Aug. 24, 1943. W. E. KENT 2,327,601

AIR VOLUME CONTROL

Filed March 12, 1942

Fig. 4.

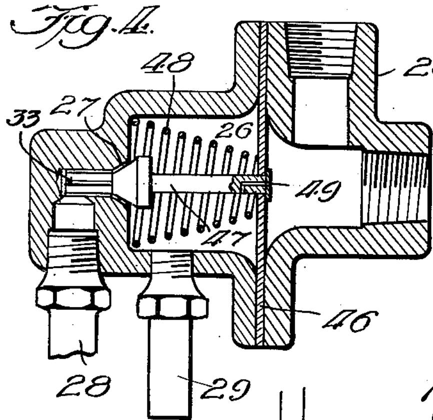


Fig. 1.

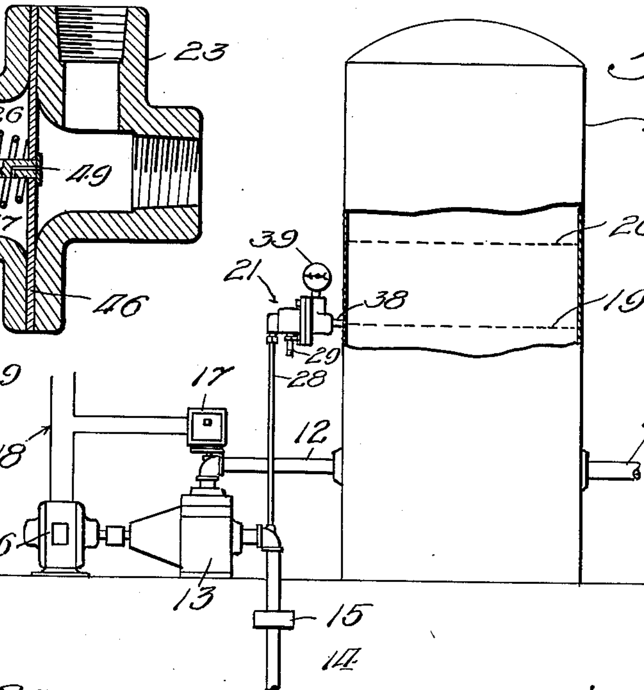


Fig. 2.

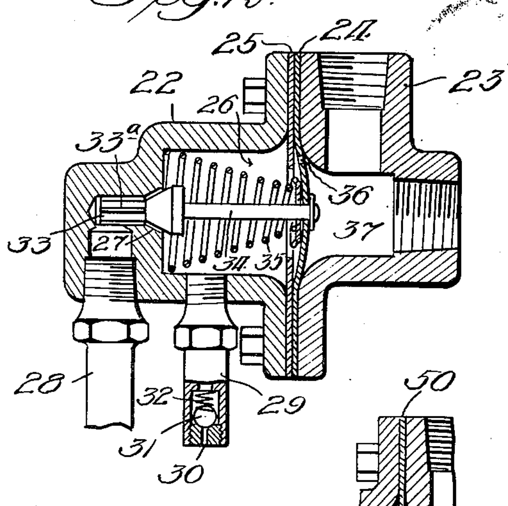


Fig. 3.

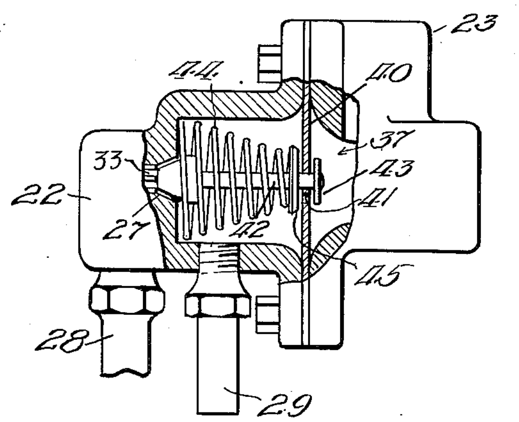
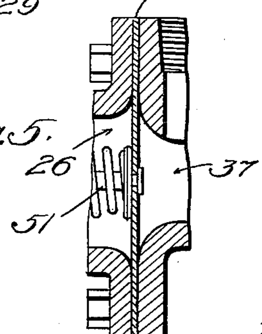


Fig. 5.



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AIR VOLUME CONTROL

Walter E. Kent, Decatur, Ill.

Application March 12, 1942, Serial No. 434,409

20 Claims. (Cl. 103—7)

My invention relates to automatic controls for self-contained water systems of the type in which distribution is effected by pressure established in the storage tank, as distinguished from gravity flow systems. Arrangements of this character are customarily used in country districts or in other locations which do not have access to central pumping stations.

Cardinal requirements of such a system are an automatic introduction of air into the storage tank and the maintaining of this air above a predetermined pressure over the surface of the water to insure adequate flow at the various outlets of the system. Failure to introduce air in proper amounts results in water logged tanks, sluggish distribution in the system, increased wear of the motor and pump, and higher operating costs. One objection to existing systems is that the air is forced into the tank at or near the shut-off pressure which is ordinarily of the order of forty pounds per square inch.

It is therefore one object of my invention to devise a fully automatic air control for introducing air into the storage tank at the allowable minimum tank pressure or a pressure close thereto, i. e., when the pump is operating at full capacity and highest efficiency.

A further object is to provide a control which automatically interrupts the flow of air into the tank at a pressure materially less than the shut-off pressure of the pump.

These and further objects of my invention will be set forth in the following specification, reference being had to the accompanying drawing, and the novel means by which said objects are effectuated will be definitely pointed out in the claims.

In the drawing:

Fig. 1 is an elevation showing a characteristic water system equipped with my automatic air control device.

Fig. 2 is a sectional elevation of the control shown in Fig. 1.

Figs. 3, 4 and 5 are similar elevations showing various modifications.

Referring to Figs. 1 and 2 of the drawing, the numeral 10 designates a pressure tank which supplies water to any desired number of outlets through a pipe 11 and to which water is delivered through a pipe 12 by means of a pump 13 connected to a suction pipe 14 that may extend into a well. The pipe 14 may include a check valve 15 and the pump 13 may be of any standard type provided that it is capable of pumping some air. The pump is driven by a motor 16 under the control of a pressure switch 17, as commonly used in systems of this character, which is electrically connected to the motor and to an electrical supply by a circuit 18.

The switch 17 is responsive to the pressure in the pipe 12 and while it may be adjusted to stop and start the motor at any desired pressure limits, it will be considered for purpose of example and not by way of limitation that the motor will start when the pressure in the tank falls to twenty pounds per square inch and will stop when the pressure in the tank reaches forty pounds per square inch. Water levels in the tank corresponding to these pressures, respectively, and with a normal air supply in the tank, are indicated by the numerals 19 and 20 in Fig. 1.

The control for automatically introducing air into the tank is designated by the numeral 21 in Fig. 1 and is shown in section in Fig. 2 to which reference will now be made. The control comprises abutting casing parts 22 and 23 between which are clamped a diaphragm 24 and a stiff plate 25 which defines with the casing part 22 a suction chamber 26. This chamber communicates through a port 27 with a pipe 28 which is connected to the suction pipe 14.

An air inlet nipple 29 is provided to permit under certain conditions the entrance of atmospheric air into the chamber 26 and its inlet end includes a passage 30 that is closed by a ball valve 31 under the impulse of a light spring 32, except when a partial vacuum is created in the chamber 26 as hereinafter described.

A valve 33 provided with guide ribs 33a is disposed in operative relation to the port 27 and is carried by one end of a stem 34 whose opposite end extends freely through the plate 25 for securement to the diaphragm 24. A spring 35 encircles the stem 34 with its opposite ends abutting the casing part 22 and diaphragm 24, respectively, and acts to maintain the valve 33 in the open position and the diaphragm in the bowed position as shown. The free portion of the diaphragm includes an aperture 36 which may be of any desired size, depending upon the conditions of operation, but which in any case provides a restricted means of communication between the chamber 26 and a chamber 37 in the casing part 23. Under the specific conditions assumed herein, the diameter of the aperture may be of the order of 3/64". The chamber 37 connects through a pipe 38 with the tank preferably at the low pressure water level 19 and a pressure gage 39 may be mounted on the part 23 to indicate tank pressures.

In describing the operation of my improved control and system, it will be assumed that the pump 13 is not running. The pressures in the chambers 26 and 37 are then equalized so that the valve 33 is held open by the spring and the diaphragm occupies the bowed position shown in Fig. 2, i. e., the aperture 36 is not masked by the plate 25.

When the tank pressure falls to twenty pounds, the pressure switch 17 closes and the pump 13 begins operating, drawing water through the pipe 14 and delivering it to the tank by way of the pipe 12. The pump establishes a partial vacuum in the chamber 26 which tends to unseat the valve 31 and permit a flow of atmospheric air into the system, but whether this condition results depends upon the location of the water level in the tank when the pump starts. If this level is substantially as indicated by the numeral 19, i. e., below the aperture 36, no partial vacuum will be created in the chamber 26, because air flowing through the aperture will break the suction in the chamber 26 and will be recirculated by the pump back to the tank. The ball 31 remains seated during this period.

However, if the water level in the tank is above the aperture 36 when the pump starts, the flow of water through the aperture from the tank is insufficient by reason of its restricted area to destroy the partial vacuum in the chamber 26, so that the valve 31 is pulled open and air is drawn into the system from the atmosphere.

The loading applied by the spring 35 to the diaphragm is preferably such that when a tank pressure of twenty-three or twenty-four pounds is reached, the diaphragm 24 is flexed to the left to close the valve 33 and to also mask the aperture 36 by the plate 25. This action occurs in either of the above two modes of operation and the valve 33 remains closed until the pump is stopped by the establishment of the high pressure limit in the tank. When the pump stops, the pressure in the control equalizes on both sides of the diaphragm, whereupon the spring 35 opens the valve 33 in preparation for the next cycle.

It will be particularly noted that the air is introduced into the system within a tank pressure range of twenty to twenty-four pounds, or generally at a pressure substantially closer to the low tank pressure than to the high, that is, during the period when the pump is operating at the fullest capacity and highest efficiency. Such an arrangement contrasts advantageously with other types of systems in which the air is introduced at or near the high pressure limit.

In Fig. 3 is illustrated a modification of the control wherein the diaphragm is eliminated in favor of a stiff plate 40 which is clamped between the casing parts 22 and 23 and includes an aperture 41 corresponding in size and function to the aperture 36. As before, the valve 33 is operably related to the port 27 and is mounted on one end of a stem 42 whose opposite end extends slidably through the plate 40 for securement to a head 43 which is exposed to the tank pressure in the chamber 37 and is positioned to mask the aperture 41 at a predetermined pressure in the chamber 37. The valve 33 is biased to an open position and the head 43 to an unmasking position by a spring 44 whose opposite ends abut, respectively, an interior wall of the casing part 22 and a washer 45 fixed to the stem 42. Otherwise, this form of the control is identical with that illustrated in Fig. 2 and its operation is similar in that, when the pump is started, the creation of a partial vacuum in the chamber 26 depends upon the relation of the water level in the tank to the aperture 41. Above a tank pressure of twenty-three or twenty-four pounds, the head 43 is moved towards the left to close the valve 33 and mask the aperture 41, the spring 44 being sized in relation to the area of the head 43 to accomplish this result. When the pump stops, pressure is equalized in the chambers 26 and 37 whereupon the valve 33 and head are moved to the open positions shown by the spring 44.

The modification shown in Fig. 4 is in many respects the most preferable. This structure utilizes a diaphragm 46 to which is secured one end of a valve stem 47 whose opposite end carries the usual valve 33 for controlling flow through the port 27. As in the other forms, the valve 33 is biased to an open position by a spring 48 whose ends abut the casing part 22 and the diaphragm 46. An aperture 49, corresponding in size and function to the previously noted apertures, is provided in the stem 47 to establish a restricted means of communication between the chambers 26 and 37. The operation of this device is the same as that illustrated in Fig. 2, the difference being that the aperture 49 is always open. In this form, the aperture 49 could be located in the diaphragm, if desired.

In Fig. 5 which shows only a portion of a still further modification, the arrangement and operation is identical with the form shown in Fig. 4, except that an aperture is not provided in either the diaphragm 50 or the valve stem 51. Hence, there is no direct communication between the chambers 26 and 37 and it would be necessary to use a relief valve (not shown) with the tank to periodically discharge excess air.

I claim:

1. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, and a movable member connected to the valve and responsive to a predetermined tank pressure for closing the valve.

2. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a movable member connected to the valve and responsive to a predetermined tank pressure for closing the valve, and spring means interposed between the casing and member and operative to hold the valve open below said pressure.

3. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a diaphragm connected to

the valve and exposed on one side to the tank pressure and on the opposite side to the suction pressure, and spring means interposed between the casing and diaphragm and operative to hold the valve open below a predetermined tank pressure and yielding to permit the closing of the valve by the diaphragm at said pressure.

4. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, and a movable member connected to the valve having an aperture providing a restricted means of communication between the suction chamber and tank and responsive to a predetermined tank pressure for closing the valve.

5. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, and a movable member connected to the valve having an aperture providing a restricted means of communication between the suction chamber and tank and responsive to a predetermined tank pressure for closing the valve, the aperture being sized to admit liquid from the tank in a quantity insufficient to destroy the suction in the suction chamber when the liquid in the tank is at an elevation above the aperture and air from the tank to relieve the suction when the liquid in the tank is at the same elevation as or below the aperture.

6. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a diaphragm connected to the valve and having an aperture providing a restricted means of communication between the suction chamber and tank, the aperture being sized to admit liquid from the tank in a quantity insufficient to destroy the suction in the suction chamber when the liquid in the tank is at an elevation above the aperture and air from the tank to relieve the suction when the liquid in the tank is at the same elevation as or below the aperture, and spring means interposed between the casing and diaphragm and operative to hold the valve open below a predetermined tank pressure and yielding to permit the closing of the valve by the diaphragm at said pressure.

7. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a diaphragm connected to the valve and having an aperture providing a restricted means of communication between the suction chamber and tank, the aperture being sized to admit liquid from the tank in a quantity insufficient to destroy the suction in the suction chamber when the liquid in the tank is at an elevation above the aperture and air from the tank to break the suction when the liquid in the tank is at the same elevation as or below the aperture, spring means interposed between the casing and diaphragm and operative to hold the valve open below a predetermined tank pressure and yielding to permit the closing of the valve by the diaphragm at said pressure, and closure means overlying the aperture when the diaphragm is flexed to close the valve.

8. In a liquid pressure system, the combination of a tank, a pump for supplying liquid under pressure to the tank, means for starting and stopping the pump at predetermined minimum and maximum tank pressures, respectively, a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a passage including a restricted portion connecting the chamber with the tank substantially at the low pressure liquid level, the portion being sized to admit liquid from the tank in a quantity insufficient to destroy the suction in the suction chamber when the liquid in the tank is at an elevation above the portion and air from the tank to break the suction when the liquid in the tank is at the same elevation as or below the portion, and means including the valve responsive to a tank pressure substantially less than the maximum tank pressure for interrupting the air supply.

9. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a wall portion separating the chamber from a passage communicating with the tank, a movable member exposed to the tank pressure in the passage and connected to the valve, and spring means abutting the casing and connected to the valve, the spring means being operative to hold the valve open below a predetermined tank pressure and yielding to permit the closing of the valve by the member at said pressure.

10. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a wall portion separating the chamber from a passage communicating with the tank and having an aperture providing a restricted means of communication between the chamber and passage, the aperture being sized to admit liquid from the tank in a quantity insufficient to destroy the suction in the suction chamber when the liquid in the tank is at an elevation above the aperture and air from the tank to relieve the suction when the liquid in the tank is at the same elevation as or

below the aperture, a movable member extending through the wall portion for exposure to the tank pressure in the passage and connected to the valve, and spring means abutting the casing and connected to the valve, the spring means being operative to hold the valve open below a predetermined tank pressure and yielding to permit the closing of the valve by the member at said pressure.

11. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a passage including a portion providing a restricted means of communication between the suction chamber and tank, and means connected to the valve and responsive to a predetermined tank pressure for closing the valve.

12. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a passage including a portion providing a restricted means of communication between the suction chamber and tank, the portion being sized to admit liquid from the tank in a quantity insufficient to destroy the suction in the chamber when the liquid in the tank is at an elevation above the portion and air from the tank to relieve the suction when the liquid in the tank is at the same elevation as or below the portion, and means connected to the valve and responsive to a predetermined tank pressure for closing the valve.

13. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a diaphragm connected to the valve, a passage including a portion providing a restricted means of communication between the chamber and tank, the portion being sized to admit liquid from the tank in a quantity insufficient to destroy the suction in the chamber when the liquid in the tank is at an elevation above the portion and air from the tank to relieve the suction when the liquid in the tank is at the same elevation as or below the portion, and spring means interposed between the casing and diaphragm and operative to hold the valve open below a predetermined tank pressure and yielding to permit the closing of the valve by the diaphragm at said pressure.

14. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a passage including a portion providing a restricted means of communication between the chamber and tank, the portion being sized to admit liquid from the tank in a quantity insufficient to destroy the suction in the chamber when the liquid in the tank is at an elevation above the portion and air from the tank to break the suction when the liquid in the tank is at the same elevation as or below the portion, spring means interposed between the casing and valve and operative to hold the valve open below a predetermined tank pressure and yielding to permit the closing of the valve at said pressure, and closure means connected to the valve and exposed to the tank pressure and adapted to overlie the portion when the valve is closed.

15. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, and a movable member connected to the valve and responsive to a predetermined tank pressure for closing the valve, the member being biased to a position opening the valve below said pressure.

16. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, and a diaphragm connected to the valve and exposed on one side to the tank pressure and on the opposite side to the suction pressure, the diaphragm closing the valve at a predetermined tank pressure and biased to a position opening the valve below said pressure.

17. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, and a diaphragm connected to the valve and having an aperture providing a restricted means of communication between the chamber and tank, the aperture being sized to admit liquid from the tank in a quantity insufficient to destroy the suction in the chamber when the liquid in the tank is at an elevation above the aperture and air from the tank to relieve the suction when the liquid in the tank is at the same elevation as or below the aperture, the diaphragm closing the valve at a predetermined tank pressure and biased to a position opening the valve below said pressure

18. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a diaphragm connected to the valve and having an aperture

providing a restricted means of communication between the chamber and tank, the aperture being sized to admit liquid from the tank in a quantity insufficient to destroy the suction in the chamber when the liquid in the tank is at an elevation above the aperture and air from the tank to break the suction when the liquid in the tank is at the same elevation as or below the aperture, the diaphragm closing the valve at a predetermined tank pressure and biased to a position opening the valve below said pressure, and closure means overlying the aperture when the diaphragm is flexed to close the valve.

19. An air volume control for a liquid system having a tank for storing the liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a wall portion separating the chamber from a passage communicating with the tank, and a movable member exposed to the tank pressure and connected to the valve, the member closing the valve at a predetermined tank pressure and biased to a position opening the valve below said pressure.

20. An air volume control for a liquid system having a tank for storing liquid under pressure and a pump for supplying liquid to the tank comprising a casing provided with a suction chamber having an outlet port communicating with the pump and an air inlet, the inlet being open when a suction is established in the chamber and closed at all other times, a valve for controlling flow through the port, a wall portion separating the chamber from a passage communicating with the tank and having an aperture providing a restricted means of communication between the chamber and passage, the aperture being sized to admit liquid from the tank in a quantity insufficient to destroy the suction in the chamber when the liquid in the tank is at an elevation above the aperture and air from the tank to relieve the suction when the liquid in the tank is at the same elevation as or below the aperture, and a movable member extending through the wall portion for exposure to the tank pressure and connected to the valve, the member closing the valve at a predetermined tank pressure and biased to a position opening the valve below said pressure.

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