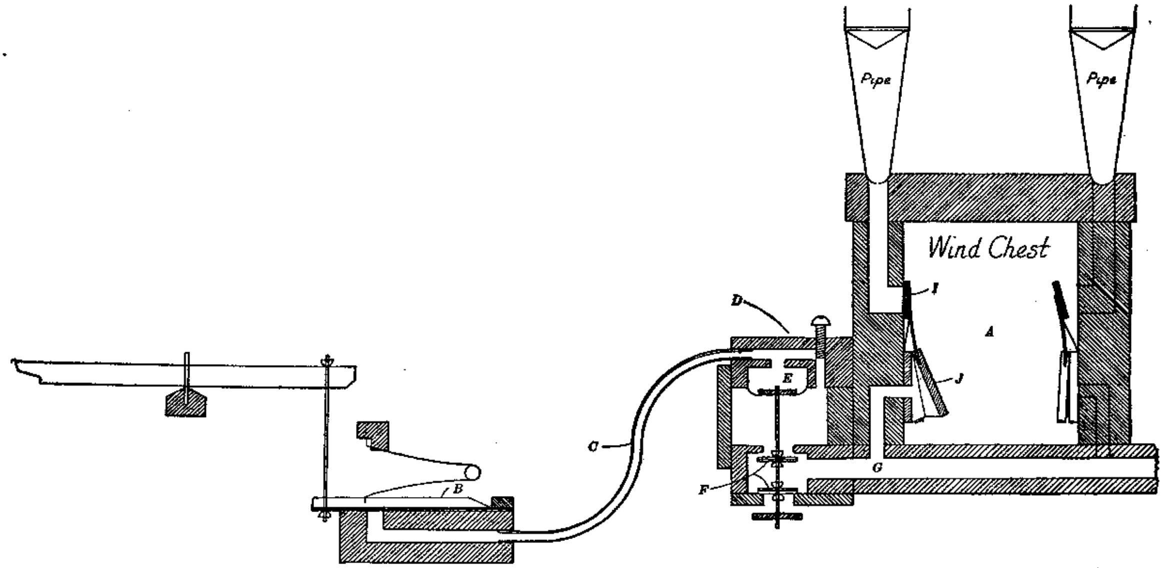

Fig. 33

Figure 33 represents a sectional view of a *Pneumatic Action* from key to pipe. *A* is an air-chamber controlled by a draw-knob, say — *Open Diapason.*

When a *key* is depressed it opens the small *pallet* (*B*), and exhausts the *tube* (*C*) leading to *primary* (*D*) (adjoining the *Wind-Chest*), exhausting the *pouch* (*E*), to which is connected a double-seated *valve* (*F*); thereby the small *pneumatic* (*J*) located under the pipe will be exhausted, and the air pressure in *chamber* (*A*) will **collapse** the pneumatic and thereby open the *valve* (*I*) that leads to the *pipe.* In Fig. 33 the valve (in the ***Wind**-Chest*) of the left-hand *Pipe* is closed, while that of the right hand is open.

The *Tubular-Pneumatic system,* as a substitute for the long *Tracker action,* was first practically applied in 1867 to an organ exhibited in the Paris Exposition of that year. Henry Willis introduced it with improvements to the organ in St. Paul's Cathedral in 1874.

Since then the system has been greatly developed.

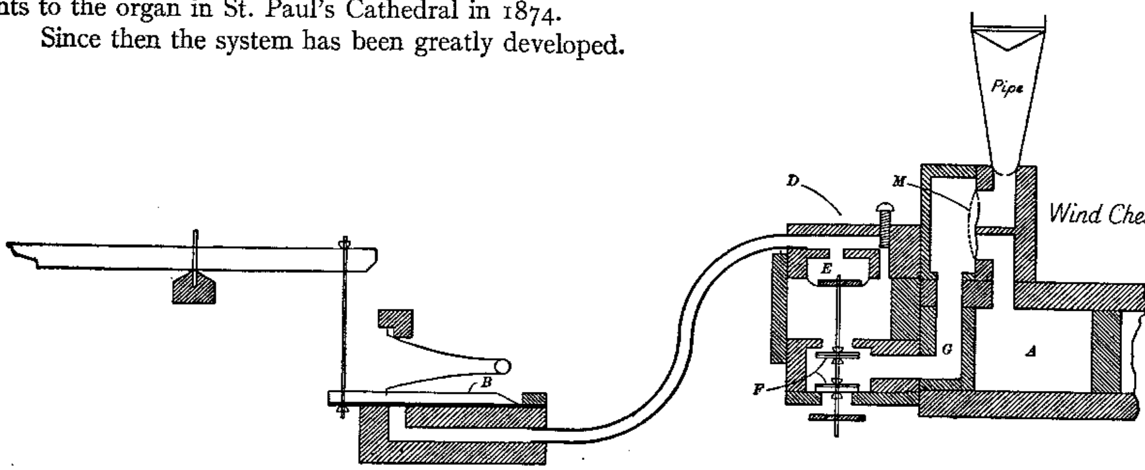

Fig. 34

36. Figure 34 represents a sectional view of an improved pneumatic *Ventil Wind-Chest,* very simple in construction and consequently very durable.

The mechanism between key and wind-chest is the same as in Fig. 33 — the difference is in the construction of the *Wind-Chest.* The leather diaphragm *M* is glued over two ports and forms the ***pneumatic valve*** that controls the wind to the pipe.

When the key is depressed, the channel *G* is exhausted, and the diaphragm *M* assumes the position as indicated in dotted lines; therefore, the pipe wind in chamber *A* is admitted to the pipe.

ELECTRO-PNEUMATIC ACTION

37. The idea of applying electricity to the organ mechanism occurred first to the English organist, Dr. H. J. Gauntlett (1805–1876), and the first attempt at an electric action was patented by him in 1852. The idea was developed by the English organ-builder, Charles Spackman Barker, in collaboration with the French organist, Dr. Peschard. The first Electro-Pneumatic organ was erected by them in 1866, and the second was erected by them in 1867 in the church of St. Augustin, Paris. Barker took out English patents in January, 1868. Hilborne L. Roosevelt, the American organ-builder, was the first in America to use the idea successfully, which he did in Grace Church, New York City, in 1878. Here the Organ in the western gallery was connected with a new Organ in the chancel at a distance of one hundred and fifty feet, and with an Echo Organ in the lofty roof. More than twenty miles of electric wire were used, yet the response is instantaneous. Other eminent organ-builders are accredited with improving the electric action, which, although not yet perfected, is undoubtedly the action of the future. It has the advantage of occupying but a small space, as all the wires necessary for the control of a large organ may be formed into a cable the size of the wrist. The *console* can, therefore, be at any distance from the instrument, the response being instantaneous. This is a great advantage in divided organs, and the console can, if necessary, as in concert halls, be made movable.

The reliability of the modern electric action has been demonstrated, and all the large and important organs that are being built are equipped with this or a similar system.

When *Electro-Pneumatic* organs were first used in this country, however, the complicated combination of electro-magnets and pneumatics was anything but satisfactory from a mechanical standpoint, and for some time electric organ-action was considered a failure, owing to the constant adjustment that was necessary from time to time to keep the organ in a playable condition.

Within the last few years great improvements have been made, and to-day *Electro-Pneumatic* organs are becoming very popular. The action, being simplified, makes them just as reliable as the *Tubular-Pneumatic,* and, on account of their simplicity, there is very little difference in the cost of manufacture.

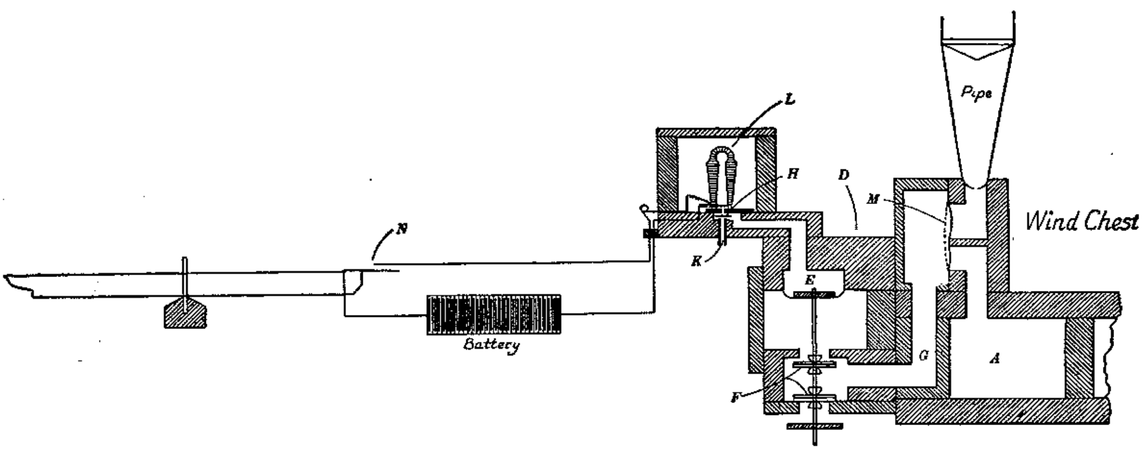

FIG. 35

Figure 35 represents a sectional view of a modern *Electro-Pneumatic* action from key to pipe. This action can be applied to any system of pneumatic wind-chest. The sketch shows how the *electro-magnet* (*L*) is applied to a Ventil Chest, as indicated in Fig. 34; but instead of a tube leading from *primary* (*D*) to *key-pallet* (*B*), as in Figs. 33 and 34, a small electric wire is used. Depressing the *key* closes the electric circuit at *key-contact* (*N*), and energizes the *electro-magnet* (*L*), which attracts the small metal *armature-valve* (*H*), and allows the pressure in *pouch* (*E*) to exhaust through *vent* (*K*), thus operating the *wind-chest* as described in Fig. 34

ADJUSTABLE COMBINATION STOP-ACTION

38. There are various systems of *Adjustable Combinations,* controlled by pistons or buttons conveniently located under the respective manuals, also by pedal-studs.

The systems not moving the draw-knobs are termed *Blind,* and are somewhat confusing to the organist, as he is only guided by a small indicator (which is located over the manuals), indicating what particular button has been used. He must therefore remember what stops have been previously set on that particular button, taxing, in a mechanical direction, the attention, which otherwise could be concentrated on the composition before him.

By a modern visible *Adjustable Combination Stop-Action* (Fig. 36), the organist can set any stop or groups of stops and bring them into use by simply pressing a button. This device has important advantages that recommend it to the organist: First, any desired combination of stops can be instantly made without leaving the organ bench; when the selected combination is desired, the button may be pressed and the draw-knobs will be thrown out, and any other group of stops that may have been out will be simultaneously returned.

Second, with this system the organist can change his combinations to suit each number on the program, for by pressing the button, the stops are moved in or out as the case may be; therefore, at a glance, he can see just what stops are in use, the registration being prepared before starting to play.

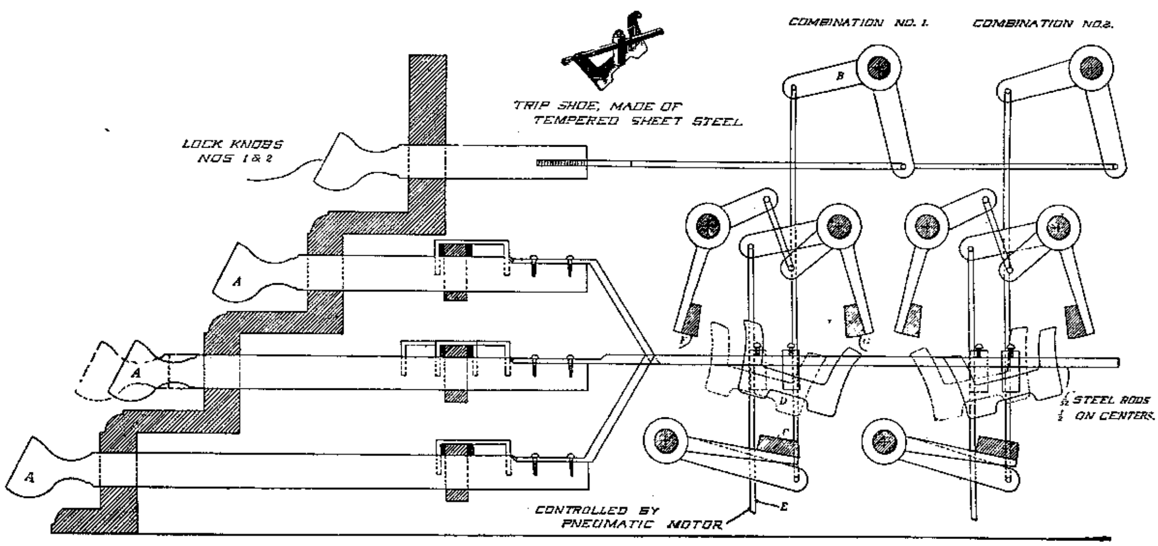

FIG. 36

Figure 36 shows the mechanism for two *Adjustable Combinations* controlled by *Pistons* 1 and 2 of the Swell Organ. *A*, *A*, *A* are the draw-knobs to be operated.

To set Combination No. 1, draw the desired stops, then pull the *lock-knob*, which is engraved *Combination No.* 1. This knob is connected by a *bell-crank B* to *bar C*, which engages the *trip-shoe* (on *stop-rods* that are drawn) at *D* and tilts one arm of the trip-shoe up. The same movement tilts down the corresponding arm of the trip-shoe, on stop-rods that are not drawn.

A *pneumatic motor* is connected to the rod *E*, which operates the two parallel horizontal bars *F* and *G* simultaneously towards one another. The pneumatic motor is operated by *Piston No.* 1. Now suppose the combination of stops previously selected has been pushed in and other stops drawn, and the organist wishes to instantly use the stops previously selected. By pressing *Piston No.* 1, the pneumatic motor is inflated, raising rod *E*, to which is connected bars *F* and *G*. Bar *G* engages all of the arms of trip-shoes on the stops that had been previously selected, pushing them out; bar *F* engages all of the arms of trip-shoes on all other stops, pushing them in. The same operation applies to all the pistons; in other words, if there are four pistons on the Swell Organ, there are four corresponding lock-knobs.

For further illustration, draw *Stopped Diapason*, pull lock-knob engraved *Adjustable Combination No.* 1, return *Stopped Diapason*, draw *Salicional*, pull lock-knob No. 2, return *Salicional*, draw *Oboe*, pull lock-knob No. 3, return *Oboe*, draw *Flute*, pull lock-knob No. 4, now press Piston No. 1. *Stopped Diapason* will be thrown out, and at the same time *Flute* will be returned; press Piston No. 2, *Salicional* will be thrown out, *Stopped Diapason* will be returned; press Piston No. 3, *Oboe* will be thrown out, and *Salicional* will be returned; press Piston No. 4, *Flute* will be thrown out, and *Oboe* will be returned. The above stops will be controlled by the various pistons, as long as the lock-knobs have not been disturbed.

The above mechanism is double-acting, and so arranged and constructed that the performer can lock any desired complement of stops to the respective pistons, and the operation of the locking device does not interfere with the player's performance.

To further facilitate the manipulation of modern organs, some builders duplicate the *pistons* with *pedal-studs*, thereby making possible the changing of combinations either by pistons or pedals.

WIND FOR THE ORGAN

39. Various methods have been used for supplying wind for the organ, from the ancient system of tread-power to the modern electrical *Centrifugal Blower*. The *Hydraulic Motor* connected to the bellows lever has been and is at present used with very satisfactory results, especially for organs of medium size. However, this device is gradually giving way to the more modern *Centrifugal Blowers*, which are especially built for the purpose. With the latter device the clumsy bellows is dispensed with, and instead a small reservoir or governor is used to control an exceptionally steady wind supply, which only the organist can appreciate.

VOICING

40. Along with other great improvements in organ building, the voicing has not been overlooked; possibly more improvements have been made in this art in the last five years than in fifty years previous. For instance, there are the thin scale *Violes* (Fig. 37), which are especially characteristic of the string department of the Orchestra.

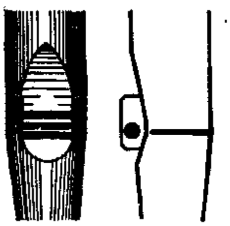

Fig. 37
Section of Small Scale Viole

The reed department of the organ has also been greatly improved; the rasping *Trumpet* has now been replaced with a smooth-toned *Tuba* usually on high-wind pressure; the delicate reed tones, such as the *Vox Humana, Orchestral Oboe, Clarinet, Cor-Anglais*, etc., have been wonderfully improved, and some fully represent the tones produced by Orchestral instruments.

The *Flutes* — many in quality and construction — also have experienced improvements. The *Doppel Floete*, for instance (Fig. 38), is a stopped wooden pipe, with two mouths, — in fact, two pipes in one, and produces an exceptionally round, full, fluty tone.

Last, but not least, the *Diapasons*, the foundation stops of the organ, have also been greatly improved both in fulness of tone as well as power, and the later specimens produced in this country are equal, if not superior, to those found in Europe.

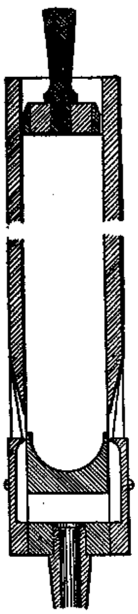

Fig. 38

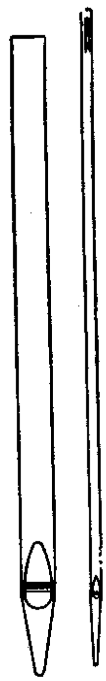

Fig. 39

Figure 38 gives a longitudinal section of a *Doppel Floete*, showing the double mouth. Figure 39 shows the proportions of *C C Diapason* and a small scale *Viole* of the same pitch.