HOW IT WORKS

BEFORE BEGINNING to discuss the technique of rebuilding the player piano, it may be well to give the reader a brief illustrated outline of its operation. An understanding of how the player piano works—what makes it play—is essential for a repairman who expects to produce a good job.

The player piano operates using vacuum, or suction, as its motive power. In most players, the vacuum is created by pedaling with the feet, which operates suction bellows in the lower portion of the piano. This vacuum is channeled through large supply hoses into the upper action of the piano, where it does the work of playing the keys.

Probably the most important parts of the player piano are its valves and pneumatics. These parts utilize the vacuum and actuate the piano's notes. Each note has its individual valve and pneumatic unit. The valve controls the suction which collapses the pneumatic on cue from the music roll. The pneumatic, which is nothing more than a small bellows with a push-rod attached, operates its piano note by suddenly collapsing, due to the rapid admission of vacuum to its interior. The note strikes with a loudness

which is proportional to the degree of suction which actuates its pneumatic.

Figure 1 is a drawing of a typical valve and pneumatic unit, in schematic form. The tube A leads from the suction supply bellows, and provides motive power to actuate the valve B and collapse the pneumatic C. Tube D leads from the tracker bar (the brass or wooden bar over which the music roll plays). When a perforation in the music roll passes over the tracker bar, air is admitted through tube D. This air allows the pouch E (a flexible diaphragm of very thin leather) to rise, due to the vacuum above it. Pouch E, in rising, carries with it the valve B, lifting the valve away from its lower seat and throwing it upwards against its upper seat. This seals off the hole in the upper valve seat, and allows vacuum to rush up past the valve stem through the hole in the lower valve seat, and into the pneumatic C. Thus the pneumatic collapses, and pushes rod F upwards which plays a note on the piano. When the perforation passes away from the tracker bar, the tube D is once again sealed off, and vacuum is admitted to the chamber underneath the pouch E through the small hole G, called the bleed (usually a small stamped brass cup with a hole in its base). Atmospheric pressure on top of the valve B forces the valve downward onto its lower seat. This seals off the suction supply to the pneumatic C, and allows atmosphere to rush into the pneumatic through the hole in the upper valve seat, thus opening the pneumatic again.

Figure 2 is an actual cross section of the modern Pianola, reproduced by permission of the Hardman-Peck Company, its manufacturer. Note that it operates on the single-valve principle.

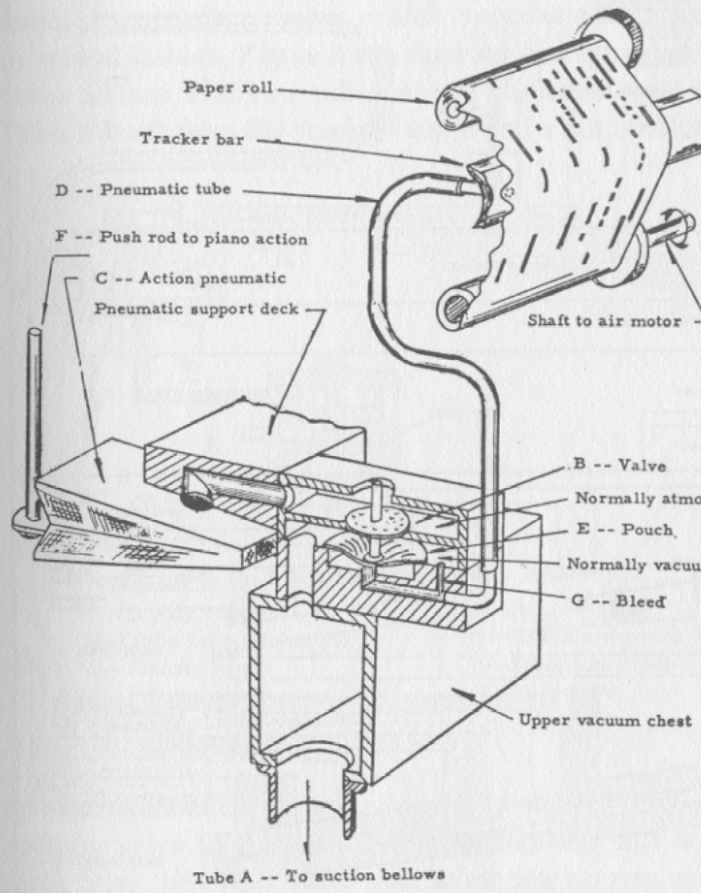

Fig. 1. Single Valve Pneumatic System

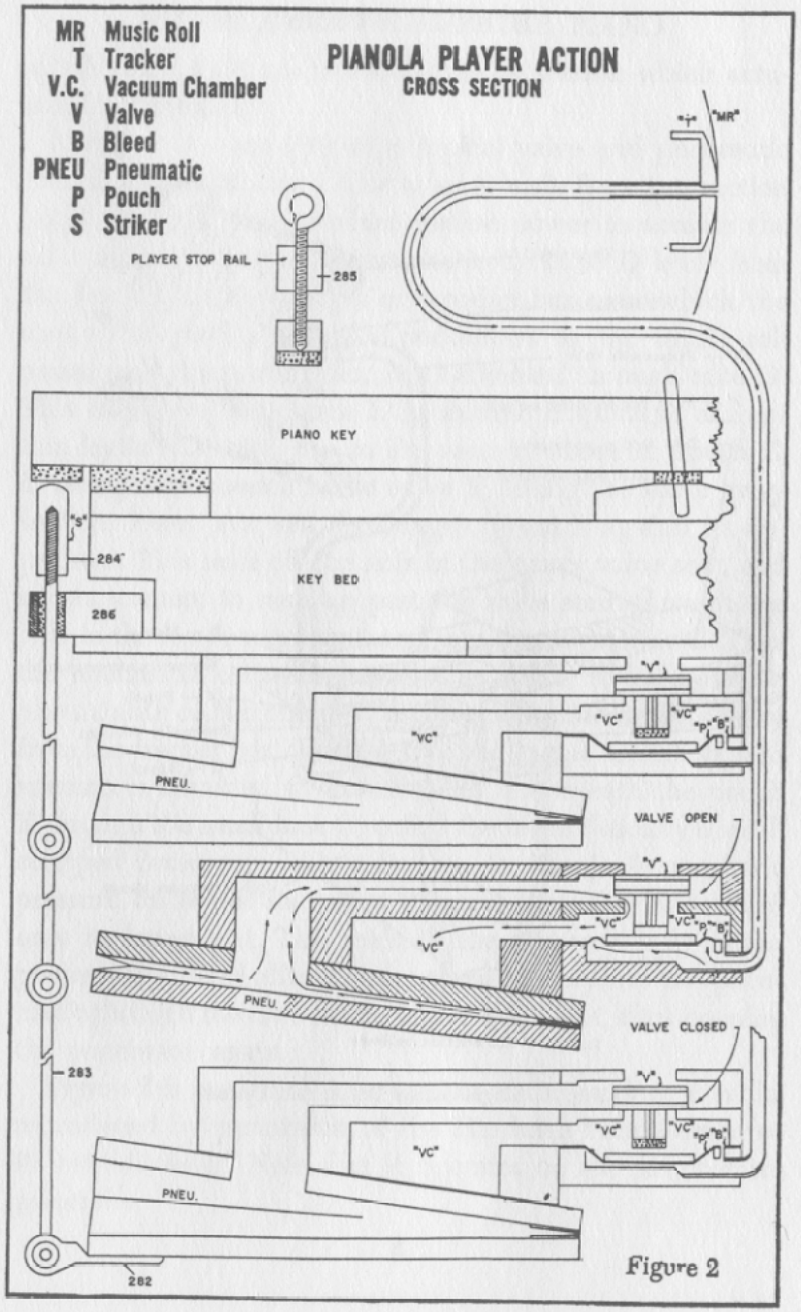

Figure 2

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A variation on this mechanism is found in pianos which are built with a double-valve action. In this case, two valves per note are used. The first, or primary, valve actuates the main, or secondary, valve, which operates the pneumatic in normal fashion. Figure 3 is a drawing of a typical double-valve action. The two tubes A are suction supply tubes. Tube B leads from the tracker bar. When a note perforation

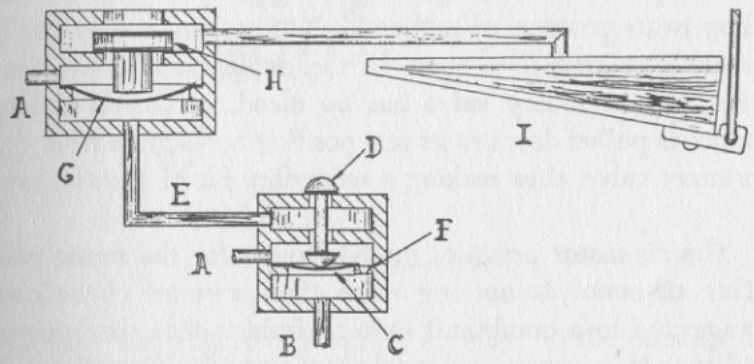

Fig. 3. A Typical Double-valve Action

A—Suction supply
B—Tube from tracker bar
C—Primary pouch
D—Primary valve
E—Channel from primary to secondary valve
F—Primary bleed
G—Secondary pouch
H—Secondary valve
I—Pneumatic

opens the tracker bar hole, primary pouch C rises, lifting primary valve D. As the valve moves, its top part is lifted away from the upper valve seat, admitting atmosphere into channel E. At the same time the lower part of the valve is thrown against the lower seat, shutting off vacuum to channel E. The effect of this is to admit atmosphere to the chamber beneath the secondary valve pouch G, causing

it to rise and to throw secondary valve H against its upper seat, closing off atmosphere to pneumatic I and admitting suction to it. Thus the pneumatic closes. When the perforation passes away from the tracker bar, the bleed F restores the vacuum beneath the primary pouch C, the primary valve D drops to its rest position, and atmosphere in tube E is sealed off. Vacuum is admitted to tube E, and this pulls secondary pouch G down again, allowing secondary valve H to drop to its position of rest and admit atmosphere to pneumatic I, causing it to open. In the double-valve player action, the secondary valve has no bleed, as the secondary pouch is pulled down to its rest position by vacuum from the primary valve, thus making a secondary bleed unnecessary.

The air-motor provides motive power for the music roll. This air-motor is nothing more than a series of bellows connected to a crankshaft in such fashion that the bellows collapse in a certain order when vacuum is alternately admitted and shut off by a series of eccentric-driven sliding valves, causing the crankshaft to rotate. The vacuum supply to the air-motor is channeled through a governing device which assures constant speed of the air-motor regardless of what vacuum may be present in the main supply bellows (i. e., regardless of how hard the player pianist pumps the pedals). Different types of governors are found in player pianos, but the basic principle of their operation is always the same. They control the flow of vacuum to the air-motor, thus controlling its speed. The governor is usually a fairly large pneumatic, through which the vacuum supply to the air-motor flows. Inside this pneumatic is some sort of "strangling" device, usually a sliding valve made of wood

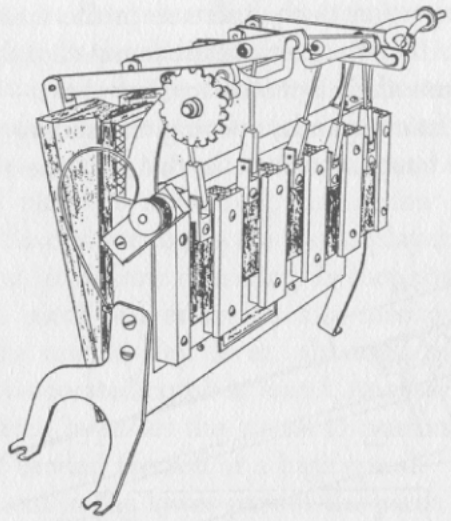

Fig. 4. An Air-motor

or metal—see Figure 5. A spring attached to the pneumatic exerts constant force on it, tending to keep it open at all times. As the player pianist pumps, the suction to the air-motor flows into the governor pneumatic through a supply hose, and out again through another hose, after passing through the sliding valve inside the pneumatic. This suction tends to partially collapse the pneumatic, against the force of the spring. This collapsing of the pneumatic moves the sliding valve's position, and partially constricts the flow of suction through the pneumatic. If the player pianist pumps harder, the air-motor would naturally tend to speed up, due to higher vacuum turning it. However, in this case the governor pneumatic collapses farther, moving the sliding valve so that it closes off the suction supply opening still more, thus reducing the supply of suction to the air-

motor in proportion to the increase in the main supply bellows suction. If the player pianist pumps lightly, this would normally cause the air-motor to slow down—but the governor pneumatic expands, opening the sliding valve and allowing more suction to flow. In this way the suction to the

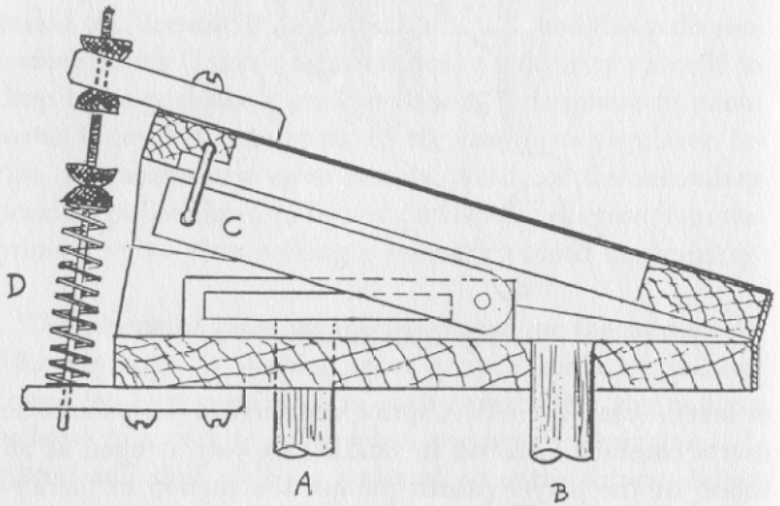

Fig. 5. An Air-motor Governor Unit

A—Channel from suction supply
B—Channel to air motor
C—Sliding valve
D—Adjustable spring

air-motor is always kept constant, regardless of the level of the supply vacuum.

Usually attached to the governor pneumatic is the tempo regulation device, which is simply a sliding valve which partially shuts off the flow of regulated suction, after it has passed through the governor, which operates the air-motor. The position of the sliding valve is determined by the tempo lever. If the music roll being played runs at a high tempo,

the lever is set to the prescribed position on the tempo indicator. This moves the sliding valve such that it allows most of the suction to reach the air-motor. If the tempo lever is set to a low value, little of the suction is allowed to reach the air-motor, thus moving the roll at a slow speed.

When the piano is rewinding, the action cutoff valve shuts off the flow of suction to the upper player action, thus preventing the piano from operating. In foot-powered player pianos, these cutoff valves are usually mechanically operated from the rewind-play lever, although occasionally a pneumatically-operated cutoff is found. Another valve opens a channel which bypasses the governor pneumatic, making the air-motor rewind the roll at a high speed.

The apparatus in the lower part of the piano supplies the necessary suction to operate the player mechanism. Each foot pedal has its own pump bellows, to which it is connected by linkage. When a pedal is pressed, one of the pumps opens, drawing air from the pneumatic stack into it. When the pedal is released, the air with which the pump has filled itself is expelled into the atmosphere. This is accomplished by two simple valves, usually in the form of flaps of leather, which act as check valves to control the direction of flow of the air. Figure 6 is an illustration of the principle of operation of the pumps. A represents the fixed board of the pump, and B represents the movable board, attached through linkage to the foot pedal. Channel C leads through the reservoir to the player action. The leather flap valves D are attached to the boards at their ends, but are free to move away from the boards at their centers. When the pedal is pressed and the pump opens, valve D on the movable board is drawn tightly against its seat, while valve D on the

fixed board is pulled away from its seat, drawing air from channel C. When the pedal is released, the pump has filled itself with air from channel C, and it begins to close. Valve D on the fixed board is then pressed against its seat, while

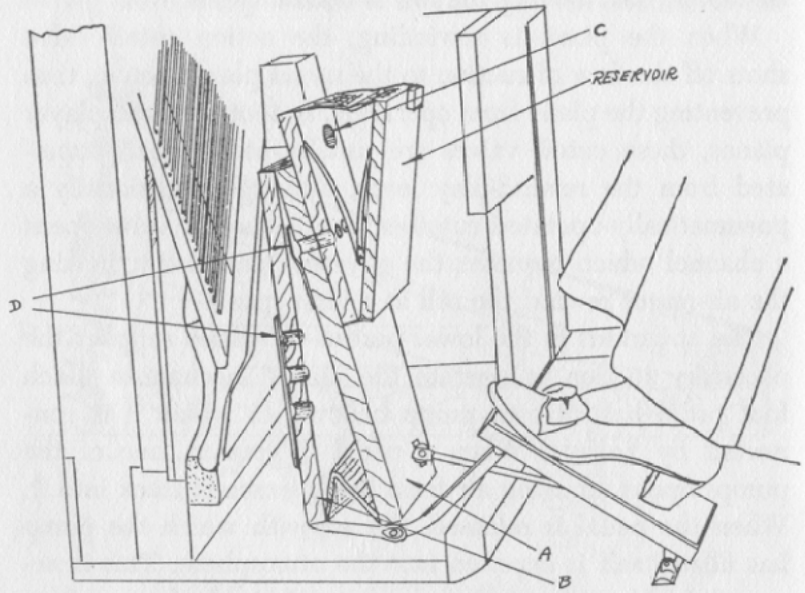

Fig. 6. Main Pump Bellows

A—Fixed Deck
B—Movable deck
C—Channel to player action
D—Leather flap valves

valve D on the movable board moves away from its seat, expelling the air in the pump into the atmosphere.

The reservoir acts as a cushioner and equalizer for the supply of air. The two foot pump bellows supply vacuum only while they are being pushed open, and this would lead to very erratic performance of the piano if there were no means to smooth out the vacuum supply and assure a

reasonably constant suction. The reservoir is a large spring-loaded bellows which "stores" the generated suction inside it. When the piano is playing, the reservoir is partially collapsed. The movable board of the reservoir is in a continually "floating" state, moving in and out quickly as variations in suction occur. If a heavy chord is struck, the reservoir springs snap the movable board out instantaneously to maintain the working vacuum and to keep the piano playing normally. Pianos with small reservoirs usually give the player pianist better opportunity to accent certain notes by quick, hard strokes of the pedals. However, pianos with large reservoirs usually maintain their playing level more uniformly and are better able to handle sudden demands for vacuum. Some player pianos are equipped with two reservoir bellows at the ends of the bellows unit, rather than a single reservoir extending across the unit—but the function is the same in both cases.

The rest of the player piano's mechanism is comparatively simple. The roll drive transmission shifts the control gears from rewind to play position as determined by the control lever. The automatic tracking device shifts the position of the roll to see that its perforations are always in direct alignment with the holes in the tracker bar. Some automatic trackers shift only the upper spool, some shift the tracker bar, and some shift both the upper and lower spools, but their operation is basically the same. Most player pianos are equipped with various "interpretive" devices whereby the operator can make the piano play at different loudness levels at his discretion. These devices are controlled from levers or push-buttons which are located on the control rail in front of the key-bed. These so-called expression controls were

manufactured in literally dozens of forms, and any general description of them would be impossible. However, they all operate by causing the bass and treble sections of the hammer rail to move closer to the strings, or by "strangling" the suction supply to the player action in much the same fashion as the air-motor governor operates.

Many player pianos came equipped with an automatic device for operating the sustaining pedal. This consists of a large pneumatic which is connected to the sustaining pedal mechanism, and which is controlled either by a push-button or lever on the control rail or by a special sustaining pedal perforation cut into most music rolls. This pneumatic actuates the sustaining pedal when the finger button is pushed or when the pedal perforation crosses the tracker bar, the result being the lifting of the dampers from the strings, just as though the regular sustaining pedal had been pressed.

REBUILDING

BEFORE ANY PARTS of the mechanical action can be removed from the piano, the removable case parts must be taken off the front of the instrument. Remove the upper front panel of the piano by lifting it from its brackets or by turning thumb nuts and raising it off its mounting screws. Remove the flat board, if any, above the fallboard, and also the fallboard itself. On some pianos, the two vertical pieces of wood at the two ends of the front of the piano must be removed to allow the upper player action to come out. The bottom front panel should also be removed—and in some cases it is helpful to remove the piano's top, especially if it is a small player.

The player action, or pneumatic stack, is removed from the piano by loosening the control rods at the ends of the action, detaching the air-motor supply hose, removing the bolts or screws at the ends of the action which hold it in place, and then lifting the action outward from the back of the piano and slightly upward at the same time. This procedure may vary with some pianos which have the large vacuum supply hoses attached to the action beneath one or