N. E. FROST.

VACUUM SYSTEM FOR USE IN CONNECTION WITH HEATING, REFRIGERATING, EVAPORATING, AND OTHER APPARATUS.

APPLICATION FILED MAY 31, 1910.

1,012,837.

Patented Dec. 26, 1911.

2 SHEETS—SHEET 1.

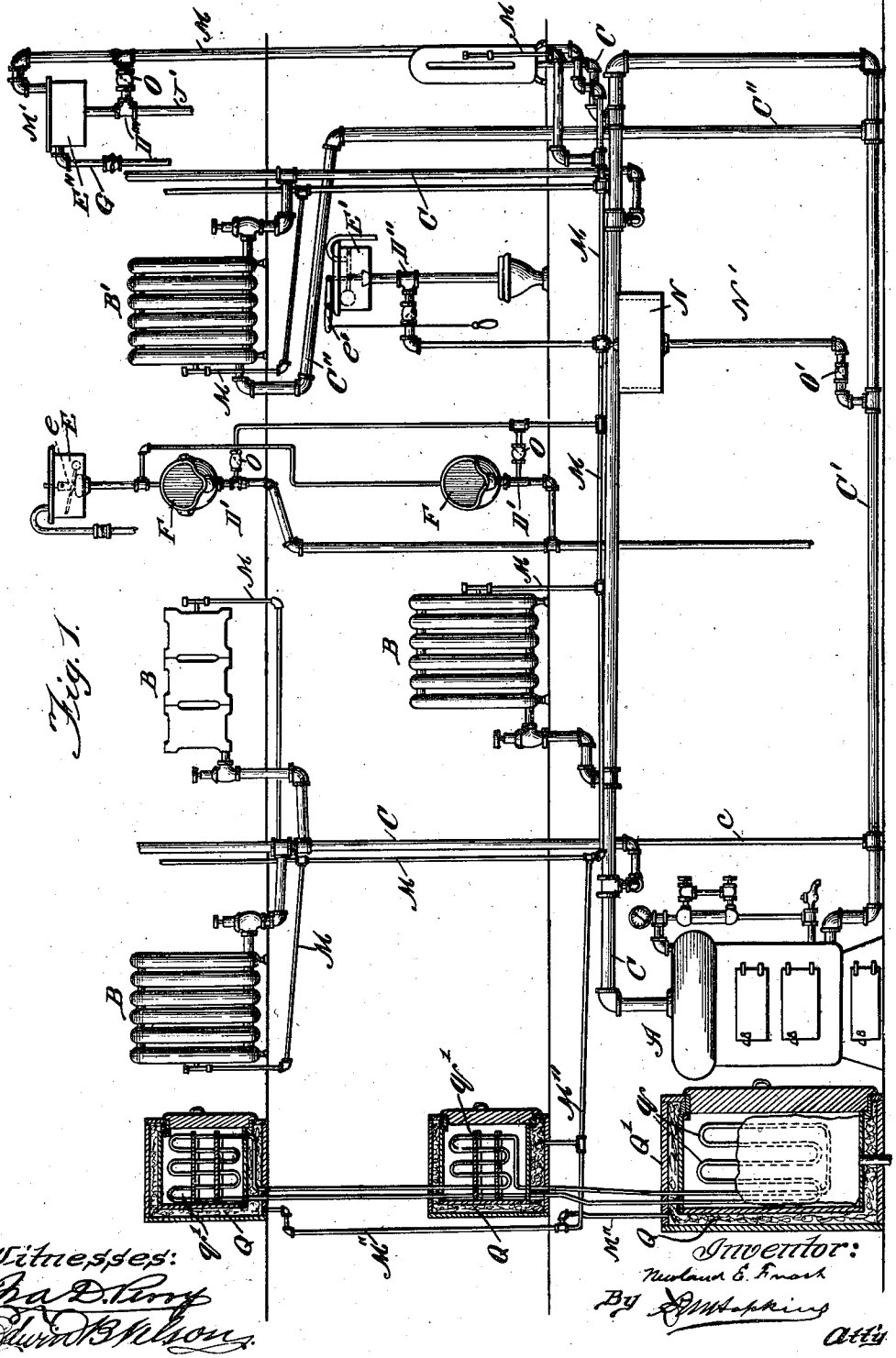

Fig. 1.

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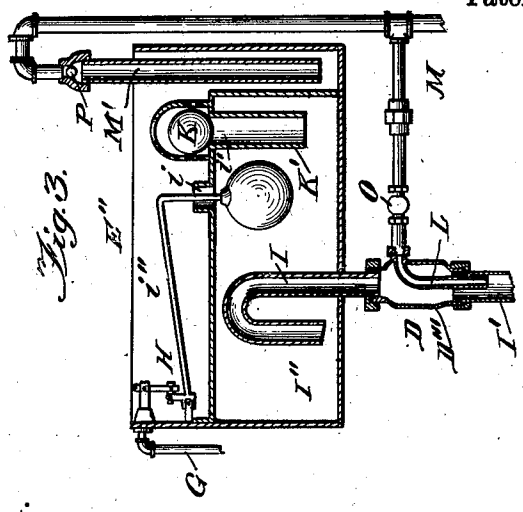


Fig. 3.

Fig. 4.

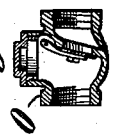
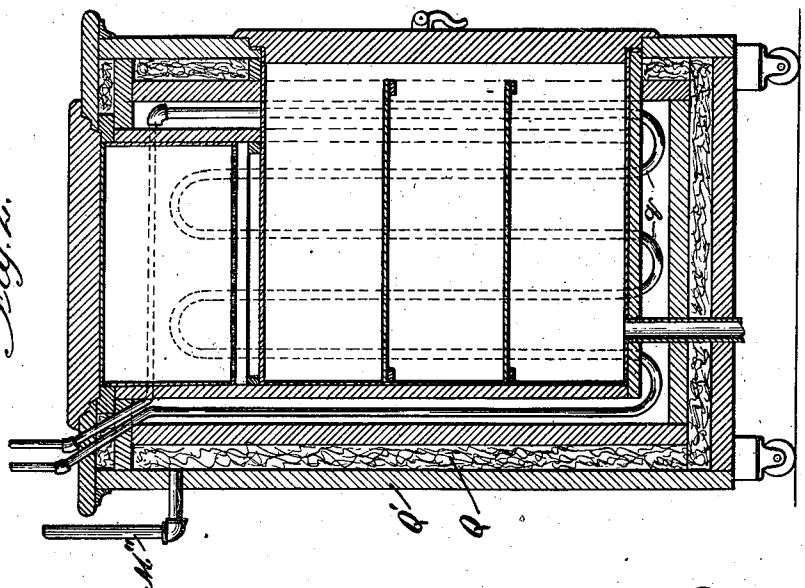


Fig. 5.

Fig. 2.



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UNITED STATES PATENT OFFICE.

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VACUUM SYSTEM FOR USE IN CONNECTION WITH HEATING, REFRIGERATING, EVAPORATING, AND OTHER APPARATUS.

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Application filed May 31, 1910. Serial No. 564,179.

To all whom it may concern:

Be it known that I, NEWLAND E. FROST, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Vacuum Systems for use in Connection with Heating, Refrigerating, Evaporating, and other Apparatus, of which the following is a specification.

So called "vacuum systems" for aiding the heating of buildings are well known in the art. Briefly stated the heating system comprises a heater, one or more radiators and one or more pipes connecting them in a circulating system, all of which may be constructed and arranged in any of a number of different ways known in the art, and the vacuum system for aiding the circulation of the heat circulating medium of the heating system consisting of a system of pipes communicating with the interiors of several radiators and means for producing a partial vacuum in the vacuum system.

The present invention relates to a system of apparatus of this class for producing and maintaining a partial vacuum within not only radiators but the chambers of other devices or apparatus, such as refrigerators, evaporators and the like in which the system includes a vacuum producer which has no relatively movable parts and therefore requires no attention or repairs, and which system operates automatically and at no expense whatever, excepting in some rare instances in the use of the improved system, at a nominal expense, so that, with these trifling exceptions, the only cost incident to the use of the improved vacuum system is the original expense of installing it.

There are, of course, many uses to which a partial vacuum may be put, in the useful arts, and it is, therefore, to be understood that the exclusive right to use the invention for any purpose for which it may be found to be useful is reserved as being within the scope of the invention. Among these many uses may be mentioned the aiding of the insulation of heat and cold. A vacuum being a poor conductor of heat, this characteristic may be availed of in the construction of the insulating walls of refrigerators and other structures. The walls of refrigerators are usually made double so as to form within them cells or chambers in which the insulating material is packed. By making these chambers airtight and maintaining a partial vacuum within them their nonconducting efficiency will be increased. Or it may be used in evaporators of various kinds.

One of the objects of the present invention is to insure an adequate and uniform vacuum producing force within the vacuum producer, without regard to the pressure of the water in the primary water supply and to insure the uninterrupted operation of the vacuum producer for a sufficient length of time, when once it is set in operation, to produce the necessary vacuum. To this end, each vacuum producer is supplied with water from a tank or receptacle, each of said tanks being elevated to such a level as to give the water the necessary head and provided with an outlet of sufficient capacity to permit the discharge of the water in a sufficient volume per unit of time under the pressure of the atmosphere to form the vacuum, and means are provided for starting the flow of water from the tank and for thereafter preventing the flow from being interrupted until the tank has emptied itself. An outlet pipe communicates at its upper end with the bottom of the tank, and through the tank with the atmosphere, so that when the outlet opening of the tank is uncovered the water in the outlet pipe will be under atmospheric pressure. Incorporated in the outlet pipe and located below the level of the tank is a vacuum producer having a vacuum chamber which communicates with the interior of the outlet pipe and also with the interior of the chamber to be evacuated, the outlet pipe being of sufficient height to provide a hydrostatic column of sufficient height to give it the necessary force to produce the desired degree of vacuum. It is immaterial at what level the vacuum producer communicates with the outlet pipe because wherever it is located it is subjected to a force proportional to a hydrostatic column of the entire height of the pipe, including the portions thereof which are both above and below the producer.

To these ends the invention consists in the features of novelty that are hereinafter de-

scribed with reference to the accompanying drawings, which are made a part of this specification, and in which:

Figure 1 is a diagrammatic view of a complete system for both heating and refrigerating, embodying the invention. Fig. 2 is an enlarged vertical section of a refrigerator which may be used as either a master refrigerator of a local refrigerator, or both, in a system embodying the invention. Fig. 3 is a vertical section of a tank the emptying of which, for producing the partial vacuum, is controlled by the degree of the vacuum in the system itself. Fig. 4 is a section of a check valve closing inward or toward and opening outward or away from the vacuum system whereby it is closed by a pressure on the outside of the system which is higher than the pressure within the system and opened by a reduction of the pressure on the outside of the system to less than that within the system. Fig. 5 is an axial section of an ejector of modified form for producing a partial vacuum within the system.

A is a heater, for heating the circulating medium, which is shown in the drawing as being a steam boiler, although it may be used as a water heater, when water is used as the circulating medium.

B and B′ are radiators all of which may be used in a steam heating system while the one shown at B′ may be used also in a hot-water heating system. They differ in construction only in that those lettered B have only a single opening at the bottom for both the inlet of the heated circulating medium and the outlet of the cooled circulating medium or the water of condensation, while that shown at B′ has two openings at bottom, one for the inlet only and the other for the outlet only, this being the type of radiator usually used in hot-water systems. Where only a single opening is used it communicates with one end of a pipe C, the other end of which communicates directly with the top of the heater for conducting the heated circulating medium to the radiator, and also communicates with the bottom of the heater through a smaller pipe *c* which branches off from the pipe C for returning the water of condensation to the heater, either directly or through a return pipe C′ which is common to a plurality of radiators. Where the radiator has two openings at the bottom one of them communicates with one end of a separate direct pipe C, the other end of which communicates with the top of the heater, and the other communicates with one end of a separate return pipe C″, the other end of which communicates with the bottom of the heater as aforesaid.

According to the present invention, one or more vacuum producers D, which may be of any desired construction but which are preferably of the simplest possible construction is used. Preferably they consist of ordinary ejectors which have their vacuum or rarefying chambers placed in communication with the interiors of the radiators, or other chambers to be evacuated and the water for supplying each of these ejectors is taken from an elevated tank, the water for supplying the tank being taken from any desired primary source that will give it the necessary quantity. The ejector is incorporated at any convenient point in the pipe through which the water discharged from the tank flows. It may be incorporated in a waste pipe of one or more of the fixtures of the plumbing system of the building as shown at D′, or in the pipe through which the water flows from the elevated tank to one or more of the fixtures of the plumbing system at intervals of greater or less frequency as shown at D″, or in a pipe which extends from an elevated tank to a waste pipe and has no relation to any plumbing or similar fixture and whose sole function is to supply the ejector with the necessary current of water for producing the vacuum. In each of the first two instances the water is not diverted from its original purpose in the plumbing system, but in addition thereto supplies the ejector or ejectors and hence, in either instance, the ejector is operated and the partial vacuum produced within the radiators or chambers of other devices without any additional expense whatever. In the last instance the vacuum producer is auxiliary to the producers of the plumbing system and are called into use in cases of emergency. For example, when the quantity of water used in the fixtures of the plumbing system is not sufficient, due to infrequency of their use, or to their temporary disuse, as, for instance, over night, or Sundays, or holidays or other days when more or less vacuum is to be kept up, if the vacuum falls to the point of inadequacy for giving the necessary aid to circulation in the heating system, this auxiliary vacuum producer will operate. Or this so called auxiliary vacuum producer may be used alone, as for example in buildings which are already equipped with plumbing systems that are not provided with the vacuum producing feature, or even in buildings not yet constructed when it is not desired to equip the several fixtures with vacuum producers, or where the apparatuses are of such a nature that they do not require a supply of water. The water for supplying the tank of this auxiliary vacuum producer may be taken from an original source which is independent of the plumbing system as shown at G. If this supply of water for the auxiliary vacuum producer has to be pumped up to the necessary level, maintaining and running the

pump for doing so will entail a small cost and this cost will be the only additional expense incident to the use of the vacuum system, but, when the necessary supply of water for supplying the vacuum system can be had at the necessary level without cost of raising it thereto, the maintaining of the vacuum system will entail no additional expense and may advantageously be entirely separate from the plumbing system. In any event the supplying of water to the ejectors, and consequently the operation of the ejectors, is intermittent, or periodical and at either regular or irregular intervals. This is accomplished by providing each tank with a suitable valve or equivalent device, which when conditioned to permit the flow from the tank to commence will permit it to continue until the entire contents of the tank is discharged. Furthermore the starting of the discharge may be done either manually or automatically, and if automatically it may be controlled by the level of the water in the tank or the pressure in the vacuum system. For instance, the elevated tank shown at E for intermittently supplying flushing water to one or more plumbing fixtures F and the associated ejector is equipped with means, conventionally shown at *e*, for automatically discharging the contents of the tank when the water reaches a predetermined level therein and hence at practically regular intervals. An example of such an automatic periodically flushing tank is shown in Reissue Patent No. 11,215 granted December 29, 1891, to Murphy and Atkinson. The tank shown at E′ is equipped with manually operable means, conventionally shown at *e′* for discharging the contents at will. The elevated tank shown at E″ will be discharged and the ejector periodically operated automatically, at irregular intervals, by means such as shown in Fig. 3, the operation of which is controlled by the state of the vacuum in the system. Here the water supplied to the tank through a pipe, G, leading from a source independent of the plumbing system (or, if desired, from the same source as supplies the plumbing system), is maintained normally at a given level in the tank by float-controlled valve H. The normal level is slightly below the overflow bend of the siphon I of the discharge pipe I′, and this siphon is located in the main chamber I″. It is closed save for two openings, *i* and *i′* which communicate with an auxiliary or priming chamber *i″* which is located above the main chamber and is of sufficient capacity to contain a sufficient quantity of water to prime the siphon, when allowed to rapidly escape into the main chamber. The opening *i* is surrounded by a short tube which extends upward into the priming chamber and determines its holding capacity, and normal water level of the latter and when this level is reached the water overflows into the main chamber until the float therein rises and closes the valve of the supply pipe, G, which discharges into the priming chamber. The opening *i′* is controlled by a buoyant valve K which is preferably spherical and remains normally seated, but which rises from its seat when an additional volume of water is emptied into the priming chamber. This additional volume of water will escape into the main chamber and further compress the air which is trapped against the under side of the float valve K in a tube K′ which surrounds the opening *i′* and projects downward into the main chamber, thus producing upon the under side of the float valve K an upward pressure tending to unseat it. This tendency is augmented by the rising of the level of the water in the priming chamber above normal and the two forces combined unseat the float valve and cause it to rise from its seat, uncover the opening *i′* and permit the entire contents of the priming tank to rush into the main chamber and prime the siphon. The entire contents of the main chamber then passes down through the pipe I′ and operates the ejector D‴.

The vacuum producing chambers, L, of all of the ejectors, being the open chambers of whatever construction in which the air is rarefied by the suction produced in them by the water rushing past them, communicate with all of the radiators through a system of pipes M, and a storage tank N is preferably incorporated in this system. In each branch pipe of this system adjacent to each ejector is arranged a check valve O which seats inward, toward the system, so as to permit the air to be drawn out of the system by the ejectors, but prevents the admission of air to the system and supplying the vacuum, and in this way a partial vacuum is constantly maintained in all of the radiators. As before stated, if the quantity of water used in the plumbing system is not sufficient to maintain this vacuum and it falls below an effective state, this falling will automatically cause the contents of the tank E″ to be discharged and the vacuum will be restored to an effective state by the ejector D‴. This is done by carrying the open end M′ of the adjacent branch of the pipe M downward in a well which forms a part of the priming chamber *i″* and forms a stand-pipe of sufficient capacity to contain enough water to prime the siphon when it is allowed to fall back into the priming chamber. The opening at the top of this stand pipe, through which it communicates with the pipe M, is surrounded by a valve-seat and within the stand-pipe is a buoyant spherical valve P.

The vacuum in the system, when normal, will draw water out of the priming chamber and lift it up in the stand pipe until the valve P comes to its seat. Thereafter should the vacuum in the system fall below an efficient state, the water in the stand pipe will fall and allow the valve P to leave its seat and the entire column of water in the stand pipe will fall back rapidly and augment the water in the priming chamber. This additional volume of water will cause the valve K to be unseated and prime the siphon in the manner and with the results already described.

A pipe N′ leads from the storage tank N back to the bottom of the heater for carrying thereto all water of condensation which may accumulate in the vacuum system, and this pipe is provided with a check-valve O′ seating inward toward the system, so that the vacuum in the system can not draw water thereinto from the heater. The vacuum system may also communicate through the medium of branch pipes M″ with the insulating chambers Q of one or more refrigerators for aiding the efficiency thereof by maintaining a partial vacuum therein. The pipe may communicate with the insulating chamber of a refrigerator which is adapted to contain its own ice, as shown at Q′, and may be used as a master refrigerator only, having a coil *q* connected by pipes with the cooling coils *q′* of any desired number of local refrigerators; or it may communicate with the insulating chambers of a number of local refrigerators constructed as shown in Fig. 2 and adapted to contain their own ice; or it may communicate with the insulating chamber of a refrigerator such as is shown in Fig. 2 which may be used as both a master refrigerator and a local refrigerator.

The ejectors of the two forms shown differ in construction only in that in the form shown in Fig. 5 the vacuum producing chamber is formed by a web which is integral with the main body or shell of the ejector and is so located within it that it covers the opening with which the vacuum pipe communicates and extends downward and therefrom, while in the form shown in Fig. 3 the vacuum producing chamber is of tubular cross section, and is concentric with the shell of the ejector excepting at its upper portion where it bends and joins the shell around the opening with which the vacuum pipe communicates.

What I claim as new and desire to secure by Letters Patent is:

1. The combination with a device having a chamber to be evacuated, of an automatic vacuum system for producing and maintaining a partial vacuum in said chamber, the said vacuum system having an elevated tank or receptacle, an outlet pipe extending downward from the tank or receptacle to provide a hydrostatic column, the upper end of said pipe being open to atmospheric pressure, a vacuum producer having a vacuum chamber communicating with the outlet pipe at a level below the tank or receptacle and a pipe communicating with said vacuum chamber and the chamber to be evacuated.

2. The combination with a device having a chamber to be evacuated, of an automatic vacuum system for producing and maintaining a partial vacuum in said chamber, said vacuum system having an elevated tank or receptacle, an outlet pipe extending downward from the tank or receptacle to provide a hydrostatic column, the upper end of said pipe being open to atmospheric pressure, means for supplying the tank with water, means for starting the flow of water through said pipe, means for thereafter preventing the stopping of said flow until the water in the tank falls to a predetermined level, a vacuum producer having a vacuum chamber communicating with the outlet pipe aforesaid at a level below the tank, and a pipe communicating with said vacuum chamber and the chamber to be evacuated.

3. The combination with a device having a chamber to be evacuated, of an automatic vacuum system for producing and maintaining a partial vacuum in said chamber, said vacuum system having an elevated tank or receptacle, an outlet pipe extending downward from the tank or receptacle to provide a hydrostatic column, the upper end of said pipe being open to atmospheric pressure, means for starting the flow of water through said pipe, means for thereafter preventing the stopping of said flow until the water in the tank falls to a predetermined level, means for thereafter starting the flow of water, a vacuum producer having a vacuum chamber communicating with the outlet pipe at a level below the tank, and a pipe communicating with said vacuum chamber and with the chamber to be evacuated.

4. The combination with a device having a chamber to be evacuated, of an automatic vacuum system for producing and maintaining a partial vacuum in said chamber, said vacuum system, having an elevated tank or receptacle, an outlet pipe extending downward from the tank or receptacle to provide a hydrostatic column, the upper end of said pipe being open to atmospheric pressure, means for supplying the tank with water, means for starting the flow of water through said pipe, means for thereafter preventing the stopping of said flow until the water falls to a predetermined level in said tank, automatic means for thereafter again starting the flow of water, a vacuum producer having a vacuum chamber communicating with the outlet pipe at a level below the tank, and a pipe communicating with said vacuum chamber and the chamber to be evacuated.

5. The combination with a device having a chamber to be evacuated, of an automatic vacuum system, for producing and maintaining a partial vacuum in said chamber, said vacuum system having an elevated tank or receptacle, an outlet pipe extending downward from said tank or receptacle to provide a hydrostatic column, the upper end of said pipe being open to atmospheric pressure, means of supplying the pipe with water, means for causing water to flow through said pipe, a vacuum producer having a vacuum chamber communicating with said pipe at a level below the tank or receptacle, and a pipe communicating with said vacuum chamber and with the chamber to be evacuated.

6. The combination with a device having a chamber to be evacuated, of an automatic vacuum system for producing and maintaining a partial vacuum in said chamber, said vacuum system having an elevated tank or receptacle, an outlet pipe extending downward from the tank or receptacle to provide a hydrostatic column the upper end of said pipe being open to atmospheric pressure, means for supplying the tank with water, means for starting the flow of water through said pipe, means for thereafter preventing the stopping of said flow until the water in the tank falls to a predetermined level, a vacuum producer having a vacuum chamber communicating with the outlet pipe at a level below the tank, a pipe communicating with said vacuum chamber and the chamber to be evacuated, and automatic means for thereafter again starting the flow of water, said automatic means being under the control of the pressure in the vacuum system.

7. The combination with a plurality of devices having chambers to be evacuated and a plumbing system having a plurality of elevated tanks or receptacles, means for supplying them with water, outlet pipes extending downward from said tanks or receptacles, respectively, to provide hydrostatic columns, means for causing water to flow through said outlet pipes, and a vacuum system for producing and maintaining a partial vacuum in the chambers to be evacuated, said vacuum system having a number of vacuum chambers communicating with the outlet pipes, respectively, at levels below the tanks or receptacles, and a number of pipes communicating with one of said vacuum chambers and with a plurality of said chambers to be evacuated, whereby a flow of water through any of said outlet pipes will produce a partial vacuum in a plurality of said chambers to be evacuated.

8. The combination with a plurality of devices having chambers to be evacuated and a plumbing system having a number of fixtures and a number of elevated flushing tanks, outlet pipes extending downward from said tanks and communicating with said fixtures, providing for hydrostatic columns, means for starting the flow of water through said pipes, of a vacuum system for producing and maintaining a partial vacuum in the chambers to be evacuated, said vacuum system having a number of vacuum producers having vacuum producing chambers communicating with the discharge pipes at levels below the tanks, and pipes connecting a plurality of said vacuum producing chambers with the chambers to be evacuated, and an auxiliary vacuum producer having a vacuum chamber, an elevated tank or receptacle, an outlet pipe extending downward therefrom and with which the vacuum chamber communicates below the level of the tank or receptacle, a pipe communicating with said vacuum chamber and with the chambers to be evacuated, and means controlled by the pressure in the vacuum system for starting the flow of water through the auxiliary vacuum producer.

9. The combination with a plurality of devices having chambers to be evacuated and a plumbing system having a number of fixtures, a number of elevated flushing tanks, outlet pipes extending downward from the tanks for supplying the fixtures with water, said outlet pipes being adapted to provide hydrostatic columns, being open at their upper ends to atmospheric pressure, and means for causing water to flow through the outlet pipe of any given tank, of a vacuum system having vacuum chambers communicating with the outlet pipes below the tanks, and pipes connecting said vacuum chambers with the chambers to be evacuated, and an auxiliary vacuum producer having an elevated tank, an outlet pipe extending downward therefrom and providing for a hydrostatic column, a vacuum producer having a vacuum chamber communicating with said outlet pipe at a level below the tank, a pipe communicating with said vacuum chamber and with the chambers to be evacuated means for starting and stopping the flow of water through the outlet pipe, said starting and stopping means being controlled by the pressure in the vacuum system.

10. The combination with a device having a chamber to be evacuated, of a vacuum system for producing and maintaining a partial vacuum therein, said system having in combination a vacuum producer, consisting of an ejector having a vacuum chamber, a pipe communicating with the chamber to be evacuated and with the vacuum chamber, an elevated tank, an outlet pipe extending downward from said tank and communicating with the vacuum chamber

of the ejector, means for supplying the tank with water, means for automatically stopping said supply when the water in the tank rises to a predetermined level, means controlled by the pressure of the vacuum in the system for starting the flow of water from the tank and means for thereafter preventing the interruption of said flow until the water in the tank falls to a predetermined lower level.

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