many places in Egypt of ventilating by a bent tube facing the wind, similar to the ones used on steamships, being placed on the roof, the air being pressed down into the interior by the pressure of wind, which is one pound to the foot when travelling at the rate of three and a half miles per hour, but when this method is adopted on permanent buildings it is a failure, because when ventilation is most necessary there is no wind with power enough to create a current.

TABLE *to show the Discharge of Air in linear feet per minute. Calculated from Montgolfier's formula; the expansion of air being taken as 0·002 for each degree Farenheit, and one-fourth being deducted for friction (Round numbers have been taken)*

Height of column.	Difference between Internal and External Temperature.																						
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	30
10	88	102	114	125	135	144	153	161	169	176	183	190	197	204	210	216	222	228	233	239	244	249	254	279
11	92	107	119	131	141	151	160	169	177	185	192	200	207	213	220	226	233	239	245	250	256	261	267	292
12	96	111	125	136	147	158	167	176	185	193	201	209	216	223	230	237	243	249	255	261	267	273	279	305
13	100	116	130	140	153	164	174	183	192	201	209	217	225	232	239	246	253	259	266	272	278	284	290	318
14	104	120	135	147	159	170	181	190	200	209	217	225	233	241	248	255	262	269	276	282	289	295	301	330
15	108	125	139	153	165	176	187	197	207	216	225	233	241	249	257	264	272	279	286	292	299	305	312	341
16	111	129	144	158	170	182	193	204	213	223	232	241	249	257	265	273	281	288	295	302	309	315	322	353
17	115	133	148	162	176	188	199	210	220	230	239	248	257	265	274	282	289	297	304	311	318	325	332	363
18	118	136	153	167	181	193	205	216	226	237	246	255	264	273	282	290	298	305	313	320	327	335	342	374
19	121	140	157	172	186	198	210	222	233	243	253	262	272	281	289	298	306	314	321	329	336	344	351	384
20	126	144	161	176	190	204	216	228	239	249	259	269	279	288	297	305	314	322	330	338	345	353	360	394
21	125	147	165	181	195	209	221	233	243	255	266	276	286	295	304	313	321	330	338	346	354	361	369	404
22	131	151	169	185	200	214	226	239	250	261	272	[illegible]	292	302	311	320	329	338	346	354	362	370	378	414
23	134	154	173	189	204	218	232	244	256	267	278	[illegible]	[illegible]	[illegible]	318	327	336	346	354	362	370	378	386	423
24	136	158	176	193	209	223	237	249	261	273	284	295	305	313	323	333	344	353	361	370	378	386	394	432
25	139	161	180	197	213	227	241	254	267	279	290	301	312	322	332	342	351	360	369	378	386	394	402	441
26	142	164	183	201	217	232	246	259	272	284	296	307	318	328	338	349	358	367	376	385	394	402	410	450
27	145	167	187	205	221	237	251	264	277	290	302	313	324	335	345	355	365	374	383	392	401	410	418	458
28	147	170	190	207	225	241	255	269	282	295	307	319	330	341	351	361	371	381	390	399	408	417	426	467
29	150	173	194	212	229	245	260	274	287	300	312	324	335	347	357	368	378	388	397	407	416	425	433	475
30	153	176	197	216	233	249	264	279	292	305	318	330	341	355	363	374	384	394	404	414	423	432	441	483
31	155	179	200	219	237	253	269	283	297	310	323	335	347	358	369	380	391	401	411	420	430	439	448	491
32	158	182	204	223	241	257	273	288	302	315	328	341	353	364	375	386	397	407	417	427	437	446	455	499
33	160	185	207	226	245	261	277	292	307	320	333	346	358	370	381	392	403	414	424	434	443	453	462	506
34	162	188	210	230	248	265	282	297	311	325	338	351	363	375	387	398	409	420	430	440	450	460	469	514
35	165	190	213	233	252	269	286	301	316	330	343	356	369	381	393	404	415	426	436	447	457	467	476	522
36	167	193	216	236	255	273	290	305	320	334	348	361	374	386	398	410	421	432	442	453	463	473	483	529
37	170	196	219	240	259	277	294	310	325	339	353	366	379	392	404	415	427	438	448	459	470	480	490	536
38	172	198	222	243	262	281	298	314	329	344	358	371	384	397	409	421	432	444	454	465	476	486	496	543
39	174	201	225	246	266	284	302	318	333	348	362	376	389	402	414	426	438	450	461	471	482	492	503	551
40	176	204	228	249	269	288	305	322	338	353	367	381	394	407	420	432	444	455	467	477	488	499	509	558
45	187	216	241	264	286	305	324	341	358	374	389	404	418	432	445	458	471	483	495	506	518	529	540	591
50	197	228	254	279	301	322	341	360	377	394	401	426	441	455	469	483	496	509	522	534	546	558	569	623
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	30

To use the table, determine the height of the warm column of air from the point of entrance to the point of discharge. Ascertain the difference between its temperature and that of the external air Take out number from table, and multiply by the section area of the discharge-tube or opening, in foot or decimals of a foot. The result is the discharge in cubic feet per minute, multiply by 60—result, discharge per hour. *Example*—Height of column, 32 feet; difference of temperature between internal and external air, 17 deg. Looking in the table, we find opposite to 32 and under 17,375 feet. That would be for an area of 1 square foot.

But supposing our air opening to be only ¾ of a foot, we must multiply 375 by ¾ or 0·75 of a foot.

$$\begin{array}{r} \cdot375 \\ \cdot75 \\ \hline 1875 \\ 2625 \\ \hline 281\cdot25 \end{array}$$

Therefore we get 281 feet (per minute), multiplied by 60 = 16,860 feet per hour.

With a view to prevent wind acting upon the currents all air ducts should be bent, having two or more elbows, and the mouth should either face up or downward. To avoid the chilling sensation of drafts when ventilation is secured by air ducts, the inlet should be sufficiently large to allow the necessary quantity to enter the room slowly, say about the rate of one mile per hour, and the inlet should be larger than the outlet. It is the size of the outlet that regulates the quantity of air entering and passing out of a room. Therefore it is necessary to know the size of tube or valve required to pass the proper quantity of air. Montgolfier's formula gives a valuable table showing the size needed under many variations between the temperature outside and inside, and also the height of the rooms, which will answer if the inlet end of the air duct is well shielded against the pressure of wind.

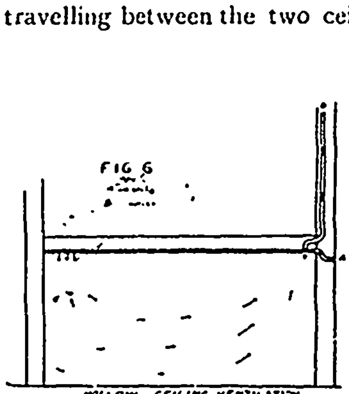
It is not necessary to make channels large enough to pass all the air needed, except the house be as tight as a glass show case, because there are generally streams of air passing in and out of the chinks of windows and doors, and even walls and plaster, except they happen to be painted and papered. Marcker proved by experiments that the following amount of air passes in one hour through a square meter of wall when the difference in the temperature was only 1° C., viz.: Sandstone, 1.69; limestone, 2.32; good brick, 2.83; loamy brick, 5.12, and that it increased in the ratio of the increase in the difference of the temperature between the outside and the interior.

No doubt the best way to venti'ate is by bringing in the fresh air at or near the ceiling at one end of the room, and extracting the tainted air at or near the floor line at the opposite end of the room, but this can only be done when an exhaust fan is used or there is a long chimney at least three times the height of the room. And even when a chimney is used, some method should be made to create some artificial heat at the bottom, to increase the draught at times when the temperature is nearly equal inside and out, because of the resistance to be overcome in drawing down the warm air in the room.

Dwellings can be simply and well ventilated by leaving all the interior partition walls two inches short of the ceilings, so that the air of every room can freely pass slowly out in long thin volumes into the entrance hall and staircase well. Then fix one double draught ventilator with a 24 to 30-inch body over the well on the roof. This will keep the air fresh and pure.

When a house is in course of erection a proper system of ventilation can be made for each room separately by building the outside walls hollow, having a 4-inch space carefully plastered smooth on both sides inside. This space would greatly benefit the house by keeping it warmer in winter and cooler in summer, but the space would also answer for an air duct leading to every room which would convey the necessary amount of air in slowly and cool the current a little in summer and warm it in winter. To draw off the tainted air of each room the main chimney should be so built as to be handy for inserting every tube drawing the foul air from the rooms, also handy to receive the smoke pipes serving all the needed fires. There should be a wrought iron tube inside the chimney, with branches to receive the smoke. Round the smoke-tube there should be about 6 inches of space to act as an air flue, and into that air space all air ducts should be carried. The chimney should have a couple of slow-turned elbows near the top in order to prevent the pressure of the outside atmosphere bearing its weight down the full length of the chimney, injuring the chimney efficiency. A straight vertical chimney or air flue is of little use for creating a draught, except it is carried to a great height, besides having plenty of heat or a forced draught at the bottom.

The space between joists could be made useful for bringing in and tempering the incoming current in winter, or better still, if the ceilings could be made with two plates having a half-inch space between, coupled at one end of the room with the outside atmosphere, by a long bent flue, and pierced with holes at the other end of the room to allow the fresh air to enter. The fresh air while travelling between the two ceiling plates across the top of



HOLLOW CEILING VENTILATION

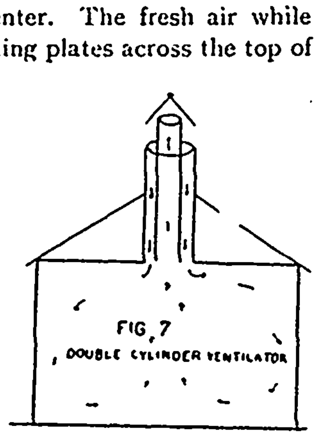


FIG. 7
DOUBLE CYLINDER VENTILATOR